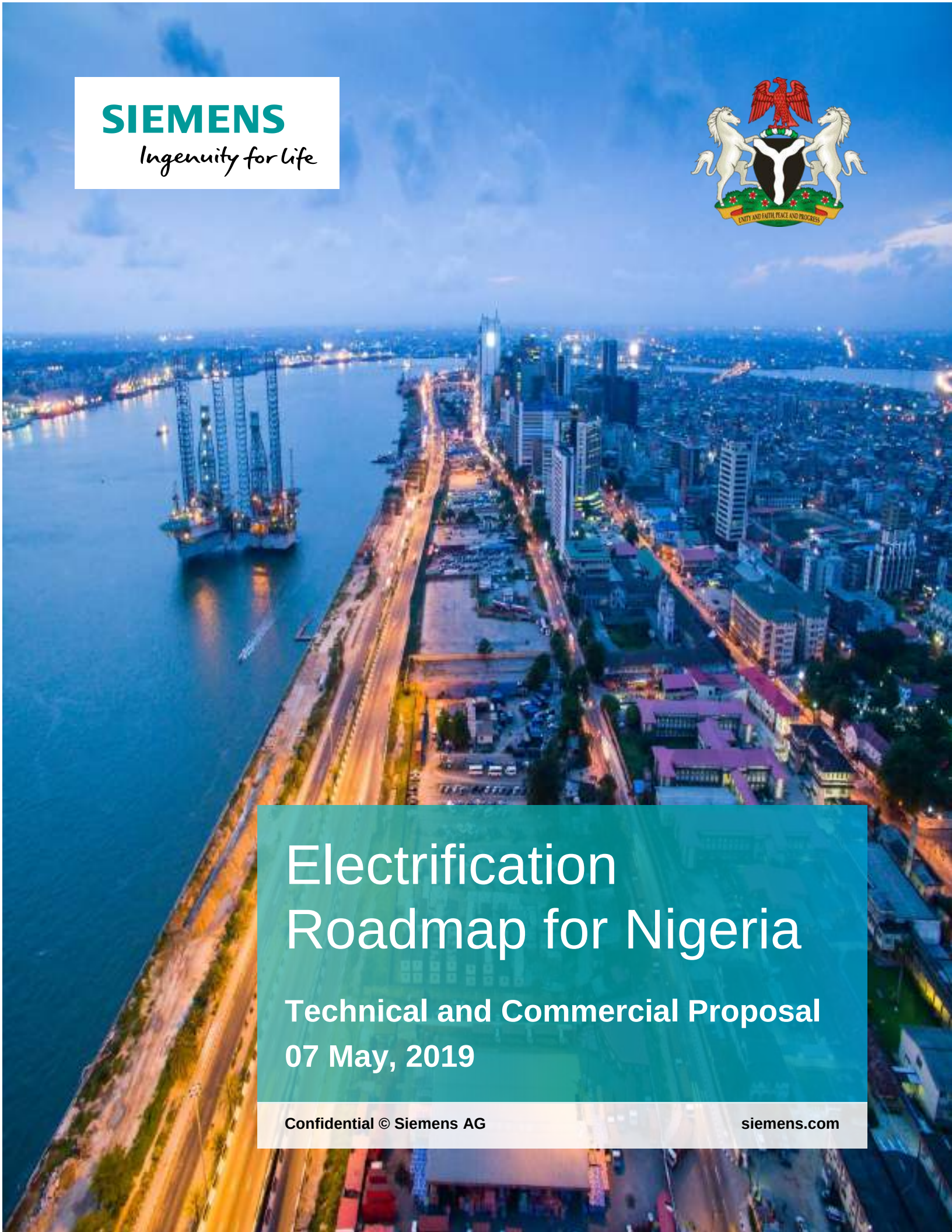

SIEMENS

Ingenuity for life

Electrification Roadmap for Nigeria

Technical and Commercial Proposal

07 May, 2019

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1. Background

Nigeria's power system is constrained by an imbalance between power generation and consumption. While >13 GW of power generation capacity is available, only ~3.4 GW is reaching final customers (households, commercial and industrial users) on average, with a peak operating capacity of 5.2 GW achieved in 2018 (versus 5.1 GW in 2016). Existing assets are partly idle and do not actively participate in the energy system. Removing severe bottlenecks within the transmission and distribution grid is necessary to allow free flow of electricity. This includes rehabilitating defective connections of key substations to the existing control center in order to improve the operation of transmission network and to unlock its potential.

On this background, the Federal Government of Nigeria and Siemens have defined the Nigeria Electrification Roadmap. The Roadmap is structured in three Phases, with Phase 1 focusing on essential and "quick-win" measures to increase the system's end-to-end operational capacity to 7 GW, Phase 2 targeting remaining network bottlenecks to enable full use of existing generation and "last mile" distribution capacities, bringing the system's operational capacity to 11 GW, and finally Phase 3 developing the system up to 25 GW capacity in the long term, with appropriate upgrades and expansions in both generation, transmission and distribution.

FIGURE 1: NIGERIA ELECTRIFICATION ROADMAP HIGHLIGHTS

2. Nigeria Electrification Roadmap: Program Overview

The Nigerian Electrification Roadmap initiative was birthed on the back of the meeting between President Muhammadu Buhari and German Chancellor Angela Merkel on 31st August 2018. It is aimed to resolve existing challenges in the power sector and expand the capacity for future power needs.

In developing the roadmap and eventually, this proposal, Siemens has, at different times and fora, engaged with relevant stakeholders in the power sector. The Bureau of Public Enterprise (BPE), acting on behalf of the Federal Government provided a veritable platform for these engagements. In October 16 -17, 2018, Siemens facilitated a workshop with the Federal Ministry of Power, Works and Housing (FMPWH), Nigerian Electricity Regulatory Commission (NERC), and Transmission Company of Nigeria (TCN) to shares thoughts and ideas on the power sector situations and align on critical solutions. The outcome of the workshop was developed into the Roadmap submitted to President Buhari on November 18, 2018.

