NCF-Envirothon 2024 New York

Current Issue Part A Study Resources

Key Topic #4: Global Perspectives on Renewable Energy

15. Describe the landscape of renewable energy across various regions of the world, including strengths and challenges.
16. Explain the barriers to transitioning to renewable energy and identify solutions to these barriers.
17. Evaluate the effectiveness of different approaches to renewable energy given varying environmental, social, and economic conditions.
18. Explain the roles of economic and political policy, public perception, community advocacy, and scientific advancements in a successful transition to renewable energy.

Study Resources

Study Resources begin on the next page! ➡

Five Ways to Jump-Start the Renewable Energy Transition Now

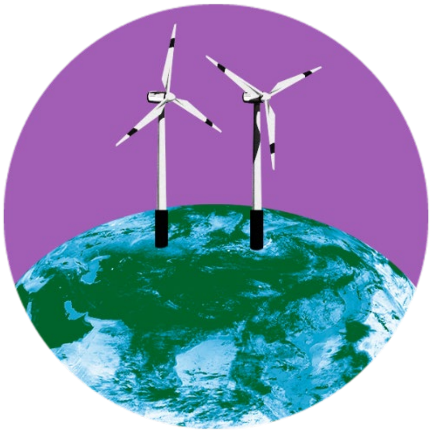
United Nations, 2023

Four key climate change indicators – greenhouse gas concentrations, sea level rise, ocean heat and ocean acidification – set new records in 2021. This is yet another clear sign that human activities are causing planetary-scale changes on land, in the ocean, and in the atmosphere, with dramatic and long-lasting ramifications.

The key to tackling this crisis is to end our reliance on energy generated from fossil fuels - the main cause of climate change.

"The good news is that the lifeline is right in front of us," says UN Secretary-General António Guterres, stressing that renewable energy technologies like wind and solar already exist today, and in most cases, are cheaper than coal and other fossil fuels. We now need to put them to work, urgently, at scale and speed.

The Secretary-General outlines five critical actions the world needs to prioritize now to transform our energy systems and speed up the shift to renewable energy - "because without renewables, there can be no future."



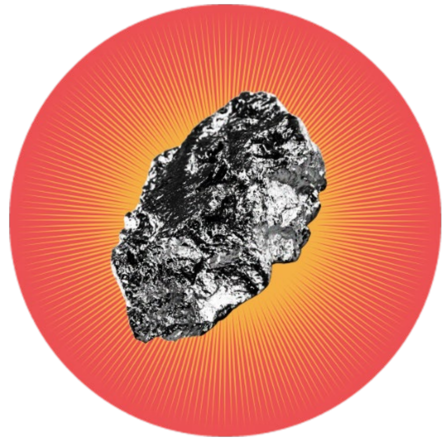
Make renewable energy technology a global public good

For renewable energy technology to be a global public good - meaning available to all, and not just to the wealthy - it will be essential to remove roadblocks to knowledge sharing and technological transfer, including intellectual property rights barriers.

Essential technologies such as battery storage systems allow energy from renewables, like solar and wind, to be stored and released when people, communities and businesses need power. They help to increase energy system flexibility due to their unique capability to quickly absorb, hold and re-inject electricity, says the International Renewable Energy Agency.

Moreover, when paired with renewable generators, battery storage technologies can provide reliable and cheaper electricity in isolated grids and to off-grid communities in remote locations.

Improve global access to components and raw materials



A robust supply of renewable energy components and raw materials is essential. More widespread access to all the key components and materials - from the minerals needed to produce wind turbines and electricity networks, to electric vehicles - will be key.

It will take significant international coordination to expand and diversify manufacturing capacity globally. Moreover, greater investments are needed to ensure a just transition - including in people's skills training, research and innovation, and incentives to build supply chains through sustainable practices that protect ecosystems and cultures.

Level the playing field for renewable energy technologies

While global cooperation and coordination is critical, domestic policy frameworks must urgently be reformed to streamline and fast-track renewable energy projects and catalyze private sector investments.

Technology, capacity and funds for renewable energy transition exist, but there needs to be policies and processes in place to reduce market risk and enable and incentivize investments - including through streamlining the planning, permitting and regulatory processes, and preventing bottlenecks and red tape. This could include allocating space to enable large-scale build-outs in special Renewable Energy Zones.

Nationally Determined Contributions, countries' individual climate action plans to cut emissions and adapt to climate impacts, must set 1.5C aligned renewable energy targets - and the share of renewables in global electricity generation must increase from today's 29 percent to 60 percent by 2030.

Clear and robust policies, transparent processes, public support and the availability of modern energy transmission systems are key to accelerating the uptake of wind and solar energy technologies.

Shift energy subsidies from fossil fuels to renewable energy

Fossil-fuel subsidies are one of the biggest financial barriers hampering the world's shift to renewable energy. The International Monetary Fund (IMF) says that about $5.9 trillion was spent on subsidizing the fossil fuel industry in 2020 alone, including through explicit subsidies, tax breaks, and health and environmental damages that were not priced into the cost of fossil fuels. That's roughly $11 billion a day.

Fossil fuel subsidies are both inefficient and inequitable. Across developing countries, about half of the public resources spent to support fossil fuel consumption benefits the richest 20 percent of the population, according to the IMF.

Shifting subsidies from fossil fuels to renewable energy not only cuts emissions, it also contributes to the sustainable economic growth, job creation, better public health and more equality, particularly for the poor and most vulnerable communities around the world.

Triple investments in renewables

At least $4 trillion a year needs to be invested in renewable energy until 2030 – including investments in technology and infrastructure – to allow us to reach net-zero emissions by 2050.

Not nearly as high as yearly fossil fuel subsidies, this investment will pay off. The reduction of pollution and climate impact alone could save the world up to $4.2 trillion per year by 2030.

The funding is there - what is needed is commitment and accountability, particularly from the global financial systems, including multilateral development banks and other public and private financial institutions, that must align their lending portfolios towards accelerating the renewable energy transition.

In the Secretary-General's words, "renewables are the only path to real energy security, stable power prices and sustainable employment opportunities."

1. Introduction

The world's population is growing at an unprecedented rate and that has necessitated a dramatic increase in energy demand globally. Matching supply with this surging demand is a principal and critical challenge for countries around the world. Currently, this demand is being met through the increased use of fossil fuels. The majority of the world's power is generated from the use of coal, oil and gas. These so-called fossil fuels, when burned, release heat energy which is then converted into electricity releasing into the atmosphere a lot of carbon dioxide (CO2), a greenhouse gas that contributes to the issue of global warming. A renewable energy supply offers a solution to both challenges. For economic growth and human advancement, energy has always been universally considered one of the most crucial measures (Rawat and Sauni, 2015). There is a three-dimensional relationship alongside a bi-directional causal relationship between economy, the environment and energy (Azad et al., 2014).

Globally, the population is growing at fast rate; however, the world's energy demand is likely to grow even more rapidly than the increase in the population. According to International Energy Outlook (2013), global energy demand will be increased by 56 per cent between 2010 and 2040 (Azad et al., 2014). Currently, the majority of the world's energy consumption is satisfied by consuming energy created using fossil fuels. To satisfy the ever-increasing energy demand and to protect the climate, break-through advancements have been made in the past to design technologies that can control and harness power from alternative energy sources. As controlling carbon emissions is critical in dealing with climate change, renewable energy is an appropriate way to satisfy energy demand without degrading the ecosystem (Jing, 2016). Apart from bringing environmental sustainability, renewable energy offers another advantage—the ability to provide power to even the most underprivileged people living in the remotest areas where traditional power is not yet available (Rawat and Sauni, 2015).

Awareness of the need to encourage deployment of renewable energy has increased drastically in recent years. More countries, whether developed or developing, are promoting and changing policies to promote the deployment of renewable energy. In 2005, only 55 countries had taken steps to make renewable targets and create policies supporting renewable energy. This number had increased to 144 countries by 2013, with almost all the world understanding the need to reduce carbon emissions.

2. Background

Despite remarkable promotion and commitment from various nations, only a small percentage of energy is generated from renewable energy, especially in developing countries. This scenario is because of the numerous barriers that control the diffusion

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of renewable energy. These barriers prevent renewable energy from effectively competing with traditional energy and hamper achievement of the necessary large-scale deployment (Nasirov et al., 2015). Penetration and scale-up of renewable require a strong political and regulatory framework which supports and promotes a continued focus on fossil fuels (Karatayev et al., 2016).

A review of the literature shows that many studies have been conducted to identify barriers to the use of renewable energy. However, very few studies have grouped these barriers and discussed the impact of these barriers in the deployment of renewable energy. The variables which were identified from the literature review for use in future research were *social barriers*, *economic barriers, technological barriers and* regulatory barriers.

The objective of this research is to discover the impacts of breaking barriers in the deployment of renewable energy. This research tries to resolve the following questions to reach a solution which is in line with the objective of this research:

a. What are the factors affecting the deployment of renewable energy and are they significant or not?
b. What impact will breaking barriers have on the deployment of renewable energy?
c. In the wake of breaking barriers, is Rogers' (2003) theory of diffusion (political and social) valid for renewable energy?

3. Theory

Theory of diffusion (technical, political & social) in the wake of breaking barriers.

Diffusion of innovation theory is one of the most important concepts in theorizing the changing format of energy provision, being concerned with the process of adoption of innovations by society (Lacerda et al., 2014). Rogers (1983: 11) defined diffusion as 'the process by which innovation is communicated through certain channels over time among members of a social system' and innovation as 'an idea, practice or object that is perceived as new by an individual or other unit of adoption' (Sahin, 2006). Other types of diffusion include social diffusion and theories of change, going back to Lewin's description of the need to alter group standards to promote lasting individual change (Lewin, 1951). The focus has since shifted towards external conditions that are likely to be more influential than group decisions (Darnton, 2008). Political diffusion deals with the spread of policies and governance approaches across jurisdictional boundaries which come about because of external pressures and/or internal pressures relating to quests for legitimacy (Weyland, 2005). More fundamentally, diffusion defines the often random movement of a

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characteristic. The theory of diffusion is used to understand the attitude and perception of people with regard to government policies.

4. Hypotheses

This literature review looks at the outcomes of penetration and deployment of renewable energy, which are affected by four major factors: social barriers, economic barriers, technological barriers and regulatory barriers.

4.1. Social barriers

The transition from conventional resources to renewable energy has encountered public resistance and opposition. This is due to a lack of awareness of the benefits of renewable energy, disruption of seascape, and acquisition of land which could have been used for agriculture, tourism, etc. (Goldsmiths, 2015).

Public awareness and information barriers: Sustainable development stems from the satisfaction of human desires, through socially recognized technological systems and suitable policies and regulatory tools (Paravantis et al., 2014). The main concerns with respect to public understanding are: 1) insufficient information regarding ecological and financial benefits; 2) inadequate awareness of renewable energy technologies (RET); and 3) uncertainties about the financial feasibility of RE installation projects (Nasirov et al., 2015).

