NCGG Internship Report

Submitted by

Nitesh Tiwari

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Internship report

Dr. Gazala Hasan

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Introduction:

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, but since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil, and gas), which produces heat-trapping gases.

History of climate change and global warming.

- Industrial Revolution, in about 1750 - 1950, human activities such as burning fossil fuels, including coal and oil, have increased greenhouse gas concentrations in our atmosphere
- In 1950, after World War 2, there was excessive use of cars and buses due to which the amount of co2 is continuously increasing and by 2020 its amount has increased to 30%.
- Fossil fuel was used in large quantities due to which the amount of Co2, Ch4, Cfcl3, No2 increased in the atmosphere.

Green House Effect:

Greenhouse gas (GHG) emissions are gases in the Earth's atmosphere that trap heat. These gases contribute to the greenhouse effect, leading to an increase in the Earth's surface temperature. Human activities, particularly the burning of fossil fuels, deforestation, and industrial processes, have significantly increased the concentrations of these gases, contributing to climate change.

Here are some key points about greenhouse gas emissions:

Common Greenhouse Gases:

Carbon Dioxide (CO_2): The primary greenhouse gas emitted through human activities, mainly from the burning of fossil fuels (coal, oil, and natural gas), deforestation, and certain industrial processes.

Methane (CH_4): Emitted during the production and transport of coal, oil, and natural gas. It also results from livestock digestion, rice paddies, and the decay of organic waste in landfills.

Nitrous Oxide (N_2O): Produced by agricultural and industrial activities, as well as the combustion of fossil fuels and biomass.

Fluorinated Gases: This category includes hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3), which are synthetic gases with high global warming potential. They are commonly used in refrigeration, air conditioning, and various industrial processes.

Sources of Greenhouse Gas Emissions:

Energy Sector: The burning of fossil fuels for electricity and heat is a major source of CO_2 emissions. Additionally, methane emissions occur during the extraction and transport of fossil fuels.

Transportation: Combustion of gasoline and diesel fuels in vehicles is a significant source of CO_2 emissions. Methane is also emitted from livestock and manure management in the agricultural sector.

Industry: Certain industrial processes, such as cement production, chemical manufacturing, and metal production, contribute to CO_2 and other greenhouse gas emissions.

Land Use Changes: Deforestation and changes in land use release large amounts of stored carbon into the atmosphere, contributing to CO_2 emissions.

Waste Management: Landfills produce methane as organic waste decomposes.

Global Warming Potential (GWP):

Each greenhouse gas has a different capacity to trap heat in the atmosphere over a specific time period. GWP is a measure that compares the warming potential of different gases relative to carbon dioxide over a specified timeframe (usually 20, 100, or 500 years).

Mitigation Strategies:

Renewable Energy: Transitioning to renewable energy sources, such as solar, wind, and hydropower, can reduce reliance on fossil fuels.

Energy Efficiency: Improving energy efficiency in industries, buildings, and transportation helps reduce overall greenhouse gas emissions.

Afforestation and Reforestation: Planting trees and restoring forests can capture and store carbon, mitigating the impact of emissions.

Carbon Capture and Storage (CCS): This technology captures CO_2 emissions from industrial processes and power generation before they are released into the atmosphere.

Monitoring and reducing greenhouse gas emissions are critical components of global efforts to address climate change and mitigate its impacts on the environment and societies. International agreements like the Paris Agreement aim to coordinate these efforts on a global scale.

Melting Glaciers:

since the industrial revolution, carbon dioxide and other greenhouse gas emissions have raised temperatures, even higher in the poles, and as a result, glaciers are rapidly melting, calving off into the sea and retreating on land.

Human activities are at the root of this phenomenon. Specifically, since the industrial revolution, carbon dioxide and other greenhouse gas emissions have raised temperatures, even higher in the poles, and as a result, glaciers are rapidly melting, calving off into the sea and retreating on land.

Water level of ocean:

Global mean sea level has risen about 8–9 inches (21–24 centimeters) since 1880. The rising water level is mostly due to a combination of melt water from glaciers and ice sheets and thermal expansion of seawater as it warms.

Average sea levels have swelled over 8 inches (about 23 cm) since 1880, with about three of those inches gained in the last 25 years.

Sea levels are anticipated to rise by another 7.6–91.4 cm by 2025.

About Paris Agreement:

The Paris Agreement is a landmark international treaty aimed at addressing the global challenge of climate change. It was adopted on December 12, 2015, during the 21st Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France. The agreement officially entered into force on November 4, 2016. provisions of the Paris Agreement: Global Temperature Goal: The central objective of the agreement is to limit the increase in global average temperature to well below 2 degrees Celsius above pre-industrial levels, with an aspirational target of limiting the increase to 1.5 degrees Celsius. This more ambitious target aims to reduce the severity of climate impacts.

Nationally Determined Contributions (NDCs): Each participating country (referred to as a Party) is required to submit its NDC, outlining its specific climate action plan, targets, and policies. These contributions can be adjusted over time but should reflect the country's best efforts to reduce greenhouse gas emissions and enhance climate resilience. Transparency and Accountability: The Paris Agreement establishes a robust framework for transparency, reporting, and review. Countries are obligated to regularly report on their emissions and progress in implementing their NDCs. This transparency is essential to building trust and ensuring that countries are held accountable for their commitments.

Global Stock take: The agreement calls for a periodic global stock take of collective progress toward meeting the temperature goals. This assessment allows for adjustments in NDCs and global strategies to align with the latest science and changing circumstances.

Financial Support: Developed countries are expected to provide financial support to developing countries to help them mitigate and adapt to the effects of climate change. The agreement sets a goal to mobilize $100 billion annually from a variety of sources to support these efforts.

Loss and Damage: The Paris Agreement recognizes the concept of "loss and damage," which refers to the harm caused by climate change that cannot be mitigated or adapted to. While it does not establish a specific mechanism for compensation, it acknowledges the importance of addressing this issue.

Technology Transfer and Capacity Building: The agreement encourages the exchange of climate-friendly technologies and capacity-building assistance to help developing countries transition to a low-carbon, climate-resilient future.

