Experience in Design, Engineering, Testing and Implementation of Electrical Systems for a Large Gas Processing Plant

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Abstract

This paper presents the experience of the authors in the Design, Engineering, Testing and Implementation of Electrical Systems for Large Gas Processing Plants. The following areas are covered in this paper:

1. Design Criteria for electrical systems
2. Constraints in Design and Engineering of Electrical Systems for Large Plants
3. Development of Protection Control and Power Management System philosophies for different voltage levels
4. Experiences in actual implementation of a project

The paper provides the user with the identification of the critical areas of concern in designing electrical systems for large gas processing plants and highlights the lessons learnt by the authors during the implementation of the project.

The paper summarizes the experiences of the electrical equipment vendor, the end customer, and the engineering procurement and construction contractor involved in the project.

Acronyms:

- PDCS - Power Distribution Control System
- PMCS - Power Management and Control System
- ATS - Automatic Bus Transfer System
- IED - Intelligent Electronic Device
- ILS - Intelligent Load Shedding
- FAT - Factory Acceptance Test
The Dolphin Project is a major transborder project in the Middle East. This project uses the gas from one of the largest gas fields in the world, the North Field off the coast of Qatar. The two offshore platforms, within 90 km of the shore, collect the gas from 12 wells each. 2.6 billion cubic feet of gas (scf/day) is collected by the platforms and sent to the Ras Laffan facility by pipeline.

The Ras Laffan facility is one of the largest single location gas processing plants of its type, with six compression trains. Here, the incoming gas is stripped of hydrogen sulphide and other impurities like mercury. Then the high-value condensate and the natural gas liquids (NGL) are separated. The main product after processing is methane gas, which is compressed and transported to the UAE by a 364 km subsea pipeline (48 inch Ø).

The site is energized through two incomers from the utility grid and from internal power generation based on steam turbines. The internal power generation utilizes the waste heat recovery from six turbo compressors, each rated for 90 MW shaft power used in the process. The plant network is made up of 13 substations distributed across the plant site, with 82 transformers distributing power to the diversified loads.

### System at a Glance

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility incomers</td>
<td>33 kV 2nos</td>
</tr>
<tr>
<td>Plant power generation</td>
<td>3 x 43.75 MVA</td>
</tr>
<tr>
<td>Emergency generators</td>
<td>2 x 3150 kVA + 1 x 500 kVA</td>
</tr>
<tr>
<td>HV Motors (6.6 kV)</td>
<td>56</td>
</tr>
<tr>
<td>LV Motors at 690 V AC</td>
<td>1120</td>
</tr>
<tr>
<td>Variable-speed drives 400 V</td>
<td>57</td>
</tr>
<tr>
<td>Total transformers</td>
<td>82</td>
</tr>
<tr>
<td>UPS system AC</td>
<td>16</td>
</tr>
<tr>
<td>UPS system DC</td>
<td>26</td>
</tr>
<tr>
<td>Total substations</td>
<td>13</td>
</tr>
<tr>
<td>Substations HV + LV</td>
<td>10</td>
</tr>
<tr>
<td>Substations LV</td>
<td>3</td>
</tr>
<tr>
<td>No of 690 V switchboards</td>
<td>30</td>
</tr>
<tr>
<td>No of 400 V switchboards</td>
<td>27</td>
</tr>
<tr>
<td>Fault levels</td>
<td></td>
</tr>
<tr>
<td>33 kV</td>
<td>31.5 kA</td>
</tr>
<tr>
<td>6.6 kV</td>
<td>31.5 kA</td>
</tr>
<tr>
<td>690 V</td>
<td>63 kA and below</td>
</tr>
</tbody>
</table>

The LV motors are connected at 690 V whereas small power, lighting, HVAC, and the variable-speed drives are at 400 V.

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**Figure 1 - PDCS Network & Distances of Substations**
The design of the electrical system, with in-plant generation and connection to the local grid with high reliability and fast load shedding, posed its own challenges.

At the early implementation stage all the data available for the design of the basic electrical system is preliminary and based on the designer’s experience, the associated technical referential, and the particulars of the process plant at hand. This calls for a consolidation of the experience gained on other large projects to identify and add extra capacities, so that frequent redesign is minimized and changes in the capacity of power equipment is minimized.