Not in my backyard' (NIMBY) syndrome: According to NIMBY syndrome, people do support renewable energy generally, but not in their own neighbourhood. Renewable power project proposals often face opposition from individual citizens, political leaders, grassroots organizations, national interest groups and, in some cases, even environmental groups (Jianjun and Chen, 2014). Public opposition occurs for a number of reasons, including landscape impact, environmental degradation and lack of consultation concerns among local communities (Nasirov et al., 2015).

Loss of other/alternative income: A major issue with renewable plants (especially solar and wind farms) is the vast area of land required to produce an amount of energy equivalent to that which can be produced from a small coal fire power plant (Chauhan and Saini, 2015).

To make a significant contribution to global energy consumption, there is a need to develop large scale renewable energy plants, but this requires vast areas of countryside. Enormous parts of the countryside, which includes farmland, need to be converted into buildings or roads or any other infrastructure to support a renewable energy power plant. In achieving this, often agriculture, tourism, fishing, etc. can be affected (Nesamalar et al., 2017).

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Lack of experienced professionals: Universal transition from fossil fuels to renewable energy sources requires the solid foundation of a skilled labour force. There is huge demand for skilled professionals to design, build, operate and maintain a renewable energy plant.

Incompetent technical professionals and lack of training institutes prevent renewable energy technologies from scaling new heights (Ansari et al., 2016). There is a need to teach renewable energy courses and for proper training to be conducted to develop the skills required to install and operate renewable energy projects. The shortage of trained workforce to design, finance, build, operate and maintain renewable energy projects is considered a major obstacle to the wide penetration of renewable energy (Karakaya and Sriwannawit, 2015).

H1: Social barriers have a significant influence on the deployment of renewable energy.

H2: Social barriers have a significant influence on economic barriers.

4.2. Economic barriers

Factors influencing economic and financial barriers are high initial capital, lack of financial institutes, lack of investors, competition from fossil fuels, and fewer subsidies compared to traditional fuel (Raza et al., 2015). These factors have prevented renewable energy from becoming widespread.

Tough competition from fossil fuel: Fossil fuels will remain a dominant player in supplying energy in the future. A report by EIA's International Energy Outlook (2016) suggests that fossil fuels (oil, natural gas and coal) are expected to supply 78 per cent of the global energy used in 2040. Investment in fossil fuels (including supply and power generation) still accounts for 55 per cent of 2016 global energy investment, compared with 16 per cent for renewable energy. Coal is still a dominant fuel source in most counties because of its abundance, which makes it cheap and accessible (Dulal et al., 2013). There have been huge changes in energy since summer 2014. Oil, as measured by the Brent crude contract, which was priced at $115.71/barrel in June 2014, fell to $27.10 on 20 January 2016, a huge drop of 76 per cent. Similarly, the ARA coal contract dropped from $84/tonne in April 2014 to $36.30 in February 2016. There was a huge decline in the price of natural gas, which slid from around $4.50/MMBtu in June 2014 to $1.91 in mid-February 2016. Due to falling prices and fossil fuel still emerging as a cheaper alternative to renewable energy, it is able to offer tough competition to renewable energy projects.

Government grants and subsidies: The amount of government subsidies provided to conventional energy is much higher than the subsidies awarded to renewable energy.

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This keeps renewable energy at a disadvantage. The subsidies provided by governments to generate electricity from fossil fuel sources is overshadowing the wide use of low emission technologies. For example, coal companies in Australia and Indonesia still receive government subsidies for mining and exploration (Dulal et al., 2013).

Fewer financing institutions: Renewable energy developers and producers face severe difficulties in securing financing for projects at rates which are as low as are made available for fossil fuel energy projects (Ansari et al., 2016). There are limited financial instruments and organizations for renewable project financing. This reflects that the investments are considered somewhat risky, thus demotivating investors (Ohunakin et al., 2014).

High initial capital cost: Renewable energy projects require high initial capital cost and, because of the lower efficiency of renewable technology, the net pay back period is high, which in turn pushes investors on to the back foot (Ansari et al., 2016). Both the users and the manufacturers may have very low capital and to install a plant they require capital financing. This problem is further highlighted by the strict lending measures that restrict access to financing even when funding is available for traditional energy projects (Suzuki, 2013). High cost of capital, often lack of capital and most important with high payback period projects often becomes un-viable (Painuly. J, 2001).

Intangible costs: Currently, in almost all countries, the total cost of fuel includes the cost of exploration, production, distribution and usage, but it does not include the cost of the damage it does to the environment and society. Despite severe effects on health and on the atmosphere, the unseen costs (externalities) which are connected with traditional fuels are not included in their price (Arnold, 2015). Understanding these impacts is essential for evaluating the actual cost of utilizing fossil fuels for energy generation.

H3: Economic barriers have a significant influence on the deployment of renewable energy.

4.3. Technological barriers

There are a number of legitimate technological barriers to the widespread deployment of renewable energy, including limited availability of infrastructure, inefficient knowledge of operations and maintenance, insufficient research and development initiatives, and technical complexities like energy storage and unavailability of standards (Zhao et al., 2016).

Limited availability of infrastructure and facilities: There is limited availability of advanced technologies required for renewable energy, especially in developing

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countries, which acts as a factor preventing penetration of renewable energy. Even if this technology is available, the cost of procuring it is very high (Dulal et al., 2013). Since renewable energy power plants are mostly placed in remote locations, they require additional transmission lines to connect to the main grid. Since most of the existing grids are not designed to integrate with renewable energy, these existing grids need to be upgraded or modified (Izadbakhsh et al., 2015). Grid integration is amongst the biggest problems affecting the development of renewable energy projects.

Lack of operation and maintenance culture: Since renewable energy technology is comparatively new and not optimally developed, there is a lack of knowledge about operation and maintenance. Efficiency cannot be achieved if a plant is not optimally operated and if maintenance is not carried out regularly (Sen and Bhattacharyya, 2014). Lack of availability of equipment, components and spare parts will require a substantial increase in the production costs, as these items need to be imported from other countries, therefore being procured at high prices and so increasing the overall cost (Bhandari et al., 2015).

Lack of research and development (R&D) capabilities: Investment in research and development (R&D) is insufficient to make renewable energies commercially competitive with fossil fuel. Both governments and energy firms shy away from spending on R&D as renewable energy is in its development stage and risks related to this technology are high (Cho et al., 2013).

Technology complexities: There are not enough standards, procedures and guidelines in renewable energy technologies in terms of durability, reliability, performance, etc. This prevents renewable energy from achieving large scale commercialization (Nasirov et al., 2015). A major technical issue which renewable energy is facing today is the storage of energy. The supply of sun or wind is not continuous despite their infinite abundance and electricity grids cannot operate unless they are able to balance supply and demand. To resolve these issue, large batteries need to be developed which can compensate for the times when a renewable resource is not available (Weitemeyer et al., 2014).

H4: Technological barriers have a significant influence on the deployment of renewable energy.

H5: Technological barriers have a significant influence on economic barriers.

4.4. Regulatory barriers

Factors like lack of national policies, bureaucratic and administrative hurdles, inadequate incentives, impractical government targets, and lack of standards and

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certifications have prevented renewable energy from expanding dramatically (Stokes, 2013).

Ineffective policies by government: Strong regulatory policies within the energy industry are not only required for a nation's sustainable development, but also resolve the inconsistency between renewable and non-renewable energy. Lack of effective policies creates confusion among various departments over the implementation of the subsidies. Major issues such as unstable energy policy, insufficient confidence in RET, absence of policies to integrate RET with the global market and inadequately equipped governmental agencies act as barriers to the deployment of renewable energy projects (Zhang et al., 2014).

Inadequate fiscal incentives: There have not been enough measures by governments to remove tax on imports of the equipment and parts required for renewable energy plants. Feed-in tariffs are the measures by which governments aim to subsidize renewable energy sources to make them cost-competitive with fossil fuel-based technologies, but the absence of these adequate financial incentives results in high costs that hinder the industry's development, operation and maintenance, and stagnate the future (Sun and Nie, 2015).

Administrative and bureaucratic complexities: Obstacles arising in the deployment of renewable energy projects are manifold, including (and not limited to) administrative hurdles such as planning delays and restrictions. Lack of coordination between different authorities and long lead times in obtaining authorization unnecessarily increase the timeline for the development phase of the project. Higher costs are also associated with obtaining permission due to lobbying. All these factors prolong the project start-up period and reduce the motivation required to invest in renewable energy (Ahlborg & Hammar, 2014).

Impractical government commitments: There is a gap between the policy targets set by governments and the actual results executed by implementation (Goldsmiths, 2015). There is a lack of understanding of a realistic target and loopholes in the implementation process itself. The responsibility for overcoming these commitment issues lies with governments. Policies should be devised that can offer clear insight into important legislation and regulatory issues so that the industry can be promoted as stable and offering growth. Governments can fix this mismatch by becoming more responsive and reactive.

Lack of standards and certifications: Standards and certificates are required to ensure that the equipment and parts manufactured or procured from overseas are in alignment with the standards of the importing company. These certifications make sure that companies are operating the plant in compliance with local law. Absence of such standards creates confusion and energy producers have to face unnecessary difficulties (Emodi et al., 2014).

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H6: Regulatory barriers have a significant influence on the deployment of renewable energy.

H7: Regulatory barriers have a significant influence on economic barriers.

4.5. Breaking barriers in deployment of renewable energy

Deployment of renewable energy is crucial not only to meet energy demands but also to address concerns about climate change (Byrnes et al., 2013). However, the barriers (social, economic, technological and regulatory) existing in this sector prevents the development and penetration of renewable energy globally.

User-friendly procedures: Bureaucratic procedures in the deployment of renewable energy are considered the biggest hindrance, and this demotivates investors and entrepreneurs from entering and investing in renewable energy. Government policies are not aligned at national and state level, thus failing to attract energy sector investment (Nesamalar et al., 2017). Countries with excessively complicated administrative procedures have less penetration of renewable energy compared to countries with simple and straightforward procedures (Huang et al., 2013).

Higher stakeholder satisfaction: Energy is the backbone of the socioeconomic development of any country (Raza et al., 2015). By utilizing more renewable energy resources, nations can help fulfil energy deficiencies without damaging nature. The repercussions of this change would be the creation of more jobs in the designing, building, operation and maintenance of renewable energy project infrastructures. Higher levels of diffusion will help to achieve economies of scale, and that will bring down the costs and thus the price for the end user. This will improve investors' confidence and will trigger increased investments in renewable energy projects. Higher benefits can be reaped from the availability of green energy as there will not be severe environmental implications, and that can help in maintaining the earth's ecosystem.

