International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-8, Issue-6, November 2021
https://doi.org/10.55524/ijirem.2021.8.6.92
www.ijirem.org

Power Generation and Storage Application Technologies

Dr. Anubhav Soni
SOMC, Sanskriti University, Mathura,
Uttar Pradesh, India
Email Id- anubhavs.somc@sanskriti.edu.in

Dr. Jitendra
SOMC, Sanskriti University, Mathura,
Uttar Pradesh, India

ABSTRACT
In this article we evaluate the ecological impressions of carbon capture and use (CCU) and carbon capture and storage (CCS) of technologies. To this end research on the assessment of the life cycle from the different literatures has been addressed. There are a total of 27 reports, 11 on CCS and 16 on CCU. CCS research has shown that power plants will reduce their global warming potential (GWP) from 63 to 82 percent, with combustion of oxygen fuel in pulverized coal and integrated combined cycle gasification (IPCG) plants to the greatest reduction and post-combustion capture in combined-cycle gas turbine (CCGT) plants, achieving the least reductions. CCS has higher environmental impacts than without acidification and human toxicity. The GWP for CCU varies greatly depending on how it is used. Mineral carbonation will decrease GWP by 4% to 48% compared to no CCU. In addition, compared to conventional DMC techniques, under CO2 lowers the GWP by 4.3 times and ozone depletion by 13 times for chemical extraction.

Keywords
Carbon Capture, Climate Change, Combustion, Storage, Sustainable Development.

1. INTRODUCTION
The importance of sustainable development in regional growth and its history can be traced back to the 1970s and was defined and characterized in 1987 by the WCED as "development that fulfils the demands of the present without compromising the capacity of future generations to satisfy their needs." In Ryo de Janeiro in 1992, the United Nations Climate and Sustainability Conference (UNCED), also known as the 'Earth Summit,' decided to launch the mechanism for the creation of sustainable development objectives (SDG) collection, which could be a valuable tool for cohesive and focused actions on sustainable development [1].

1.1 Sustainable Development Requirement
Poverty continues mostly a rural issue, with the preponderance of the world's impoverished residing in rural areas. It is believed that 76 percent of the developed poor in the globe live in rural regions, which is much more than 58 percent of the entire people living in rural areas. Poverty significantly limits people's dietary quantity and regularity. Workers in industrialized countries typically make just $1 to $2 a day and, with less money in such countries, their economic need for food is less. In contrast, environmental limitations including ground, water and electricity complicate the rural situation.

- Sustainable Development Dimensions Objectives The UN High-Level Global Sustainability Panelprovided he most consistent and coherent examination of the principles relevant to any SD framework in 2012.It should have a common character, dealing with problems affecting not just rich nations but all countries.
- A widely accepted worldwide strategy for long-term growth should be articulated.
- It may cover many key areas which have not been fully safeguarded by the MDGs (MDGs).
- It should be comprehensive, with all three SD dimensions included.
- It may have short-term goals while remaining long-term with a potential 2030 deadline.
- It should engage stakeholders in resource mobilization and execution.

In light of fresh scientific findings, frequent evaluations of these targets should be possible. On the other hand, it was challenging to define a set of quantitative measures during the present study. Since metrics are generated from sustainable development dimensions, the researchers have found that the quantity and kinds of dimensions within companies are not universal requirements.

1.2 Achievement of Sustainable Development Objectives
The High Level Committee on Global Sustainable development has presented a thorough evaluation of sustainable development's achievements, summarized as follows:

- Global Prosperity and Inequalities: during the last two decades, global GDP has risen by 75%, while the disparity has steadily increased.
- Eradication of poverty: The nation is on pace to meet the Millennium Development Goals.
- Trees: Despite a slowing rate of deforestation, the globe keeps losing its forest area at an unprecedented rate.
- Ocean Assets: Overfishing is now widely acknowledged as being over-exploited or mistreated, which is much larger than the previous two decades.
- Climate change: annual overall emissions of CO2 in the period 1990-2009 have risen by 38 percent, resulting in a potential increase in the temperature of 5°C.
- Biodiversity and ecosystems: research indicates a decrease in the majority of forests and an increase in the rate of extinction of species.
- Gender: While freedom, education, health and working circumstances for women have greatly improved, there are still continuing inequalities in all communities.
- Education: Education throughout the globe has seen major changes. Literacy rates are rising over the world, but progress is sluggish.
- Appetite: Global food production now has stabilized; enough food is produced to adequately feed all of us; but food availability is another matter.
- Over the course of the past several decades, significant technological advances have impacted various areas of study, traditions and cultural connections, as well as

collateral climatic effects, creating new opportunities and problems.

- Environmental and social costs of the Green Revolution (Institute for Food and Development Policy 2009).
- Climate change presents a danger both to nations and to people.
- Environmental devastation reflects, among other things, the destruction of productive land, unsustainable land use and desertification.
- Developments in the Global Economy: No nation is immune to global economic trends since the global economy is interconnected.
- Responsibility and accountability: institutions at all levels confront increasing pressure from individuals who question if they will operate in the public good in the longer term.
- In the year 2050, two-thirds of a global total population will be under water stress and worldwide decline in urban air quality.
- Food security: persistent hunger is not really about more food; it's about availability. The only important issue to be addressed with relative ease is waste.

1.3 Sustainable Development Technology Innovation

Meeting the sustainable growth goals would need effort on many fronts, including exploitation and exploitation of the potential of technological development. Examples of such breakthroughs include carbon capture and storage systems, more efficient irrigation techniques, medicines that are essential, household water treatment devices and industrial procedures that minimize waste and pollution. Although some necessary developments can be fostered at national level through public and private processes, such initiatives have proved insufficient to achieve global sustainability objectives, in particular to meet the needs of the world's most disadvantaged, poorest, or underprivileged people in current and future generations. Very often, innovations are either completely unavailable or not matched to end user needs, because of a lack of a sufficiently feasible demand[2].

This curriculum initiative aims to promote awareness and knowledge of how the 'global innovation system' for sustainable development innovation may be improved with an inclusive approach. Researchers conduct a comparative study to assess how effectively the economy responds to five sustainable development needs, with a special focus on equality. The article examines specific instances of "framework interventions" to improve the global innovation system in order to provide policy recommendations which are generalizable and generalizable in a number of sectors. The findings assist realize the potential of science and technology to solve the most pressing problems of sustainable development [3].

Existing research argues that policy on innovation needs a mix of tools, particularly that which focuses on long-term technological progress. Emerging socio-technical systems are vulnerable not just to market flaws (such as negative environmental externalities), but to systemical and transition failures. A number of examples are: various institutional limitations, a lack of diversity in the actor base, skill gaps, a lack of collaboration amongst important players.

The many phases of technological development and three main types of policy tools for innovation as well as their relative positions are shown below: Technology-push tools like pilot plants, patent legislation, tax breaks, etc. make fundamental and applied knowledge inputs simpler to get. Instruments promoting new markets and new technologies such as public procurement, feed-in tariffs, standards and other demand-drawing processes. Systemic tools that provide infrastructure, encourage stakeholder alignment, inspire strategy and vision and provide organizational solutions for functions at the level of innovation systems [4].

1.4 CO2 Technologies

Byproducts are formed during combustion, and the kind of combustion has an impact on the byproduct elimination process used. Capturing options are available on the market, but usually are expensive, representing around 70-80% of the total cost of a full CCS device, which includes collection, transportation and storage. As a consequence, important R&D goal is to cut running expenses and the energy penalty. There exists three kinds of −after combustion, pre-combustion, and oxy-fuel – capture systems using different combustion processes[5].