The particularities of this specific project started with an ambient design temperature of 49°C and the ratings of the outdoor equipment adjusted for this temperature. Furthermore, an ambient design temperature of 40°C was considered for the indoor equipment.

The main electrical design parameters of the plant network to be considered are as follows:

- Plant is designed to operate for 365 days a year.
- An internal power generation made up of three generators rated at 43,75 MVA and driven by steam turbines operating in parallel. The steam is generated by four steam boilers and a heat recovery unit
- Issues arise on the load sharing and the turbine loads including the stoppage of turbines that provide flue gases for the heat recovery
- The diesel generation is to be connected to the system at the local substation close to the critical loads at 6,6 kV
- Two incomers from the local grid at 33 kV to which the internal power needs to synchronize
- The system is designed with flexibility to select the source of power and to be able to supply all the loads
- Automatic transfer of loads in the event of outage at: 6,6 kV, 690 V, and 400 V levels
- Load centres spread in the plant and related cable routing
- Start-up of large inertial loads and hot restarts.

The plant has 56 large motors operating on a 6,6 kV bus

- Protection and control systems
- IEDs for the low-voltage modules
- Integrated power management and fast load shedding

The electrical equipment was selected to have inbuilt extra capacity to avoid changes in the rating and quantity. This philosophy has been applied for the power and distribution transformers, medium-voltage switchboards and low-voltage distribution.

The design stage decision to have 20 per cent spare feeders on the medium-voltage switchboards provided the much needed buffer during the several changes encountered during the different phases of design development.

The topography of the network is monitored in real time basis by the ILS.

Figure 2 - PDCS Network and Distances of Substations
The Dolphin Plant has two 33 kV incomers from the local utility grid, to which the plant power generation has to be synchronized at the 33 kV switchboard level, as shown in Figure 1. The 33 kV bus is rated for 2500 A, with a short circuit rating of 31.5 kA.

The public grid supplies approximately 20 per cent of the plant’s energy requirements under normal operation conditions. However, the grid might be required to supply a higher percentage of load in case of internal power generation problems or tripping.

The public grid has been very reliable with 100 per cent availability so far, which has proven to be useful for starting the large HV motors in the direct online mode.

The transformers connecting the system to the utility have double star winding configurations with a closed delta tertiary winding. This is to eliminate the harmonics generated at plant level from being transmitted to the utility grid.

A 33 kV GIS solution utilizing vacuum circuit-breakers was selected to build in reliability, safety and high availability. It needs to be mentioned that these GIS have a very high availability and a life of more than 25 years. The first inspection of the equipment is needed only after a decade of operation.

The medium-voltage switchgear uses vacuum circuit breakers (CBs). Surge suppressors are used for the 6,6 kV motor circuits to protect the motor windings against dV/dt and the high-frequency overvoltage generated when opening and closing the vacuum CBs. They were selected for their high reliability, being almost maintenance free.

The incoming feeders from the utility, along with the internal power generation, feed the double busbar system with full flexibility.

The emergency power supply station receives dual input from the main substation and it has a dedicated diesel-based power generation of 2 x 3150 kVA connected to each 6,6 kV bus.

The LV switchboards are connected to two transformers with an automatic transfer system (ATS) as shown in Figure 3. The ATS can also be operated manually at the switchboard level by the operator when in local mode or remotely from the control room via the PDCS in remote mode.

Motors rated from 2,2 kW up to 300 kW are connected to the 690 V system. Motors below 2,2 kW, HVAC and lighting are connected to the 400 V system.

The variable speed drive systems operate at 400 V and are rated between 11 kW to 50 kW. The low ratings of the variable speed drives compared to the overall load or the switchboard loads ensure that harmonics do not have any adverse effect on the network such as overheating of the other motors, cables, or transformers.

