Forum: Committee EVC 2

Issue: Measures to reduce the negative impacts of renewable energy

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Introduction

Globally, the primary sources of greenhouse gas emissions are electricity and heat (31%), agriculture (11%), transportation (15%), forestry (6%) and manufacturing (12%). Energy production of all types accounts for 72 percent of all emissions. In the global context, the increasing significance of renewable energy has brought to light unintended consequences, emphasizing the need for change. Although renewable energy sources are generally deemed more environmentally friendly than traditional fossil fuels, they are not exempt from challenges and negative impacts. With the increasing share of renewables into the power grid, they have brought positive and negative consequences. Positively, renewables produce less greenhouse gas emissions, provide power for rural areas, energy security, and reduction in pollution and global warming. However, renewables must be grid connected and come with a number of factors such as the share of renewable power, network size and location, energy conversion technology, impact on system inertia, droop, T2 power quality, system protection, etc., which, when added to distribution networks, modify power flows and shift from the traditional one-way flow from high to low voltage levels in the power system. A resilient and adaptable energy infrastructure is essential for the successful integration of renewable energy into existing power grids. This subtopic delves into the intricacies of grid integration and the deployment of smart infrastructure. Delegates will navigate discussions on grid modernization, examining the role of advanced technologies, smart grids, and decentralized energy systems. Attention will be given to the challenges posed by the intermittent nature of renewable sources and the policy frameworks needed to ensure a seamless transition toward a more interconnected and intelligent energy grid. In the pursuit of sustainable energy, the issue of intermittency in renewable sources becomes paramount. Energy storage solutions stand at the forefront of addressing this challenge, offering a means to store surplus energy generated during peak production periods. This subtopic explores various storage technologies, such as pumped-hydro, battery storage, and thermal energy storage, evaluating their efficiency, scalability, and economic feasibility. Delegates will delve into the intricate balance between energy supply and demand, examining how effective storage solutions can enhance the reliability and stability of renewable energy systems. While the benefits of renewable energy are undeniable, careful consideration must be given to the environmental impact of project siting and management. This subtopic explores strategies for promoting ecosystem-friendly siting practices and effective environmental management in the development and operation of renewable energy projects. Delegates will examine the delicate balance between energy needs and biodiversity conservation, discussing policies that encourage responsible sitting, mitigate ecological disruption, and uphold environmental sustainability standards. This subtopic underscores the importance of holistic approaches to ensure the long-term harmony between renewable energy initiatives and the natural world.

Definition of Key Terms

Renewable energy

Energy produced from a source that is not depleted when used. Examples include, solar, wind power, hydroelectric, hydropower, geothermal, biomass, solar heating, and more. Nuclear energy, although an efficient power source and alternative to fossil fuels, is not a renewable energy.

Grid Integration

The process of incorporating a new generation of variable renewable energy into an existing power system, understanding the supply and demand of that balance, and evaluating how integration will impact those grids.

Intermittent renewable energy production

Intermittent renewable energy production refers to the generation of electricity from renewable sources, such as solar and wind, that is not constant or predictable throughout time. Unlike continuous power generation methods like traditional fossil fuel or nuclear power plants, intermittent renewable energy sources are subject to fluctuations based on natural variability. For example, solar power is dependent on sunlight availability, which varies due to weather conditions and day-night cycles, while wind power relies on wind speed and patterns. The intermittent nature of these renewable sources poses challenges for maintaining a consistent and reliable power supply, requiring additional technologies like energy storage or backup systems to balance the intermittency and ensure a stable electrical grid.

Environmental Sitting

The careful selection and planning of locations for renewable energy projects, such as wind farms, solar installations, or hydropower facilities. This process involves assessing and considering various environmental factors, including the ecological impact on local ecosystems, potential effects on biodiversity, land use, and any other environmental considerations associated with the development and operation of renewable energy infrastructure. The goal is to minimize adverse environmental effects and promote sustainable practices in the pursuit of cleaner and more sustainable energy sources.

Less Economically Developed Countries (LEDCS)

LEDCs, or Less Economically Developed Countries, refer to nations characterized by lower levels of industrialization, lower income per capita, and often face challenges in meeting basic human needs such as education, healthcare, and infrastructure development. These countries typically exhibit a lower standard of living and may rely heavily on agriculture and primary industries for economic sustenance.