Successful research and development (R&D) ventures: In a study conducted by Halabi et al. (2015), it was pointed out that technological advancement to effectively generate, store and distribute renewable energy at lower costs is crucial. However, compared to conventional energy, insufficient R&D initiatives are undertaken. This is due to fact that organizations are unable to earn beneficial returns from R&D, and that makes the future of these initiatives look dull.

Cost savings: The biggest challenge that renewable energy faces is the competition from low cost fossil fuels (El-katiri, 2014). Renewable energy projects require huge land areas to produce the amount of energy which a conventional plant can produce in a small area. Prohibitive costs are involved in establishing and running renewable energy projects, mainly due to the huge financial capital required to acquire a

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A Just Transition to Renewable Energy in Africa

South Africa's plan could be a roadmap for countries transitioning from high-polluting energy sources to renewables

From Africa Renewal – United Nations: November 2022

By: Kingsley Ighobor

Wind turbines in the Sinai Desert, Hurghada, Egypt

The President of the African Development Bank (AfDB) Akinwumi Adesina has a nuanced view of what a just transition to renewable energy means for Africa. He believes it should be pragmatic and sensitive to Africa's development reality but not antithetical to the commitments of net zero greenhouse gas emissions.

In an interview with Africa Renewal ahead of COP27, which is scheduled for 6-18 November in Sharm El-Sheikh, Egypt, Mr. Adesina says that Africa, in the short term, needs to tap a range of energy sources — wind, solar, geothermal and gas.

His rationale? About 600 million Africans, about half the continent's population, lack access to electricity; some 900 million have no access to clean cooking fuels and technologies.

"African countries need space to industrialize, and the energy mix that will allow them to do that is fundamental," he insists, preferring an incremental, rather than a leapfrog approach toward renewables.

“We shouldn’t get ourselves confused,” he cautions. “Moving from coal to gas will reduce emissions in Africa by 40 per cent and pivoting from fuelwood to gas for cooking will reduce emissions significantly.”

In addition, he emphasizes that geopolitical factors, such as the war in Ukraine and its impact on global oil prices put “Europe in a serious situation with energy security…I think Africa should become a major supplier of gas to help energy security in Europe.”

At the same time, Mr. Adesina, who is considered a top African development expert, underscores the AfDB’s renewable energy bona fides.

“Don't get me wrong,” he maintains. “We're doing flat-out everything to get to renewables, but we must be realistic. Wind and solar are highly variable [in Africa]. Africa does not have nuclear power. Even hydro is no longer reliable because of droughts and low water levels.

“And by the way, when people talk about emissions, if Africa were to triple the use of natural gas for energy generation, it will contribute 0.67 per cent to global emissions.”

African Common Position

Mr. Adesina unsurprisingly echoes the African Common Position on Energy Access and Just Energy Transition adopted on 22 July 2022 by the African Union (AU) Executive Council.

The common position states that “Africa will continue to deploy all forms of its abundant energy resources, including renewable and non-renewable energy to address energy demand.”

It dichotomizes energy needs, with gas, green and low-carbon hydrogen and nuclear energy preferred for the short-to-medium term and mostly renewables for the long-term.

Amani Abou-Zeid, AU Commissioner for Infrastructure and Energy, contends that Africa has a right to a “differentiated path towards the goal of universal access to energy, ensuring energy security for our continent and strengthening its resilience, while at the same time acting responsibly towards our planet by improving the energy mix.”

However, environmentalists continue to clamour for a total abandonment of oil and gas in favour of renewable energy based on the Paris Agreement on climate, which aims for a 50 per cent cut in emissions by 2030 and net zero by 2050.

UN Secretary-General António Guterres has also consistently advocated urgent significant investments in renewables.

“Had we invested massively in renewable energy in the past, we would not be in the middle of a climate emergency now,” Mr. Guterres said in September, referring to frequent climate disasters and rising fuel prices in his address to the UN Global Compact board meeting.

The world must end its “addiction to fossil fuels,” he declared. “Leaders in business, as well as government, must stop thinking about renewables as a distant project of the future. Without renewables, there can be no future.”

The world must end its “addiction to fossil fuels,” he declared. “Leaders in business, as well as government, must stop thinking about renewables as a distant project of the future. Without renewables, there can be no future.

UN Secretary-General’s Five-Point Plan

The UN chief outlined a five-point plan for transitioning to renewables.

First is the need to achieve a fair and accelerated energy transition, which requires “patents that can be made freely available — especially those relating to battery and storage capacity,” he stressed.

Second is increasing and diversifying renewable energy technology supply chains, which are currently “concentrated in a handful of countries.” He said pertinent technologies should be considered “global public goods” and readily available to all.

His third point is putting “policies and frameworks in place to incentivize investments and eliminate bottlenecks caused by red tape, permits and grid connections.”

Fourth is shifting fossil fuels subsidies to renewables. The $500 billion spent annually to lower the price of fossil fuels “more than triple what renewables receive…if we channel these resources and subsidies to renewables, we not only cut emissions, we also create more decent and green jobs,” he argues.

Fifth is investing up to $4 trillion in renewable energy projects. He expressed concern that Africa, with substantial renewable energy potentials, currently receives just 2 per cent of clean energy investments.

“The cost of capital for renewable energy projects in the developing world can be seven times higher than in the developed world,” he laments. “Upfront costs for solar and wind power account for 80 per cent of lifetime costs, meaning big investments today will reap even bigger rewards tomorrow.”

The UN Secretary-General's emphatic call for significant investments in renewable projects, particularly in developing countries, converges with the AU’s position, which is linked to adequate financing and investments that address energy poverty in Africa.

In other words, huge investments in Africa’s mostly untapped renewable sources could speedily wean the continent off fossil fuels.

South Africa’s Plan

It is exactly what South Africa, the world’s 12th biggest carbon emitter, wants to achieve with an investment plan to fast track its transition to renewable energy. Coal accounts for 80 per cent of South Africa’s power generation, with substantial economic, environmental and social ramifications.

Approved by the country's cabinet earlier this month, the plan consists of the $8.5 billion investments pledged at COP26 in Glasgow by Britain, France, Germany, the US and the European Union in concessional and commercial loans, as well as investment guarantees. The details of this Just Energy Transition Partnership investment deal will likely be wrapped up ahead of COP27.

The cabinet says it hopes to "achieve the decarbonization commitments made by the government of South Africa, while promoting sustainable development, and ensuring a just transition for affected workers and communities."

Under the transition plan, turbines and solar panels will replace high-polluting coal power stations. If successful, it could be a model for other developing countries.

Regarding a just transition to a renewable energy future, Mr. Guterres said in September: "Lip service won't do. We need credible actions and accountability." South Africa's plan, which might be replicated in other African countries, seems like such a credible action.

China on Course to Hit Wind and Solar Power Target Five Years Ahead of Time

Beijing bolstering position as global renewables leader with solar capacity more than rest of world combined

By Amy Hawkins and Rachel Cheung

June 28, 2023 – The Guardian

China is shoring up its position as the world leader in renewable power and potentially outpacing its own ambitious energy targets, a report has found.

China is set to double its capacity and produce 1,200 gigawatts of energy through wind and solar power by 2025, reaching its 2030 goal five years ahead of time, according to the report by Global Energy Monitor, a San Francisco-based NGO that tracks operating utility-scale wind and solar farms as well as future projects in the country.

It says that as of the first quarter of the year, China's utility-scale solar capacity has reached 228GW, more than that of the rest of the world combined. The installations are concentrated in the country's north and north-west provinces, such as Shanxi, Xinjiang and Hebei.

In addition, the group identified solar farms under construction that could add another 379GW in prospective capacity, triple that of the US and nearly double that of Europe.

China has also made huge strides in wind capacity: its combined onshore and offshore capacity now surpasses 310GW, double its 2017 level and roughly equivalent to the next top seven countries combined. With new projects in Inner Mongolia, Xinjiang, Gansu and along coastal areas, China is on course to add another 371GW before 2025, increasing the global wind fleet by nearly half.

"This new data provides unrivalled granularity about China's jaw-dropping surge in solar and wind capacity," said Dorothy Mei, a project manager at Global Energy Monitor. "As we closely monitor the implementation of prospective projects, this detailed information becomes indispensable in navigating the country's energy landscape."

The findings are in line with previous reports and government data released this year, which predicted that China could easily surpass its target of supplying a third of its power consumption through renewable sources by 2030.

China's green energy drive is part of its effort to meet dual carbon goals set out in 2020. As the world's second largest economy, it is the biggest emitter of greenhouse gases and accounts for half of the world's coal consumption. The Chinese president, Xi Jinping, pledged in 2020 to achieve peak CO_2 emissions before 2030 and carbon neutrality by 2060.

A coal-fired power plant in Shanghai. China approved more coal power in the first three months of 2023 than in the whole of 2021. Photograph: Aly Song/Reuters

The report attributed China’s remarkable progress in expanding its non-fossil energy sources to the range of policies its government has implemented, including generous subsidies to incentivise developers as well as regulations to put pressure on provincial governments and generating companies.

China began operating the world’s largest hybrid solar-hydro power plant in the Tibetan plateau on Sunday. Named Kela, the plant can produce 2bn kW hours of electricity annually, equal to the energy consumption of more than 700,000 households.

It is only the first phase of a massive clean energy project in the Yalong River basin. The installation has a 20GW capacity now and is expected to reach about 50GW by 2030.

Despite China’s careful planning, its energy transition is not without its challenges. In recent years, record heatwaves and drought crippled hydropower stations, resulting in power crunches that brought factories to a halt. An outdated electricity grid and inflexibility in transferring energy between regions add to the uncertainty.

The Kela plant is located in the sparsely populated west of the country, where more than three-quarters of coal, wind and solar power is generated. But the vast majority of energy consumption happens in the east. Transporting energy thousands of miles across the country results in inefficiencies.

The way China’s grid is organised can incentivise building coal plants around renewable generators. Much of the new renewable capacity is not connected to the local energy supply and often bundled with coal power to be transmitted to areas of higher demand.

More coal power was approved in the first three months of 2023 than in the whole of 2021.

