Internship Report on MACC Project

Chevron Bangladesh

Bibiyana Gas Plant

MACC Project

Internship Report

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Executive Summary

The Marginal Abatement Cost Curve (MACC) Project at Chevron Bangladesh's Bibiyana Gas Plant was a transformative initiative aimed at enhancing operational efficiency, reducing fuel consumption, lowering costs, and meeting Chevron's sustainability goals. The project focused on replacing gas engine generators at the North Pad (NP) and West Pad (WP) with electrical power supplied from the South Pad (SP), significantly reducing fuel gas consumption and greenhouse gas (GHG) emissions. This shift to a more sustainable energy model delivered substantial long-term environmental benefits, particularly in reducing the carbon footprint of the plant's operations. To support this transition, the project involved the design and installation of key electrical infrastructure. While diesel generators at NP and WP were retained for black-start capabilities to ensure reliability in the event of grid outages, the primary shift to electrical power marked a significant step towards reducing the facility's environmental impact. A core element of the MACC Project was its innovative approach to resource utilization. Rather than relying solely on internationally sourced equipment, the project incorporated high-quality local products such as transformers and BBS Medium Voltage Cables. This integration provided an opportunity for Chevron to assess the performance of locally manufactured components in comparison to international standards, highlighting the potential for using local resources in future projects. This innovative approach not only supported Chevron's operational goals but also demonstrated a commitment to supporting local industries while ensuring the performance and reliability of the electrical system. The CMIEM team's ability to innovate, think creatively, and solve complex challenges within budget was essential to the project's success. Their strategic approach, which included optimized resource allocation and cost-effective design adjustments, ensured that the project met Chevron's ambitious standards for safety, reliability, and performance. The project's emphasis on environmental impact was central to its success. By reducing fuel consumption and GHG emissions, the MACC Project aligned with Chevron's sustainability objectives, significantly contributing to the company's broader environmental goals. The transition to an electrified power supply not only enhanced operational reliability and efficiency but also reinforced Chevron's commitment to sustainable energy solutions. The success of the MACC Project serves as a testament to Chevron's leadership in driving innovative, cost-effective, and environmentally responsible operations.

1. Introduction

My internship at Chevron Bangladesh was a remarkable experience where I was assigned to work on the MACC (Marginal Abatement Cost Curve) Project. The project aimed to eliminate gas engines from the Bibiyana Remote North Pad (NP) and West Pad (WP), as well as electrical supply from Bibiyana South Pad, to reduce carbon emissions and optimize costs. During my internship, I gained valuable insights into sustainable energy practices and project management.

2. Purpose

The MACC Project at Chevron's Bibiyana gas field represents a pivotal initiative in Chevron's drive toward sustainability and environmental responsibility. This initiative focuses on reducing fuel gas consumption, operational costs, and greenhouse gas (GHG) emissions by transitioning the power supply for the North Pad (NP) and West Pad (WP) from gas engine generators to electrical power sourced from the South Pad (SP).

Chevron's Energy Transition (ET) team leveraged the Marginal Abatement Cost Curve (MACC) tool to identify and prioritize this opportunity for GHG reduction. The project connects the Bibiyana Gas Plant's Gas Turbine Generator (GTG) power to NP and WP, ensuring a reliable and consistent energy supply. In the event of grid outages, diesel generator sets at NP and WP will provide backup power, ensuring uninterrupted operations. By eliminating gas engines, the project not only reduces fuel gas consumption but also enables the export of surplus fuel gas, optimizing resource utilization while contributing to Chevron's broader sustainability objectives.

The project aligns with Chevron's global sustainability goals, targeting operational efficiency improvements and environmental stewardship. The strategic approach emphasized cost savings through innovative design solutions, effective use of resources, and collaboration across teams. These measures ensured the project was completed within budget constraints while maintaining operational reliability and furthering Chevron's commitment to sustainability.

3. General

This section outlines the technical codes, standards, and terminology relevant to the MACC Project at Chevron Bangladesh. The project follows industry-recognized codes and standards to ensure compliance with safety, reliability, and performance requirements. Adhering to these standards is essential for maintaining consistency and ensuring that all electrical installations meet operational and safety criteria.

3.1 Technical Codes and Standards

3.1.1 Chevron Engineering Guidelines

These guidelines will be the primary reference for determining the design and execution of electrical systems, including the sizing of cables, transformers, and other critical components. Specifically, ELC-SU-270-B.1 should be referenced for the necessary studies related to electrical design.

3.1.2 National Electrical Code (NEC, USA)

This code will be used for calculations such as Step-down Transformer Sizing, Cable Sizing, and Voltage Drop Calculations. Compliance with the NEC ensures the design adheres to standard electrical safety and performance practices in the USA.

3.1.3 IEEE Standards

- IEEE 979: This standard is referenced for substation fire protection schemes to ensure proper design and protection from fire hazards in substations.
- IEEE LV Switchgear and Control Gear Assemblies: Reference ELC-SU-3987-5.0 to ensure compliance with IEEE standards related to low-voltage switchgear.

3.1.4 International Electrotechnical Commission (IEC)

IEC Low Voltage Switchgear and Control Gear Assemblies: Refer to ELC-SU-6029-C for IEC standards, ensuring compliance with international standards for low-voltage switchgear.

3.1.5 Fire and Gas System Standards

Fire and Gas System Integration: Adhere to standards for integrating fire and gas systems with the overall facility control system, ensuring accurate safety and alarm mechanisms for critical transformer protection.

3.2 Terminology

The terminology used in the MACC Project is aligned with the standard industry definitions to ensure clear communication and consistency across all project stages. Some key terms and their definitions include:

- MTO (Material Take-Off): Refers to the process of listing materials required for the electrical system design. Bulk MTOs are used to estimate quantities for procurement.
- ACB (Air Circuit Breaker): A protective device used to disconnect the electrical supply in case of faults or overloads.
- UPS (Uninterruptible Power Supply): A system that ensures a constant power supply by providing backup power in case of failures in the primary power system.
- Surge Protection Device: A device used to protect electrical equipment from voltage spikes caused by lightning or other surges.
- Sub-station: A part of the electrical distribution system where voltage is stepped down and distributed to other areas. In this context, it's focused on Step-down transformers and associated equipment.
- Step-down Transformer: A transformer used to reduce high voltage to a lower voltage suitable for use in electrical systems.
- Control Cable: Cables that carry signals to control or monitor devices, such as circuit breakers, relays, and control systems.

These terms are fundamental to the understanding of the project's electrical and operational systems and ensure that all technical personnel can engage effectively with the processes and equipment used in the MACC Project.

4. Existing Electrical Power System Overview

The existing electrical power system at the Bibiyana Gas Field, designed to provide localized power generation for the remote North Pad (NP) and West Pad (WP), relied extensively on gas engine generators. These generators, powered by fuel gas from the gas field itself, served as a reliable energy source for these pads. However, the system had several limitations that affected its efficiency, cost-effectiveness, and environmental sustainability. Those are -

4.1 High Fuel Gas Consumption

The gas engine generators consumed a significant volume of fuel gas to maintain continuous power generation. This was a critical issue as fuel gas, although readily available at the field, is a valuable resource with economic and operational implications.

4.2 Increased Operational Costs

The reliance on gas engine generators translated into high operational costs due to the fuel consumption rate, maintenance needs, and system inefficiencies. This increased the overall expense of operating the field's electrical infrastructure.

4.3 Carbon Emissions

Gas engine generators emit carbon dioxide (CO_2) and other greenhouse gases during operation. This reliance on combustion-based energy production contributed to the site's carbon footprint, posing challenges to Chevron's sustainability and decarbonization goals.

4.4 Environmental Impact

The continuous use of gas engine generators not only affected air quality but also posed challenges in meeting stricter environmental regulations and stakeholder expectations for reducing ecological impact.

Recognizing these challenges, the MACC Project was initiated to replace gas engine generators with an electrical power supply from the South Pad (SP)—a transition that successfully optimized fuel usage, reduced operational costs, and aligned with Chevron's sustainability objectives.