Long-Term Goal: The Paris Agreement sets the long-term goal of achieving a balance between anthropogenic emissions and removals of greenhouse gases in the second half of this century, often referred to as "net-zero emissions." The Paris Agreement represents a significant global effort to combat climate change by fostering international cooperation, setting clear objectives, and providing a framework for countries to work collectively to reduce emissions and build resilience to climate impacts. It has been ratified by a large number of countries and is considered a critical step in the fight against global climate change.

Objective of The Paris Agreement:

The primary objective of the Paris Agreement is to combat climate change and limit global warming to well below 2 degrees Celsius above pre-industrial levels, with an aspirational goal of limiting it to 1.5 degrees Celsius.

This overarching objective is driven by several key goals and aims:

Mitigation: The agreement seeks to significantly reduce greenhouse gas emissions to prevent the most severe impacts of climate change. Each participating country is required to submit a nationally determined contribution (NDC) outlining its specific commitments to reduce emissions.

Adaptation: It aims to enhance the ability of countries to adapt to the impacts of climate change, particularly those that are already occurring. This includes measures to build climate resilience, protect vulnerable communities, and manage risks associated with a changing climate.

Global Stock take: A periodic global stock take is conducted to assess collective progress towards the temperature goals and inform future climate action. This helps ensure that countries' efforts are in line with the latest climate science and evolving circumstances.

Transparency and Accountability:

Global Temperature Goal:

Financial Support:

Long-Term Goal:

Methodologies on Paris Agreement:

The Paris Agreement is a complex international treaty that involves a range of methodologies and processes for its implementation.

- Nationally Determined Contributions (NDCs):
- Transparency Framework:
- Global Stock take:
- Financial Mechanisms:
- Technology Transfer and Capacity Building:
- Loss and Damage Mechanism:
- Long-Term Strategies:
- Compliance Mechanism:
- International Collaboration:

History of Paris Agreement from 2015 to 2022:

Adoption of the Paris Agreement (2015): The Paris Agreement was adopted at the 21st Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015. It marked a historic moment when 196 parties to the UNFCCC reached a consensus on a global climate deal. Entry into Force (2016): The Paris Agreement officially entered into force on November 4, 2016, after the threshold of 55 countries representing at least 55% of global greenhouse gas emissions ratified the agreement.

COP 22 in Marrakech (2016): COP 22, held in Marrakech, Morocco, focused on implementing the Paris Agreement. Parties discussed the rules and guidelines necessary for the agreement's operation, transparency, and financing.

First Facilitative Dialogue (2018): In 2018, the first facilitative dialogue, known as the Talanoa Dialogue, took place. It aimed to take stock of global progress in relation to the Paris Agreement's goals and encourage increased climate ambition.

COP 24 in Katowice (2018): COP 24 was instrumental in finalizing the rulebook for the Paris Agreement, which established the guidelines and procedures for its implementation. It also addressed issues related to climate finance and technology transfer.

Second Facilitative Dialogue (2019): The second round of the Talanoa Dialogue occurred in 2019, continuing the discussions on climate ambition and progress toward the Paris Agreement's goals.

NDC Updates and Ambition (2020-2023): Leading up to 2020, countries were encouraged to enhance their NDCs to align with the Paris Agreement's goals. Some countries submitted more ambitious targets and strategies for reducing emissions and enhancing climate resilience.

COP 26 in Glasgow (2021): COP 26 was a critical summit that focused on ramping up climate ambition. Key outcomes included countries' commitments to reach "net-zero" emissions by mid-century and a global agreement on limiting coal use and increasing financial support for developing countries.

Third Facilitative Dialogue (2022): The third phase of the Talanoa Dialogue occurred in 2022, continuing the process of reviewing and enhancing climate ambition and efforts.

Ongoing Implementation (2023): The period from 2023 onward involves continued implementation and enhancement of the Paris Agreement. Countries will work on achieving and surpassing their NDCs and addressing issues like climate finance, loss and damage, and adaptation. Please note that developments beyond January 2022 are not included in this response. The effectiveness and progress of the Paris Agreement depend on ongoing efforts, international collaboration, and the commitment of individual countries to meet their climate goals.

Actions taken by India on these directions (Paris Agreement): The Paris Agreement has several impacts on India, as it does for all signatory countries. India, as one of the world's largest and fastest-growing economies, faces both challenges and opportunities in the context of this global climate agreement.

Here are some of the key impacts of the Paris Agreement on India:

Mitigation Efforts: India has committed to reducing the emissions intensity of its GDP by 33-35% by 2030 compared to 2005 levels. This commitment is a significant step toward reducing greenhouse gas emissions.

Renewable Energy Expansion: The agreement has accelerated India's efforts to transition to a cleaner and more sustainable energy system. India has set ambitious targets for renewable energy, including significant expansion of solar and wind power.

Climate Finance: The Paris Agreement emphasizes the provision of financial support by developed countries to developing nations. India is among the countries that seek climate finance to support their mitigation and adaptation efforts. Access to financial resources is vital for implementing climate projects and building resilience.

Technology Transfer: The agreement promotes the transfer of climate-friendly technologies. India benefits from technology transfer in areas like renewable energy, energy efficiency, and sustainable agriculture.

Capacity Building: Capacity building is crucial for developing countries to effectively implement climate action. The Paris Agreement includes provisions for capacity-building support, which can help India enhance its institutional and technical capabilities.

Adaptation and Resilience: India is vulnerable to the impacts of climate change, such as extreme weather events, sea level rise, and changing monsoon patterns. The Paris Agreement emphasizes adaptation, and India has been working on building resilience to climate impacts.

International Relations and Cooperation: The agreement promotes international cooperation, which is essential for addressing a global issue like climate change. India has engaged in diplomatic efforts and collaborations to address climate change and advance its interests on the global stage.

Air Quality and Health Benefits: Many of the actions taken to mitigate climate change also led to improvements in air quality. This has direct health benefits for India, where air pollution is a significant public health concern.