Subsequently, there were further engagements with the Distribution Companies and TCN including field visits to all the eleven (11) Disco's in January 2019. A second workshop was organized and facilitated by Siemens in March 2019 to further identify and validate projects for the phase 1 of the roadmap. The outcome of this workshop and further discussions with the Disco's and TCN have been developed into this technical and commercial proposal.

The aim is to initiate these projects as quickly as possible so there will be visible impact in the grid within the next 2years.

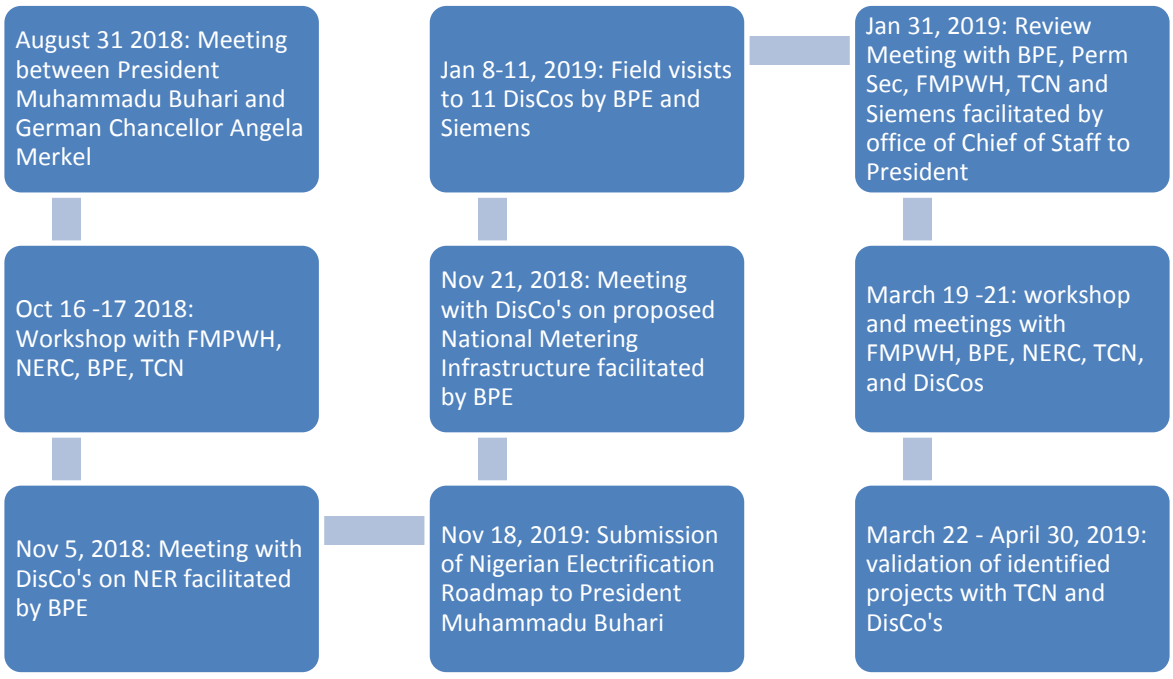


FIGURE 2: SUMMARY OF NIGERIA ELECTRIFICATION ROADMAP ACTIVITIES

This proposal covers high-level technical specifications for identified projects in phase 1 and other projects which could be considered in phases 2 and 3. Aside tangible grid network assets that require an upgrade or replacement, there are other intangible projects which are proposed to improve significantly the grid quality and reliability. In identifying these projects, Siemens has been technically guided by the preliminary power system simulation analyses carried out on the grid network by Siemens Experts in the Power Technologies Institute.

Nigeria's electrification as a basis for economic development

There was a moderate economic recovery in 2017 with real 'Gross Domestic Product' (GDP) projected to grow at 2.2% spurred by increased infrastructure spending and restoration of oil production to previous levels. There is awareness of electricity constraints as hurdle to more economic prosperity and development. The per capita electricity consumption in 2015 was only 0.15 MWh/capita (or 0.69 toe/capita), compared to South Africa with 4.0 MWh/capita and Ghana with 0.3 MWh/capita. To close the gap to peer countries (such as Algeria and Morocco) the power generation consumption per capita needs to increase 8-fold. While South Africa is leading the energy development, past developments of Algeria is a reasonable proxy for Nigeria. Therefore, additional investments in the overall energy supply chain is necessary to drive the ambitious GDP growth expectations.

Ambitious GDP growth requires additional investments in the entire energy supply chain, such as

- **Exploration,**
- **Flare gas collection,**
- **Gas pipeline,**
- **Transmission and distribution grid, and**
- **Power generation.**

