Abstract

Résumé:
This paper describes the project methodologies applied for the refurbishment and upgrades of the Gibraltar Electricity Authority HV grid and substations with clear limitations in the possible impacts.

A brief description of the original GEA grid and the main project’s constraints and how this has influenced the grid architecture design and the project management choices begin the paper. In the second part, the authors present how the optimized replacement plan for the various substations and the implementation strategy has been finalized using grid simulation tools and evaluating each choice impact on the global project and future stages. The integration of the refurbished and new parts is detailed and how these new architectures, features and architectures impacted existing parts with the respect of the continuity of service and lowest environmental impact is described. Third part presents FAT & SAT methodologies and explain the capabilities given to GEA to define the priority of evolutions based on GEA grid constraints and requirements. As conclusion, project key features and learned lessons are explored and described with impacts on GEA future grid.
Upgrade PACS methodologies apply to Gibraltar Electric Authority's power Distribution system

DIGITAL REMOTE IOS TO SIMPLIFY SUBSTATION RETROFITS & UPGRADES: ENEDIS PCCN EXAMPLE

Yann-Eric Bouffard-Vercelli
Upgrade PACS methodologies apply to Gibraltar Electric Authority's power Distribution system

Tyrone Fa
Upgrade PACS methodologies apply to Gibraltar Electric Authority's power Distribution system

Authors
Bruno André
MATPOST
2019

Yann-Eric Bouffard-Vercelli
MATPOST
2019

Tyrone Fa
MATPOST
2019

License

La SEE (Société de l'Electricité, de l'Electronique et des Technologies de l'Information et de la Communication – Association reconnue d'utilité publique, régie par la loi du 1er juillet 1901) met à la disposition de ses adhérents et des abonnés à ses publications, un ensemble de documents numériques accessibles à partir de son portail des publications. Ces documents incluent notamment les articles des revues REE, 3 EI et e-STA disponibles sous forme numérique ainsi que des publications additionnelles regroupées dans l'espace eREE. Les présentes conditions précisent les conditions de diffusion et d'utilisation de ces documents et des informations qu'ils contiennent. L’accès à ces documents, qu’il se fasse de façon gratuite ou dans le cadre d’abonnements ou d’achats faits à titre onéreux, implique l’acceptation sans restriction de ces dispositions.

Droits de propriété et de diffusion des contenus téléchargés sur le portail des publications

Les contenus rendus accessibles sur le portail des publications sont, en règle générale, protégés par le droit d’auteur. En tant que producteur, et le cas échéant d’auteur, des informations rassemblées dans les contenus accessibles par ce portail, SEE se réserve l’exclusivité des droits de copie et de diffusion de tout ou partie de ces contenus.
Les contenus sont rendus accessibles à titre individuel, pour les besoins de la personne en détenant des droits d'accès en cours de validité. Aussi, la modification, la reproduction et/ou la diffusion via Internet ou le Web, intranet, extranet ou toute autre forme numérique ou imprimée, de tout ou partie des contenus téléchargés sont interdites. Une tolérance est consentie quant à la reproduction d'extraits limités de ces contenus, dans le cadre de travaux ou d'activités auxquels ils sont utiles, à la condition que l'origine de ces reproductions partielles soit mentionnée de façon lisible et sans ambiguïté. Figurent en particulier : la REE (ou toute autre revue accessible sur le portail) en tant que la source, la référence de la publication et le nom de l'auteur (s'il figure dans la revue).

Ces dispositions s'appliquent également aux figures, illustrations, logos ou images.

**Publication externe des contenus du portail des publications**

Tout extrait des contenus du portail destiné à être utilisé dans des publicités, des communiqués de presse ou du matériel de promotion nécessite un accord préalable écrit de la SEE. Une version préliminaire du document proposé contenant ces extraits doit accompagner chacune de ces demandes. SEE se réserve le droit de refuser un tel usage externe pour quelque raison que ce soit.

**Responsabilités**

La SEE apporte tout le soin possible à la préparation des informations délivrées dans les contenus produits. Cependant elle ne peut être tenue pour responsable d'aucune perte ou frais qui pourrait résulter d'imprécisions, d'inexactitudes, d'erreurs ou de possibles omissions portant sur des informations publiées, ni des résultats obtenus par l'utilisation et la pratique des informations délivrées.