5. Project Design

5.1 Conceptual Engineering

The engineering shall comply with International Standard and CES. CONTRACTOR will perform the conceptual study to appropriated options in according to the above modifications with respect to safety, reliability, constructability, and cost for both 480V (step up via transformer to 11kV for transmission) and 4.16kV options. The conceptual study will comprise for:

- 11kV option and 4.16kV option, both NP & WP
- Aboveground & underground cable installations

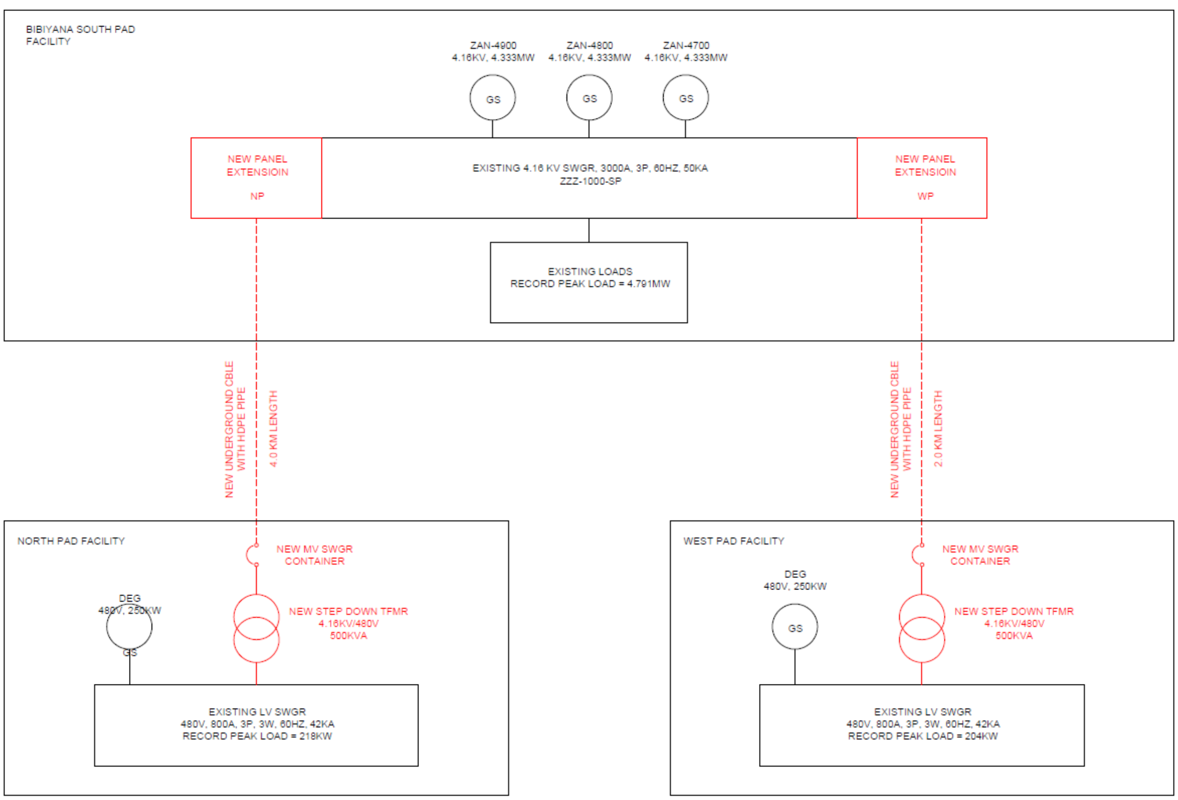
With necessary calculations (Transformer sizing, Cable sizing), simplify single line diagram, advantages & disadvantage, budgetary cost estimates, material list including with long lead item list, conclusions (Summary scope of work for 11kV and 4.16kV options to NP and WP), high level project schedule and milestones, high level risk assessment and mitigation, high level site specific and infrastructure requirement, recommendation actions for a future phase. The work will include with review the latest existing power system studies reports and evaluate the existing system capacity of major equipment (MCC, Transformer, GTG) followed by CES ELC- SU-5270 as necessary and compare between alternative based upon system capacity of major equipment with recommendation. The work will also include with recommendation a detail designed deliverable list for the future work after the option is chosen. Typical deliverable for detail design can be recommended below from the time being but it can be changed to reflect the project development during detail design stage,

5.1.1 List of Deliverables

- Single Line Diagrams
- Metering and Protection Diagram
- Datasheet
- Power Layout
- Transmission Line Cable Layout
- Earthing Layout
- Electrical Equipment Layout

- Typical Installation Detail Drawing
- Demolition Drawing for NP and WP
- MTO
- Cable Sizing Calculation
- Electrical Load List Transformer Sizing Selection
- Cable Schedule
- Connection Diagram
- Power System Studies (Load Flow Study, Short Circuit Study, Motor Starting Study
- and Transient Stability Study)
- PMS Integration
- CONTRACTOR will deploy specialist personnel to perform the engineering activities
- Detailed

Fig 01: Conceptual Design Block Diagram



5.2 Detailed Engineering

5.2.1 Exchange of Information & Documentation

- Ensure timely and efficient exchange of information and documentation per the agreed schedule.
- Submit weekly progress reports for project management purposes.

5.2.2 Document Review

- Review all documents: civil, architectural, structural, electrical, instrument, and automation scope of work.
- Make recommendations for modifications and/or upgrades to engineering scopes as needed.

5.2.3 Contractor Responsibilities

- Collect and verify onsite measurements for the length of underground cables from SP-NP and SP-WP.
- Use the verified data in relevant calculations for underground cable design.

5.2.4 Underground Cable Design

- Design underground cables from SP-NP and SP-WP with a voltage drop of less than 3%.
- Design the underground cable trench for SP-NP and SP-WP.

5.2.5 Step-up/Step-down Transformer Sizing

- Determine the NP 4.16KV/480V step-up/down transformer size for loads under 275 KW.
- Determine the WP 4.16KV/480V step-down transformer size for loads under 360 KW.

5.2.6 Circuit Breaker Installation

- Plan to add two draw-out type, three-pole power circuit breakers (1200A) to the SP switchgear room.
- Design the installation of new three-pole power circuit breakers (1200A) at NP and WP switchgear rooms (if needed).

5.2.7 Equipment Delivery List

- Prepare a preliminary equipment delivery list to identify any long lead items.

5.2.8 Delivery of Documents

- Deliver appropriate documents to Chevron after completion of engineering deliverables.

5.2.9 Cost Estimate & Schedule

- Develop a +/- 10% cost estimate and schedule for the DED submission proposal.

5.2.10 Technical Support & Approvals

- Provide technical support and submit relevant approval documents to Chevron.

5.2.11 Lightning Protection System Design

- Design the Lightning Protection System for NP and WP step-down transformers.

5.2.12 MTOs

- Identify the longest lead item and segregate it with MTOs for proper tracking.