Economic Opportunities: The shift toward clean energy and sustainable development presents economic opportunities. India has the potential to become a global leader in renewable energy and other green technologies. Public Awareness and Advocacy: The Paris Agreement has raised public awareness about climate change and its impacts. Civil society, including environmental organizations and youth movements, has become more active in advocating for climate action in India. In summary, the Paris Agreement has influenced India's climate policies, energy sector, and overall approach to sustainable development.

Problem Statement:

How effective has the Paris Agreement been in achieving its goal of limiting global warming to well below 2 degrees Celsius or 1.5 degrees Celsius above pre-industrial levels?

To what extent has the long-term goal of achieving "net-zero emissions" in the second half of the century been integrated into countries' climate strategies, and what policies and innovations are needed to achieve this goal?

My focus will be on how we can work in this direction in India.

Solutions:

These are some solutions I think in my research.

- ***Electrifications of Rail Network***
- ***Stop fossil fuel subsidies***
- ***Promote electric vehicles***
- ***Increase carbon tax:***
- ***Plants & tree transplant policy***
- ***Awareness to people's***

Electrifications of Rail Network in India:

India has the 4th largest railway system in the world, behind only US, Russia and China. The Indian Railways consists of a total track length of 126,366 km with 7,335 stations. 5243 km of track length was achieved during 2022-23 as compared to 2909 Kms during 2021-22.

Indian Railways had electrified 59,524 route kilometres (RKM) which is about 90% of the total broad gauge network of Indian Railways (65,300 RKM, including Konkan Railway) by 1 August 2023.[2] Indian Railway aims to electrify all of its broad gauge network by December 2023. The entire electrified mainline rail network in India uses 25 kV AC.

India is the third largest producer of electricity in the world. During the fiscal year (FY) 2022–23, the total electricity generation in the country was 1,844 TWh, of which 1,618 TWh was generated by utilities. The gross electricity consumption per capita in FY2023 was 1,327 kWh.

Largest source of power in India:

Thermal power is the "largest" source of power in India. There are different types of thermal power plants based on the fuel used to generate the steam such as coal, gas, and Diesel, natural gas. About 71% of electricity consumed in India is generated by thermal power plants.

Railway power source: Electricity is typically generated in large and relatively efficient generating stations, transmitted to the railway network and distributed to the trains. Some electric railways have their own dedicated generating stations and transmission lines, but most purchase power from an electric utility.

RVNL has a power trading licence and the Railways already directly sources power from:>

- Ratnagiri Gas & Power Pvt Ltd (RGPPL) in Maharashtra
- Adani Power in Gujarat

Adani Power and Ratnagiri Power, like many other power plants, generate electricity through the process of thermal power generation.

Here's a general overview of how electricity is produced in these types of power plants:

Fuel Supply: The first step involves the supply of fuel to the power plant. Typically, thermal power plants use coal, natural gas, or oil as their primary fuel source. Adani Power and Ratnagiri Power may use coal, as it is a common fuel source in India.

Combustion: The fuel is burned in a combustion chamber or boiler to produce high-temperature and high-pressure steam. This steam is generated by heating water with the heat produced from the burning fuel.

Steam Generation: The high-pressure steam generated in the combustion process is used to turn a steam turbine. The steam expands in the turbine's blades, causing the turbine to rotate.

Generator: The rotating steam turbine is connected to a generator. As the turbine turns, it spins the generator's rotor within a magnetic field, which generates electrical current through the process of electromagnetic induction.

Transmission and Distribution: The electricity generated in the generator is in the form of alternating current (AC). It is then sent to a transformer, which steps up the voltage for efficient transmission over long distances. The electricity is then transmitted over high-voltage power lines to substations and, eventually, distributed to homes, businesses, and industries at lower voltages.

Cooling System: Thermal power plants require a cooling system to dissipate the waste heat generated during the electricity generation process. This can be done using cooling towers, which transfer the heat to the atmosphere through the evaporation of water.

Due to which the temperature of our environment is continuously increasing.

My only purpose in telling all this is that even though India has electrified all its railway lines, the companies from which the Railways buy electricity still generate electricity using fossil fuels and coal, due to which our environment is continuously getting polluted. The amount of greenhouse gas is continuously increasing, which we are not able to control even today, the companies which are generating electricity using fossil fuels and coal, all these companies will have to shift towards renewable energy.

Electricity Consumption by India:

India is the third largest producer of electricity in the world.[8] During the fiscal year (FY) 2022–23, the total electricity generation in the country was 1,844 TWh, of which 1,618 TWh was generated by utilities.[5]

The gross electricity consumption per capita in FY2023 was 1,327 kWh.[5] In FY2015, electric energy consumption in agriculture was recorded as being the highest (17.89%) worldwide.[7]

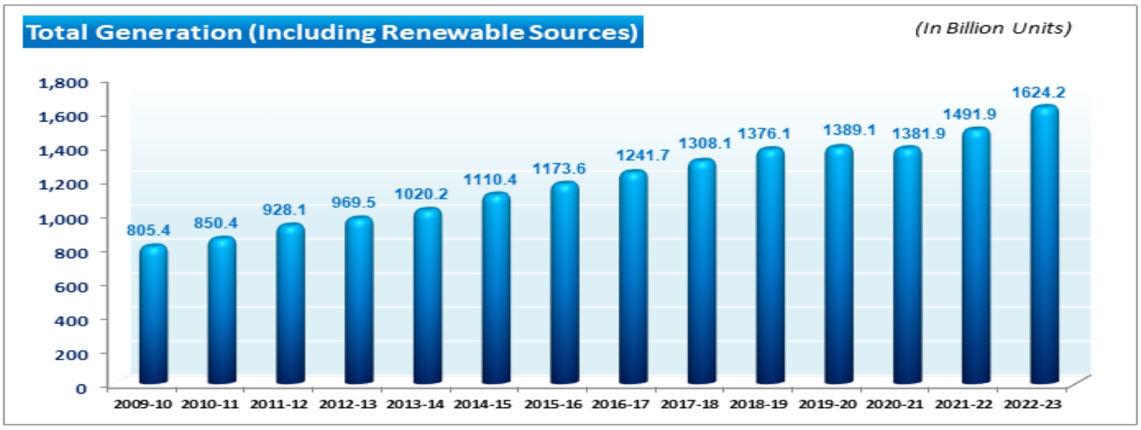
The per capita electricity consumption is low compared to most other countries despite India having a low electricity tariff.