**Utilisation des informations recueillies lors du téléchargement de contenu**

Le portail des publications est susceptible d'utiliser des « cookies » afin notamment de permettre l'utilisation de paniers d'achat et de personnaliser les parcours sur le site. SEE se réserve la possibilité d'utiliser les informations recueillies lors des téléchargements pour ses besoins internes et notamment pour l'amélioration de ses services, sans qu'elles puissent être cédées à des partenaires commerciaux. Conformément à la loi "informatique et libertés" du 6 janvier 1978, chaque utilisateur du portail dispose d'un droit d'accès et de rectification aux informations qui le concernent. Pour exercer ce droit, les utilisateurs doivent s'adresser à SEE – 17 rue de l'amiral Hamelin – 75783 Paris Cedex 16, par simple lettre ou en utilisant le formulaire de contact disponible sur son site.

Paris, le 28 avril 2013

**Sponsors**

**Organizers**
**Abstract**— This paper describes the project methodologies applied for the refurbishment and upgrades of the Gibraltar Electricity Authority’s power Distribution system. Upgrade PACS methodologies apply to Gibraltar Electric Authority’s power Distribution system. Tyron FA Yann-Eric BOUFFARD-VERCELLI Bruno ANDRÉ Gibraltar Electricity Authority – Gibraltar Schneider Electric – France Schneider Electric – France tyrone.fa@gibelec.gi yann-eric.bouffard-vercelli@se.com bruno.andre@se.com

**Introduction**

Gibraltar Electricity Authority (GEA) manages Gibraltar HV/LV electrical grid over the territory of 6.8 km² with approximately 20,600 customers as at December 2017 (85% residential and 15% industrial/commercial) located in the south of Spain. Figure 1: Gibraltar territories

Local Diesel generators are used as unique power sources as GEA grid is islanded from the European grid. Over the next 10 years, projections show a 50% growth of the consumption linked to the new needs from harbour connection, data centers, airport extension, land reclamation projects and healthcare building increases. In 2010, GEA grid was an aging underground HV/LV network with many supply and power failures, increasing over recent years (in 2013 more than 52 unplanned outages were experienced, with a duration longer than 90 minutes).