5.2.13 Major Equipment Installation & Commissioning

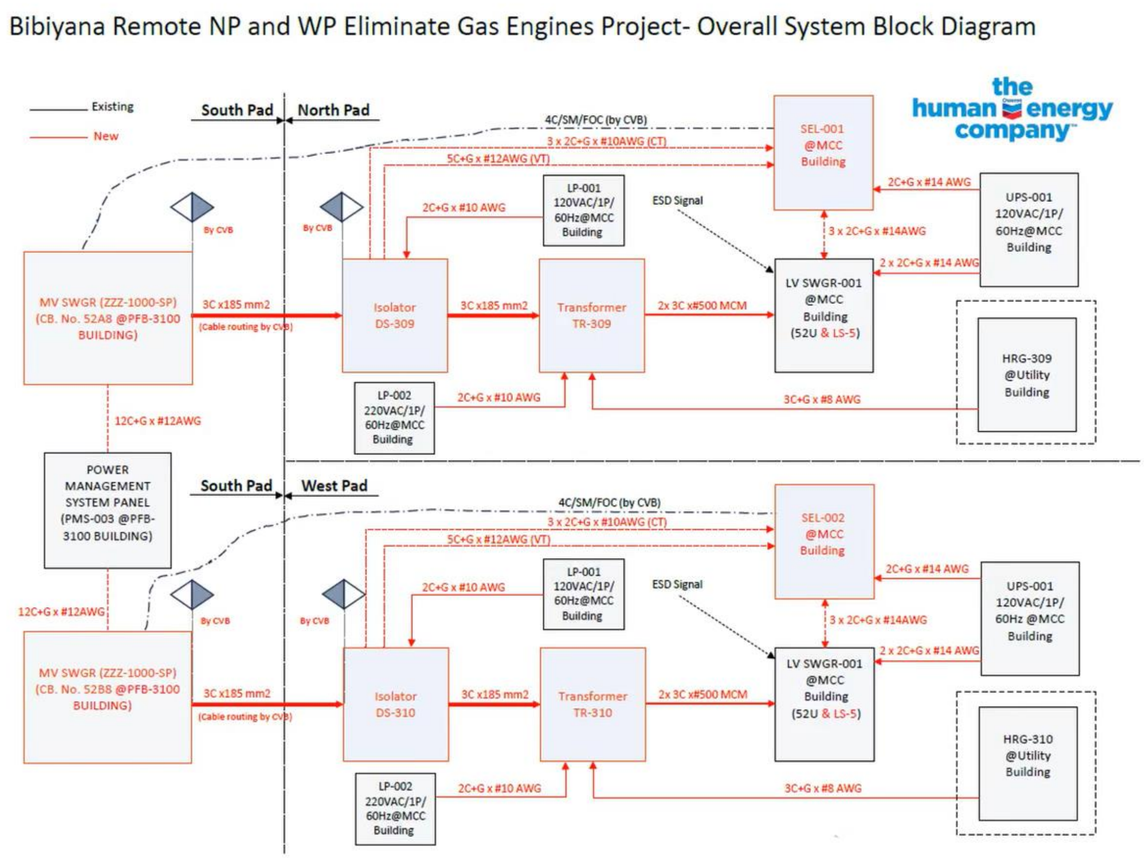
- Install, hook up, and commission major equipment, including SP/NP/WP power circuit breakers.
- Lay underground cables from SP-NP and SP-WP.
- Install transformers at NP/WP and complete associated power and control cable terminations per approved design documents.

This detailed engineering approach ensured a well-coordinated, cost-effective, and technically sound execution of the MACC Project, successfully transitioning the NP and WP from gas engine generators to an electrified power supply while maintaining operational reliability, safety, and sustainability.

6. Project Approach & Methodology

The project was implemented following a design approach to ensure the seamless transition from gas engines to electrical power. Below is the overall system block diagram illustrating the key components and their interactions:

Fig 02: Overall System Block Diagram



Description of the Diagram

6.1 Power Source and Efficient Medium-Voltage Distribution

Power is generated from the GTG feeder at the South Pad and directed to the Medium Voltage Switchgear bus bar located at the Bibiyana South Pad. Two MV switchgear units are installed as primary hubs for distributing power, with one panel connecting to the North Pad and the other to the West Pad, both linked by a bus bar to maintain uninterrupted power flow.

6.2 Transmission to Remote Pads

Electrical power from MV switch gear panel is transmitted using 3C x 185 mm^2 cables, meticulously laid over 3.6 km from the South Pad to the North Pad and 1.8 km to the West Pad. These high-capacity cables are designed to handle the required load efficiently, maintaining the integrity of the power supply while supporting the seamless operation of critical systems across the pads. The precise routing and installation of these cables ensure the robustness and reliability of the overall energy distribution network.

6.3 Off-line Isolators

The power is transmitted to the isolators at each pad to enhance system safety and facilitate seamless maintenance. Two isolators (DS-309 and DS-310) are strategically installed at the North and West Pads. These isolators allow specific sections of the system to be isolated for maintenance or fault management, ensuring that the rest of the network remains operational without interruption. This design feature enables efficient and safe operations, allowing necessary maintenance or fault resolution while maintaining the power supply to the rest of the system.

6.4 Transformers

From the isolators, the output power is directed to the high voltage side of the step-down transformers at each pad. Two step-down transformers (TR-309 and TR-310) are installed after the isolators, where they convert the medium voltage of 4.16 kV into 480 V, making it suitable for powering critical systems and equipment. Once the voltage is stepped down, the low voltage is distributed through low voltage switch gear located in the MCC building, ensuring that power is efficiently and safely delivered to various components across the system.

Power transformer cooling fans are supplied with 220V AC from LP002 local panels at both the West and North Pads. These local panels ensure reliable power to cooling fans, essential for optimal transformer performance and preventing overheating.

To enhance further protection, the High Resistance Grounding (HRG) systems installed at the utility building provide fault protection for the transformers. The HRG systems effectively manage fault currents, offering a safe and controlled path for fault energy, thus preventing damage to the transformers and ensuring the continued reliability of the system.

6.5 LS-5 Series Relay

The LS-5 Series Relay plays a critical role in managing power distribution from the transformer's low-voltage (LV) side to the MCC building's Low Voltage Switchgear. It enables seamless load transfer between the GTG (Gas Turbine Generator) supply and local diesel generators during emergencies while ensuring system safety through monitoring essential parameters. The LS-5 relays are configured for synchronization between NP-SP/WP-SP and remote diesel generators, equipped with features like mains de-coupling, overvoltage, underfrequency, and reverse power protection. Additionally, the relays support remote monitoring via Ethernet or Modbus, ensuring reliable communication and control. Comprehensive commissioning and testing guarantee that the system operates efficiently, providing a robust, safe, and resilient power distribution network.

6.6 SEL Relay Panel

The SEL-311L relay is integral to this project for advanced protection, control, and automation of the electrical system, ensuring reliable and efficient operation. The SEL-311L relay is installed in the MCC buildings, where it is securely mounted and connected to power, control, communication, and instrumentation cables as per design schematics to integrate with current and voltage transformers (CTs/VTs) and other system components. The relay is configured with protection settings, communication protocols, and trip parameters to provide differential protection for transformers and transmission lines, enabling rapid fault detection and isolation to prevent equipment damage. Secondary and primary injection tests verify its functionality, including fault response and communication, while robust security features support system integration and remote monitoring. Thus, it ensures compliance with safety, reliability, and operational standards.

6.7 Uninterruptible Power Supply

At both pads, the UPS provides a stable and uninterrupted power supply to the SEL relay and LS-5 series relay, ensuring their continuous operation even during power disruptions. The SEL relay is powered by a 120V AC input, which is internally converted to DC to support its operational and protection functions. Similarly, the LS-5 series relay receives a 120V AC supply from the UPS and converts it to 24V DC to perform its designated functions effectively.

7. Project Execution with Significant Milestone

The execution of the MACC Project involved a series of well-coordinated steps, which were carefully planned and implemented to ensure the project met its objectives of reducing fuel gas consumption, cutting operational costs, and decreasing greenhouse gas emissions. The implementation was divided into several key phases, each addressing critical components of the system:

- Offline Isolator at NP/WP
- Transformer 500 KVA at NP/WP
- Install Medium Voltage Switchgear Extension at South pad
- Install Relay protection wall-mount panel SEL-311L at NP/WP
- MV Cable Routing & Splicing for NP/WP
- Install Woodward Control LS5 and Generator Synchronization
- Interconnection, function test, & commissioning

7.1 Offline Isolator Installation at NP/WP

Offline isolators (DS-309 and DS-310) were installed at the North Pad (NP) and West Pad (WP) to allow safe maintenance and fault isolation without impacting the entire power network. These isolators allow specific sections of the system to be isolated for maintenance or fault management, ensuring that the rest of the network remains operational without interruption. This design feature enables efficient and safe operations, allowing necessary maintenance or fault resolution while maintaining the power supply to the rest of the system.

Fig 03: Installation of Offline Isolators

7.2 500 KVA Transformer Installation at NP/WP

Fig 04: Installation of Offline Step-down Transformer

At both the NP and WP, 500 KVA step-down transformers (TR-309 and TR-310) were installed to convert medium voltage (4.16 kV) to low voltage (480 V). These transformers are pivotal for powering critical systems at each pad, ensuring that the electrical load requirements are met with consistent voltage levels while maintaining efficiency and reliability.