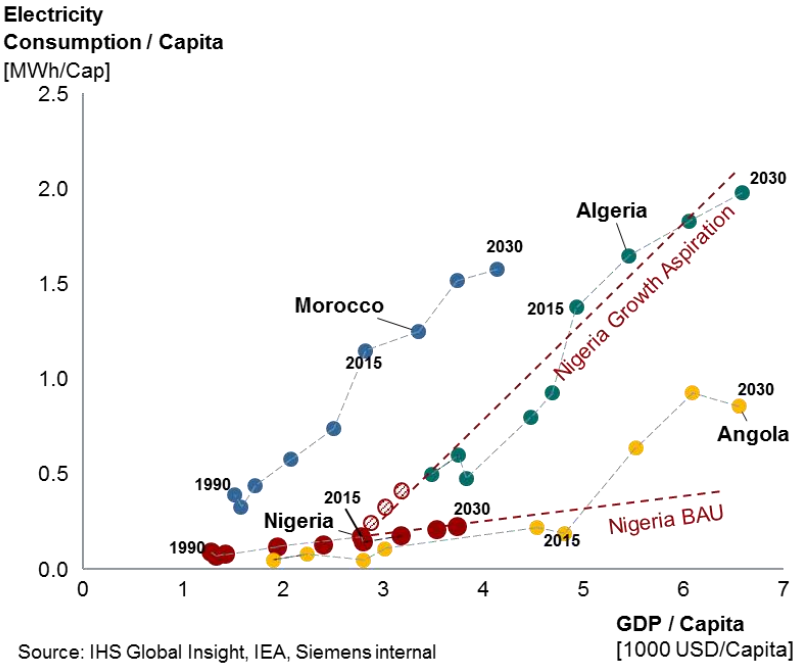


FIGURE 3: NIGERIAN ELECTRICITY CONSUMPTION / CAPITA

"Security of Supply" through flare gas utilization.
"Security of Finance" through smart meter infrastructure.

Beside flare gas collection, treatment, and distribution through national and international gas pipelines, the rehabilitation of existing infrastructure, as well as enhancing

metering to all customers are other key tasks to be done for short- and medium-term improvements. A reliable and secure power system supports the ambitious governmental targets of electrification of economy as a prerequisite for economic growth of the Nigerian nation.

Create attractive business environment in power generation sector by combining measures of loss reduction and power generation expansion.

Our analysis of Nigeria's power sector clearly shows that a bold move in increasing the countries power generation is necessary to create earnings in the mid-term.

With Business-as-usual capacity additions, deficits of the power generation sector will result in multi-billion US$ economic losses. Due to insufficient collection of revenues, high technical and commercial losses and below optimal performance of the existing power plants fleet, the power generation sector will continue to require subsidies and face harsh financing conditions for new projects. Removing the 'Aggregate Technical and Commercial Collection' (ATC&C) Losses will result in positive earnings of the power generation sector after only a few years lead time. Still, without additional expansion of generation capacity, accumulated earnings will only become positive after 2028. Further to electrifying Nigeria, ATC&C will lead to a sound business environment in the power generation sector that will benefit local companies as well as attract additional foreign investment into Nigeria.

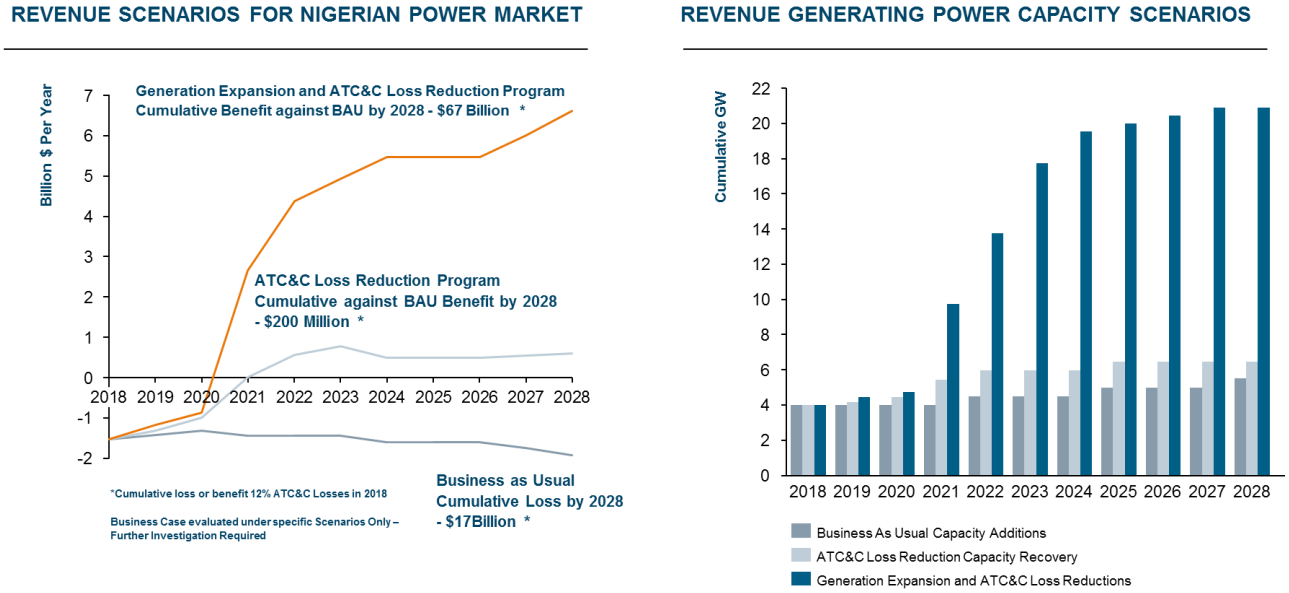


FIGURE 4: NIGERIAN POWER MARKET REVENUE GENERATION

To further speed up electrification of Nigeria, satisfy the demand for power, and enable earnings in the power generation sector above 5 bn USD annually, power generation capacity must be expanded to above 10 GW in the short-term and 25 GW in the mid-term.

Based on this ratio, to unleash the full economic potential, Nigeria must not only aim to remove ATC&C losses, but also include a rapid increase of power generation capacity in their short- and mid-term planning.

3. Proposed Phase 1 Projects

Phase 1 Objectives are to increase power delivered by additional 2GW, significantly reduce ATC&C losses and achieve improved grid stability and reliability.