**GEA HV Grid & Retrofit and Upgrade Project Constraints**

In 2015, GEA initiate a plan to refurbish, expand and prepare the electric grid of the future with respect to the continuity of customer services, integration of new technologies (smart and flexible grid, renewable generation, ...) and a clear target to strongly reduce SAIFI and SAIDI. GEA specifications clearly indicate the need to have the most flexible architecture for a step by step migration based on customer quality level and GEA Grid management expectations. Before upgrading and replacing the GEA HV/LV grid and substations, the selected supplier simulates working scenarios to ensure that at each step the power delivery will be maintained and to ease future GEA grid evolutions imposing specific choices for project management and planning definition to allow maximum flexibility in energy management. A. GEA existing HV Grid Gibraltar Electricity Authority’s HV/LV grid (11 kV & 6.6 kV) is based on an historical architecture with a mix between mesh structure and open rings with near no redundancy and security management. HV Circuit Breakers are mostly not- motorized or remotely controlled and near all IEDs (Protection, Measurement and Control devices) were analogue. Power Diesel generation plants delivering energy to GEA grid are over 35 years old and face environmental constraints. Figure 2: Gibraltar Electric HV grid (2016) Aims of the GEA grid refurbishment and upgrade project are: • Upgrade or replace the primary equipments (CBs, Transformers, protections, measurement units) with the recent technology adapted to the future needs. • Restructure of the existing HV grid to simplify and optimise the power delivery to final customer with a strong reduction of the SAIDI/SAIFI • Avoid all local actions and replace them by remote capabilities with an efficient SCADA system and the associated communication network • Prepare future consumption growth and introduction of renewable sources
The strategy applied to GEA grid project is a step by step approach, with 3 main directions: • The HV Distribution Center substations (5) • The HV/LV rings (14). Decision was taken to consider each ring as a single project. • The GEA HV & LV Dispatching center. A. GE HV project solution approach and methods Each refurbishment/retrofit HV Distribution Center Substation or HV/LV ring is based on the same methodology: 1. Expertise on site of the existing devices (primary, secondary, power supply, telecommunication, etc.) to evaluate the work plan 2. Based on the site work plan, use of simulation tools to evaluate the impacts of each phase and define the path with the lowest impact regarding customers and with the highest security 3. Upgrade/replacement of primary devices, protection, RTU, communication LAN & WAN, etc. and associated engineering. 4. Factory acceptance tests and validation 5. Implementation on site and test in-situ GEA HV grid project consider the following supplies: • Retrofit/replacement of the primary devices (Circuit Breaker, Switch, Auxiliary power supply, cabling, ), • Ethernet Communication FO networks to the various equipment, protection devices, Gateways and RTU/PLCs with redundant capabilities, • IEC 61850 SCADA to allow operators to visualise and control the connected equipment and with capabilities to set on-line protection & automation scheme settings. • New automation schemes (distributed and global) to reduce impact of any grid failure, power supply constraint or unplanned even on the customers and automatically restructure GEA grid. GEA HV/LV grid upgrade and refurbishment project’s greatest difficulties are linked to the high density of the GEA grid, the inherent constraints of the power supply continuity and to the limited on-site working slots. These have imposed the greatest anticipation level on this type of project, simulation to identify any future incompatible architectures and maximum cooperation between the suppliers of all project elements, the site teams and GEA. B. Architecture of the HV grid solution Figure 3: GEA final HV grid & Distribution Center substations The strategy applied in collaboration between GEA and the various suppliers has been to determine the best electrical topologies regarding the existing grid and the constraints of power supply in Gibraltar; Cost and future evolutions are also elements of the equation. The result is a HV &LV grid based on a group of five (5) primary HV Distribution Centers linked by seven (7) parallel 11 kV cables to the new Power Generation station (NMPs), which will be the only power generating plant in Gibraltar. From the HV Distribution Centers, a series of HV open rings power the LV customers through HV/LV substations. C. HV Distribution Center substations As part of the GEA HV grid, the Distribution Center substations (DC) equipments have been when possible upgrade or replaced depending of their age, future use and potential performances. In each Distribution Center substation, three main programs have been applied: • Circuit Breaker and switching devices • Protection, Measurement and Control equipments • Auxiliary services and communication elements 1) HV DC substation Circuit Breaker All CBs have to be motorized and their switching time reduce to 150ms. CB upgrades and retrofits have been done directly in Gibraltar with pre-industrialised modules to reduce the unavailability time and limit the costs. 