The load flow study was done for each substation that feeds HV motors. The feeders are allocated to the bus after simulation study for the start of the motors including flying start to ensure that voltage is maintained within acceptable limits (for the other loads) during starts and flying starts. If there is an excessive voltage drop or longer startup time, electronic starters might have been required. In this case the plant network along with the utility grid is powerful and this was not necessary. This was shown during the load flow studies and proven during start-up.
Hermetically sealed, mineral oil-type transformers up to 4000 kVA ratings and mineral oil, conservator-type transformers above 4000 kVA were used for the plant. The transformers at the 33 kV bus are rated for a load of 10 MVA and the star point on its secondary side is earthed through resistors to restrict earth currents and to have discrimination for the protective relays. The transformers for the LV application are connected to the low-voltage switchgear by bus ducts at 690 V and 400 V, their secondary side star point neutral is solidly grounded. Figure 4 depicts the plant voltage levels and the short circuit currents for the busbars.

All the transformers in the system have off-load tap changers to compensate the load flow voltage drops.

The low-voltage system is configured to be protected by relays for the incomers, while the motors are monitored and protected by use of IEDs that communicate with the plant wide PDCS. The variable speed drives are integrated into the LV switchgear.

All HV cables are directly buried (no special concrete cable trench). The LV cables are directly buried from the switchgear room up to the process unit pipe rack, where they are laid on galvanized cable trays supported by the pipe racks.

Figure 4 - Plant Voltage Levels and Fault Currents

Best Practices:

• Planning and engineering effort to finalize the load list for medium-voltage loads
• Finalizing the location of the substations at an early stage
• Plan for redundancy at the plant concept stage

Lessons Learnt:

• Leverage the stable grid for parallel operation with the plant, to enhance system stability as compared to island operation
• Parallel operation with the grid improves the reliability as an additional back-up source, coupled with the fast load-shedding system
The protection system for the plant consists of:
- Relays for all the voltage levels except 690 V and below
- IEDs for 690 V and 400 V

The relays were selected to ensure the complete functionality of protection, control, and transient recording for further analysis. The relays needed to be networked on the bus for data communication and control from the higher level controller in order to be integrated into the PDCS. All the loads on the low voltage side are controlled by the IEDs that communicate as slaves on a two-wire bus system with the PDCS. It is then possible to extract the historical operational data of the drive from the Relay/IED locally, and in the remote version via the higher level controller.

The three back pressure steam turbine generators transmit the exact LP steam amount required by the gasplant process and satisfy part of the electrical power demand of the plant: the balance of the electrical demand (around 20 per cent) is imported from the grid. This is achieved by a coordinated operation of the protective relays, speed governor, and the AVR transient performance. The design of the PDCS system architecture for such large sites was achieved in line with several parameters such as:
- Ensure a safe and 100 per cent secure isolation of the electrical fault in order to avoid any propagation of faults to the plant's electrical network and to ensure personnel safety and process integrity
- Automatic capability to maintain the maximum of the plant's processes running during most electrical failures by permanently adapting the electrical network balance and achieving a proper load-shedding system
- The protection and control of the electrical substations of the plant is set up in each substation, by digital protection and bay computers connected on a redundant Ethernet network running across the entire electrical substation plant
- Dedicated human machine interface provides the operator with the necessary information to be able, at any moment, to control and adapt the electrical elements to the process requirements.

Intelligent Load Shedding (ILS) considerations

The aim of load shedding is to keep the balance between available power generation (turbo generators and grid) and power consumption by shedding some of the load feeders in order to keep the site up and running.

The islanding mode of operation from the external grid is extremely critical as the power generation in the plant is limited with only a negligible to small spinning reserve.

Successful load shedding prevents the collapse of the site’s power supply, and, as such, increases the power quality. The Intelligent load shedding solution comprises:
- Recovering the balance between consumption and generation in the shortest time, resulting in a minimum disturbance to the plant’s electrical network
- Shedding only the necessary loads, resulting in a minimum impact for the process
- Allowing for flexible feeder allocation according to changing priorities, resulting in better adjustment to the process
- Adapting the load shedding sequence to the actual configuration of the network
Hypothetical Situation: Loss of a Generator or Network Islanding

These criteria would trip an emergency (fast) load shedding. The algorithm is based on the following principles:

- The amount of load to be shed is calculated per generator loss, based on the generator’s actual spin reserve. This calculation allows a single step to restore the supply/load balance instead of a series of steps (with the traditional underfrequency approach) – see Figure 5.
- The list of loads to be shed (per generator) is dynamically defined in real time by calculating the number of loads (of the lowest priority) that will correspond to such a spin reserve amount.
- The load priorities can be modified dynamically in order to better follow the evolution of the environment.