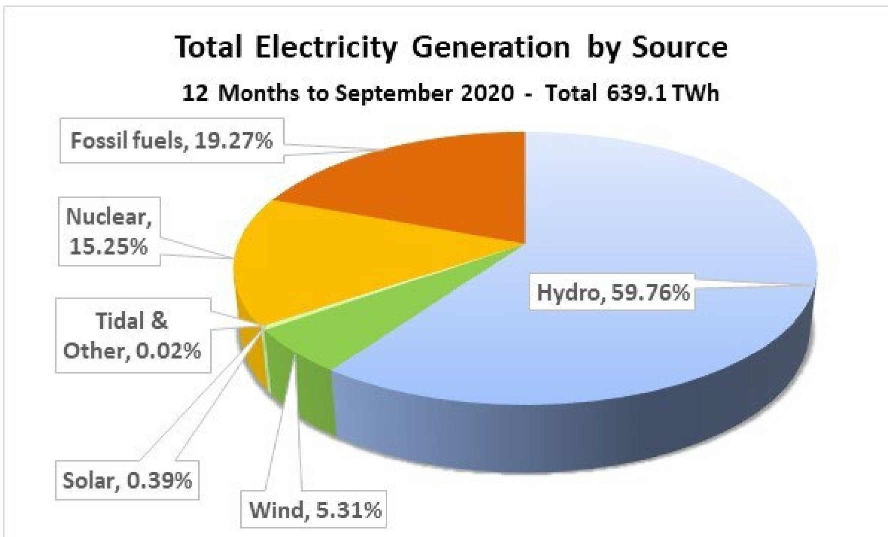
“China is making strides,” said Martin Weil, a researcher at Global Energy Monitor and an author of the report. “But with coal still holding sway as the dominant power source, the country needs bolder advancements in energy storage and green technologies for a secure energy future.”

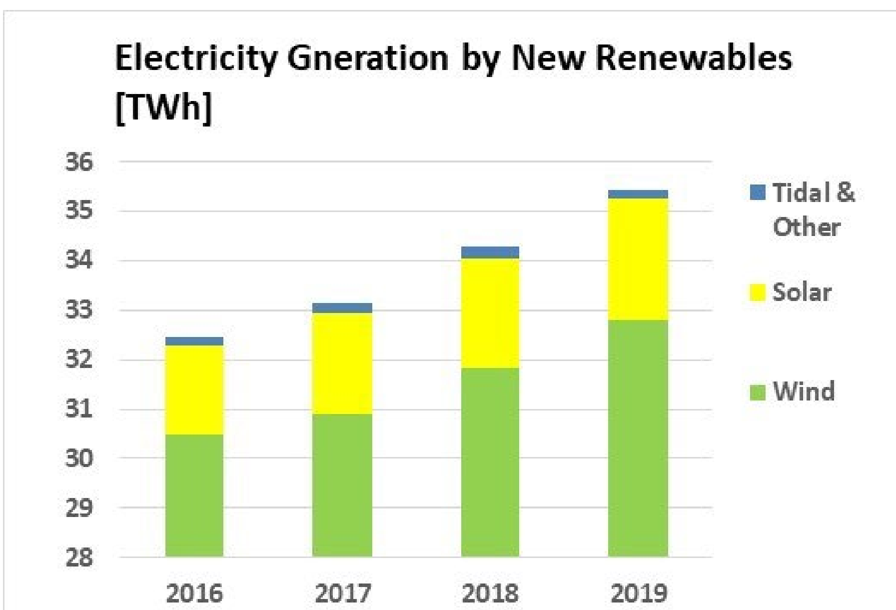
Renewable Energy – Canada

International Trade Administration, 2021

Executive Summary

Canada is one of the world's leading countries in using clean, renewable energy. Approximately 65% of the total electricity generation in 2019 was sourced from hydro, wind, solar, and other sources such as biomass, geothermal and marine/tidal wave energy. Hydro power is historically Canada's main source of energy, providing around 60% of the electricity. New renewable sources - wind, solar, tidal waves and others – have the highest growth rate and are projected to reach 12% of total power generation by 2035, according to the Canada Energy Regulator (CER).





(Source: Statistics Canada)

Total electricity generation has been relatively stable in recent years, around 640 TWh annually, as steady, slow increases in industrial, commercial, and residential electricity needs have been offset by improved efficiency solutions. A slight annual increase is expected for the coming years. Canada's total installed electricity generation capacity from all sources was approximately 135 GW in 2017 and is projected to reach 170 GW by 2035.

Canadian provinces and territories have the authority over their own electrical power systems, and all are pursuing renewable power generation sources. Quebec has 98% of electricity generation from hydro power, while British Columbia, Manitoba, Newfoundland and Labrador, Prince Edward Island and Yukon systems rely on between 89% to 95% hydro.

The renewable energy sector needs, for the maintenance and upgrade of the existing capacities and for further new capacities, are estimated to drive one third of Canada's $20 billion USD total annual imports for the electrical power sector. Around 45% of all Canadian imports for the electrical power sector are from U.S. providing significant opportunities for U.S. exporters.

Current Market Needs

The main market drivers at the macro level are primarily the need for ongoing maintenance and the upgrade of the existing power generation capacities. In addition, slow increase of the total capacity combined with policies and planning for further shifting the generation towards renewable sources supported by all government levels from federal to provincial and local level are also driving the market.

Hydro

Canada has a total installed capacity of over 80,846 MW in over 450 hydroelectric power stations and 200 small hydro plants (less than 10 MW), almost entirely in water accumulation and down the river generation plants. The remaining technical potential that Canada has in building hydro power generation is more than the current installed capacity. New projects of large capacity are already in development or in planning capacities from 500 MW to over 2,000 MW, including:

- Lower Churchill Project on Muskrat Falls and Gull Island in Labrador,
- Site C dam on the Peace River in British Columbia,
- Keeyask on the Nelson River, Manitoba.

Many small hydro plants are also in development. The segment will require hydraulic turbines and electrical generators across the entire range of electrical ancillary equipment and materials used in hydro power stations.

Wind

Wind is Canada's second largest source of renewable energy. Installed wind energy capacity in Canada was 114 MW in 2009. Strong provincial policies and support like the "Fed-in-Tarif" program introduced by Ontario in 2009, led to a steady dynamic growth on an average annual rate of 16% for the last 10 years. Total installed capacity reached 13,413 MW at the end of 2019. There were over 300 operational wind farms in Canada with a total of over 6,770 wind turbines. 37 wind farms have at least 100 MW capacity, including three with over 300 MW capacity each. Almost all are on shore and grid connected wind farms. The leading provinces for wind power generation are Ontario (5,436 MW), Québec (3,882 MW), and Alberta (1,685 MW).

The market is expected to continue to grow in 2020 – 2025 by an average annual rate of 5% (Source: CanWEA – Canadian Wind Energy Association). For the forecasted annual growth, the market will need all types of equipment and components from wind turbines and wind driven electrical generators, to all ancillary components and materials.

Solar

The total solar photovoltaic (PV) power installed capacity for electricity generation was approximately 3,700 MW in over 44,000 installations by the end of 2019. Note that all installed power capacities are in direct current (DC). That is combined from 2,600 MW in centralized installations (feeding only directly to the grid) and 1,100 MW of distribution installations which also consume for individual needs. The majority are connected to the low voltage grids and only about 15% to high voltage grids. For off grid installations, there is no available data. PV generation is located mainly in Ontario with about 3,000 MW, and the rest in all other provinces, each having under 25 MW, except British Columbia and Alberta.

According to the former National Energy Board, recently renamed Canada Energy Regulator, Canada's future renewable energy capacity is expected to grow with wind capacity doubling and solar capacity more than tripling by 2040 (Source: CanSIA – Canadian Solar Industries Association). For the forecast increased capacity, the market will need all types of components from PV cells/ panels and inverters to all ancillary operational components and materials for grid or local distribution connection. Similar needs are also for the maintenance of the existing installations.

Energy Storage and Combined Projects

Energy storage projects were initiated in Canada for the past several years and there are already local significant players in this segment, developing various technologies from battery storage to dynamic (flywheel) solutions. An important trend in discussion is between the wind, solar and storage industries in developing combined projects.

Other Energy Sources

This market segment needs a variety of specialized equipment and ancillary component and materials.

- Tidal Wave Energy: A longtime initiative. Canada has a research project for electricity generation from tidal waves in the Bay of Fundy, Nova Scotia. At present, the project is developed by a not-for-profit consortium led by the provincial government, Fundy Ocean

Research Center for Energy (FORCE), which determined that approximately 2,500 MW may be extracted from the 8,000MW of kinetic resource of the Bay of Fundy. The project is budgeted at about $40 million. The federal government provided a grant covering roughly half of the budget.

- Geothermal Energy: Only in initial phase. In Canada there are 18 projects in development, mainly at the research stage. A detailed listing is available from the industry association.
- Biogas and Renewable Natural Gas (RNG): Operational and initiate projects in Canada have a total capacity of 196 MW, of which approximately 50% are used for electricity generation and the rest mainly for combined electricity and heat (co-generation) and heat only.
- Biomass: Produced in 47 facilities located in Canada in all provinces coast to coast. 2 new plants are in construction and 6 others are in planning.

‘Global China’ is a Big Part of Latin America’s Renewable Energy Boom, but Homegrown Industries and ‘Frugal Innovation’ are Key

By Zdenka Myslikova, Nathaniel Dolton-Thornton, and The Conversation

Published July 8, 2023 in Fortune

The story of renewable energy’s rapid rise in Latin America often focuses on Chinese influence, and for good reason. China’s government, banks and companies have propelled the continent’s energy transition, with about 90% of all wind and solar technologies installed there produced by Chinese companies. China’s State Grid now controls over half of Chile’s regulated energy distribution, enough to raise concerns in the Chilean government.

China has also become a major investor in Latin America’s critical minerals sector, a treasure trove of lithium, nickel, cobalt and rare earth elements that are crucial for developing electric vehicles, wind turbines and defense technologies.

In 2018, the Chinese company Tianqi Lithium purchased a 23% share in one of Chile’s largest lithium producers, Sociedad Química y Minera. More recently, in 2022, Ganfeng Lithium bought a major evaporative lithium project in Argentina for US$962 million. In April 2023, Brazilian President Luiz Inacio Lula da Silva and Chinese President Xi Jinping signed around 20 agreements to strengthen their countries’ already close relationship, including in the areas of trade, climate change and the energy transition.

China’s growing influence over global clean energy supply chains and its leverage over countries’ energy systems have raised international concerns. But the relationship between China and Latin America is also increasingly complicated as Latin American countries try to secure their resources and their own clean energy futures.

Alongside international investments, Latin American countries are fostering energy innovation cultures that are homegrown, dynamic, creative, often grassroots and frequently overlooked. These range from sophisticated innovations with high-tech materials to a phenomenon known as “frugal innovation.”

Chile Looks to the Future

Chile is an example of how Latin America is embracing renewable energy while trying to plan a more self-reliant future.

New geothermal, solar and wind power projects – some built with Chinese backing, but not all – have pushed Chile far past its 2025 renewable energy goal. About one-third of the country is now powered by clean energy.

But the big prize, and a large part of China’s interest, lies buried in Chile’s Atacama Desert, home to the world’s largest lithium reserves. Lithium, a silvery-white metal, is essential for producing lithium ion batteries that power most electric vehicles and utility-scale energy storage. Countries around the world have been scrambling to secure lithium sources, and the Chilean government is determined to keep control over its reserves, currently about one-half of the planet’s known supply.