7.3 Medium Voltage Switchgear Extension at South Pad

The existing MV switchgear at the South Pad was extended to serve as the primary power distribution hub for the project. The additional switchgear units provided a centralized system for routing power to the NP and WP, ensuring robust control and redundancy in the power distribution network.

Fig 05: Installation of MV Switchgear Panel

7.4 Installation of Relay Protection Wall-Mount Panel (SEL-311L) at NP/WP

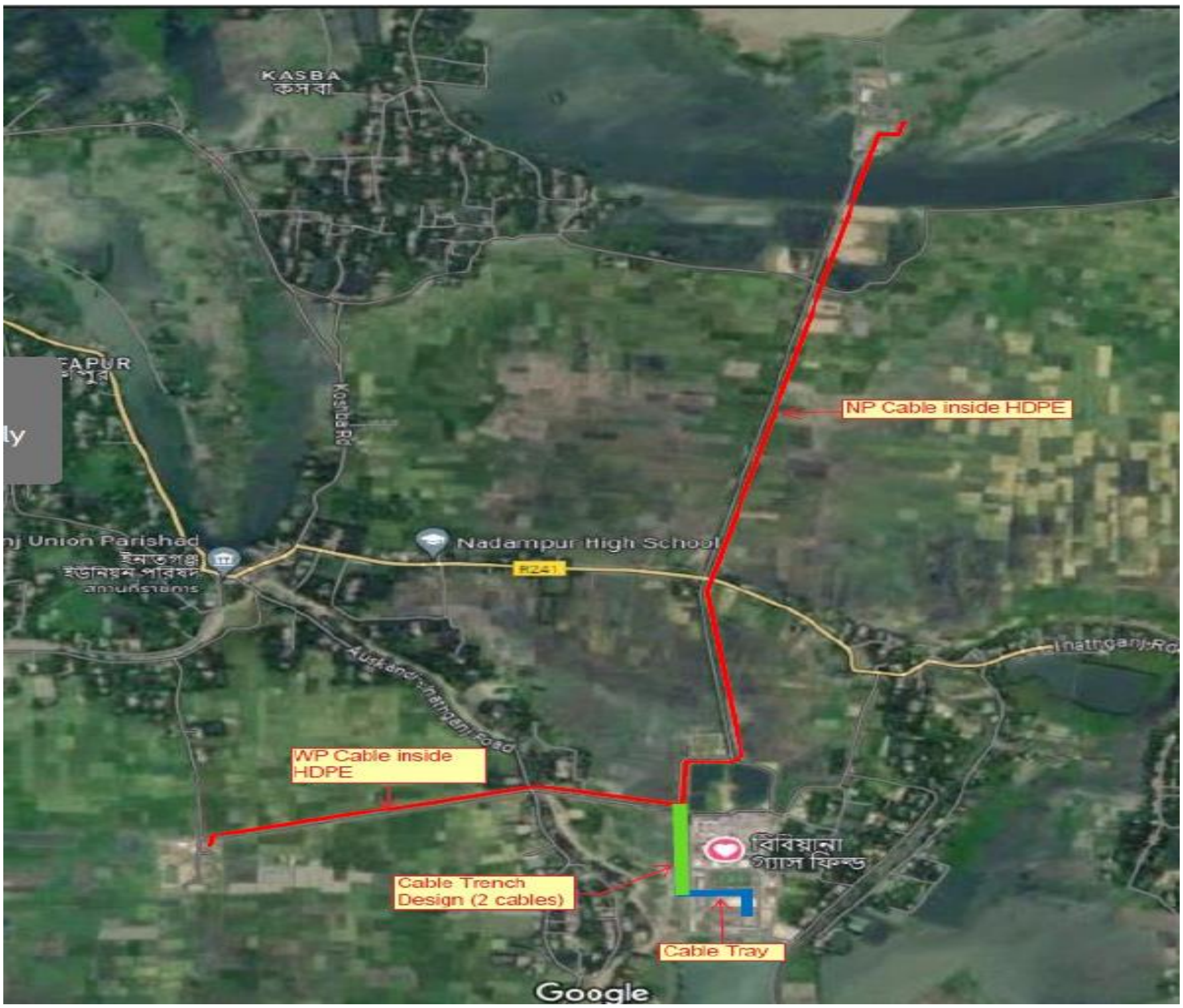
Advanced SEL-311L relay protection panels were installed at both the NP and WP to enhance the safety and reliability of the system. These relays provide real-time fault detection, isolation, and protection, ensuring that the system remains operational even during unexpected conditions. This technology significantly reduces downtime and prevents damage to critical components.

Fig 06: Installation of SEL-311L Relays

7.5 Medium Voltage Cable Routing & Splicing

As part of the MACC project, high capacity 3C x 185 mm² medium voltage (MV) cables were installed and expertly spliced to establish secure and reliable electrical connections between the South Pad and the remote North Pad (NP) and West Pad (WP). The entire process was carried out with precision and care to ensure uninterrupted power transmission across the network.

Fig 07: Cable Routing Path



This image illustrates the cable routing path for the North Pad (NP) and West Pad (WP) as part of the MACC project. Below are the key details based on the map:

7.5.1 Cable Routing Details – A Reliable Path to Sustainable Power

➢ South Pad to North Pad

Spanning 3.6 km, high-capacity Medium MV cables are meticulously routed inside durable HDPE conduit & open cut underground. These conduits provide robust protection against environmental & mechanical hazards, ensuring the longevity and reliability of the power supply to the North Pad.

➢ South Pad to West Pad

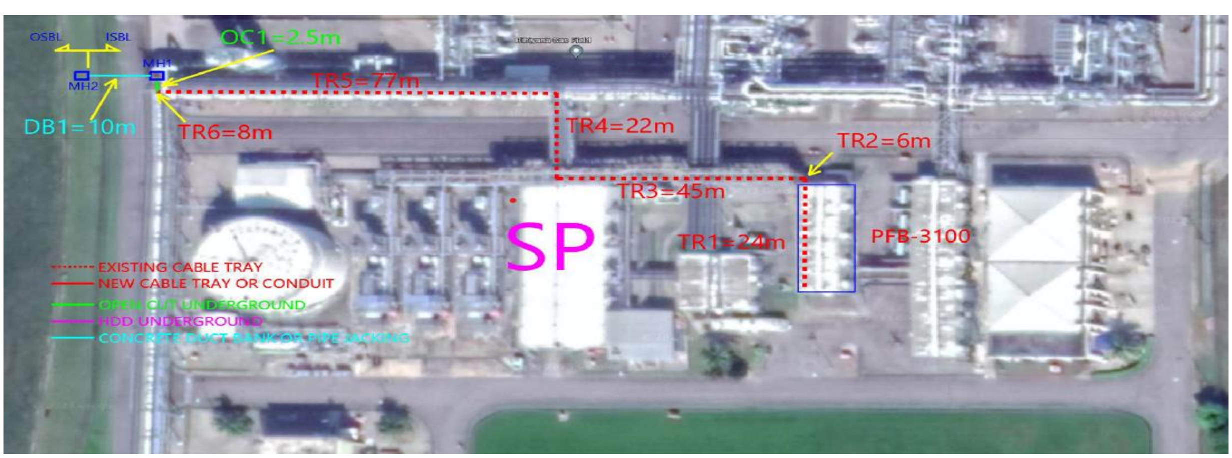
Covering 1.8 km, the MV cables follow a similar installation approach, securely enclosed in HDPE conduits and open cut underground. This routing ensures durability and protection throughout the journey, delivering uninterrupted power to the West Pad.