The Indian national electric grid has an installed capacity of 416.0 GW as of 31 March 2023.[2] Renewable energy plants, which also include large hydroelectric power plants, constitute 40.7% of the total installed capacity.

India's electricity sector is dominated by fossil fuels, in particular coal, which produced about three-quarters of the country's electricity.[10][11] The government declared its efforts to increase investment in renewable energy.

Under the government's 2023-2027 National Electricity Plan, India will not build any new fossil fuel power plants in the utility sector, aside from those currently under construction.[12][13] It is expected that non-fossil fuel generation contribution is likely to reach around 44.7% of the total gross electricity generation by 2029–30.

Generation (Billion Units)



Generation Growth (%)

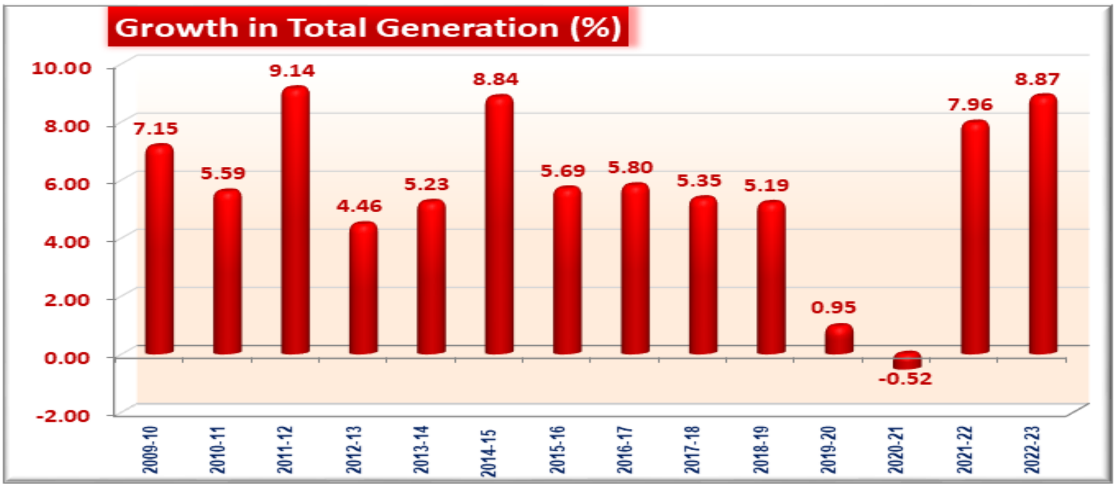


Figure 8.1: Electricity Generation year wise graph

The data also shows that peak power demand touched a record high of 241 GW during April-September 2023 compared to 215.88 GW in the first half of fiscal 2022-23.

The power ministry had estimated the country's electricity demand to touch 229 GW during summer.

Installed GENERATION CAPACITY(FUELWISE) AS ON 31.05.2023		
CATAGORY	INSTALLED GENERATION CAPACITY(MW)	% of SHARE IN Total
Fossil Fuel		
Coal	205,235	49.1%
Lignite	6,620	1.6%
Gas	24,824	6.0%
Diesel	589	0.1%
Total Fossil Fuel	**2,37,269**	**56.8 %**
Non-Fossil Fuel		
RES (Incl. Hydro)	**173,619**	41.4%
Hydro	**46,850**	**11.2 %**
Wind, Solar & Other RE	125,692	30.2 %
Wind	42,868	10.3 %
Solar	67,078	16.1 %
BM Power/Cogen	10,248	2.5 %
Waste to Energy	554	0.1 %
Small Hydro Power	4,944	1.2 %
Nuclear	6,780	1.6%
Total Non-Fossil Fuel	**179,322**	43.0%
Total Installed Capacity (Fossil Fuel & Non-Fossil Fuel)	**4,17,668**	**100%**

Figure 8.2: Total installed capacity

Total installed capacity of our country is 4,17,668 MW, and in this whole capacity, electricity generated from fossil fuel is 2,37,269 MW and from non-fossil fuel it’s generated 1,79,322 MW.

We need to convert fossil fuel generation power plant (they generate 2,37,269 MW) into renewable power plant so that we can reduce the emissions of greenhouse gases.

NTPC Dadri Industrial Visit:
9th December, 2023

Thermal power is the "largest" source of power in India. There are different types of thermal power plants based on the fuel used to generate the steam such as coal, gas, and Diesel, natural gas. About 71% of electricity consumed in India is generated by thermal power plants.

Many power plants generate electricity through the process of thermal power generation.

Due to which the temperature of our environment is continuously increasing.

Even though India has electrified all its railway lines, the companies from which the Railways buy electricity still generate electricity using fossil fuels and coal, due to which our environment is continuously getting polluted. The amount of greenhouse gas is continuously increasing, which we are not able to control even today, the companies which are generating electricity using fossil fuels and coal, all these companies will have to shift towards renewable energy.

There are about 70 NTPC power plants in India that generate NTPC currently produces 25 billion units of electricity per month. and also produce large amounts of greenhouse gas. I'm trying to understand if we can shift all these plants to renewables. If we can control these gases then it will be very easy to protect our environment from getting
polluted by these gases.

About NTPC Dadri:

NTPC Dadri is a coal-based thermal power plant located in Dadri, Gautam Budh Nagar, Uttar Pradesh, India.

Here are some key details about NTPC Dadri:

Location: NTPC Dadri is situated in Dadri, which is in the Gautam Budh Nagar district of Uttar Pradesh, India. The plant is strategically located near the National Capital Region (NCR).

Type of Plant: It is a coal-based thermal power plant. Coal is the primary fuel used for power generation at this facility.