1.4.1 Post-combustion

Following combustion, the procedure removes the amount of flue gas as a whole from the flue gas. For modern power plant retrofitting, post-combustion technologies are an alternative. The process was tested on a small scale, with yields producing 800 t/day being achieved. A significant parasite load, on the other hand, is the principal impediment to post-combustion capture. Because CO_2 levels in combustible flue gas are often quite low, there is an increased energy penalty and associated expense to capture the amount -CO 2 (more than 95.5 percent) required for transportation and storage. According to the National Energy Technology Laboratory in the USA, after capture of the fuel, the cost of electric power production would be increased by 70 percent. According to a recent study, the cost of electricity in gas and coal-fired facilities would increase by 32 percent and 66 percent correspondingly after combustion. There are presently 16 linked large-scale CCS projects under development.

1.4.2 Pre-combustion

This technique pretreats the fuel until it is ready to burn. Pretreatment for coal entails gasification inside a low-oxygen environment, which results in a syngas consisting mainly of CO and H_2 and relatively devoid of other polluting gases (Equation 1). The syngas will next experience a changeover of water gas interaction with steam that results in additional H_2, while the CO gas will be converted into a high concentration of CO TO 2 (> 20%) in the H 2/TO 2 fuel gas melt, which facilitates the separation of CO_2 [6].

$$\mathrm{Coal} \xrightarrow{\text{gasification}} \mathrm{CO} + H_2 \tag{1}$$

$$\mathrm{CO} + \mathrm{H_2O} \xrightarrow{\text{water-gas shift}} \mathrm{H_2} + \mathrm{CO_2} \tag{2}$$

$$\mathrm{CH_4} + \mathrm{H_2O} \xrightarrow{\text{reform}} \mathrm{CO} + \mathrm{H_2} \tag{3}$$

The H_2 is subsequently burnt in the air, resulting mostly in the production of N_2 and water vapor. Pre-combustion capture might be used in coal-fired combined cycle integrated gasification power plants, however it might result in 7-8 % efficiency losses. The road plan has been developed for the advances in IGCC technologies, which can improve IGCC performance to the point where present IGCC technology is matched or exceeded without capture.

Most of the natural gas, including –CH_4, may be transformed into H_2 and CO containing syngas (Equation 3). The reaction from water gas change (Equation 2) will raise the H 2 concentration and the remainder of the procedure is the same as for coal. A cost and performance study was undertaken on a modern combined cycle gas turbines fueled by natural gas and equipped with a pre-capture device , obtaining an efficiency of 80% for capture and avoiding cost of up to $29/t for advanced design [7].

1.4.3 Combustion of Oxygen Fuel

Oxygen is utilized instead of air for burning in oxygen-fuel combustion. This reduces the nitrogen content of the exhaust gas, which affects the final separation process. The significant reduction in thermal NOx is another benefit of this approach. Because pure oxygen is utilized for combustion the major components. The leftover gases, which have a high percentage of residual CO2, may be compressed, transported and deposited (80 to 98% depending on the fuel used). Though theoretically feasible, this system absorbs an energy-intensive air separator with a considerable amount of oxygen. As a result, the expenses are high, and the fuel penalty might be as high as 7% when compared to a plant that does not use CCS. Furthermore, large amounts inside the flue gas might exacerbate the problem of system degradation.

1.4.4 Carriage of CO2

It must be transferred to a warehouse or commercial use facilities after all of the remaining flue gas constituents have been separated. Regardless of ltd. 2's ultimate purpose, any CCS project need a dependable, safe, and economically viable transportation infrastructure. Depending on the amount, a variety of modes of transportation may be used, ranging between road tankers to boats and pipelines. According to a research on CCS in the North Sea, the transportation of tankers by ship using technology developed from LGG carriers with pipes at total costs of 20 to 30 USD/ton when carried over 2 TCO2/year across the distance of storage in the North Sea is possible and economically efficient [7].

Pipelines are considered the most viable method for onshore transit of large quantities of ÚCO NO 2 across great distances, since the CCS would be needed if widely implemented. Rail and road containers are more competitive across shorter distances. Transport costs vary significantly based on the country's economic situation. According to a cost research study carried out in China, using ship tankers at mass flow of 4000 tonnes per day would have cost 7.48 USD/ton per ton/sound for rail tankers, compared with 12.64 USD/ton per ton/official ton/sounding for rail tankers, and 7.05 USD/ton/official tanker for 300 km pipelines[8].