3.1 Results of Preliminary Network Studies

As introduced above, Phases 1 and 2 of the Nigeria Electrification Roadmap focus on the complete enablement of the existing "last mile" distribution capacity in the 11 kV and LV networks. Previous analyses had indicated that the capacity of this "last mile", given as the non-coincidental peak load of 11 kV distribution feeders in historic system operation, is about twice as high as the peak supply delivered by TCN to the respective distribution utilities (where the peak was 5.2 GW across all Nigeria in 2018):

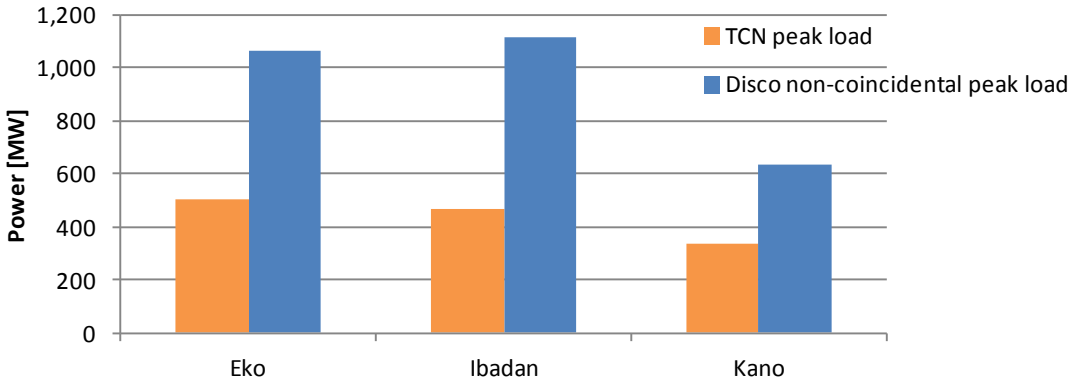


FIGURE 5: PEAK LOAD FOR EKO, IBADAN AND KANO DISCOS

Further, preliminary studies by Siemens in the last years have been performed on the transmission network in the Lagos region and the 33 kV sub-transmission networks of Eko, Ibadan and Kano Electricity Distribution Companies (Disco's). Findings from these analyses include:

- Non-coincidental feeder peak load in Nigeria assumed to be **~11 GW**
- Certain additional capacity in transmission level is available
- 132/33 kV transformers feeding into the Disco's are bottlenecks
- Individual bottlenecks exist across transmission network
- Individual bottlenecks exist in 33 kV sub-transmission networks by Disco's
- Operational challenges impacting system stability and value-chain
- Today, power **distribution** by the Disco's to end-customers is limited by power infeed from TCN
- In addition, capacity bottlenecks in the distribution networks do exist

Phase 1 of the Nigeria Electrification Roadmap is focusing on essential and "quick-win" measures to increase the system's end-to-end operational capacity from today's ~5 GW to

7 GW. One important aspect is the capacity of the 132/33 kV interface between TCN and the distribution utilities. In according with the Fichtner study from 2017, the following Phase 1 projects for TCN were identified:

Substation Name	Location	Voltage Level	Configuration	MVA
EPZ (Lekki Free Trade Zone)	Lagos	330/132/33 kV	2X150+2x60	120
New Ijora	Lagos	330/132/33 kV	2X150+2x60	120
Akangba - Alagbon - Transmission Line	Lagos	330 kV	Double Circuit	
Ministry of Defense	Abuja	132/33 KV	2x60	120
World Trade Center Abuja	Abuja	132/33 KV	2x60	120
Epe	Lagos	330/132/33 kV	2X150+2x60	120
Oko-Oba	Lagos	330/132/33 kV	2X150+2x60	120
Port Harcourt	Port-Harcourt City	132/33 KV	2x60	120
Port Harcourt	North Cross-River	132/33 KV	2x60	120
Ibadan	TBD*	132/33 KV	2x60	120
Jos	TBD*	132/33 KV	2x60	120
Enugu	TBD*	132/33 KV	2x60	120
Yola	Mobile Substation	132/33 KV	2x60	120
Benin	Benin	132/33 KV - 60 MVA	2x60	120
Additional Mobile Substations	TBD* 10 sets	132/33 KV	1x60	60

***TBD – To be determined**

TABLE 1: TCN PHASE 1 PROJECTS IDENTIFIED

To find out the impact on the transmission network by adding those loads to network model provided by TCN, Siemens PTI prepared a preliminary study. Following assumed model developments were carried out:

FIGURE 6: LOCATION LAGOS - EPZ, EPE, OKO-OBA

For the lines, the following existing lines are used as reference:

- Lekki – Aja 330 kV
- Akamgba – Alagbon 132 kV

For the Oko-Oba 330/132kV transformers, the following transformer is used as reference:

- Aja 330kV / 132 kV / 33 kV

To close the loop by supplying the transmission station “New Ijora” a 14 km double 330 kV lines Akangba – Alagbon are needed.

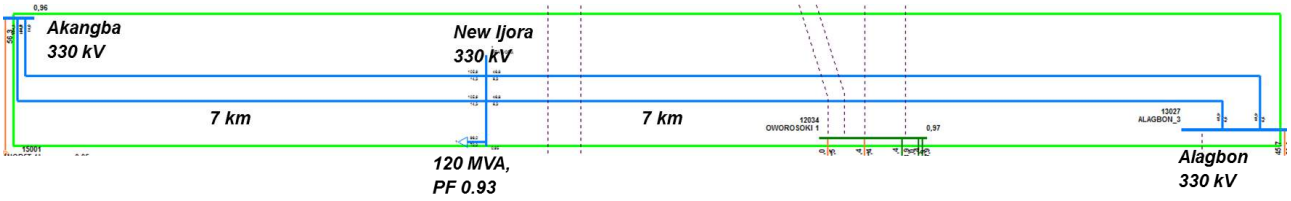


FIGURE 7: LOCATION LAGOS - NEW IJRA, AKANGBA-ALAGBON-TRANSMISSION LINE

Location Abuja: Ministry of Defense, World Trade Center Abuja

To supply the both new transmission stations and to close the loop between Katampe and APO a (13 + 4 + 7) km double 132 kV lines Katampe - Ministry of Defense - World Trade Center Abuja - APO are needed.