High Voltage Power Lines

High voltage power lines refer to the electrical transmission lines that carry electric power at higher voltages, ranging from 69,000 volts and above. These lines are a crucial component of the electricity grid, facilitating the efficient and long-distance transmission of electricity from power generation facilities, such as power plants, to distribution networks and ultimately to end-users.

Corona Discharge

Corona discharge refers to the ionization of air surrounding a conductor, typically in high-voltage systems, leading to the formation of a faint luminous discharge or "corona." This phenomenon occurs when the electric field near a conductor is strong enough to ionize the surrounding air molecules, creating a visible glow or halo of light.

Background Information

Subtopic 1 Grid Integration and Smart Infrastructure

For a greener future for the globe we must implement more renewable energy power plants, however this requires more effort in planning, infrastructure, regulation, and management. Additionally, places that have potential to have wind or solar plants implemented, usually tend to be more rural, this will also require transportation and connection of the energy made to the rest of a respective nation(s). The infrastructure is the most important part to renewable energy implementation.

Consequences of Poor Management

For transmission of energy, energy might be transmitted through high voltage power lines. The careful planning of high voltage power line placement is imperative due to several scientific and mechanical considerations. The electromagnetic fields (EMFs) generated by these power lines can have potential health implications, and careful positioning helps minimize exposure to populations. Additionally, the proximity and configuration of power lines affect the electrical coupling with surrounding objects, impacting their performance and potentially causing unwanted interferences. For instance in the state of California, United States, powerlines came into contact with tree branches, causing sparks and fires to spread that contributed to 10% of the wildfires from 2016-2020. This has led to the practice of power companies of those respective areas to shut off the power, however this inhibits the quality of life for individuals that rely on that energy at home and interrupts pace of life. Additionally this has impacted institutions as they continue to have a reliance on electricity to provide education, healthcare, and more.

The unsuccessful integration of renewable power plants into grids has, in some instances, led to an upsurge in blackouts. When renewable energy sources such as solar and wind are not seamlessly integrated into existing power grids, the intermittency and unpredictability of these sources can strain grid stability. Blackouts, or widespread power outages, have severe consequences that extend from urban areas to rural landscapes. In cities, blackouts disrupt critical infrastructure, such as transportation systems, communication networks, and essential services, impacting daily life, businesses, and emergency response capabilities. In rural areas, where dependence on electricity is often crucial for basic needs like water supply, agriculture, and healthcare, blackouts can result in prolonged periods of hardship, affecting both livelihoods and overall well-being. Therefore, the effective and resilient integration of renewable power into grids is vital to ensure a reliable and sustainable energy supply for diverse communities.

The efficient transmission of electricity relies on minimizing resistive losses during power transmission. Careful planning ensures that power lines are strategically placed to minimize the distance and resistance, optimizing the overall efficiency of the power grid. This involves considerations of factors such as line length, conductor material, and the surrounding environment. Moreover, high voltage power lines can induce corona discharge and audible noise, especially in certain weather conditions. Careful placement takes into account factors like weather patterns, proximity to residential areas, and environmental conditions to mitigate these effects.

Grid Infrastructure

The global surge in solar generation has been substantial in recent years, with projections indicating continued exponential growth. However, a significant challenge arises as this increase in solar energy generation amplifies the likelihood of grid disturbances. Many studies have examined the disruptions in the grid resulting from the extensive integration of utility-scale solar energy into the high-voltage transmission lines of balancing authority. The findings underscore the necessity for regions with heightened adoption of utility-level solar energy to engage in increased energy exchanges with other regions, aiming to mitigate potential disruptions to the grid. It is crucial to recognize that as the installed capacity of solar generation rises, so does the potential for energy imbalances within the grid.

Beyond solar energy production, grid infrastructure issues occur with all implementations of renewable energy sources. As the world witnesses a substantial uptick in various renewable energy sources, similar challenges in grid stability emerge. Whether it be wind, hydro, or other forms of renewable energy, the mounting capacity of these sources in transmission lines can exacerbate the risk of disturbances in the power grid. Regions adopting substantial utility-level renewable energy must recognize the need for heightened inter-regional energy exchanges to counterbalance potential grid disruptions. The universal importance of proactive strategies to maintain grid stability, considering the increasing installed capacity of diverse renewable energy sources. As we strive for a sustainable energy future, understanding and addressing the challenges associated with the integration of renewable energy into grids becomes imperative across the spectrum of clean energy technologies.