To optimize the mass/volume ratio, the whole CCO chain 2 is transported via a dense phase in either liquid or supercritical conditions. Super-critical is the ideal condition for transit of a pipeline via the CA 2, This means that the pipeline's operational temperature and strain should stay inside a super-critique boundary, i.e. above 32.1 °C, atm and 72.9 atm. The typical pressure and temperature range of the pipeline is between 85 and 150 bar. Impurities in the −after CO 2 flow are a significant issue, because their inclusion may modify the pressure and temperature envelopes in order to stabilize one-phase flow. Furthermore, the existence of water levels greater than 50 ppm may result in the creation of carbonic acid inside the pipeline, that might cause corrosion. Hydrates may also develop and obstruct the operation of valves and compressors. The corrosion rate of carbon steel, which is often used in pipeline construction, is predicted to be approximately 10 mm/year [9].

Currently, just a few more transit pipes are in use. Canyon Reef Transporter, a 225-kilometer pipeline completed in Texas in 1972, is the largest pipeline. (USA). The longest pipelines is indeed the 800-kilometer Cortes pipeline, that has been transporting 20 million tonnes of energy resources from a Colorado source to oil wells in Denver City, since 1983. CO2 pipes are typically made of carbon steel, consist of sealed sections of tweleve meters each with crack arrester every 350 meters and valves block every 16 to 32 kilometers. In 1-metre-deep holes, the onshore pipes are buried. Deeper water offshore pipelines must also be installed in trenches to protect against fishing and mooring activities. Deep water pipes are not typically necessary unless they are smaller than 400mm in diameter [10].

2. DISCUSSION

The high CO2 flux may subsequently be transferred for geological or CO2 storage purposes. Kikuchi evaluated the economic and technical consequences of large-scale CO2 recycling and proposed an improved CO2 capture and reuse system for the production of industry, agriculture and electricity. A recent inauguration of a demonstration facility in Luzhou, China, gathered CO2 (160 t/day) ammonia and urea is used throughout the manufacturing process. Meats, drinks, coolants, as well as firefighting gases all contain CO2. CO2 consumption contributes for just 2% of total emissions, but chemical consumption forecasts predict that CO2 emissions would drop by 700 megatons per year, considerably surpassing the combined capability of nuclear, wind and cellulosic biofuel technology. Other relevant developing sectors need the use of CO2 as an energy storage buffer gas.

A process, which depends on the fast interaction of CO2 with rich silicate stones or inorganic waste of Mg/Ca and is capable of producing stable carbonates, may be utilized for the utilization of CO2. The unfavorable kinetics of this process have been addressed directly by increasing pressure and/or temperature or employing active leaching agents indirectly. The pH swing has become extremely important among the indirect methods, since it enables the chemicals employed during the phase separation and the recovery of pure components to be recycled.

CO2 may be stored in deep freshwater aquifers and stocks of oil or gas which have no further useful value. Geological storage is now seen as the most viable option for the storage of the enormous quantities of CO2 required to effectively control climate change and global warming. Hundreds of millions more tonnes of CO2 have been trapped due to a variety of physical and chemical mechanisms, may be present in a typical geological storage facility. The three most commonly recognized natural CO2 storage formations are depleted (or almost depleted) petroleum, gas and freshwater aquifers. Although deep ocean storing is a viable alternative for CO2 storage, ecological concerns are likely to limit its use (like eutrophication and ocean acidification). Deep saline aquifers have been determined to have a CO2 storage capability of 400 to 10,000 GT, compared to 920 GT for sinking oil as well as gas fields. Different geological settings take the durability as CO2 storage sites into account.