In April 2023, Chile’s president announced a national lithium strategy to ensure that the state holds partial ownership of some future lithium developments. The move, which has yet to be approved, has drawn complaints that it could slow production.

However, the government aims to increase profits from lithium production while strengthening environmental safeguards and sharing more wealth with the country’s citizens, including local communities impacted by lithium projects. Latin America has seen its resources sold out from under it before, and Chile doesn’t intend to lose out on its natural value this time.

Learning from Foreign Investors

Developing its own renewable energy industry has been a priority in Chile for well over a decade, but it’s been a rough road at times.

In 2009, the government began establishing national and international centers of excellence – Centros de Excelencia Internacional – for research in strategic fields such as solar energy, geothermal energy and climate resilience. It invited and co-financed foreign research institutes, such as Europe’s influential Fraunhofer institute and France’s ENGIELab, to establish branches in Chile and conduct applied research. The latest is a center for the production of lithium using solar energy.

The government expected that the centers would work with local businesses and research centers, transferring knowledge to feed a local innovation ecosystem. However, reality hasn’t yet matched the expectations. The foreign institutions brought their own trained personnel. And except for the recently established institute for lithium, officials tell us that low financing has been a major problem.

Chile’s Startup Incubator and Frugal Innovation

While big projects get the headlines, more is going on under the radar.

Chile is home to one of the largest public incubators and seed accelerators in Latin America, StartUp Chile. It has helped several local startups that offer important innovations in food, energy, social media, biotech and other sectors.

Often in South America, this kind of innovation is born and developed in a resource-scarce context and under technological, financial and material constraints. This “frugal innovation” emphasizes sustainability with substantially lower costs.

For example, the independent Chilean startup Reborn Electric Motors has developed a business converting old diesel bus fleets into fully electric buses. Reborn was founded in 2016 when the national electromobility market in Chile was in its early stages, before China’s BYD ramped up electric bus use in local cities.

Reborn's retrofitted buses are both technologically advanced and significantly cheaper than their Chinese counterparts. While BYD's new electric bus costs roughly US$320,000, a retrofitted equivalent from Reborn costs roughly half, around $170,000. The company has also secured funding to develop a prototype for running mining vehicles on green hydrogen.

Bolivia's "tiny supercheap EV" developed by homegrown startup Industrias Quantum Motors is another example of frugal innovation in the electric vehicles space. The startup aspires to bring electric mobility widely to the Latin American population. It offers the tiniest EV car possible, one that can be plugged into a standard wall socket. The car costs around $6,000 and has a range of approximately 34 miles (55 kilometers) per charge.

Phineal is another promising Chilean company that offers clean energy solutions, focusing on solar energy projects. Its projects include solar systems installation, electromobility technology and technology using blockchain to improve renewable energy management in Latin America. Many of these are highly sophisticated and technologically advanced projects that have found markets overseas, including in Germany.

Looking Ahead to Green Hydrogen

Chile is also diving into another cutting-edge area of clean energy. Using its abundant solar and wind power to produce green hydrogen for export as a fossil fuel replacement has become a government priority.

The government is developing a public-private partnership of an unprecedented scale in Chile for hydrogen production and has committed to cover 30% of an expected $193 million public and private investment, funded in part by its lithium and copper production. Some questions surround the partnership, including Chile's lack of experience administering such a large project and concerns about the environmental impact. The government claims Chile's green energy production could eventually rival its mining industry.

With plentiful hydropower and sunshine, Latin America already meets a quarter of its energy demand with renewables – nearly twice the global average. Chile and its neighbors envision those numbers only rising.

Zdenka Myslikova is Postdoctoral Scholar in Clean Energy Innovation, Tufts University and Nathaniel Dolton-Thornton is Assistant Researcher in Climate Policy, Tufts University.

Renewable Energy in Singapore: Resources, Plan, and Strategy

20 June 2022 – by Eric Koons; Last updated on 31 July 2023

Over 95% of the energy currently consumed in Singapore is from LNG and oil. However, the country has robust renewable energy targets for the next several decades, largely driven by local solar energy production and importing clean energy from neighbouring countries.

Renewable energy in Singapore is produced in a liberalised energy market, meaning that most, if not all, of its energy investments are commercial. However, as Singapore resumes its production in the post-COVID era, energy demand in the Singapore is rising, along with climate change concerns, and production needs to increase. This is fueled, in part, by the electrification of the transportation segment. Additionally, the high initial investment for developing renewable energy systems keeps solar PV systems investments relatively low.

We are hopeful that the country's changing renewable energy policies will create a shift in its energy investment profile. The rise in its carbon tax from S$5 to S$10-15 per tCO_2e by 2023 will drive this change. As a result, the carbon tax should reshape commercial investment in the energy market to favour renewable energy sources.

Singapore's Current Energy Mix in 2023 – Natural Gas and Solar Energy Systems

For most of its energy security and production, Singapore relies on liquefied natural gas (LNG) and oil. On the other hand, Singapore's renewable energy initiative is led by solar power. Singapore has reached its target of 350 MWp solar production (its 2020 green energy agenda goal) and is targeting 2 GW by 2030.

Energy Source Classification	Energy Source	Total Production Capacity in 2021	Percent Change 1965-2021
non-renewable	coal	0.00 TWh	not available*
non-renewable	oil	1.58 TWh	-89%
non-renewable	LNG	50.30 TWh	+250%
green, non-renewable	nuclear	0.00 TWh	not available*
renewable	solar	0.72 TWh	not available*
renewable	wind	0.00 TWh	not available*
renewable	hydropower	0.00 TWh	not available*
renewable	other renewables	0.41 TWh	not available*

Source: Our World In Data ** – the resource was not or is not being utilized*

Singapore's Energy Mix Over Time

Singapore is undertaking bold steps to reduce its carbon footprint and increase renewable energy capacity. Firstly, Singapore altered its energy capacity by switching from oil to natural gas. This effectively brought down the carbon emissions by 30%.

Secondly, solar power is being brought into Singapore's energy mix. With a total expected solar capacity of around 2 GW by 2030, Singapore is seriously rethinking its electricity generation and is moving towards renewable energy options.

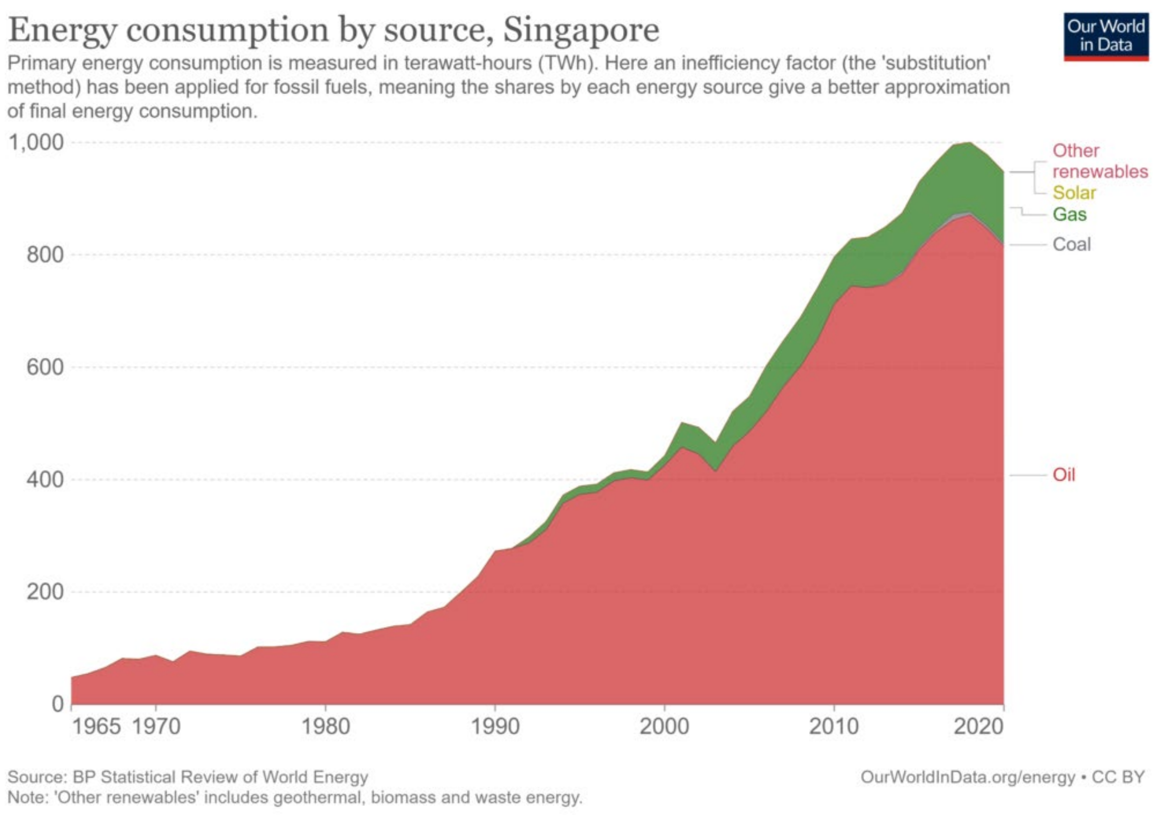
Thirdly, Singapore aims to connect with regional power grids to access cost-effective clean energy. This is already underway with the Singapore-Australia Sun Cable, which will supply 15% of Singapore's energy needs (or 30GW).

Finally, hard-to-decarbonise industries will harness carbon capture and storage/utilisation (CCSU) technologies to meet greenhouse gas emissions targets.

Singapore Renewable Energy Percentage

Due to various reasons, there has been minimal investment in renewable energy in Singapore in recent decades. As of 2020, solar energy only accounted for 0.08% of the country's total energy consumption, while fossil fuels like oil and natural gas accounted for around 98%.

Furthermore, the Singapore-Australia Sun Cable will likely change this ratio in favour of solar, but construction will not start until 2024.