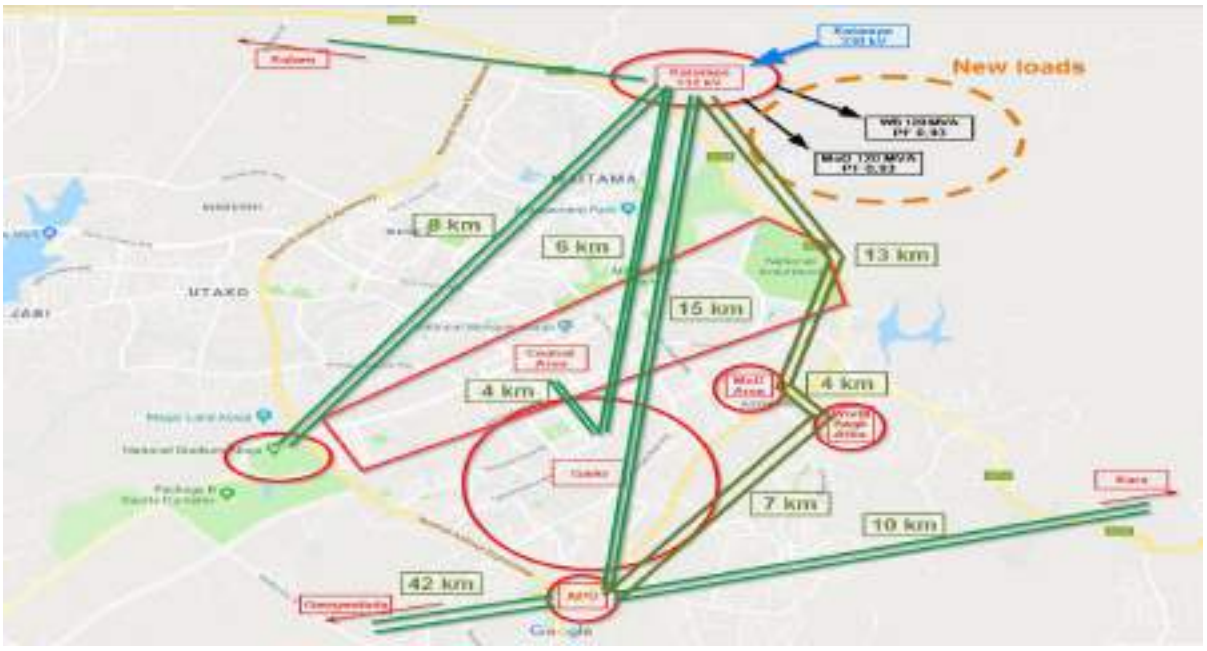


FIGURE 8: LOCATION - MINISTRY OF DEFENSE WORLD TRADE CENTER ABUJA

Location Port Harcourt: Port Harcourt City, Port Harcourt North Cross-River / Calabar

Due to not exactly specified location of the additional transmission station, the additional loads were modeled on the 132 kV existing stations. The additional overhead lines have to be considered in detail in future steps.