➢ Cable Tray System Design

The MV cables are routed securely using a cable tray system, providing organized cable management and facilitating easy maintenance. Once cables reach the designated transition point, they shift from the cable tray system to a cable trench for further routing to the North & West Pads. The cable tray route is carefully divided into six sections for optimal cable management, ensuring safety, accessibility & operational efficiency. The tray sections are as follows:

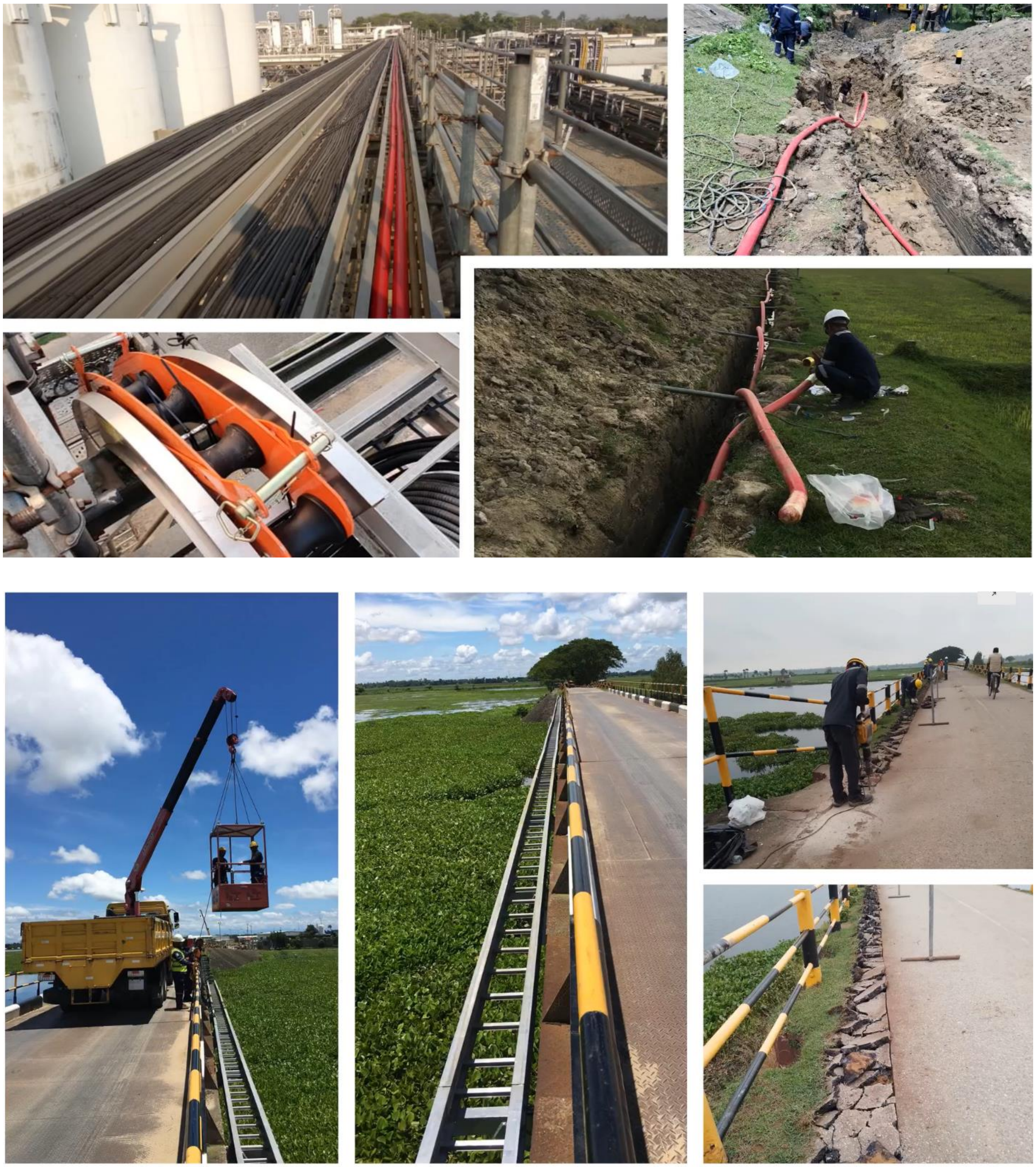
- TR1: 24 meters
- TR2: 6 meters
- TR3: 45 meters
- TR4: 22 meters
- TR5: 77 meters
- TR6: 8 meters

Fig 08: Aboveground Cable Tray Route



The total cable tray route spans 182 meters, optimized for functionality, future maintenance, and long-term operational reliability. This design reflects Chevron's focus on maintaining engineering standards while ensuring safety and performance.

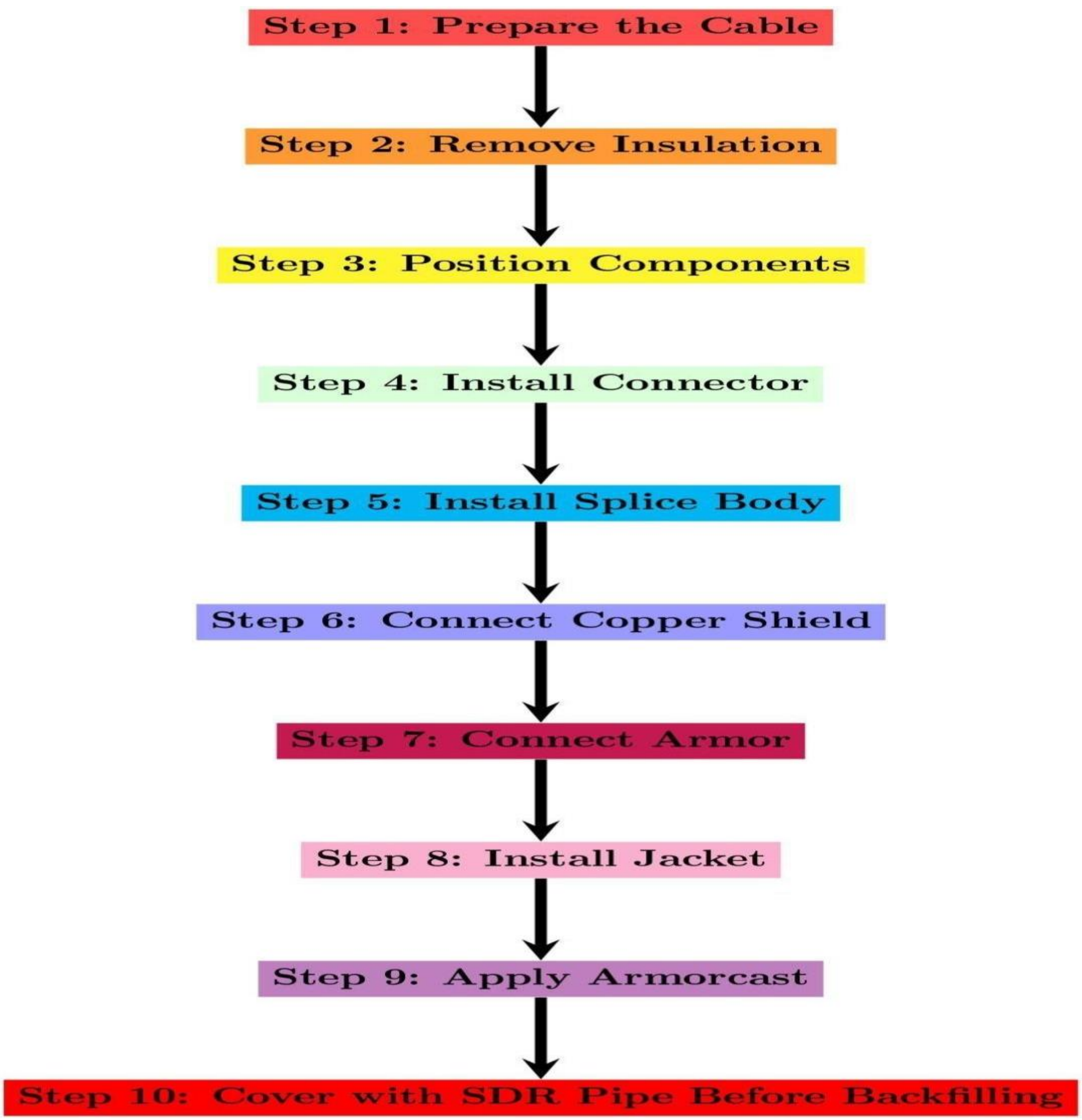
Fig 09: Cable Routing and Installation Process



7.5.2 Medium Voltage (MV) Cable Splicing – Ensuring Seamless Power Transmission

The Medium Voltage (MV) cable splicing work for the North Pad and West Pad involved creating approximately 12 high-quality joints using cold shrink type splicing kits. The cable splicing process involves several precise steps, starting with cable preparation and ending with protective measures such as sealing and wrapping the splice.