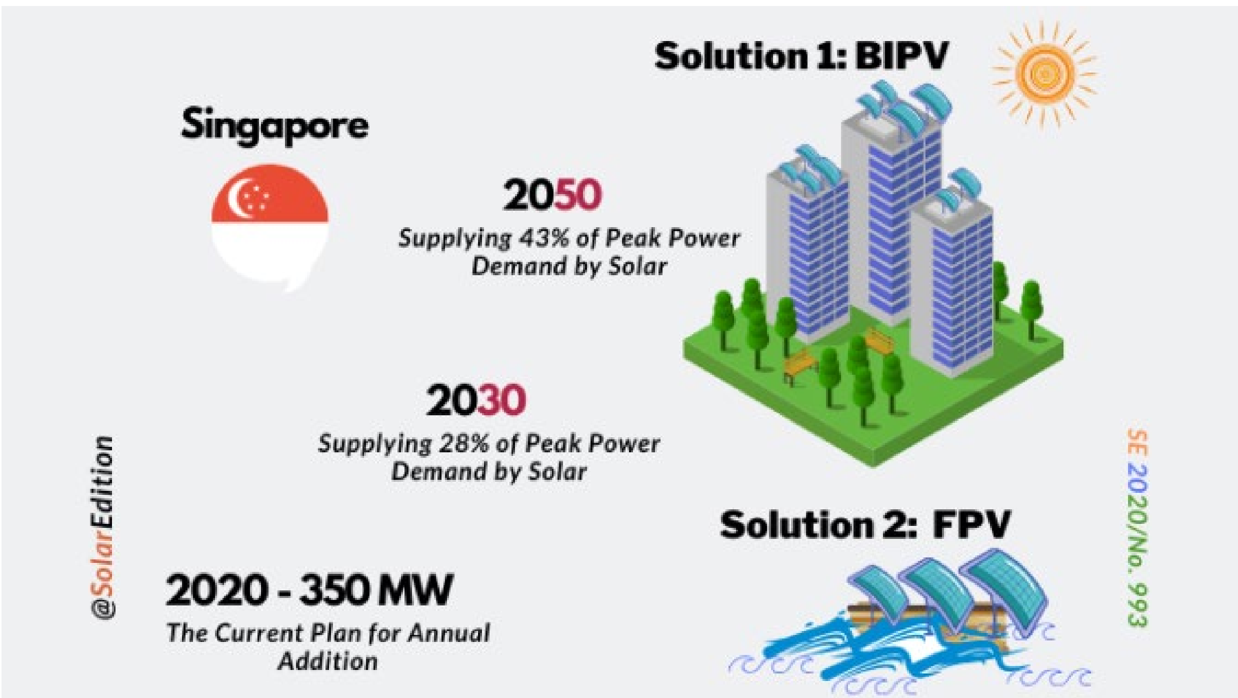


Solar Energy in Singapore Is Leading The Way

Only a few types of renewable energy are viable in Singapore. The country has a very small amount of land, with low wind speeds and large ports limiting tidal energy potential. Therefore, solar is leading the way in Singapore, although there is a small amount of land available for deploying solar panels. Moreover, further investments in solar energy production, international energy generation and regional grids for clean electricity importation are critical to sustainable renewable energy growth.

What is Singapore's Renewable Energy Plan?

In addition to bringing online 2 GW of domestic solar production by 2030, Singapore plans on supplying 30% of its energy needs with low-carbon imports by 2035. In addition to solar, many other renewable energy options are being thrown around. For example, Sembcorp Industries is introducing a green hydrogen (decarbonised) production facility in the country.



Renewable Energy Singapore: A Changing Policy Landscape Will Spur Growth

The pro-renewable energy agenda ensures that investments in Singapore's renewable energy sector are fully utilised. It also ensures future renewable investment for both the residential and non-residential sectors. So, with the current energy mix largely dependent on oil and LNG, many changes will be in the coming decades.

The Role of Citizens in Producing and Consuming Their Own Renewable Energy

Susanne Hirschmann – Som Energia, European Institute of the Mediterranean – 2023

Climate change has reached the Mediterranean region, which now has to face enormous problems. Since 1950, the air temperature in Catalonia has increased by more than 1.6ºC, rivers have run dry and hitherto unknown insects such as the tiger mosquito are appearing (Generalitat de Catalunya, 2016). To stop this, carbon dioxide emissions must be radically lowered. By using clean energy sources like wind, water, biomass and the sun and reducing our energy demand with energy efficiency measures, carbon dioxide emissions can be avoided and climate change can be decelerated. Therefore, the transition from fossil fuels to renewable energies is unquestionably the solution that must be put into practice as soon as possible. But the remaining question is: who will be the main player in this new power game that will change the energy system, big companies or the people?

Power to, by and from the People

A real change in the energy system means power to the people. A decentralised energy production with, on the one hand, wind parks, solar fields owned by a group of people and efficient use of urban spaces to cover the energy demand in crowded areas and, on the other, smaller installations owned by individuals to cover the demand in the rural sector. This means citizens generating their own energy because who, if not consumers themselves, better understands their energy needs? There are several powerful reasons why people must be involved in taking important decisions about the future of our energy. First, by producing our own energy we will get a feeling for energy. With the decoupling of energy production and energy consumption that took place in the early industrialisation period, we lost the ability to determine the amount of energy needed to sustain our standard of living. How much energy do we need to cover our energy demand, is our energy consumption sustainable or should we lower the amount of energy we are consuming every day? When energy comes only from power plants it is nearly impossible to see the impact of these plants on nature, such as big coal mines destroying thousands of hectares of fertile land. By producing electricity on our own roof our vision of energy surely will change and we can understand what the kilowatt-hours on our electricity bill really mean. Second, lack of acceptance is one of the big problems renewables are facing: renewables, yes, but not in my own backyard. Most people do not want to live next to huge wind parks or giant solar fields but this opinion often goes hand in hand with big installations that are planned without asking or informing anyone living in the affected area. People who have decided that the energy they are consuming should come from renewable power plants as near as possible will have another perspective on renewables. They will see the need for this investment and will also benefit from the power plants as they will be the owners of the installations. Jobs and money will stay local.

People who have decided that the energy they are consuming should come from renewable power plants as near as possible will have another perspective on renewables

But there is more to it than that. The discussion is not only about people's own backyards, it is about a new society that will blossom into a paradise of participation and a firmly imbedded feeling for democracy. For instance, to provide a platform to work together and achieve more participation, cooperatives can be created. In 2006, Som Energia was the first renewable energy source cooperative (REScoop) to sell renewable energy to its members in Spain. REScoop refers to a business model where citizens jointly own and participate in renewable energy or energy efficiency projects. Now there are already more than ten cooperatives in the Iberian Peninsula pursuing the same goals. The most important aspect of cooperatives is the concept: it is not about money, it is about people. These people take decisions together democratically, invest in renewable energy projects, generate their own energy and thereby ensure that the money stays local. Now there are many more cooperatives pulling in the same direction, decentralising and changing energy systems towards renewables and giving power back to those the energy belongs to: the people.

Güssing: How Participation and Political Willingness Changed the Austrian Region for the Better

The example of Güssing, a town in Austria with approximately 27,000 inhabitants, is a success story about how locally-generated energy can benefit the whole region and its community and why a favourable legal framework is important to promote renewables.

In 1988, the region of Güssing was one of the poorest regions in Austria. With high unemployment rates, rural depopulation, young people leaving the town to find work in Vienna and the high cost of covering energy needs for electricity, heating and mobility, the region had to face problems similar to those of the region of Castile and León in Spain, with one of the highest exodus rates in the country. To make the situation worse, there was a lack of infrastructure as no train or highway passed nearby so it was not attractive for business to settle in this region. To solve these problems, Güssing decided to work out the details of a new energy concept, based mainly on biomass with 100% renewables, to become self-sufficient. With this positive change in political opinion a favourable legal framework was developed to clear the way for energy produced regionally for and by the people. Without a stable framework and the political willingness to let participation and innovative projects happen, Güssing would not have had the chance to develop as it has done so far. The first step was the implementation of an energy efficiency programme including new insulation of buildings and optimising heating systems. Due to these measures, the energy needs of the town hall decreased by more than 50%. Later, the town started to invest in a biomass gasification plant, which led to energy self-sufficiency. This plant is powered by wood that surrounds the city and is available in abundance. At present, Güssing produces more energy from renewable sources than is consumed in the town annually. The region can benefit from the electricity sold, the district heating system and the biodiesel, which brings an added value of 13 million euros per year. As the infrastructure was improved, more businesses started to be interested in this region and there are now 50 new enterprises with more than 1,000 direct or indirect jobs in the renewable energy sector (bmvit, 2007). People are involved and money stays local and can be reinvested in local projects (Vansintjan, 2015).

Güssing is a good example of a town achieving self-sufficiency, but relying on biomass is not the only way people can produce and consume their own renewable energy.

The Spanish Sun and the Spanish Problem with Self-Consumption

In Spain it is interesting to widen the horizon to how solar energy can be used for self-consumption in the future. The latest publication about self-consumption from the European Commission clearly points out that self-consumption of PV (photovoltaic) energy is going to be one of the new cores of EU energy policy and therefore this should include Spain. To achieve the goal of greater self-consumption by European citizens the legal situation in some countries must be changed because some governments are building barriers to avoid this development towards a democratic energy system (European Commission, 2015). "Self-consumption of PV energy" is defined by the European Photovoltaic Industry as "the possibility for any kind of electricity consumer to connect a photovoltaic system, with a capacity corresponding to his consumption, to his own system or to the grid, for his own or for on-site consumption" (Roesch, 2013). Self-consumption seems to be easy to achieve and, together with other additional drivers for change in current energy systems, something which should be supported. Some countries, such as Denmark or Germany, are already in the fast lane to achieving the glorious objective of "power to the people", but is this also a reality in Spain or just a utopia? Crossing Germany by car means passing through lovely villages, in which even church rooftops are covered by solar panels, and driving by huge solar fields and wind parks along the road. In Spain it seems that only tourists getting burnt on the beach are benefiting from the high solar irradiation, but it is rare to see solar panels in public. It is a big opportunity that Spain is missing. Nearly one and a half times the size of Germany, with just half of its population and global irradiation rates much higher than in northern European countries, Spain could easily be one of the role models for the energy transition but it is squandering this golden opportunity. Even though solar energy is very attractive because of the economic benefit of the installation, it is not very popular in Spain. The cost of solar power is decreasing and becoming more affordable. In 2010 the price was €2/Wp (Fraunhofer ISE, 2015) and today the average price of Multi-Si Modules has dropped down to €0.36/Wp. At the same time, energy bills are rising in many countries and the future price development seems to be following this trend. Between 2005 and 2015 the price of electricity in Europe rose by about 10 cents and in Spain and Germany prices even doubled, which should make renewables even more attractive. But it seems that the Spanish government does not share the same ideology and prefers to block this movement. In the last few years, instead of moving forward, the legal situation for cooperatives, small-scale consumers and producers of renewable energy has become increasingly precarious. The fixed charges on electricity bills rose, meaning saving energy no longer reduces the bill and small consumers pay higher prices than big consumers who do have variable charges. But energy efficiency is still the best way to save energy because the best kWh is the one that is not consumed. Installing solar panels on a roof legally involves so much paperwork and time that people get frustrated and do not even try to become prosumers. Last but not least, laws such as Royal Decree 900/2015, which is the basis of the so-called "sun tax", reinforces stigmas and fears that self-consumption is illegal and it is better to avoid this technology. The Spanish government should change direction as there are so many good self-consumption projects just waiting for their opportunity to develop and spread across the country. Some will be explained here. There are two main ways to achieve self-consumption: as an individual or a group.