Capacity: NTPC Dadri has a total installed capacity that includes multiple units. The plant has undergone expansions and upgrades over the years to enhance its power generation capabilities.

Units: The power plant consists of several units, each equipped with power generation equipment. The specific details of the units, their capacities, and the technologies employed may vary.

Technology: NTPC Dadri, like other NTPC plants, adopts advanced technologies for power generation to ensure efficiency and compliance with environmental regulations. The technology used may include supercritical and ultra-supercritical steam parameters for improved efficiency.

Environmental Initiatives: NTPC Dadri, like other NTPC facilities, likely incorporates environmental management practices and initiatives to minimize the environmental impact of its operations. This may include measures for emissions control and waste management.

Community Engagement: As part of NTPC's corporate social responsibility (CSR) initiatives, NTPC Dadri may be involved in community development programs. These initiatives can include education, healthcare, and other community welfare activities.

Expansion and Upgrades: Power plants often undergo expansions or upgrades to meet growing electricity demand and to incorporate newer and more efficient technologies. NTPC Dadri may have undergone such changes since my last update in January 2022.

Here's a general overview of how electricity is produced at NTPC Dadri thermal power plant.

Electricity Generation Process at NTPC Dadri:

The electricity generation process at NTPC Dadri, being a thermal power plant, involves the conversion of thermal energy from the combustion of coal into electrical energy.

Here is a generalized overview of the electricity generation process at a coal-based thermal power plant like NTPC Dadri:

Coal Handling:
Coal is transported to the power plant and unloaded into bunkers or storage silos.
From the storage, coal is transported to the coal handling plant where it is crushed into small pieces to increase its surface area for efficient combustion.

Combustion (Boiler):
The crushed coal is then fed into the boiler where it is burned. The combustion of coal produces high-temperature flue gases and heat energy.
The boiler is a critical component where water is heated to produce steam.

Steam Generation:
Water is circulated through tubes within the boiler, and the heat generated by the burning coal converts water into steam.
The steam produced is at high pressure and temperature.

Steam Turbine:
The high-pressure steam is directed to a steam turbine.
The steam turbine converts the thermal energy of steam into mechanical energy as it flows over the turbine blades, causing the turbine to rotate.

Generator:
The rotating turbine is connected to a generator shaft.
As the turbine spins, it drives the generator, converting the mechanical energy into electrical energy.

Power Transmission:
The electrical energy generated is in the form of alternating current (AC).
Transformers are used to step up the voltage of the generated electricity for efficient transmission over long distances.

Grid Connection:
The electricity is then fed into the power grid, where it becomes part of the overall electrical supply network.

Cooling:
After the steam passes through the turbine, it is condensed back into water in a condenser.
Cooling water, often sourced from nearby rivers or cooling towers, is used to condense the steam and turn it back into water.

Figure 9.1 Cooling Tower at NTPC Dadri

Ash Handling:

The combustion of coal produces ash, which is collected and disposed of through ash handling systems.

Environmental Controls:

Various environmental control measures are employed, including the use of electrostatic precipitators or bag filters to capture particulate matter and flue gas desulfurization systems to reduce sulfur dioxide emissions.

Figure 9.2 Gas Tower at NTPC Dadri

About Control Room:

The control room at NTPC Dadri, like those at other modern power plants, plays a crucial role in monitoring and controlling various aspects of the power generation process. The control room is typically equipped with advanced technologies and a comprehensive Supervisory Control and Data Acquisition (SCADA) system to ensure the safe and efficient operation of the plant.

Here's an overview of how the control room works at NTPC Dadri:

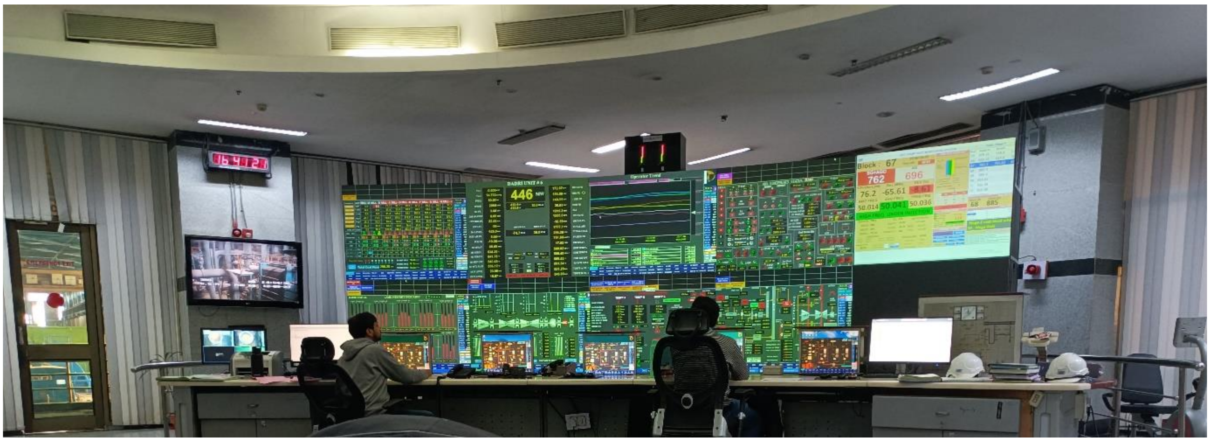


Figure 9.3 Control Room at NTPC Dadri

Centralized Monitoring:
The control room serves as a centralized hub where operators monitor and control the entire power generation process.
Various displays, control panels, and computer screens provide real-time information on the status of equipment, processes, and key parameters.

SCADA System:
A SCADA system is a central component of the control room. It allows operators to remotely monitor and control different parts of the power plant.
SCADA gathers data from sensors and devices throughout the plant and presents it in a user-friendly interface.

Process Control:
Operators have the ability to control and adjust various parameters such as steam pressure, temperature, and flow rates using the SCADA system.
Process control systems ensure that the plant operates within safe and efficient limits.