Subtopic 2 Energy Storage Solutions for Renewable Sources

Limitations of Renewable energy

A key issue with renewable energy sources is its inability to keep up with the demands of a nation’s energy consumption through the means of renewable energy. Energy institutions are likely to continue relying on fossil fuels for several reasons, particularly during critical hours of high energy demand, such as 6-9 am and 6-9 pm. During these peak usage times, solar energy production is constrained by the absence of sunlight, and wind power generation may be insufficient due to variable wind patterns. The intermittent nature of renewable energy sources poses a significant challenge in meeting the consistently high demand during these key periods. Unlike renewables, fossil fuels offer the advantage of being easily stored in barrels for later use. This storage capability allows energy providers to maintain a reliable and on-demand energy supply, addressing the intermittency issues associated with renewables. Until effective large-scale energy storage solutions for renewable sources are developed, the convenience and flexibility of fossil fuel storage make them a practical choice for meeting the dynamic energy demands of key usage hours. This reliance, however, underscores the ongoing need for advancements in energy storage technologies to facilitate a smoother transition towards a more sustainable energy landscape. If solutions to storing renewable energy aren't produced or implemented, globally we will continue to depend on fossil fuels.

Lithium Battery Storage

While addressing the challenges associated with the intermittent nature of renewable energy during peak usage hours, one potential solution lies in the utilization of lithium-ion batteries. These batteries have gained prominence as a rechargeable energy storage technology, commonly employed in electronic devices, electric vehicles, and increasingly, in grid-scale applications. Lithium-ion batteries have the capability to store excess energy generated during periods of high renewable output, such as when the sun is shining or the wind is strong. During these times, surplus energy can be stored in lithium-ion batteries, and subsequently, released during peak demand hours when renewable sources may be less productive.

Pumped Hydro Storage Facilities

Another viable solution for mitigating the challenges posed by the intermittent nature of renewable energy is the implementation of pumped hydro storage systems. In situations where power plants, such as those utilizing wind power, generate more electricity than can be immediately consumed, grid operators often resort to a process known as "curtailment," where excess energy is essentially wasted. Pumped hydro storage serves as an effective means of capturing and utilizing this surplus energy.

Pumped hydro storage facilities consist of two reservoirs positioned at different elevations. During periods of excess energy production, the surplus electricity is used to pump water from the lower reservoir to the upper reservoir. Subsequently, during high-demand periods when additional power is needed, the stored water is released from the upper reservoir, flowing downhill and passing through turbines to generate electricity. This process effectively transforms the system into a large-scale, grid-connected battery.

Pumped hydro storage offers several advantages, including its ability to store large quantities of energy for extended durations and its comparatively lower cost per unit of storage capacity compared to some battery technologies. However, site-specific requirements, geographical constraints, and potential environmental impacts must be considered when implementing pumped hydro storage. Balancing the benefits of this technology with ethical considerations, such as environmental and social impacts, is crucial for a comprehensive and sustainable approach to energy storage solutions.

The challenges posed by the intermittent nature of renewable energy, particularly during peak usage hours, underscore the continued reliance on fossil fuels for meeting the dynamic energy demands of nations. While lithium-ion batteries and pumped hydro storage systems present promising solutions to address the storage limitations of renewable sources, ethical considerations and advancements in energy storage technologies are imperative for a sustainable transition. Without effective large-scale energy storage solutions for renewables, the dependence on fossil fuels persists globally, emphasizing the urgent need for comprehensive and ethical approaches to achieve a more sustainable energy landscape.

Subtopic 3 Ecosystem-friendly Siting and Environmental Management

Lithium Production

Lithium is an essential component for manufacturing the majority of traction batteries utilized in electric vehicles (EVs) and various consumer electronics. The application of lithium-ion batteries extends beyond EVs to include a wide range of uses, such as energy storage and air mobility. The evolving landscape of battery technologies, characterized by varying active materials mixes, introduces uncertainties regarding the impact on future lithium demand. Notably, emerging technologies like lithium metal anodes, aimed at enhancing battery energy density, exhibit nearly double the lithium requirements per kilowatt-hour compared to prevalent formulations utilizing graphite anodes. With increased measures to prevent climate change with influx of hybrid electric cars to renewable energy storage solutions, lithium is in demand.