A Glimpse into the Future: Prosumers Connected Through Virtual Power Plants Will Rule the Energy Market

For a glimpse into the future of a decentralised energy system, consisting of solar panels and intelligent connected batteries, we need only look at the intelligent battery provider Sonnenbatterie and the sonnenCommunity. Members of this community can generate their own power, store it with an intelligent storage system and share surpluses online with friends or other members. This community is able to partly replace the traditional power companies as it consists of decentralised energy production and not merely providing energy from central power stations. The benefits are obvious. Members are independent of established electricity providers, have significantly lower energy costs and receive the surplus energy from other members for free. Even the problem of costly grid expansion is partly solved by direct marketing in the region and even between neighbours or small residential systems. Three technologies are combined in this visionary idea: decentralised power generation, advanced battery storage technology and digital networking. Therefore, a virtual energy cloud can be created and controlled by self-learning software that connects the members with the community. This software can make predictions about how much energy will be produced and how this energy has to be distributed to cover the whole demand of the sonnenCommunity (Sonnenbatterie GmbH 11/25/2015). Systems like these are part of so-called virtual power plants. Virtual power plants are relatively new energy management systems. They distribute and coordinate in real time the energy production of different energy sources and the actual energy demand. So wind turbines, hydroelectricity, small scale PV and batteries provide a stable energy supply. For instance, when one consumer who is producing PV electricity has run out of energy he will get access to other sources of energy, such as electricity produced by his neighbour's wind turbine. The energy can be provided at lower costs, it is more flexible and there is less energy loss because of the shorter transportation. The idea of an energy community is not unique but the example of sonnenCommunity clearly shows what the future will bring and how important the role of citizens in the new energy system will be. There is still a long way to go to turn this idea into reality in Spain. Because of the high bureaucracy barriers imposed by the government, few people even think about installing their own solar system. Furthermore, shared energy consumption is still a difficult topic in Spanish legislation.

Generation kWh: The Solution for Collective Self-Consumption

But what about all the others who do not own a house, a roof or land for solar installations? Is there a way for renters to take control of their destiny and produce and own their own energy? Helen Keller once said "alone we can do so little, together we can do so much" and she is absolutely right. One example of how we can do so much together is provided by Som Energia. The project "Generation kWh" plays on the two meanings of the word generation: a new generation of people standing up for their rights to own their own energy plants and the idea of producing green electricity. Feed-in-tariffs fulfilled the function of making renewables more attractive and ensuring their profitability in the long term and creating a stable environment to invest in them. As the rapidly changing legal situation in Spain made investments in renewables very risky, this stable environment could not be created and there was stagnation in the renewable energy sector. Therefore, Som Energia started the project Generation kWh, which asserts that self-consumption is still possible even without government funding. Every member can purchase energy shares, each worth €100, related with their specific annual consumption. For example, a standard household with an average annual electricity consumption of 2,400 kilowatt hours needs to invest €900 to cover 70% of its energy demand for 25 years. Every €100 contribution corresponds to 170-200 kWh per year, which will be compensated from the energy bill with Som Energia. The cost of generation is roughly 3.5-4 cents per kilowatt hour, whereas the current market price is about 4.5-5 cents per kilowatt hour. Thus, the participants can save 1 cent per kilowatt hour while other costs such as taxes, grid access fees and so on stay the same (Roselló, 2015). After 25 years the sum originally invested will be returned to the investor and, during this period, the investor enjoys energy bill savings. Implemented in 2015, the project bore fruit in May 2016 as the first collectively-owned solar field providing energy to about 1,300 households started to work. In total, more than 2,700 people have already participated and together they have invested more than €2,548,400, which will be invested in even more community-owned power plants (Palmada, 2016). The great support for the Generation kWh project is a perfect example of what citizens want: to participate and be part of the change.

Collective Self-Consumption in Cities

This is not the only example of how citizens can take power into their own hands. Generation kWh works on bigger installations but how can solar energy be generated and consumed in cities? For instance, Barcelona has a surface area of more than 100km2. Nobody would expect 100km2 to be completely covered by solar panels but there are so many rooftops or building façades that can be used for producing energy. The potential resources of installing PV in this city are 7-14 MW of PV technology installed on public and private rooftops. Installing PV panels on buildings means that the energy is produced where it is needed: in crowded areas where somebody is always using the oven, charging an electric car or washing clothes (Camaño-Martín, 2008).

The Mieterstrom Model for Self-Consumption in Cities

To put this into effect, the German Mieterstrom neighbour solar supply model can be used. It shows how residents can get access to power generated on their building rooftops. The functioning of the Mieterstrom model is quite simple: neighbour solar supply is based on locally-generated electricity and this electricity is used directly by the tenants in multi-family houses or neighbourhoods. An energy provider offers to supply PV electricity to the residents of a building directly from the roof and to supply energy via the grid if there is no energy being generated at a given moment. One important detail of this model is that not all the tenants have to participate. About 50-75% of the total electricity production can be used, and participating households usually cover 35% of their own electricity requirements via the PV (Zuber, 2017). The advantage is that the consumer does not have to pay high investment costs for a solar installation on a building where they might only stay for a few years but they receive electricity produced as locally as possible. Furthermore, they will pay a cheaper price because the supplier does not have to pay grid access fees as the energy is supposed to be consumed instantaneously (Roesch, 2013; Dunlop, 2016). In the near future, Spanish people will have a glimmer of hope of getting access to shared self-consumption in buildings. The Constitutional Court of Spain took a step in the right direction and eliminated obstacles to shared self-consumption on 2 June 2017, which had been illegal according to Royal Decree 900/2015 (Tribunal Constitucional de España, 2 June 2017).

Azimut: Tenants of a Whole Building are Joining Forces to Produce their Own Energy

The PV installation does not necessarily have to be owned by the supplier. The tenants themselves (with the permission of the owner) can pay for the installation and be consumer and producer of their own energy at the same time. In spring 2017 the Azimut 360 cooperative located in Barcelona presented its pilot project Agrupación de Consumos (joint consumption). Their main objective in this project is to carry out a PV installation on a rooftop of a multi-family building and link all the electricity meters to one single meter. The electricity will be distributed to the different parties living in the building and with an internal electricity meter they can manage billing themselves. This change will lower the building’s peak load and provide savings on the energy bill. Moreover, the electricity generated by the solar panels can cover a significant amount of the daily energy demand. As there are more households with different habits the energy demand will be more balanced. The tenants must work together, cooperate and make decisions about how to carry out the installations and how energy should be distributed. Projects like these help to build community and make people feel responsible for their habits according to their electricity consumption because it is not your own electricity but belongs to the whole community (azimut360, 2017).

Citizens Will Bring About Renewables: Self-Consumption is Necessary

With these inspiring examples and role models with so many people involved one thing is clear: self-consumption of renewables should not be illegal, it is necessary and must be driven by the people. But how can we bring this about? With less bureaucracy, lower prices and more publicity in favour of renewables and energy efficiency we could move towards a better future. What is needed is a change in the Spanish energy policy because it does not represent the will of the people, which should be the basis of the government’s authority. And the will of the people is democracy, including in the energy sector.

United States
Primary Consumption of Energy
by Fuel Type and Sector, 2020

Figure 2-1a. United States Primary Consumption of Energy

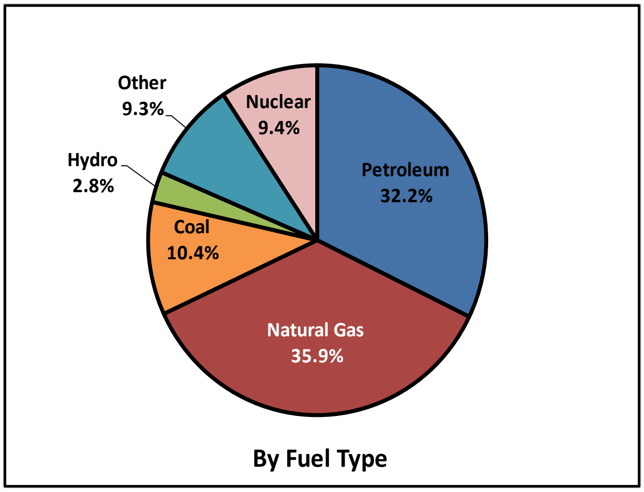


Figure 2-1b. United States Primary Consumption of Energy

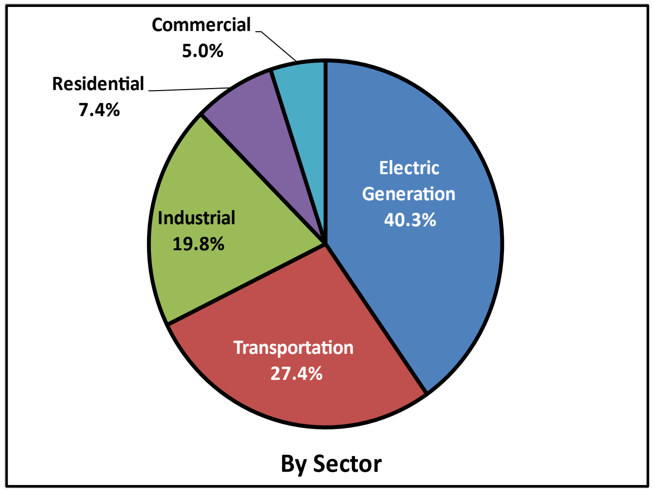


Table 2-1. (In Trillion Btu)

	Residential TBtu	Commercial TBtu	Industrial TBtu	Transportation[1] TBtu	Net Consumption TBtu	Electric Generation[2] TBtu	Primary Consumption[3] TBtu
Coal	0	14	939	0	954	8,229	9,183
Natural Gas	4,876	3,304	10,304	1,096	19,579	12,011	31,590
Petroleum Products:	913	852	4,625	21,787	28,177	184	28,362
Distillate	407	276	1,065	6,183	7,931	44	7,975
Residual	0	2	32	391	426	53	478
Kerosene	11	2	3	0	16	0	16
LPG	495	201	3,256	5	3,956	0	3,956
Gasoline	0	371	269	14,243	14,883	0	14,883
Jet Fuel	0	0	0	2,254	2,254	0	2,254
Other[4]	767	266	1,565	1,289	3,886	1,340	5,226
Electric Sales	4,997	4,393	3,272	22	12,685		
Net Consumption	11,553	8,829	20,706	24,194	65,281		
				Hydro Electricity		2,492	2,492
				Nuclear Electricity		8,248	8,248
				Wind Electricity		2,958	2,958
				Primary Consumption		35,462	88,058

1 Components of petroleum may not sum to petroleum total because ethanol values ("Other" category in transportation sector) are embedded in motor gasoline.