The algorithm takes into account the following details:

- Possible islanded subnetworks of the installation. The algorithm is initiated for each islanded network based on the network’s actual topology.
- The spinning reserve available and needed in each islanded network.
- If it is implemented in an ILS. An algorithm has been developed in order to ensure good reliability: periodically each computer receives the list of loads to shed in case of the loss of a generator (Table 1). Only the generator loss information needs then to be transmitted in order to shed the relevant loads quickly. Once a computer receives notification of a generator loss it will decide locally, which feeder needs to be shed.

<table>
<thead>
<tr>
<th>Feeders by priority order</th>
<th>Loss of G1</th>
<th>Loss of G2</th>
<th>Loss of G3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeder 1</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Feeder 2</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Feeder 3</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>……</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder 4</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1: Example of a real time preset table in each distributed computer in case of a generator loss.

Frequency drop

In order to cover other types of disturbances, a specific version of the under-frequency load shedding algorithm has been developed. The principle is to shed a predefined load amount instead of a fixed list of feeders if the frequency reaches a low threshold. This is in order to reach the balance in one step.

As for the previous algorithm, the list of feeders is calculated by summing the loads of the lowest priority that will correspond to such an amount. These values are calculated per island and are loaded into each computer managing the feeders (Table 2).

<table>
<thead>
<tr>
<th>Power to be shed (examples)</th>
<th>Group 1 f &lt; f1</th>
<th>Group 2 f &lt; f2</th>
<th>Group 3 f &lt; f3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time delay</td>
<td>100 ms</td>
<td>300 ms</td>
<td>500 ms</td>
</tr>
<tr>
<td>Feeder 1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder 2</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Feeder 3</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>……</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder 4</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 2: Example of the real-time, preset table in each distributed computer for advanced under-frequency load shedding.
Momentary overload

A momentary overload shedding uses the spinning reserve of a subnetwork reaching a predetermined threshold (configurable online). When the power demand goes over this threshold, the load management system activates an alarm and after a time delay, it begins to shed the feeders.

The time delay has to be sufficient for an operator to take an action before automatic load shedding. The feeders are tripped in priority order (priorities are the same as for the loss of a generator), with another time delay between each trip, until the power demand goes back under the threshold.

Simulation

The PDCS ILS solution provides a dedicated HMI in order for the operator to modify any online shedding priority, visualize the real-time topology of all electrical networks, and use the simulation module to evaluate all the consequences of any external grid loss, the loss of a turbo-generator, or a plant electrical network fault based on the real-time network data available.

The PDCS system for such large sites is invariably tested and commissioned in phases. Because of this, a multi-ring architecture design is a key consideration. In principle, the system architecture for such an infrastructure is based on the design shown in Figure 6.

The key benefits of the multi-ring architecture are:

- The system can be engineered and tested in phases as an individual ring level.
- The updates/modifications to the system database and architecture can be implemented without affecting the system as a whole, thus minimizing the rework at site.

In this project, the PDCS functions of the system were concentrated in one ring and the PMS functions (load shedding and generator management) were concentrated in another dedicated ring with the load shedding master PLC and triggering units.

Best Practices:

- The relays were selected for use in communicating networks complying to IEC 61850.

Lessons Learnt:

- The relays were ordered at different times. When connected to the network, the software version needed an upgrade for compatibility.
Factory Acceptance Tests (FAT) and Commissioning

The test for each component for the power system was done at the factory to ensure compliance to the order specifications. All hardware was tested for routine tests and then shipped to site.

In the case of a software based system, it is not feasible to test 100 per cent, as the full hardware was not planned to be configured for the final acceptance test. However, the functionalities were tested under simulated test conditions that were designed to be close to the actual requirements.

Lessons Learnt
- Individual communication tests of typical protection relays with the PDCS should be performed to validate the interface.
- FAT with all switchboards and associated protection systems will lead to a reduction of commissioning site activities.

Testing the software can make or break the project. The software is generally modularized with interfaces to the preceding and succeeding sections. If a comprehensive test of the system can be done, then the bugs can be identified at any stage and corrected. Correction at the site during or post commissioning can be very expensive.