Lithium Ion production and labor conditions

It's important to note that the ethical implications may vary depending on the specific practices of the mining operations and the regulations in place. Extraction processes, such as brine pumping and lithium carbonate production, can require significant amounts of water. In regions already facing water scarcity, this can exacerbate environmental issues. Mining activities can result in habitat destruction, soil erosion, and alteration of landscapes, impacting local ecosystems. Also any of these operations can cause contamination through the extraction and processing of lithium can involve the use of chemicals, leading to the potential contamination of soil and water. This pollution can have adverse effects on both the environment and human health. Along with these operations the disposal of the remains, tailings, need specific management to ensure safe and regulated disposal of waste materials created during the extraction process.

Some lithium deposits are found in areas inhabited by indigenous communities. Mining activities may infringe upon their ancestral lands, leading to displacement and conflicts over land rights. Mining operations, especially in LEDCS, may have inadequate labor practices, including low wages, poor working conditions, and lack of workers' rights. Additionally the local communities in which mining operations occur may not receive adequate compensation for the use of their resources. In some regions, there are concerns about the use of child labor or involvement in conflict financing within the supply chain. Ensuring transparency and ethical practices throughout the entire supply chain is challenging but crucial.

Efforts are being made to address these concerns through sustainable mining practices, improved regulations, and the development of alternative technologies. As the demand for lithium continues to rise, it is essential to balance the benefits of renewable energy technologies with the ethical and environmental considerations associated with their raw material extraction.

Additional Consequences to Wildlife

With the implementation of renewable energy, impacts to the environment have occurred directly impacting the livelihood and quality of life for wildlife and native plants of an area.

Environmental siting in the context of renewable power plants refers to the careful selection of locations for the establishment of these facilities, taking into consideration ecological, geographical, and social factors. This process is critical for ensuring the sustainable development of renewable energy projects. The environmental impact of power plants, whether solar, wind, or hydroelectric, can have profound effects on local ecosystems, biodiversity, and communities. Strategic environmental siting involves conducting thorough assessments to identify areas with minimal ecological sensitivity, reduced risk of habitat disruption, and lower impact on wildlife. Additionally, it considers proximity to existing infrastructure and population centers to minimize transmission losses and ensure efficient energy distribution. Proper environmental siting not only helps to avoid adverse effects on ecosystems and biodiversity but also fosters community acceptance, mitigates potential conflicts, and supports the long-term success of renewable energy initiatives. As the global transition to cleaner energy sources accelerates, the emphasis on responsible environmental siting becomes increasingly paramount to ensure a harmonious coexistence between renewable power generation and the ecosystems in which they are situated.

Some instances of this are:

- Wind turbines, a renewable energy source, are commonly built in areas that are remote and rural. Both land-based and offshore, kill millions of migratory birds and bats each year from collisions.
- Hydroelectric dams block migration routes for fish, preventing them from breeding and causing high juvenile mortality rates.
- Concentrating solar plants known as “power towers” produce beams of sunlight intense enough to incinerate insects and birds.

These are just a few examples of the countless impacts of inconsiderate environmental sitting and renewable energy management. If these consequences fail to be taken into consideration, the objective of expanding implementation of renewable energy power plants will fail to have a positive impact on the environment as a whole.

Major Countries and Organizations Involved

United States

The United States, a global leader in technological innovation and policy development, plays a crucial role in the implementation and advancement of renewable energy. Federal agencies such as the Department of Energy (DOE) and the Environmental Protection Agency (EPA) are instrumental in formulating and executing policies to promote clean energy initiatives.

Additionally, individual states, such as California and Texas, have taken significant strides in adopting renewable energy mandates and fostering innovation in renewable technologies. Additionally projected to become involved in Lithium mining pipelines. Additionally, Biden's presidency, in recent months, gained momentum, propelled by the increasing embrace of zero-emission vehicles, the commitment of numerous countries to achieve carbon neutrality by 2050, and the backing of clean energy by the U.S. President Joe Biden.