Fig 10: Cable Splicing Workflow



➢ Cable Preparation

Task: First, remove the cable jacket, armor, and semi-conductive screen to expose the insulation and copper wire shield. Ensure precise dimensions for effective overlap and secure connections.

Figure 11: Stripped Layers During Cable Preparation

This figure illustrates the cable preparation process, highlighting the stripped layers. The outer jacket and armor have been removed, revealing the semi-conductive screen, insulation, and the underlying copper wire shield.

➢ Insulation Removal

Task: Carefully strip the primary insulation following the connector supplier’s guidelines, ensuring no damage to the conductor.

Figure 12: Conductor Exposed After Insulation Removal

This figure illustrates the removal of the primary insulation, revealing the bare conductor. The process requires precision to avoid nicks or damage to the conductor strands.

➢ Positioning Components

Task: Slide the larger and smaller jacket tubes onto the cable ends, followed by the splice body and copper sleeve.

Figure 13: Components Positioned

This figure illustrates the proper placement of the jacket tubes, splice body, and copper sleeve. The larger and smaller jacket tubes are positioned on the cable ends.

➢ Connector Installation

Attach the connector securely, remove sharp edges, and apply Scotch 13 tape for a seamless connection matching the XLPE diameter.

Figure 14: Connector Installation on Cable Ends

This figure illustrates the connector installed securely on the cable ends. The sharp edges are removed to prevent damage, and Scotch 13 tape is applied to ensure a smooth, uniform diameter matching the XLPE insulation.

➢ Splice Body Installation

Task: Apply P55 grease to the insulation, screen, and connector. Shrink the splice body in place by pulling out the zip core counterclockwise.

Figure 15: Splice Body Installation Process

This figure shows the application of P55 grease to the insulation, screen, and connector, followed by the installation of the splice body. The zip core is pulled counterclockwise to shrink the splice body, ensuring a tight fit around the cable and connector.

➢ Copper Wire Shield Connection

Task: Secure the copper wires using a constant force spring, overwrap with vinyl tape, use connectors to attach the copper wire shield, and apply Scotch 2228 Mastic for additional sealing.

Figure 16: Copper Wire Shield Connection

This figure illustrates the copper wire shield connection process. The copper wires are secured using a constant force spring, then overwrapped with vinyl tape and connectors are used to securely attach the copper wire shield. Scotch 2228 Mastic is applied for extra sealing, ensuring a secure and protected connection.

➤ Armor Connection

Task: Use Scotch 25 braid and a constant force spring to connect the armor. Overwrap with Scotch 2228 Mastic and vinyl tape for reinforcement.

Figure 17: Armor Connection Process

This figure shows the process of connecting the armor using a Scotch 25 braid and a constant force spring. The connection is reinforced by overwrapping with Scotch 2228 Mastic and vinyl tape, ensuring durability and protection against environmental factors.

➢ Jacketing Installation

Task: Install the smaller and larger jacket tubes, applying Scotch 2228 Mastic to seal the edges.

Figure 18: Jacket Tube Installation

This figure illustrates the installation of the smaller and larger jacket tubes over the cable joint. Scotch 2228 Mastic is applied at the edges to ensure a secure seal, providing protection against moisture and environmental exposure.

➢ Final Wrapping

Task: Overwrap the splice with Armor cast wrap, activate it with water, and ensure a secure finish.

Figure 19: Final Splice Wrapping Process

This figure illustrates the final wrapping of the splice using Armor cast wrap, which is activated with water to form a durable and protective layer, ensuring a secure and reliable finish.

➢ Protect with HDPE Pipe and Backfill

Task: Place an HDPE pipe over the cable splice for additional mechanical protection. Carefully backfill the trench with soil to complete the installation.

Figure 20: Protect with HDPE Pipe

This figure illustrates the placement of an HDPE pipe over the cable splice, providing enhanced mechanical protection. The trench is then backfilled with soil to secure the installation and restore the ground surface.

7.6 Woodward Control LS5 and Generator Synchronization

The Woodward LS5 control system was installed to optimize generator performance through advanced load sharing and synchronization. This system ensures that the power generated by the GTG feeder is efficiently distributed and balanced, minimizing losses and maintaining stability in the power network. The synchronization feature ensures seamless integration of power sources without interruptions.

Figure 21: Installation of LS-5 Series Breaker

7.7 Interconnection, function test, & commissioning

The final phase involved the installation and interconnection of all system components, followed by comprehensive commissioning. This included rigorous testing of the isolators, transformers, MV switchgear, relay panels, and control systems to ensure they operated cohesively. The commissioning process validated the system's performance, safety, and reliability, marking the successful completion of the project.

Figure 22: MACC Commissioning Team

Each phase of execution was carefully planned, coordinated, and carried out with a focus on quality, safety, and environmental sustainability. The successful execution of the MACC Project not only eliminated gas engines but also set a new benchmark for energy efficiency and green energy practices at the Bibiyana gas field. This structured approach highlights Chevron's commitment to innovation and environmental responsibility.

8. Site Acceptance, Commissioning & Project Completion

8.1 Site Acceptance

The site acceptance process was conducted after all installations & system setups were completed. This involved an inspection and verification of the electrical infrastructure, including the power supply connection from the SP to the NP and WP, the installation of backup diesel generators & associated control systems. The technical team confirmed all components were installed as per the approved design specifications, ensuring compliance with operational & safety standards. The site acceptance was followed by the finalization of the system's readiness for commissioning.

Fig 23: Site Acceptance Inspection

8.2 Commissioning

During the commissioning phase, the systems were rigorously tested to confirm their operational efficiency. The focus was on validating the seamless transfer of power from the South Pad (SP) to NP and WP, ensuring minimal downtime and stable energy supply. The diesel backup generators were also tested to confirm they could provide support in case of grid failure. The commissioning process involved testing for load management, system stability, power quality, and operational readiness. Any identified issues were promptly addressed by the engineering team to ensure smooth functionality.

Fig 24: Commissioning Phase

8.3 Successful Completion

The MACC Project reached successful completion when all systems were fully operational & the power transition from gas engine generators to electrical power supply was successfully executed. The project not only met the primary objectives of reducing fuel gas consumption and greenhouse gas emissions but also contributed to optimizing operational efficiency at the Bibiyana Gas Plant. The systems were handed over to the operations team with all necessary documentation, training, and technical support to ensure long-term functionality. The project was completed within budget and on schedule, reflecting the effectiveness of Chevron's approach to cost management, resource allocation, and cross-departmental collaboration.

Fig 25: Celebration of MACC Project Completion

9. Key Third-Party Contributors and Their Roles

The successful execution of the MACC Project at Chevron Bangladesh's Bibiyana Gas Plant required collaboration with multiple third-party contractors and suppliers, each bringing specialized expertise to various aspects of the project. Their contributions were essential to ensuring a seamless and efficient project delivery.

9.1 Mir Akhter Hossain Ltd.

Mir Akhter Hossain Ltd. was responsible for pipe jacking under highways and LGED roads to route line cables, as well as providing cable tray support welding at the North Pad Oxbow Bridge.

9.2 Technip

Technip conducted the power system study and provided protection relay coordination settings, ensuring the reliability of the electrical system.

9.3 SPIE

SPIE provided detailed engineering services, including system design, installation, and commissioning.

9.4 Eaton

Eaton supplied offline isolators, which are critical for electrical safety and system reliability.

9.5 Powel

Powel delivered medium-voltage (MV) switchgear extension cubicles, ensuring efficient power distribution and system protection.

9.6 SEL, India

SEL provided advanced critical protection relay panels, along with supply, commissioning, and Site Acceptance Testing (SAT).

9.7 3M

3M supplied high-quality medium-voltage cable splicing materials, ensuring durable and reliable cable connections.

9.8 Batelco

Batelco provided oil cool step-down transformers, ensuring efficient voltage regulation and power distribution across the facility.

9.9 BBS

BBS supplied approximately 6 km of MV cables.

The coordinated efforts of these third-party contributors were instrumental in the successful execution of the MACC Project.