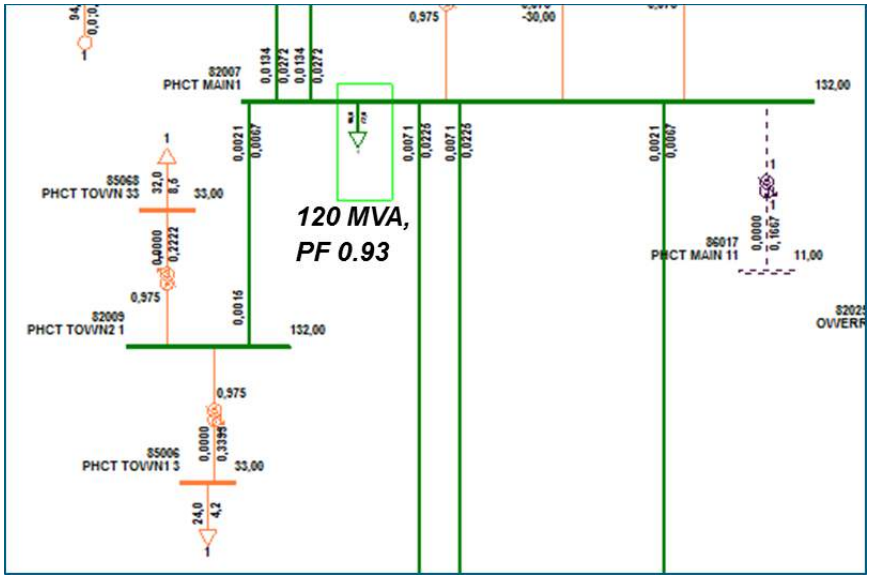


FIGURE 9: PORT HARCOURT CITY STATIONS

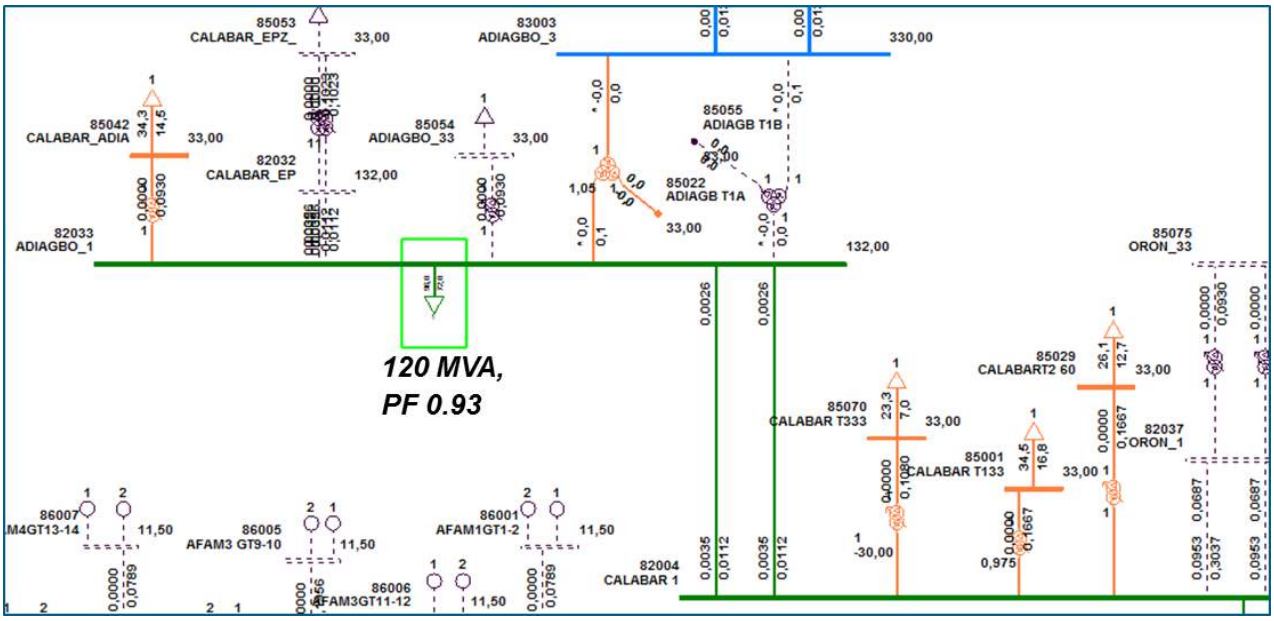


FIGURE 10:PORT HARCOURT NORTH CROSS-RIVER / CALABAR STATIONS

Location Benin

In this location the same procedure, as chosen before.

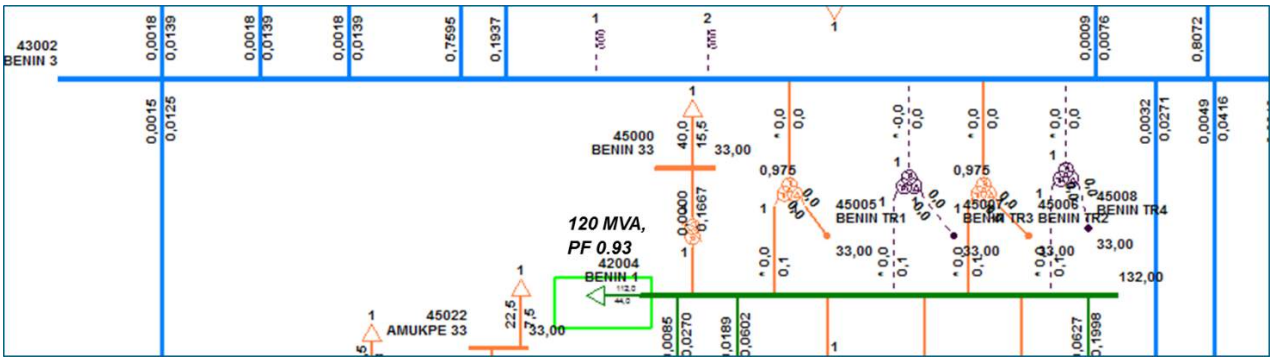


FIGURE 11: BENIN CITY STATIONS

Generation and load adjustment

To supply the 9 new loads in total of 1080 MVA the generation must be increased. With the assumed power factor of 0.93 the additional active generation was scaled proportionally to a total increase of 1004 MW. The total PQ load is then scaled down from 7.4 GW to a total value of 7.1 GW and the active generation is scaled up proportionally to a total increase of 700 MW.

Results

There is undervoltage violations on approximately one hundred nodes. This is an indication for the need of reactive power compensation in the transmission system By Introduced capacitor banks in “Port Harcourt Main 132 kV” with rated reactive power of 160 MVAr most of the voltage issues can be solved. The remaining violations can typically be solved by tap changer action or small-scale reactive power compensation.

Most loading violations are related to transformers in the areas where load was added. This can generally be tackled by adding parallel transformers. In the Port Harcourt area, 2 separate problems occur:

- Overall bad voltage performance. Further reactive power - voltage analysis shows a voltage drop of 0.5% per 10 MVAr reactive power increase at “Port Harcourt Main 132 kV”.
- Lack of local generation and corresponding large active power imports from Rivers IPP, leading to high line loading between Rivers IPP and “Port Harcourt Main 132 kV”.

If an important load increase at Port Harcourt is foreseen, both these problems need to be tackled by:

- Additional 132 kV lines or re conducting to increase capacity
- Local reactive power compensation in the Port Harcourt area.

Investigation of 33 kV sub-transmission networks (distribution utilities)

Based on the previous studied conducted by Siemens for the 33 kV sub-transmission networks of Eko, Ibadan and Kano Disco's, it is concluded that the 7 GW scenario for Nigeria can be implemented successfully with only minor upgrades and extensions in the 33 kV networks of the distribution utilities. With the main bottleneck of the 132/33 kV infeed by TCN being addressed as described above, certain additions to the 33/11 kV injection substation capacities and a small number of individual bottlenecks with e.g. overhead lines or cables will have to be mitigated accordingly. The following diagrams show the results for the related scenarios of Eko, Ibadan and Kano 33 kV sub-transmission networks.