Namibia

Namibia is a key African country making large steps towards renewable energy. In 2021, Namibia revealed plans for a substantial $9.4 billion green hydrogen initiative set to commence production by 2026. The primary objective is to produce 2 gigawatts of renewable electricity to cater to both regional and global markets. Additionally, South Africa pledged $8.5 billion at COP26 to support the country's Just Energy Transition Partnership, emphasizing the development of new economic opportunities such as green hydrogen. In February 2022, South Africa unveiled intentions to back a series of green hydrogen projects valued at around $17.8 billion over the next decade. Concurrently, Kenya, Morocco, and Nigeria are in various stages of formulating plans to incorporate green hydrogen into their energy portfolios.

China

As the world's largest emitter of greenhouse gasses, China's commitment to renewable energy is pivotal in the global transition to a sustainable future. The country has set ambitious targets for renewable energy adoption and is a major player in the production and deployment of solar panels and wind turbines. China's involvement in international agreements, coupled with its domestic policies, significantly influences the global landscape of renewable energy. China also accounts for the majority of Lithium battery production.

Australia

Australia has become a prominent hotspot for lithium mining, exerting a substantial influence on global lithium sources. The country's significance is exemplified by the Greenbushes lithium mine in Western Australia, a global leader in lithium production and a vital contributor to the worldwide supply chain for lithium. As one of the largest lithium mines globally, Greenbushes plays a pivotal role in meeting the surging demand for lithium-ion batteries, particularly in applications such as electric vehicles, portable electronics, and renewable energy storage systems.

European Union

The European Union (EU) has been at the forefront of promoting renewable energy through initiatives like the European Green Deal. Member countries collectively work towards achieving renewable energy targets and reducing carbon emissions. The EU provides a regulatory framework and financial support to member states, fostering collaboration and ensuring a coordinated approach to the transition to renewable energy. Additionally, the European Union plans to scale up renewable hydrogen projects and invest a cumulative amount of 470 billion euros ($740 billion) by 2050.

International Renewable Energy Agency (IRENA)

RENA is a key international organization dedicated to advancing renewable energy globally. Established in 2009, it facilitates collaboration among nations, conducts research, and provides policy advice to promote the widespread adoption of renewable energy. IRENA's initiatives and reports contribute significantly to shaping the international discourse on sustainable energy.

India

India, with its rapidly growing economy, faces energy challenges and opportunities. The country has set ambitious renewable energy targets and implemented policies to promote solar and wind power. India's engagement in global forums, such as the International Solar Alliance, underscores its commitment to international collaboration in advancing renewable energy solutions.

Chile

Chile stands as a leading contributor to the renowned "lithium triangle" in Latin America, a region that played a pivotal role in global lithium production in 2022, accounting for approximately 30 percent of the world's mined lithium. Within Chile, the Salar de Atacama is a prime example of the country's significant lithium-rich deposits. The Salar de Atacama is home to some of the world's largest lithium reserves, and major mining operations, such as those by companies like SQM and Albemarle, operate in this expansive salt flat.

Timeline of Events

Date (start - end)	Name	Description
June, 5 1972	United Nations Conference on the Human Environment	The United Nations (UN) addresses environmental concerns, laying the groundwork for future

		discussions on renewable energy.
June, 3 1992	Earth Summit in Rio de Janeiro:	The UN reaffirms its commitment to sustainable development, marking a pivotal moment for global environmental awareness.
February, 16 2005	Kyoto Protocol Ratification:	The international community takes a significant step with the adoption of the Kyoto Protocol, setting targets for reducing greenhouse gas emissions.
January, 26 2009	Launch of the International Renewable Energy Agency (IRENA)	IRENA is established to promote the adoption of renewable energy globally and provide a platform for collaboration among nations.
December, 1 2015	Launch of the Africa Renewable Energy Initiative	African nations unite to accelerate the deployment of renewable energy across the continent, aiming to enhance energy access and drive sustainable development.
December, 12 2015	Paris Agreement	The landmark accord sets ambitious targets to limit global warming, encouraging nations to increase their use of renewable energy sources.
January, 1 2016	United Nations Sustainable Development Goals (SDGs)	Renewable energy becomes integral to the UN's SDGs, emphasizing its role in achieving a sustainable and equitable future.
December 2019	European Green Deal	The European Union announces a comprehensive plan to make the continent the world's first climate-neutral region, heavily relying on renewable energy.
October 31-November 13, 2021	COP26 in Glasgow	Global leaders gather to strengthen commitments and discuss strategies for accelerating the transition to renewable energy on a global scale.