Equipment Monitoring:
The control room monitors the status of critical equipment such as boilers, turbines, generators, and cooling systems.
Alarms and alerts are configured to notify operators of any deviations or potential issues.
Power Distribution:

Operators in the control room manage the distribution of electrical power produced by the plant. They monitor grid conditions and ensure that power is supplied according to demand.

Safety Systems:
The control room is equipped with safety systems that can automatically shut down the plant or specific equipment in case of emergencies or abnormal conditions.
Emergency response procedures are in place and can be initiated from the control room.

Communication Hub:
The control room serves as a communication hub for coordination between different departments within the power plant.
Operators may communicate with field personnel, maintenance teams, and other relevant staff.

Data Analysis:
Data from various sensors and instruments are continuously analyzed to identify trends, optimize performance, and predict potential issues.
Historical data is often used for performance analysis and for making informed decisions about maintenance and operational improvements.

Environmental Monitoring:
The control room also monitors environmental parameters to ensure compliance with regulations. This includes emissions monitoring and control systems.

Training and Simulation:
Control room operators undergo extensive training and may use simulation systems to practice handling various scenarios and emergencies.
The control room at NTPC Dadri integrates technology and human expertise to ensure the reliable and efficient generation of electricity while maintaining a strong focus on safety and environmental compliance.

Data collected from NTPC Dadri:

Figure 9.4: Data collection by NCGG Intern Student

What is the current capacity of the thermal power plant?

Stage 1: 210*4 MW

Stage 2: 490*2 MW

Gas power plant: 829.8MW

Total 2654.8 MW

What type of fuel is currently being used in the NTPC Dadri thermal power plant?

Coal, LDC (light diesel oil)

LDC used 22000/ ton at 75% EGP

What is the age and condition of the existing infrastructure?

Stage 1: 25 years, 1990 - 2015

Stage 2: 25 years, 2010 - 2035

Current Emissions Profile:

What is the current annual greenhouse gas emissions from the existing thermal power plant?

SOx, NOx, CO, CO2.

Have comprehensive emission inventories been conducted for the facility?

May be, under research.

Renewable Energy Potential:

Which renewable energy sources (solar, wind, hydropower, geothermal etc.) are most viable for reducing greenhouse gas emissions at the current location?

As per my understanding there are two methods. By which it is possible to generate electricity, firstly from solar panels and secondly from the flow of water, there is river Ganga at a distance of about 2 kilometres from NTPC Dadri, the flow of water in the river Ganga is also good due to which we can generate electricity.

Has a renewable energy resource assessment been conducted to determine the optimal energy source?

Yes, solar power system which is generate 5 MW electricity.

Emission Reduction Targets:

What percentage reduction in greenhouse gas emissions is the organization aiming for through this conversion?

80-90%

Are there specific regulatory or international standards guiding emission reduction targets?

As per Government of India.

Technology Selection:

Which renewable energy technologies are best suited for the site to ensure maximum emission reduction?

Solar & water turbine.

What role will energy storage technologies play in optimizing renewable energy use and minimizing backup fossil fuel usage?

Under research.

Investment and Cost Analysis:

What is the estimated cost of converting the thermal power plant to a renewable power plant?

Based on that which technology we opt for the current location.

Are there any available grants, subsidies, or funding opportunities for renewable energy projects?

From govt of India.

Integration with Carbon Capture and Storage (CCS):

Is there a plan to integrate carbon capture and storage technologies to further reduce emissions?

Under research.

What is the feasibility of implementing CCS alongside the renewable power plant?

UR.

Lifecycle Analysis:

Has a comprehensive lifecycle analysis been conducted to assess the overall environmental impact of the renewable power plant, considering manufacturing, construction, and decommissioning phases?

Not now.

Regulatory Compliance & Policy Considerations:

What environmental regulations or standards need to be met during and after the conversion to ensure compliance and emissions reduction?

UR.

Are there emissions trading or carbon pricing mechanisms that should be considered?

UR.

What government policies or incentives support the transition to renewable energy?

UR.

Monitoring and Reporting:

What monitoring systems will be implemented to track greenhouse gas emissions before, during, and after the conversion?

From Control room

How frequently will emissions data be reported to relevant authorities and the public?

From there official website.

How will the performance of the renewable power plant be monitored and evaluated post-conversion?

UR.

Skills and Workforce Transition:

What training programs will be implemented to equip the workforce with the skills required for the operation and maintenance of renewable energy technologies?

UR.

How will the transition impact the existing workforce, and what strategies are in place for a smooth transition?

UR.

Technical Considerations:

What modifications are required to adapt the existing infrastructure to accommodate renewable energy technologies?

I've mentioned in this report.

What type of renewable energy technology is most suitable for the site (solar panels, wind turbines, etc.)?

Solar & water flow turbine system.

Environmental Impact:

How will the conversion impact the local environment and ecosystems?

UR.

Are there any environmental regulations or permits required for the conversion?

As per by govt of India.

Energy Storage and Grid Integration:

How will the intermittent nature of certain renewable energy sources be addressed (battery storage, grid integration, etc.)?

They don't have any storage system at NTPC Dadri.

What upgrades are needed for the local power grid to support renewable energy integration?

Grid Capacity Expansion:

Increasing the overall capacity of the power grid to accommodate the additional electricity generated by renewable sources. This may involve upgrading transformers, transmission lines, and substations.

Smart Grid Technologies:

Implementing smart grid technologies to enhance grid flexibility, reliability, and efficiency. Smart grids enable better communication and control, allowing for real-time monitoring and management of electricity flow.

Energy Storage Systems (ESS):

Installing energy storage systems, such as batteries, to store excess energy during periods of high renewable generation. ESS can then release stored energy during low generation periods, helping to stabilize the grid.

Advanced Metering Infrastructure (AMI):

Deploying advanced metering systems that provide more detailed information on energy consumption and production. This can help in better managing and optimizing the grid.

Voltage Control and Power Quality Improvement:

Upgrading equipment and technologies to maintain stable voltage levels and improve power quality, ensuring that the integration of renewable energy does not negatively impact the reliability of the grid.