2 Hydro and wind are excluded from the "Other" category and listed separately.

3 Excludes petroleum products not used as a form of energy.

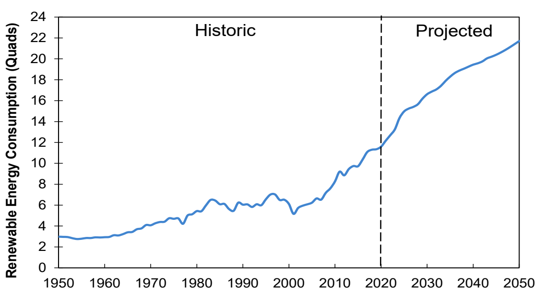
4 "Other" includes wood, waste, ethanol, landfill gas, solar, geothermal, and biodiesel.

U.S. Renewable Energy

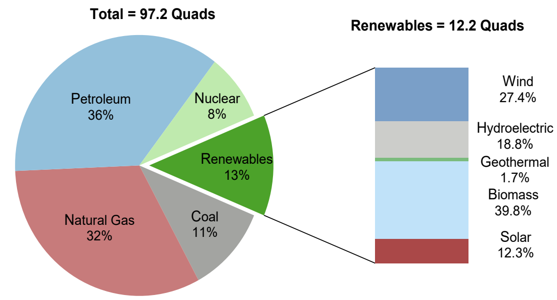
Patterns of Use

While energy is essential to modern society, most primary sources are unsustainable. The current fuel mix is associated with a multitude of environmental impacts, including global climate change, acid rain, freshwater consumption, hazardous air pollution, and radioactive waste. Renewable energy has the potential to meet demand with a much smaller environmental footprint and can help to alleviate other pressing problems, such as energy security, by contributing to a distributed and diversified energy infrastructure. About 79% of the nation's energy comes from fossil fuels, 8.4% from nuclear, and 12.5% from renewable sources. In 2019, renewables surpassed coal in the amount of energy provided to the U.S. and continued this trend in 2021. Wind and solar are the fastest growing renewable sources, but contribute just 5% of total energy used in the U.S.[1]

U.S. Renewable Energy Consumption: Historic and Projected[1,2]



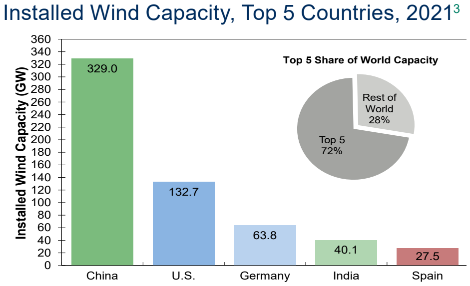
U.S. Total and Renewable Energy Consumption by Source, 2021[1]



Major Renewable Sources

Wind

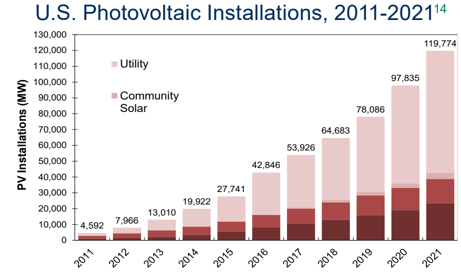
Installed Wind Capacity, Top 5 Countries, 2021[3]



- U.S. onshore wind resources have a potential capacity of almost 11,000 GW and current installed capacity of 132.7 GW.[3,4] Offshore wind resources are potentially 4,200 GW, current capacity is 42 MW, and the development pipeline contained over 28 GW of projects in 2019.[4,5,6]
- Over 16 GW of wind capacity was installed in the U.S. in 2020, a 85% increase from 2019.[7,8]
- The federal production tax credit (PTC) significantly influences wind development, but cycles of enactment and expiration lead to year-to-year changes in investment.[9] In 2020, the PTC was extended to allow wind projects beginning construction in 2020 or 2021 a PTC at 1.5¢/kWh for 10 years of electricity output.[10]
- Based on the average U.S. electricity fuel mix, a 1.82 MW wind turbine (U.S. average in 2019) can displace 3,679 metric tons of CO_2 emissions per year.[11] By 2050, 404 GW of wind capacity would meet an estimated 35% of U.S. electricity demand and result in 12.3 gigatonnes of avoided CO_2 emissions, a 14% reduction when compared to 2013.[12]
- Wind turbines generate no emissions and use no water when producing electricity, but concerns include bat and bird mortality, land use, noise, and aesthetics.[13]

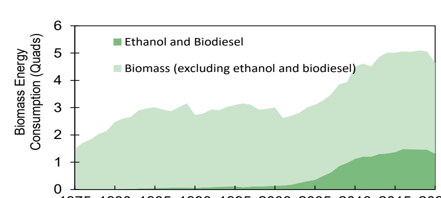
Solar

U.S. Photovoltaic Installations, 2011-2021[14]



- Assuming intermediate efficiency, solar photovoltaic (PV) modules covering 0.6% of U.S. land area could meet national electricity demand.[15]
- PV module prices have declined to $0.27/Watt in residential systems.[16] The U.S. manufactured 1% of PV cells and 3% of PV modules globally in 2020.[17]
- In 2021, a new record high of over 23.6 GW of solar photovoltaic capacity was added in the U.S., raising total installed capacity to over 121 GW.[14] Solar accounted for 46% of new generating capacity in 2021.[14]
- The U.S. Department of Energy's SunShot Initiative aims to reduce the price of solar energy 50% by 2030, which is projected to lead to 33% of U.S. electricity demand met by solar and a 18% decrease in electricity sector greenhouse gas emissions by 2050.[18]
- While solar PV modules produce no emissions during operation, toxic substances (e.g., cadmium and selenium) are used in some technologies.[15]

U.S. Biomass Consumption, 1975-2021[1]



Biomass

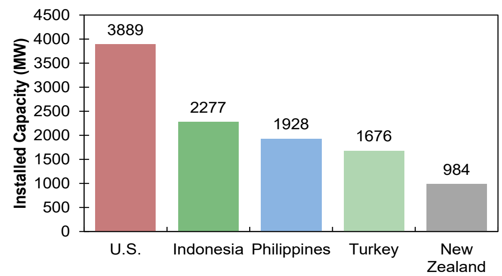
- Wood—mostly as pulp, paper, and paperboard industry waste products—accounts for 43% of total biomass energy consumption. Waste—municipal solid waste, landfill gas, sludge, tires, and agricultural by-products—accounts for an additional 9%.[1]
- Biomass has low net CO_2 emissions compared to fossil fuels. At combustion, it releases CO_2

previously removed from the atmosphere. Further emissions are associated with processing and growth of biomass, which can require large areas of land. Willow biomass requires 121 acres of land to generate one GWh of electricity per year, more land than other renewable sources.[19]

- U.S. ethanol production is projected to reach 54 million gallons per day in 2050.[2]

Geothermal

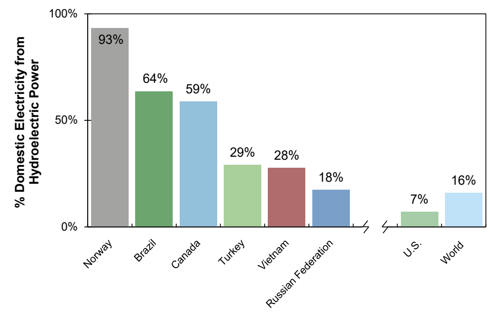
Geothermal Installed Capacity, Top 5 Countries, 2021[20]



- Hydrothermal resources, i.e., steam and hot water, are available primarily in the western U.S., Alaska, and Hawaii, yet geothermal heat pumps can be used almost anywhere to extract heat from shallow ground, which stays at relatively constant temperatures year-round.[21]
- Each year, electricity from hydrothermal sources offsets the emission of 4.1 million tons of CO_2, 80 thousand tons of nitrogen oxides, and 110 thousand tons of particulate matter from coal-powered plants.[22] Some geothermal facilities produce solid waste such as salts and minerals that must be disposed of in approved sites, but some by-products can be recovered and recycled.[21]
- Electricity generated from geothermal power plants is projected to increase from 15.9 billion kWh in 2021 to 47.4 billion kWh in 2050. Geothermal electricity generation has the potential to exceed 500 GW, which is half of the current U.S. capacity.[2,23]

Hydroelectric

Hydropower Electricity Generation, 2019[24]



- In the U.S., net electricity generation from conventional hydropower peaked in 1997 at 356 TWh/yr. Currently, the U.S. gets about 260 TWh/yr of electricity from hydropower.[1]
- While electricity generated from hydropower is virtually emission free, significant levels of methane and CO_2 may be emitted through the decomposition of vegetation in the reservoir.[25] Other environmental concerns include fish injury and mortality, habitat degradation, and water quality impairment. "Fish-friendly" turbines and smaller dams help mitigate some of these problems.[26]

Advancing Renewable Energy

Encourage Supportive Public Policy

- Lawrence Berkeley National Laboratory estimates that 45% of renewable energy growth in the U.S. can be attributed to state Renewable Portfolio Standards (RPS) that require a percentage of electricity be derived from renewable sources.[27] Clean Energy Standards (CES) that mandate certain levels of carbon-free generation can include some non-renewables such as nuclear fuels.[28] Thirty-three states, the District of Columbia, and three U.S. territories had renewable portfolio standards or goals in place as of August 2021.[29] State standards are projected to support an additional 90 GW of renewable electricity projects by 2030.[27]
- Renewable energy growth is also driven by important federal incentives such as the Investment Tax Credit, which offsets upfront costs by 10-30%, as well as state incentives such as tax credits, grants, and rebates.[30]
- Eliminating subsidies for fossil and nuclear energy would encourage renewable energy. Congress allocated over $5.7 billion in tax relief to the oil and gas industries for fiscal years 2020-2024.[31] Studies estimate that the Price-Anderson Act, which limits the liability of U.S. nuclear power plants in the case of an accident, amounts to a subsidy of $366 million to $3.5 billion annually.[32]
- Net metering enables customers to sell excess electricity to the grid, eliminates the need for on-site storage, and provides an incentive for installing renewable energy devices. Thirty-nine states, the District of Columbia, and four U.S. territories have some form of net metering program.[33]

Engage the Industrial, Residential, and Commercial Sectors

- Renewable Energy Certificates (RECs) are sold by renewable energy producers in addition to the electricity they produce; for a few cents per kilowatt hour, customers can purchase RECs to "offset" their electricity usage and help renewable energy become more cost competitive.[34] Around 850 utilities in the U.S. offer consumers the option to purchase renewable energy, or "green power."[35]
- Many companies purchase renewable energy as part of their environmental programs. Microsoft, Google, T-Mobile, Intel, and The Proctor & Gamble Company were the top five users of renewable energy as of April 2022.[36]

kWh = kilowatt hour. One kWh is the amount of energy required to light a 100 watt light bulb for 10 hours.
Btu = British Thermal Unit. One Btu is the amount of energy required to raise the temperature of a pound of water by 1° Fahrenheit.
Quad = quadrillion (10^{15}) Btu. One Quad is equivalent to the annual energy consumption of ten million U.S. households.

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