Some of the issues experienced during the commissioning of the PDCS at site were:
- Changes in software due to application modifications
- Increase in the number of recordable parameters both digital and analog
- Time delays due to data updating
- Saturation of the network
- Increase in number of alarms
- Achieving the upper limit of alarms, etc.

Commissioning of the Power System

Once the installation of the equipment was completed and basic tests were conducted to establish that equipment was ready to be energized, the product experts were there to provide the supervision for the next stage.

Temporary diesel generators were utilized to start the commissioning activities of the DC and AC UPS systems in order to provide the necessary control voltage to the switchgear controls, protection relays, F&G, and air conditioning systems.

Upon availability of control voltage, the grid incomers were commissioned to provide permanent power supply to the 33 kV switchboard, followed by the 6,6 kV switchgear. A change in the interlocking scheme of the medium-voltage switchboards was then implemented at site and finally, the LV switchgear was commissioned.

The STG (steam turbine generator) was commissioned after the commissioning of the plant utilities (boilers, air compressors which require a 6,6 kV supply). Power export to the grid was essential to conduct the full load test on each generator, since the plant load was not large enough at the time to carry out this performance test.

Emergency diesel generators were the last to be commissioned. During the course of precommissioning and commissioning some difficulties were encountered such as:
- Interconnecting busbar bridge between the two 33 kV GIS switchgear parts, where a phase crossing occurs
- Mechanical interlocks on 6 kV switchgear which need to be modified on-site on some of the switchboards

These problems had been detected early and corrected on-site without impacting the commissioning planning, thanks to the proactive action of the factories involved.
Commissioning of the PDCS and ILS

The commissioning of the power management system is a challenge in such systems, especially systems with sophisticated PMS functions like load shedding and power management functionalities.

Normally the system leaves the factory after being fully tested (FAT); however, the real performance of the system can only be validated after it is installed at the site and undergoes site testing. Invariably several areas need to be fine tuned.

In order to enable an efficient and secure fine tuning at the site, a mirror platform reflecting the actual system at the site was set up in the factory. This enabled the commissioning engineers to validate the changes foreseen on the mirror platform before the actual implementation at the site. The net impact was a reduction of time spent at the site to implement the modifications to the system.

Several changes incorporated during the site commissioning were due to the fact that the project engineers that validated the design documents had not involved the operators, that is, the final end users. The changes at site had to be made for the following categories:

- Signal adaptation based on operator/end user preferences
- Minor changes to graphic user interface
- Modification of data sampling and archiving requirements
- Uploading of the relay disturbance record and archiving

Figure 7 - Modifications to ILS Data Acquisition at Site
The net result of the above modifications was a slight increase in the data traffic and database size. Consequently, in order to reach the required level of performance, several upgrades had to be made to the computing and communications hardware.

At one stage there was an option to modify the relay firmware and make no change to the power management system software, but we had to select the more effort intensive path of software modification. The choice was made as the plant was in production and a shut-down was not an option, since all the relays would need firmware upgrades at the same time.

The software also needed major modifications to integrate the higher sampling frequency and consequent data traffic, as well as an archiving capacity. The software effort on the new requirements was significant and a new version was eventually loaded.

Best Practices:
- The grid connectivity was used to test the internal generation of the plant before commissioning
- Establishment of an identical test platform at the factory and maintaining it for the entire duration of the project site led to trouble-free modifications to the PDCS on-site
- Dedicated communication link for intelligent load shedding

Lessons Learnt:
- Transmission delays for critical parameters in case of events cascading on the network are difficult to simulate at FAT stage
- Generator analog data was connected directly to the load shedding system to improve the response time.

The other major modification done at the site was related to intelligent load shedding. The load shedding functions were simulated during FAT to prove its compliance to specification requirements. However, during commissioning it was decided to hardwire the critical analog values from the relays of the steam generator directly to the load shedding controllers as shown in Figure 7.