Grid Code Modifications:

Adapting or updating the grid codes and regulations to accommodate the characteristics of renewable energy sources and promote smooth integration. This may include revising connection standards and operational protocols.

Demand Response Programs:

Implementing demand response programs that encourage consumers to adjust their electricity usage in response to grid conditions. This can help balance supply and demand more effectively.

Interconnection Infrastructure:

Enhancing interconnection capabilities to facilitate the integration of distributed renewable energy resources, such as rooftop solar installations. This involves ensuring that the grid can effectively handle bidirectional power flow.

Forecasting and Monitoring Systems:

Implementing advanced weather forecasting and renewable energy monitoring systems to improve predictions of renewable energy generation. Accurate forecasting allows for better grid management and planning.

Training and Capacity Building:

Providing training for grid operators and personnel to effectively manage and operate the grid with a higher share of renewable energy. This includes understanding the unique characteristics and challenges associated with renewable sources.

Timeline and Project Management:

What is the expected timeline for the conversion from a thermal to a renewable power plant?

We can plan after 2035.

What project management strategies will be employed to ensure a smooth transition?

Under research.

Data Analysis collected from NTPC Dadri:

As per the guidelines of my mentor, I decided to go to NTPC Dadri to complete my research work. My visit was only for 1 day in which I had to answer all the questions which were necessary to complete my work, during my one-day visit I practically understood how thermal power plants work and how many megawatts of electricity they generate and also tried to understand how much greenhouse gases are emitted daily to generate so much electricity.

1. Need some modification in Pipelines:

When I was understanding the process of generating electricity from thermal power from an employee of NTPC, I saw that when coal is burnt, the steam generated after burning is sent towards the turbine, due to which the turbine rotates round and round and electricity is generated. If the pipeline through which we send steam to the turbine is made circular instead of straight, then we will be able to generate more electricity even with less quantity of coal.

2. Decompositions of greenhouse gases:

And the second thing that I saw in my industrial tour is that instead of releasing the gases produced after burning of coal directly into the environment, we should first convert them into less harmful substances so that we can save the environment from getting polluted. There are some methods for this which I have mentioned here.

Desulphurisation procedure at NTPC Dadri:

Desulfurization in thermal power plants is a process aimed at reducing the sulphur dioxide (SO_2) emissions produced during the combustion of fossil fuels, especially coal. The primary objective is to mitigate air pollution and adhere to environmental regulations.

There are various methods for desulfurization, with the most common ones being wet flue gas desulfurization (WFGD) and dry flue gas desulfurization (DFGD).

Here's an overview of both processes:

Wet Flue Gas Desulfurization (WFGD):

Absorption Tower: In WFGD, the flue gas from the combustion process is passed through an absorption tower.

Limestone Slurry: A slurry of limestone ($CaCO_3$) or lime (CaO) is sprayed into the absorption tower. The alkaline nature of the slurry reacts with the sulfur dioxide in the flue gas.

Chemical Reaction: The chemical reaction results in the formation of calcium sulfite ($CaSO_3$) and, through subsequent oxidation, calcium sulfate ($CaSO_4$), commonly known as gypsum.

Gypsum Separation: The gypsum is separated from the slurry, and the clean flue gas is released into the atmosphere.

Dry Flue Gas Desulfurization (DFGD):

Spray Dryer Absorber (SDA): In DFGD, a dry sorbent, typically lime or sodium-based compounds, is injected into the flue gas stream using a spray dryer absorber.

Chemical Reaction: Similar to WFGD, the dry sorbent reacts with sulfur dioxide to form solid byproducts, which are collected in a downstream particulate control device.

Particulate Control: The solid byproducts are separated from the flue gas in a baghouse or electrostatic precipitator.

Clean Gas Release: The cleaned flue gas is then released into the atmosphere.

Both methods have their advantages and disadvantages, and the choice of desulfurization technology depends on factors such as the composition of the fuel, plant configuration, and environmental regulations.

Decomposition of COx:

The decomposition of carbon monoxide (CO) and carbon dioxide (CO_2) to reduce greenhouse gas emissions typically involves using various technologies to capture and convert these gases into less harmful substances.

Here are some methods commonly employed for the decomposition of CO and CO_2:

Carbon Capture and Storage (CCS):

CO_2 Capture: In power plants and industrial facilities, technologies such as amine scrubbing or other solvent-based processes can capture CO_2 from flue gases.

Transportation: Captured CO_2 is then transported and stored in geological formations (such as depleted oil and gas fields) or used for enhanced oil recovery.

Permanent Storage: The stored CO_2 is intended to remain underground, preventing its release into the atmosphere.

Direct Air Capture (DAC):

Removal from Ambient Air: DAC technologies capture CO_2 directly from the ambient air using chemical sorbents or other capture materials.

Storage or Utilization: Similar to CCS, the captured CO_2 can be stored underground or utilized for various purposes such as producing synthetic fuels.

Catalytic Conversion:

CO and CO_2 Conversion: Catalytic processes can convert CO and CO_2 into useful chemicals or fuels. For example, CO_2 can be converted into carbon monoxide, and both can be further converted into hydrocarbons or other value-added products.

Hydrogenation: Hydrogenation reactions, often facilitated by catalysts, can convert CO_2 into methane (CH_4) or other hydrocarbons.

Electrochemical Reduction:

Electrolysis: Electrochemical processes, such as electrochemical reduction of CO_2 (ERC), use electrical energy to convert CO_2 into products like carbon monoxide or formic acid.

Renewable Energy Integration: The process becomes more environmentally friendly if the electricity used for electrolysis is generated from renewable sources.

Bioenergy with Carbon Capture and Storage (BECCS):

Biomass Combustion: In BECCS, biomass is combusted to produce energy, and the resulting CO_2 emissions are captured and stored.

Carbon Sequestration: The carbon captured during this process is considered to be effectively removed from the atmosphere, given that the biomass absorbs CO_2 during its growth.