10. Debottlenecking, Innovation, & Cost Optimization

During the planning of MACC Project, the CMIE team implemented several key strategies to ensure that the project was completed within budget while maintaining high standards of safety and quality. By making innovative design adjustments and maximizing the use of available resources, the team successfully reduced costs without compromising the project's objectives.

10.1 Debottlenecking Key Process

10.1.1 Cable Tray Routing Challenges & Solution Near the Bibiyana River Bridge

During the cable tray installation near the Bibiyana River bridge, the team faced a significant challenge as welding the tray supports beside the bridge was deemed impossible due to restricted access and safety concerns. To overcome this, an innovative solution was implemented using a man basket, which provided stable support for technicians to perform welding and secure the cable trays. This approach ensured precise installation, maintaining alignment and durability while adhering to safety protocols, showcasing the team's adaptability and problem-solving expertise.

Fig 26: Cable Tray Installation Across Bibiyana River Bridge Using Man Basket Support

10.1.2 Challenge and Solution for MV Switchgear Extension Installation

The installation of new MV switchgear extension cabinets in the MV switchgear room presented a challenge due to the narrow space, making it difficult to maneuver & position the panels. To address this, the lift craft team provided critical support, utilizing specialized lifting techniques and equipment to manage and install the panels within the confined space. This collaborative effort ensured the successful installation while maintaining safety & precision in the process.

Fig 27: MV Switchgear Extension Installation in Confined Space

10.1.3 Underground MV Cable Theft and Solution

During the execution of the MACC project, some underground MV cables between the North Pad (NP) and West Pad (WP) were stolen, posing a significant challenge to the timeline and progress of the project. To overcome this, additional cables were sourced and spliced, resulting in a total of 12 splice points (initially planned for 10 splice points). To mitigate the risk of further theft, additional security measures were enforced along the cable line areas until the project was completed. This solution ensured that the project continued smoothly while maintaining security and the integrity of the installation.

Fig 28: Installation of Additional MV Cables

10.2 Innovations in Execution

The key innovative in the execution phase was the use of a man basket during cable tray installations near the Bibiyana River Bridge. The challenging access and safety concerns around the bridge made traditional welding and installation methods unfeasible. The man basket solution provided stable support, enabling safe and precise execution, ensuring that the cable trays were installed according to the required specifications while adhering to strict safety standards.

Fig 29: Groundbreaking First-ever Use of Man Basketing

10.3 Cost Optimization Measures

During the planning of MACC Project, the CMIE team implemented several key strategies to ensure that the project was completed within budget while maintaining high standards of safety and quality. By making innovative design adjustments and maximizing the use of available resources, the team successfully reduced costs without compromising the project's objectives.

10.3.1 Switchgear Room Cost Reduction

The initial plan for installing switchgear rooms at both North and West Pads was estimated at $1.5 million. Through revolutionary thinking and detailed research, the CMIE team proposed using off-line isolator drop-out fuses, a brilliant solution that significantly reduced costs while still meeting Chevron's requirements. Their proactive approach demonstrated true innovation.

10.3.2 Underground Cable Costs and HDPE

Underground cables were planned to be laid using HDPE, which came at a high cost of $800k. The team carefully evaluated the long-term benefits of this material, concluding that its durability and reduced maintenance needs justified the higher initial investment. Their foresight in ensuring long-term reliability exemplified their strategic thinking.

10.3.3 Use of Stored or Previous Store Materials

Instead of purchasing new materials, the CMIE team cleverly utilized stored or previous store materials from earlier projects, a cost-effective solution that reflected their resourcefulness and commitment to optimizing project expenses without compromising on quality.

10.3.4 In-House Construction by Chevron Civil Department

Rather than outsourcing construction, which would have added an additional $400k, the team made the forward-thinking decision to assign this responsibility to Chevron's civil department. This strategic move not only saved costs but also empowered Chevron's own workforce, further aligning with the company's internal capabilities, and fostering a collaborative spirit.

The CMIE team's remarkable ability to innovate, think creatively, and solve complex challenges within budget truly set them apart. Their dedication to excellence and cost-efficiency played a pivotal role in the successful execution of the MACC Project. Hats off to them for their outstanding contributions!

11. Results & Impacts

The MACC Project at Chevron Bangladesh had a significant and positive impact on both operational efficiency and environmental sustainability. By eliminating gas engines and transitioning to electrical power from the Bibiyana South Pad, the project played a crucial role in reducing carbon emissions, optimizing energy use, and enhancing safety. Below are the key results and impacts of the project:

11.1 Elimination of Gas Engines

The project successfully removed gas engines from the Bibiyana Remote North Pad and West Pad, significantly decreasing the reliance on fossil fuels. This directly contributed to lowering carbon emissions from the field, aligning with Chevron's sustainability goals to reduce environmental impact.

11.2 Sustainability and Green Energy

By shifting from gas engines to electrical power sourced from the Bibiyana South Pad, the project advanced Chevron’s commitment to green energy. This transition helped minimize the environmental footprint of the Bibiyana gas field by promoting the use of cleaner, more sustainable energy alternatives.

11.3 Cost Optimization

The elimination of gas-powered engines resulted in reduced energy consumption and operational costs. By adopting a more efficient power distribution system, Chevron was able to optimize costs associated with power generation, helping achieve better financial performance while maintaining operational reliability.

11.4 Improved Operational Efficiency

The introduction of a centralized power distribution system allowed for more efficient energy management across the Bibiyana gas field. The transition from gas engines to electrical supply ensured a more streamlined process, reducing energy losses and improving overall system performance.

11.5 Environmental Impact

The reduction in carbon emissions from the elimination of gas engines was a significant environmental achievement. This move helped Chevron make strides toward its environmental sustainability targets, contributing to global efforts to reduce greenhouse gas emissions and mitigate climate change.

11.6 Safety Improvements

The MACC Project incorporated key safety measures, such as fault handling with HRG and emergency shutdown systems, ensuring that the electrical systems operated safely. These improvements not only reduced the risk of electrical hazards but also safeguarded workers and the environment.

These results highlight how the MACC Project addressed environmental concerns while optimizing operational efficiency and ensuring the safety and reliability of the Bibiyana gas field’s power systems.

12. Lesson Learning & Opportunity

The execution of the MACC Project at Chevron Bangladesh's Bibiyana Gas Plant has provided valuable lessons that can further improve future projects, particularly in terms of planning, execution, and overall efficiency. These lessons, along with identified opportunities for future growth, serve as a roadmap for continued improvement in project management and sustainability initiatives.

12.1 Lessons Learned

12.1.1 Importance of Early Risk Identification and Mitigation

One key lesson from the project was the importance of identifying potential risks early in the planning phase. The theft of underground MV cables highlighted the need for enhanced security measures around critical infrastructure. Early intervention and initiative-taking security planning could have further minimized disruptions, ensuring smooth progress. In future projects, a more comprehensive risk assessment should be conducted to address potential threats from external factors, including theft or natural disasters.

12.1.2 Effective Collaboration and Communication

The project underscored the value of effective collaboration between different teams—electrical, civil, and maintenance departments. The challenges faced in areas such as cable tray installation, confined space equipment handling, and cable splicing were overcome through timely communication and teamwork. Future projects should continue fostering a collaborative culture, encouraging cross-disciplinary coordination to tackle complex tasks efficiently.

12.1.3 Flexibility in Resource Allocation

The need to adapt to changing circumstances, such as the cable theft, was an important takeaway from the project. The decision to increase the number of splice points and source additional cables demonstrated the importance of maintaining flexibility in resource planning. Future projects should integrate contingency plans that allow for swift reallocation of resources in the event of unforeseen challenges, preventing delays and cost overruns.

12.1.4 Innovation and Technology Integration

The use of HDPE pipes, advanced cable splicing methods, and the man basket for difficult installations all contributed to the project's success. These innovative techniques improved safety, reduced costs, and enhanced operational efficiency. The lesson here is that integrating new technologies and innovative methods into future projects can provide a significant competitive advantage and lead to more efficient operations. Continuous research and development should be encouraged to explore emerging technologies that can enhance project outcomes.