This was the net effect of the measurement of data communication time for critical parameters for loadshedding. There was a significant delay in the transmission of the data over the network due to the event cascading in case of STG tripping or network connection loss, which could not be detected at the FAT stage.
In this international, high-profile project the project management team was in charge of designing and delivering to site the following equipment: the main 33 kV GIS switchboard, the 6,6 kV switchboard, the main power transformers, and the PDCS/PMS system. The design and manufacturing of this equipment was spread worldwide among various manufacturing plants under the PMT supervision. The 33 kV GIS switchboard was built in a German factory, the 6,6 kV switchboards and the main power transformers were built in two Indonesian factories, the distribution transformers in a Turkish plant and the PDCS/PMS in the south of France, bearing in mind that the project management team was based in the Paris area.

A project of this magnitude and complexity raises various challenges for the project management team such as:
- Cost
- Delivery schedule
- The management of the various interfaces and the integration of electrical equipment in the PDCS/PMS

As described above, some difficulties were encountered during the project development:
- Protection relays installed in the switchboard were developed for their protection functions and interface development with the PDCS had issues during FAT and so they were implemented at Site
- 30 kV busbar bridge configuration needed site modification

It is in such situations that a transverse coordination group can be useful to anticipate, plan and federate the various technical centres worldwide.

Site modifications of the PDCS/PMS have been listed in this paper and were mainly:
- Changes/corrections on graphics
- Modification to fit operators’ preferences
- Modifications to data-recording and archiving
- Protection relay parameter and disturbance data uploading and archiving modifications

These site modifications on a system of this magnitude have highlighted the need for a mirror configuration at the development centre in order to implement the modifications and test them in order to minimize the impacts when downloaded on-site.

The commissioning and start-up period has demonstrated the need for a PDCS specialist to remain at site for the first months of operation, to allow a smooth transfer to the operation team. Furthermore this presence on-site contributes to building up the operation team’s confidence in the system by supporting their initial day to day operations.

This was one of the first projects of its size to use the IEC 61850 protocol for industrial application. Naturally there were challenges in realizing the concept given the global project delivery. The product-centric approach to a comprehensive project did raise issues that are best solved by implementing a transverse project technical team.

This transverse team has to anticipate and ensure effective interfaces for the supply from separate geographical product organizations and enforce appropriate testing procedures. The mandate to the team has to be the delivery of an operational system as designed and ordered for the project.
About the authors

Prabhat K. Saxena of Schneider Electric has an M. Tech from the Indian Institute of Technology Delhi, India. He graduated from MREC Jaipur. He joined Cimmco Ltd and worked on turnkey electrical, instrumentation, and automation of cement plants and moving machinery like stackers and reclaimers for five years. Later he worked at Siemens® for 14 years and was responsible for large turnkey industrial projects encompassing process control, automation, drives, and power electrical projects for the Oil & Gas industry as well as the metallurgical industry encompassing blast furnaces, electric arc furnaces, and hot and cold rolling mills. He joined Alstom, which became Areva T&D, and has handled industrial business and developed the Oil & Gas business globally.

Eric Meyer of Total (Exploration & Production, technologies division) graduated from the Ecole Spéciale de Mécanique et d'Electricité (ESME Sudria). Before joining Total E&P, he previously worked in Spie Batignolles for five years as electrical and control engineer on large infrastructure projects such as the Channel Tunnel, and then he worked in TECHNIP for five years as a senior electrical engineer on several major O&G projects such as the Leuna refinery (ELF) and the Shaybah treatment plant (ARAMCO). He joined Total E&P 11 years ago as an electrical engineer and after various positions on projects and five years' expatriation he is now in charge of the electrical department in the technology division, where he is involved in the main development projects and R&D (such as the Dolphin Project).

Pi Roy of Schneider Electric is a graduate of electrical engineering and has an MBA from the University of Manchester. He has more than 12 years of experience in Areva T&D and he has worked in Singapore and the United States in protection, control, and network automation. Currently, he is working as business development director for Oil & Gas projects on global basis located in Montpellier, VT.

Nizar Saeed of Dolphin Energy graduated in electrical engineering (power and electric machines) from Aleppo University, Syria in 1978, worked for ADNOC as senior maintenance electrical engineer at oil refineries and gas plants for 25 years. He joined the Dolphin Energy gas plant maintenance department in 2004 as electrical superintendent and is in charge of the electrical maintenance section of Dolphin gas plant.