2) HV DC substation IEDs & ancillary elements Protection, Control or Measurements units have been replaced by IEC 61850 Digital IEDs and the CB LV cabinets have been rewired to integrate: • Digital protection relays (HV multi-function feeder Sepam and Differential Cable protection MiCOM) on the HV interconnector inomers, • Digital OC protection relays (Sepam) and Automatic Self Reconfiguration PLC (MICOM C264) for the outgoing HV ring feeders. • Various equipment mainly Fast Load Shedding PLC (MICOM C264), IEC 61850 switches, Gateway/SCADA server, Time synchronisation GPS based, Internal Arc Fault protection (VAMP 120) etc. All Distribution Center substation equipments are connected over an IEC 61850 FO redundant Ethernet ring connecting Distribution Center substations to GEA SCADA/Dispatching. In addition, a specific IEC 61850 redundant optical LAN is used to interconnect all HV Distribution Center substation dedicated RTU/PLC for the intelligent Fast Load shedding and Load Restore Automation schemes (iFLS) D. HV/LV substations & ring architecture As part of the GEA HV grid, the various HV/LV substations and associated grid architectures have been fully expertise and the grid simulation tools have help to define in conjunction with the associated Distribution Center substation: • HV/LV substation protection & automation plan & schemes in line with the expected performances for the HV ring management. • the optimum HV ring architecture, and which cable to be used or isolated • Global GEA Fast Load Shedding & Load Restore automation plan. Figure 4: GEA HV final grid architecture 1) HV protection plan HV ring protection plan was evaluated. Protection studies have been done using simulations tools DigSILENT and Schneider Electric RTDS simulator to choose the appropriate devices and fixe the protection settings in a global approach. 2) HV/LV substations In conjunction with the Distribution Center substations, actions done at HV/LV substations. Figure 5: GEA HV/LV distribution substation (Cumberland) The substation works have focused on: • Retrofit/upgrade/replacement of the existing switchgear when possible (motorised CB or IS). • HV feeder protection (Sepam relays) when consistent and coherent with the primary devices, the CT sensors., • HV/LV transformer OC protection (Sepam relays). Some HV fuses have been kept and will be replaced as secondary substation switchgear is upgraded. • Addition of RTU/PLC (MICOM C264) in HV/LV substation to perform the Automatic Self- Reconfiguration scheme and data collection. IV. GEA HV PROJECT TEST METHODOLOGIES The GEA project acceptance tests are split in two steps: • The Factory Acceptance Tests (FAT) run mainly in Schneider Electric premises (UK & France) for each module; • The Site Acceptance Tests (SAT) done on site (Gibraltar) with all available equipments. GEA representatives have agreed and reviewed the test plans (FAT & SAT) and participated to all FAT & SAT tests. A. GEA Project Factory Acceptance Tests To facilitate the FATs simulation devices were used to create missing information (injection box, contact case,) and to achieve automation schemes and checks their performances, the use of IEC 61850 messages allows ensure perfect simulation and inter-operability of the various schemes along all GEA HV substations & grids. B. GEA Project Site Acceptance Tests The Site Acceptance Tests (SAT) are run at equipment and systems levels. They ignore the following tests: • Visual check & tests including conformance documents and all necessary support documents (user & Maintenance manuals, compliance certificates, data sheets, wiring & cabinets schemes ...), • Wiring tests (product & cubicles) and Communication tests (Substation LAN, Grid LAN & SCADA LAN) • Single Functionality and setting checks and tests • Global Functionality and setting checks and tests • IHM displays for Control & Maintenance The Site tests are run in two strategies: • Nominal use of the different elements and global installation • Tests under constraints to check the conformance with the
customer requirements As for the FAT simulation equipments such as injection box or virtual IEDs are used in complement when needed... V. LESSON LEARNED AND CONCLUSION GEA HV grid refurbishment is on-going with 5 Distribution Center (DC) substations and 3 HV/LV rings delivered and commissioned. Some key features and lessons have been already identified and could be decline for any other similar utility grid retrofit projects. • At protection level, the benefit of having a preliminary study before deciding which protection features will be implemented has been a strong advantage especially for the cubicle design, the sensors adaptation, the cabling and more important for the Site test plan (SAT). • Use of simulation tools, analyse of the existing and dedicated engineering tools have been corner stone of the GEA project success and will make it real and successful. • IEC 61850 communication represents a key evolution for the future of HV grid and open many new opportunities and potentials to make a better and more efficient use of GEA grid and has help to reduce some phases of the project leading and delivering time. Renovation and upgrading of an existing HV grid is a challenge that the use of normalised products and solutions make possible at reasonable cost. These standardised procedures and methodologies make possible and simple the evolution over the entire duration of such project (5 to 7 years) with efficient and secured final results. Acknowledgments The authors gratefully thanks Gibraltar Electricity Authority members and all the Schneider Electric team’s members for the various countries that have participated to the GEA project studies, installations and commissioning and make it a working. REFERENCES [1] H. Grasset 2017, “Open or closed ring networks?” CIRED conference [2] C. Alvarez, J.I. Moreno, MC. Ruiz, G. Lopez, 2017, “Methodologies and Proposals to facilitate the integration of small and medium consumers in smart grids” CIRED conference, At1 Volume 1 [3] L. Hossenlopp “Engineering perspectives on IEC 61850” IEEE Power and Energy Magazine, Volume 5 Issue 3 [4] N. D’Addio, A. Abeygunawardana, M. Forbes, G. Ledwich, M. Shafiei, 2017, “Approach to large distribution network optimization using modern implementation of benders decomposition” CIRED conference, Vol. 2017, Iss. 1 [5] L. Hossenlopp, M. Aurangzeb, B. Andre “IEC 61850 capabilities applied to Oil& Gas industries” PCIC 2010

https://www.see.asso.fr/en/node/94510/landing