2022	Launch of the UN Decade of Action for Sustainable Development:	The UN calls for urgent and transformative action, with renewable energy playing a pivotal role in addressing climate change and environmental sustainability.

Relevant UN Treaties and Events

- Paris Agreement, 12 December 2015 (A/RES/70/1)
- Sustainable Development Goals (SDGs), 25 September 2015 (A/RES/70/1)
- Sendai Framework for Disaster Risk Reduction, 18 March 2015 (A/RES/69/283)
- 2030 Agenda for Sustainable Development, 25 September 2015 (A/RES/70/1)
- International Solar Alliance (ISA), 6 December 2017
- Global Compact for Safe, Orderly and Regular Migration, 19 December 2018 (A/RES/73/195)

Previous Attempts to solve the Issue

Grid Integration

Grid codes constitute a set of technical standards governing the operation and interaction of power systems within an electrical grid. As the global transition towards renewable energy accelerates, these codes play a pivotal role in facilitating the integration of intermittent sources like solar and wind power into traditional grids. By specifying operational criteria and technical requirements, grid codes ensure that renewable energy systems adhere to standards related to voltage levels, frequency control, and fault response. This adherence enables a seamless and stable integration, minimizing the risk of disruptions and optimizing overall grid efficiency. In essence, grid codes serve as a crucial framework, fostering the coexistence of traditional and renewable energy systems and contributing to the development of sustainable and resilient energy landscapes. As recently as December 2020, the EU Agency for the Cooperation of Energy Regulators published their monitoring reports concerning connection network codes, highlighting compliance issues they faced with various member states as this is a global effort for grid integration of renewable energy. Additionally, implementation of sophisticated grid management systems, like those developed by companies such as Siemens and ABB.

Energy Storage

Advancements in battery technologies, such as lithium-ion batteries for energy storage. Ongoing with notable progress in recent years. For instance, Tesla's Powerpack and Powerwall, introduced in 2015, represent efforts to address energy storage challenges. Additionally utilizing lithium batteries on a larger scale by being implemented at renewable energy power plant sights. Currently, large-scale battery storage systems are primarily being implemented in Australia, Germany, Japan, the United Kingdom, the United States, and various European countries. Notably, the Tesla 100 MW / 129 MWh lithium-ion battery storage project at the Hornsdale Wind Farm in Australia stands out as one of the more substantial systems in terms of capacity.

Projects dedicated to the exploration of hydrogen for large-scale energy storage, such as the Energiepark Mainz in Germany, exemplify innovative approaches to harnessing renewable energy. Since July 2015, the Energiepark Mainz has employed three SILYZER 200 PEM electrolysis systems to convert wind energy into hydrogen, effectively providing a means to store surplus energy generated during peak production periods. The process involves utilizing excess electricity from wind sources to power the electrolysis systems, which split water into hydrogen and oxygen. This generated hydrogen serves as a clean and efficient energy carrier that can be stored for later use, addressing the intermittency of renewable sources and contributing to grid stability. The utilization of SILYZER 200 PEM electrolysis technology underscores a commitment to advancing sustainable energy solutions by transforming renewable power into a versatile and storable form, thereby enhancing the viability of large-scale hydrogen-based energy storage systems.

Ecosystem Friendly Sitting

In March 2023, pioneered in an initiative in Great Britain by The Coal Authority and Gateshead council, as partners they made use of the abandoned old mine shafts that had filled with rain water that make up part of the extensive coalfields that exist across Great Britain and that 25% of homes/businesses operate over. By identifying the internal heat, the Coal Authority was able to implement geothermal energy to sustainably support energy production for the places they live and work.