12.1.5 Importance of Material Management

The project demonstrated that effective management of materials, including the reuse of components from previous projects, can substantially lower costs and reduce environmental impact. The lesson learned is that a more robust material tracking system could ensure timely availability and minimize waste, making resource management more efficient. In future projects, a detailed material management plan should be created at the outset, ensuring that the right materials are available when needed.

12.2 Opportunities for Future Projects

12.2.1 Expansion of Renewable Energy Integration

Given the success of transitioning from gas engine generators to electrical power, there is a significant opportunity to further explore renewable energy sources, such as solar or wind, to supplement the power supply to remote or isolated areas of the plant. Integrating renewables could reduce overall fuel dependency, lower emissions, and provide a more sustainable power solution in line with Chevron's global sustainability goals.

12.2.2 Further Automation of Systems

Future projects can capitalize on automation to streamline operations, improve efficiency, and reduce human error. The integration of automated monitoring systems for cable splicing, power generation, and backup systems could optimize performance, detect potential issues early, and reduce maintenance requirements.

12.2.3 Investing in Advanced Security Systems

The security breach that led to the theft of MV cables emphasizes the need for robust security infrastructure. Future projects could benefit from investing in advanced security technologies, such as surveillance drones, smart cameras, and real-time monitoring systems, to ensure the protection of assets and critical infrastructure. Additionally, creating a security-focused training program for personnel could further reduce the likelihood of such issues.

12.2.4 Sustainability and Circular Economy Practices

Given the success of repurposing materials from previous projects, there is an opportunity to integrate circular economy principles more thoroughly in future projects. This could involve designing projects with a focus on reusing materials, minimizing waste, and considering the entire lifecycle of project components, from production to disposal. This could enhance Chevron's sustainability efforts and contribute to long-term cost savings.

12.2.5 Enhanced Training Programs

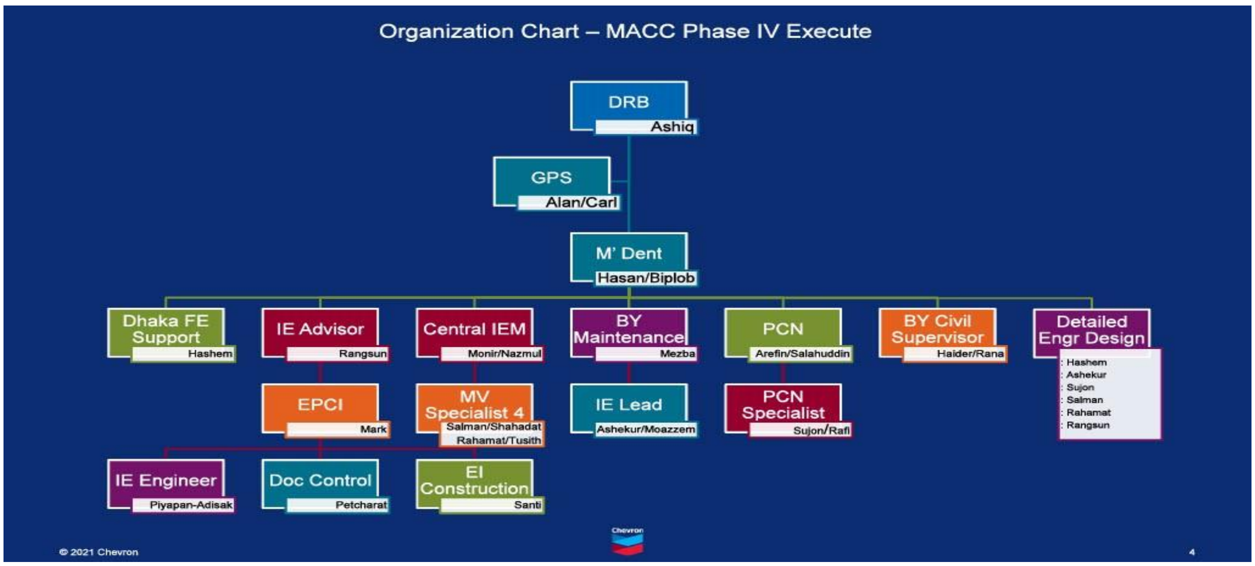
The project demonstrated the importance of skilled personnel to handle complex installations and troubleshoot unforeseen challenges. Investing in enhanced training programs for staff and contractors, with a focus on safety, advanced technologies, and problem-solving, can help mitigate risks and improve the execution of future projects. Furthermore, fostering a culture of continuous learning will ensure that the team is well-prepared for upcoming challenges.

By embracing the lessons learned and seizing the identified opportunities, Chevron Bangladesh can continue to drive operational excellence, reduce costs, and promote sustainable growth in future projects. These insights will not only enhance project delivery but will also contribute to Chevron's broader mission of achieving energy efficiency and environmental sustainability.

13. Team Organogram

The success of the MACC Project was driven by the collaborative efforts of a dedicated team from various departments within Chevron Bangladesh. The team was structured to ensure efficient project execution, effective communication, and timely decision-making. Below is an overview of the team organogram:

Fig 30: Tree Table of Team Organogram



The team structure is made up of highly skilled professionals, each playing a vital role in ensuring the success of operations. Ashiq bhai leads the DRB, providing strategic direction and ensuring effective team collaboration. Alan and Cari bhai manage GPS functions, optimizing location-based systems for operational efficiency. Hasan bhai and Biplob da oversee M' Dent, ensuring seamless maintenance. Hashem bhai provides valuable support to the Dhaka FE team, while Rangsun bhai expertise as IE Advisor ensures that industry standards and safety protocols are maintained. Monir and Nazmul bhai manage Central IEM, ensuring all engineering processes are executed flawlessly. Mezba bhai leads BY Maintenance, ensuring that systems run smoothly and efficiently. Arefin and Salahuddin bhai are instrumental in PCN, driving successful construction and networking efforts. Mark oversees EPCI processes, ensuring that projects are completed on time and within budget.

Rahamat bhai and Tusith da lead IE engineering projects, driving innovation and excellence in instrumentation. Shahadat and Salman bhai specialize in MV systems, maintaining critical electrical equipment. Ashekur and Moazzem bhai provide leadership in IE, managing complex projects with technical expertise. Sujon and Rafi bhai are key PCN specialists, ensuring effective construction and network integration. Piyapan Adisak bhai supports the IE team with precision and attention to detail in daily operations. Petcharat bhai ensures the smooth management of documentation, keeping everything organized and accessible. Santi bhai manages EI construction, ensuring projects are built to specification. Haider and Rana bhai supervise BY civil works, ensuring that the physical infrastructure is safely and efficiently constructed. Finally, Hashem, Ashekur, Sujon, Rahamat, Salman, and Rangsun bhai collaborate on detailed engineering designs, combining their expertise to ensure the highest standards of safety, efficiency, and performance. Together, this team's diverse skills and dedication contribute to the seamless execution of complex projects, highlighting the importance of collaboration and technical excellence in achieving success.

14. Future Direction & Conclusion

14.1 Future Recommendations

As the team continues to work together, the future direction lies in further strengthening the collaborative spirit and fostering cross-functional communication. Leveraging emerging technologies in electrical and instrumentation engineering, the team can explore automation and data-driven solutions to enhance operational efficiency. Additionally, the team could focus on increasing safety measures and improving environmental sustainability in all aspects of the project execution. By continuously upskilling and embracing innovation, the team can drive continuous improvement, adapt to industry changes, and meet the evolving demands of complex projects. Expanding the scope of training programs, embracing modern technologies, and collaborating more closely with external stakeholders will help further elevate the team's performance. Incorporating an initiative-taking approach to risk management and troubleshooting will ensure that challenges are managed swiftly, leading to even greater success in the future.

14.2 Conclusion

In conclusion, this team's collective expertise, commitment, and technical skills are the backbone of every successful project undertaken. The diverse talents brought by each member contribute to the smooth execution of operations, from planning and design to construction and maintenance. Through effective leadership, communication, and collaboration, the team has consistently exceeded expectations, met operational goals, and enhanced efficiency. The contributions of every individual—from expert engineers to support staff—are invaluable, ensuring that all aspects of the operation are running seamlessly. Moving forward, continued innovation, professional development, and a strong focus on teamwork will be key to maintaining success and tackling future challenges with confidence.