CCS is one of the technological options possible to achieve the global climate change objective of 2 degrees by 2050. Science research as well as application development, and also small-scale pilot experimentation, are critical for future technology adoption. The findings in this research are noteworthy in terms of CCS technology's potential usage and commercialization. It's worth noting that in 2014, a particular aspect on chemical looping combustion was published, featuring over 20 contributions chosen from the second world meeting on chemical looping. There will also be a new special edition. Large-scale CCS implementing this intensive will be hampered by the uncertainties surrounding global climate change debates. Ineffectiveness in decreasing greenhouse emissions (not only with CCS, but with other technologies as well) would, nevertheless, dramatically raise future costs. For engineers and scientists throughout the globe, the importance of R&D in promoting innovation and technical advancement in CCS becomes even more critical under these conditions. Applied electricity will play an essential role in disseminating and encouraging new insights or innovation in CCS in order to make critical information accessible for future large-scale CCS construction projects.

3. CONCLUSION

The environmental impacts of various CCS and CCU alternatives for the collection, transportation, and usage of CO2 generated by power stations and other industrial sources were assessed in this research. Post- and pre-conversion CO2 recovery, as well as oxy-fuel combustion, are the most used CO2 collecting methods. Capture by physical adsorption utilizing monoethanolamine following conversion is the most established and widely used approach, particularly for power generation (MEA). The usage of MEA and regeneration, on the other hand, significantly increases CO2 emissions and the potential for global warming. One of the problems for both CCS and CCU is the creation of more environmentally friendly sorbents. The obtained CO2 may be retained in sedimentary deposits or in the oceans, a process called as geological storage. Because the properties of depleted oil and gas wells and deep groundwater aquifers are well established, the first looks to be a more plausible possibility. In actuality, it's uncertain how dumping in oceans might affect acidity and marine life. CO2 may be employed directly in a variety of sectors, including the food and beverage and pharmaceutical industries, in addition to storage. It might also be used to manufacture high-demand items like urea, methanol, and biofuels.

The results for the other environmental impacts vary across studies. The overwhelming majority of respondents, however, stated that CCS plants had more effect than those without. The primary reason for this is additional coal mining and transportation to compensate for energy efficiency losses caused by CCS, MEA processing, and ammonia created during CO_2 uptake in MEA. As a result, the impacts of power plants were shifted upstream or downstream.

REFERENCES

[1] Beal CM, Archibald I, Huntley ME, Greene CH, Johnson ZI. Integrating Algae with Bioenergy Carbon Capture and Storage (ABECCS) Increases Sustainability. Earth's Futur. 2018;

[2] Gibbins J, Chalmers H. Carbon capture and storage. Energy Policy. 2008;

[3] Bui M, Adjiman CS, Bardow A, Anthony EJ, Boston A, Brown S, et al. Carbon capture and storage (CCS): The way forward. Energy and Environmental Science. 2018.

[4] Kelektsoglou K. Carbon capture and storage: A review of mineral storage of CO2 in Greece. Sustain. 2018;

[5] Fridahl M, Lehtveer M. Bioenergy with carbon capture and storage (BECCS): Global potential, investment preferences, and deployment barriers. Energy Res Soc Sci. 2018;

[6] Vaughan NE, Gough C, Mander S, Littleton EW, Welfle A, Gernaat DEHJ, et al. Evaluating the use of biomass energy with carbon capture and storage in low emission scenarios. Environ Res Lett. 2018;

[7] Cuéllar-Franca RM, Azapagic A. Carbon capture, storage and utilisation technologies: A critical analysis and comparison of their life cycle environmental impacts. Journal of CO2 Utilization. 2015.

[8] Pires JCM, Martins FG, Alvim-Ferraz MCM, Simões M. Recent developments on carbon capture and storage: An overview. Chem Eng Res Des. 2011;

[9] Muratori M, Calvin K, Wise M, Kyle P, Edmonds J. Global economic consequences of deploying bioenergy with carbon capture and storage (BECCS). Environ Res Lett. 2016;

[10] Verdon JP, Stork AL. Carbon capture and storage, geomechanics and induced seismic activity. J Rock Mech Geotech Eng. 2016;