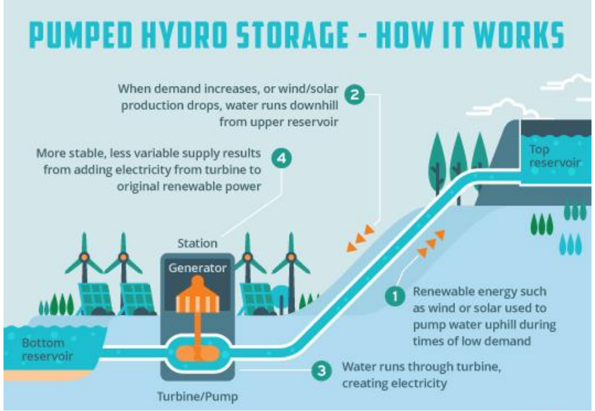
Possible Solutions

Subtopic 1 grid integration and smart infrastructure

- The integration of additional wind and solar power into the grid can be facilitated through energy storage, which helps stabilize the fluctuating generation from these rapidly expanding renewable energy sources. As we continue to deploy more wind and solar resources, the significance of storage will increase for ensuring an efficient, dependable, and environmentally friendly grid.

Hydroelectric Pumps

- Utilizing more hydro pumps at power plants. These stations store excess energy generated by various power plants during times of low energy use, utilizing otherwise lost, this can constitute as smart infrastructure for future.
    - This can also be utilized for general energy storage of the renewable
- Delegates should keep in mind that many energy storage solutions can be implemented to solve grid instability as these conflicts can commonly ebb and flow.

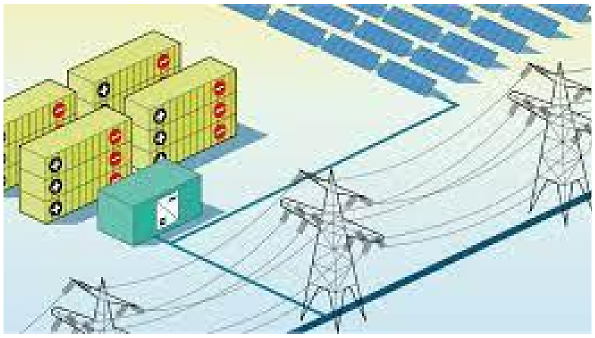


Subtopic 2 energy storage solutions for renewable sources

Hydroelectric Pumps

- Pumped hydroelectricity energy storage thus far has proved to be the most efficient system to implement for renewable energy. Using surplus electricity during periods of low demand to pump water from a lower reservoir to an upper reservoir. When energy demand is high, the stored water is released from the upper reservoir, flowing downhill and generating electricity through turbines. This method leverages gravitational potential energy to store and release electrical energy efficiently. Its scalability and proven technology make it a crucial aspect of future energy storage solutions. The only limitations of this method are the scarcity of a suitable environment that contains reservoirs and the necessary steepness/elevation difference.

Electrochemical Battery Energy Storage

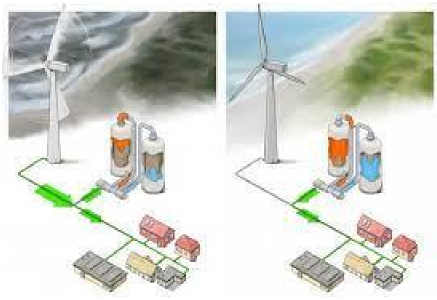


- Electrochemical battery energy storage encompasses various battery technologies, with lithium-ion batteries being mainly used. The already popular production of lithium batteries will allow for these storage solutions to easily be widely implemented. These batteries store energy through electrochemical reactions, allowing for efficient storage and discharge of electricity. As advancements continue, the development of high-capacity and longer-lasting batteries contributes significantly to addressing the intermittency of renewable energy sources and grid stability.

Thermal and Phase Transition Energy Storage Systems

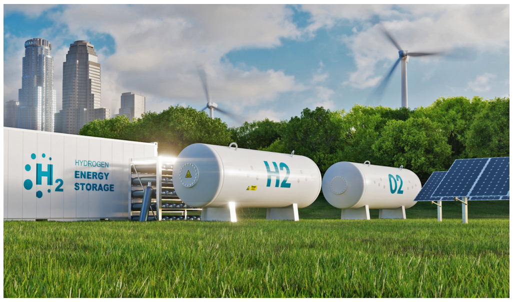
- Additionally thermal and phase transition energy storage systems involve capturing surplus energy as heat and using it for power generation when needed. Materials capable of undergoing phase transitions, such as from solid to liquid, store and release energy during these transitions. This innovative approach provides a means to store and efficiently utilize excess energy, particularly in conjunction with renewable sources like solar and wind. However this solution produces greenhouse gasses and other dangerous chemicals escaped into storage sights to water sources and the air.