3. Methods which will help for this conversion:

Till now I have read and understood about the methods of generating electricity that we have and during my industrial visit I also tried to know which method would be best towards making this plant renewable. As per my understanding there are two methods. By which it is possible to generate electricity, firstly from solar panels and secondly from the flow of water, there is river Ganga at a distance of about 2 kilometres from NTPC Dadri, the flow of water in the river Ganga is also good due to which we can generate electricity.

Rooftop Solar System:

A rooftop solar system is a setup where solar panels are installed on the roof of a building or a structure to harness sunlight and convert it into electricity. These systems are a popular and environmentally friendly way to generate clean energy.

Figure 10.1: Rooftop solar system

Advantage of rooftop solar system:

Rooftop solar systems offer several advantages, making them an increasingly popular choice for individuals, businesses, and communities.

Here are some key advantages of rooftop solar systems:

Renewable Energy Source: Solar power is a clean and renewable energy source. It relies on sunlight, which is abundant and inexhaustible, making it a sustainable choice for power generation.

Reduced Electricity Bills: By generating electricity on-site, rooftop solar systems can significantly reduce or eliminate electricity bills. Excess energy can sometimes be fed back into the grid, earning credits or payments.

Environmental Benefits: Solar power produces minimal environmental impact compared to traditional energy sources. It helps reduce greenhouse gas emissions, air pollution, and dependence on fossil fuels, contributing to a more sustainable and environmentally friendly energy mix.

Low Operating Costs: Once installed, solar panels have relatively low operating and maintenance costs. They require minimal maintenance, with occasional cleaning and inspections to ensure optimal performance.

Energy Independence: Rooftop solar systems provide a degree of energy independence, reducing reliance on centralized power grids and traditional energy sources. This can be particularly advantageous in regions with unreliable or expensive grid power.

Grid Support and Net Metering: Many locations offer net metering programs, allowing excess energy generated by a rooftop solar system to be fed back into the grid. Users can receive credits or payments for the surplus energy they contribute.

Long-Term Financial Savings: While the initial investment for a rooftop solar system may be significant, the long-term financial benefits often outweigh the costs. As technology improves and prices continue to decrease, the return on investment for solar systems becomes more favourable.

Property Value Increase: Homes and buildings with solar installations are often perceived as more valuable. Solar panels can increase property resale value and attractiveness to potential buyers.

Job Creation: The growth of the solar industry contributes to job creation, from manufacturing and installation to maintenance and support services.

Technological Advancements: Ongoing advancements in solar technology, such as increased efficiency and reduced costs, make rooftop solar systems more attractive and accessible over time.

Community and Corporate Sustainability: Rooftop solar installations contribute to corporate social responsibility and community sustainability goals. They demonstrate a commitment to clean energy and environmental stewardship.

Government Incentives: Many governments provide incentives, tax credits, rebates, or subsidies to encourage the adoption of solar energy. These incentives can significantly reduce the upfront costs of installing a rooftop solar system.

It's important to note that the effectiveness of a rooftop solar system depends on various factors, including location, sunlight exposure, system size, and local regulations. Before investing in a solar system, it's advisable to conduct a thorough assessment and consult with professionals to determine the feasibility and optimal configuration for your specific situation.

Why I’m saying that we need rooftop solar system for India over Utility Scale Solar System

The main difference between Rooftop Solar vs Utility Scale Solar is the size and installation of the photovoltaic (PV) system. While rooftop solar systems are typically installed on private properties like homes and businesses, utility-scale solar systems are designed for larger applications such as farms or entire neighbourhoods. These systems generally require extensive engineering and construction, including large panels mounted onto metal frames or concrete slabs, which can cover hundreds of acres.

Rooftop Solar is a type of distributed generation (DG) technology that enables electricity to be generated directly from the rooftops of individual buildings, primarily residential homes and small businesses. These solar installations come in various shapes and sizes depending on their application, ranging from very small 3-4 kW residential solar PV systems to much larger commercial installations up to 1 megawatt (MW). The main advantage of rooftop solar is its flexibility in terms of installation location and size.

It can be installed anywhere with enough sunlight exposure and space – often times on existing structures like roofs or balconies – without the need for significant civil engineering works or land acquisition.

On the other hand, Utility Scale Solar is an alternative form of renewable energy production which involves building large scale photovoltaic (PV) generating plants connected to a power grid. Typically, these projects involve hundreds or even thousands of acres being converted into massive PV arrays with millions of individual solar panels arranged in a grid pattern over several miles. They are usually owned by major utilities companies who then sell the energy produced to customers through the power grid network they are connected to.

Utility scale solar has some clear advantages over rooftop solar when it comes to energy production efficiency. Because these large installations generate electricity at higher efficiencies than their smaller counterparts, they tend to produce more overall output over time for less cost per kilowatt hour (kWh). Additionally, utility scale plants can take advantage of economies of scale due to them requiring fewer technicians per watt than smaller rooftop installations do. This often results in significantly lower operation and maintenance costs for long-term operations compared to traditional forms of power generation such as natural gas turbines or coal-fired plants.

Despite its many advantages however, utility scale solar does have some drawbacks compared to its distributed counterpart. One major disadvantage is that because these systems require so much land area, they’re often subject to lengthy permitting processes involving multiple government agencies which can lead to delays in project completion timelines as well as higher costs associated with acquiring access rights from landowners. Additionally, because these PV systems are so spread out geographically, they require high levels of investment in transmission infrastructure which further adds costs associated with connecting them into existing grids. Lastly, since this form of renewable energy depends heavily upon sunshine it cannot provide consistent baseload power when there are clouds present during peak demand hours making them less reliable than other forms such as wind turbines or hydropower plants.

Overall while both Rooftop Solar and Utility Scale Solar offer unique benefits when it comes to producing renewable energy, they both serve different purposes within our current electrical grid infrastructure. Rooftop Solar provides an ideal solution for distributed generation due its flexibility in terms installation size and location while Utility Scale Solar offers higher efficiency levels for generating power at larger scales where it makes economic sense. Ultimately though each option may be better suited for certain applications depending on environmental factors such as access rights availability or land suitability.

Nitesh Tiwari (NCGG Intern Student)

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