Mechanical Energy Storage



- Mechanical energy storage involves converting surplus electricity into mechanical energy and later converting it back into electrical energy when demand is high. Methods include flywheels, compressed air energy storage, and gravitational potential energy systems. These technologies offer flexibility and can be deployed in various settings, contributing to a more reliable and resilient energy infrastructure. Lots of focus must be placed on ensuring safety for workers of mechanical operations as flywheels can break or disintegrate.

Hydrogen Electrolysis



- Hydrogen electrolysis(regularly referred to as Green Hydrogen) involves using surplus electricity to split water into hydrogen and oxygen. The produced hydrogen can be stored and later used as a clean fuel for power generation or in fuel cells. As a versatile and storable energy carrier, hydrogen electrolysis holds promise for long-term energy storage and can play a vital role in the future integration of renewable energy sources into the broader energy landscape. Serving as an energy carrier, green hydrogen functions as a type of battery, enabling the storage of surplus energy generated by renewable sources such as solar and wind during their peak periods. By alleviating the intermittency inherent in renewables that may not generate power consistently throughout the day, green hydrogen ensures a consistent and ample power supply for grids. This quality renders green hydrogen particularly appealing in the realms of decarbonization, offering the prospect of substantial usable energy without contributing to climate change.

All energy solutions require high maintenance and investment. These operations are not one time implementation but a commitment from a nation of their workforce for regulation and maintaining order.

Subtopic 3 ecosystem-friendly siting and environmental management

Lowering the Unethical Consequences of Lithium Mining

To address the obstacles associated with lithium mining and mitigate its environmental repercussions, it is crucial to explore a range of approaches. These encompass enhancing sustainability, diminishing the energy and water consumption during extraction, and curbing the generation of waste. Furthermore, it is imperative to assess the potential for sustained environmental harm and evaluate the effects of mining activities on nearby communities and ecosystems.

- A possible solution is direct lithium extraction that separates lithium from other elements found in underground saltwater reservoirs. By pumping a mineral-rich brine to the surface, undergoing several stages of filtration and chemical reactions to extract lithium. The resulting product is further processed into a form suitable for battery production. Unlike conventional approaches that involve the prolonged evaporation of substantial water volumes, often raising ecological issues, DLE swiftly extracts lithium directly from brines within a matter of hours or, at most, days.
- Additionally to create a sustainable system, one key aspect involves reducing dependence on high-risk sources, contributing to the overall resilience of supply chains.

Emphasizing adherence to international labor standards is another facet, promoting ethical and socially responsible practices. The strategy also addresses environmental concerns by actively working to mitigate negative impacts, aligning with broader sustainability goals. Simultaneously, it advocates for the preservation of natural resources, recognizing their importance for future generations. In essence, this approach reflects a comprehensive commitment to sustainability, aligning with global objectives and emphasizing responsible practices across economic, social, and environmental dimensions.

Smaller Scale Implementation

- Instead of creating power plants for a larger implementation scale, it can be more beneficial to apply renewable energy on smaller individual building designs such as installing solar panels on rooftops. This will reduce electricity costs as buildings can generate their own power or sell excess energy back to the grid. However, because this will be on an individual level, it will have less conflicts with the grid as a whole. But properly developed grid infrastructure is necessary.

Utilizing Old Infrastructure

- A lesser known solution is to utilize old abandoned structures to reuse for renewable energy. Once coal mines are abandoned, they typically accumulate water from various sources. This water retains heat from deep beneath the Earth's surface. A process involves drilling bore holes to bring this heat to the surface. Subsequently, the extracted heat is passed through heat exchanges and heat pumps within buildings and homes. Notably, the inaugural mine-water heating scheme in Great Britain commenced full operation at the end of March, set to eventually provide heating for more than 1,200 homes.
- By using geothermal energy extracted from coal mines extends beyond heating structures; it can also be employed for cooling purposes, presenting numerous opportunities, particularly for energy-intensive facilities like data centers. These centers, notorious for their high carbon footprint and substantial water consumption for cooling, are being investigated by Scottish researchers. The study explores the potential of channeling hot air from data centers into coal mines, subsequently recovering the heat from the water to warm other buildings.

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