Eko

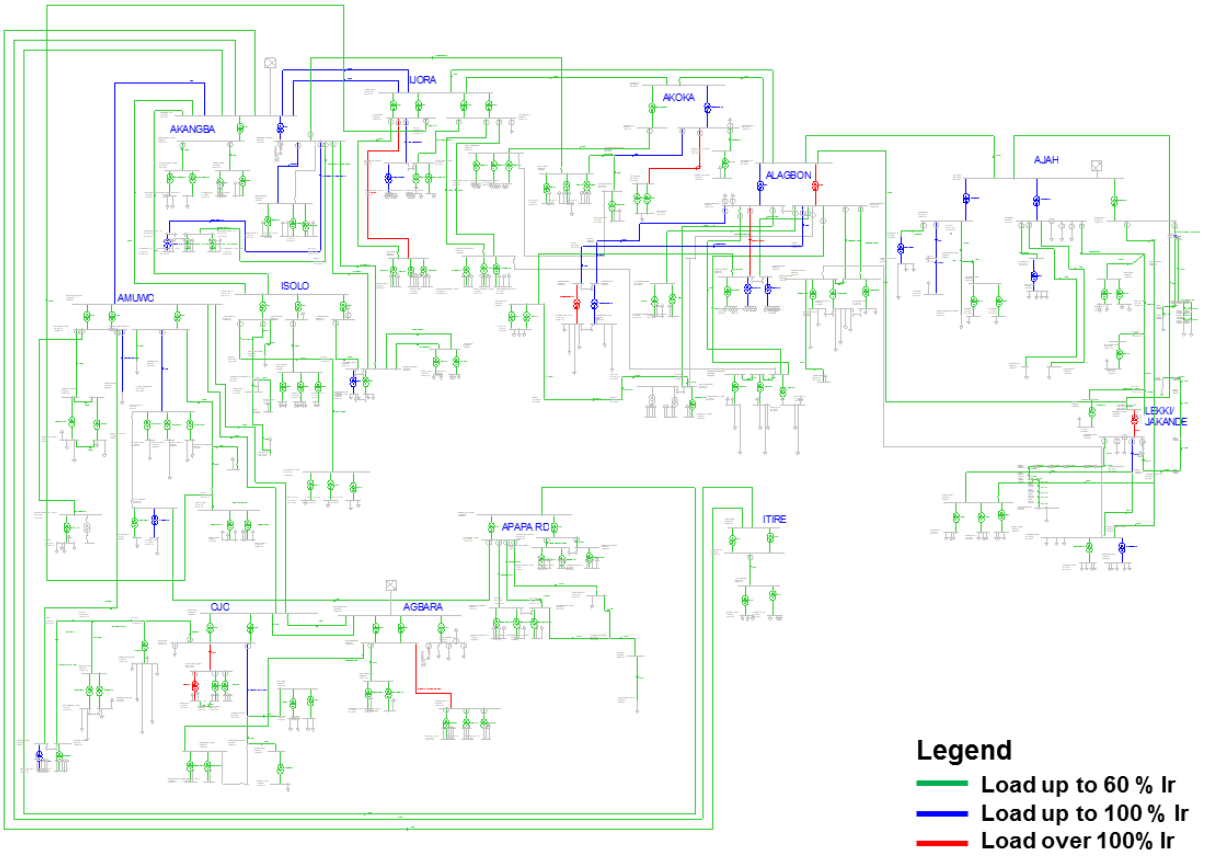


FIGURE 12: EKO DISCO NETWORK MODEL ON SINCAL

The increasing of the load from the current 505 MW to 650 MW leads to in total overloaded equipment:

- 33k V lines: 7.5 km
- 33/11 kV transformer: 1
- 132/33 kV TCN-transformer: 4w

Ibadan

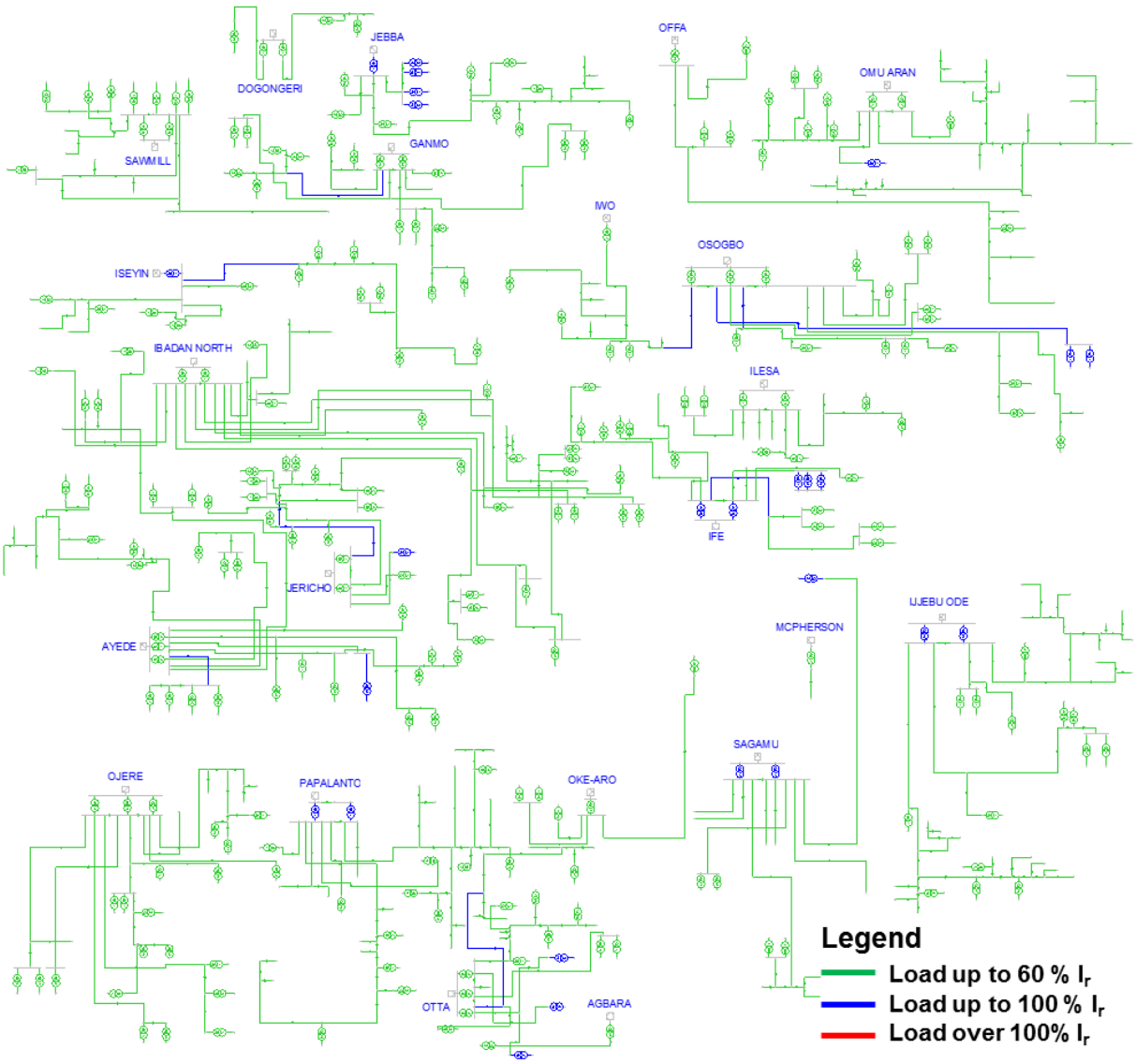


FIGURE 13: IBADAN DISCO NETWORK MODEL ON SINCAL

The increasing of the load from the current 466 MW to 700 MW leads to in total overloaded equipment:

- 33k V lines: 0 km
- 33/11 kV transformer: 1
- 132/33 kV TCN-transformer: 3

Kano

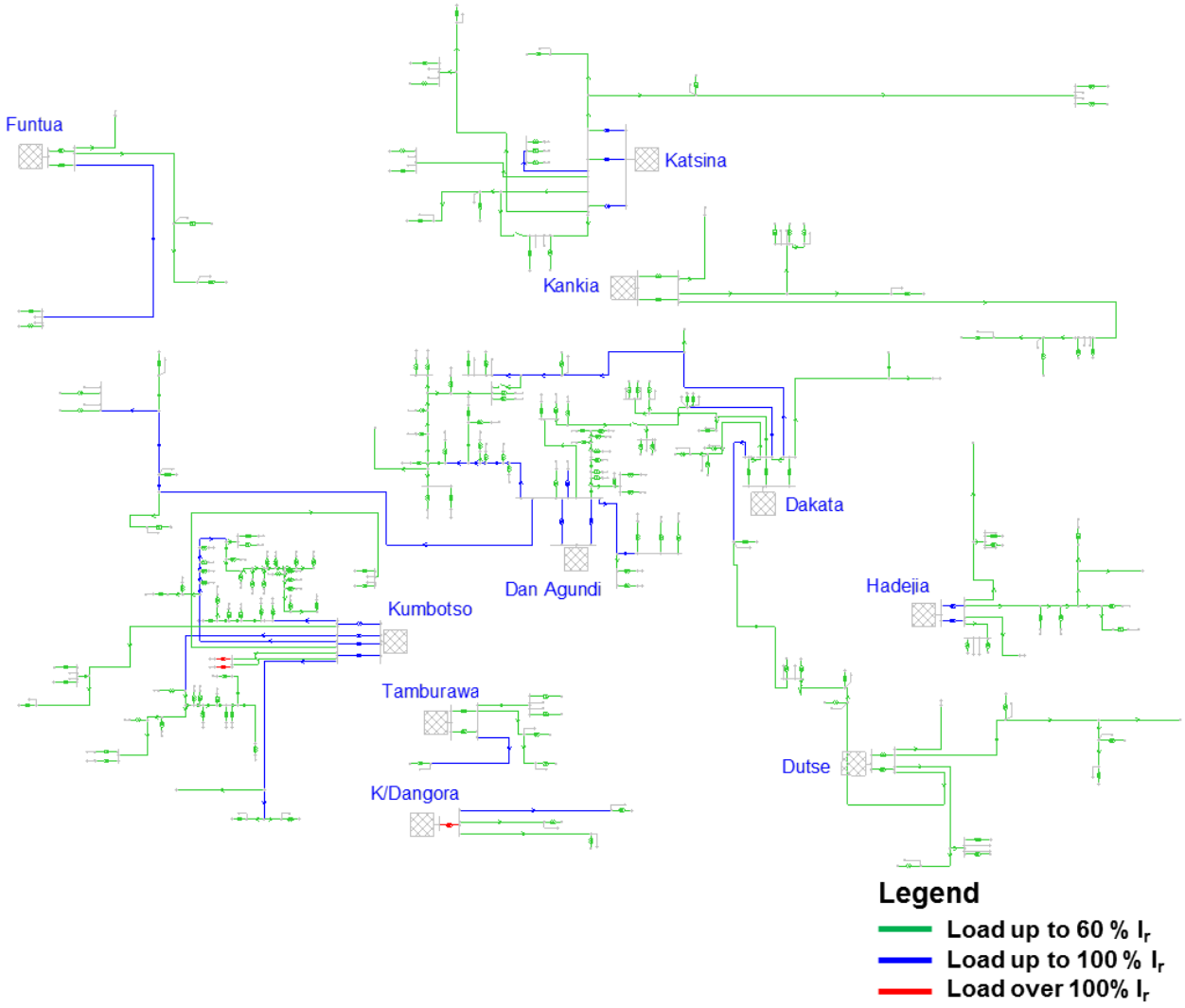


FIGURE 14:KANO DISCO NETWORK MODEL ON SINCAL

The increasing of the load from the current 505 MW to 650 MW leads to in total overloaded equipment:

- 33k V lines: 0 km
- 33/11 kV transformer: 2
- 132/33 kV TCN-transformer: 5

Summary

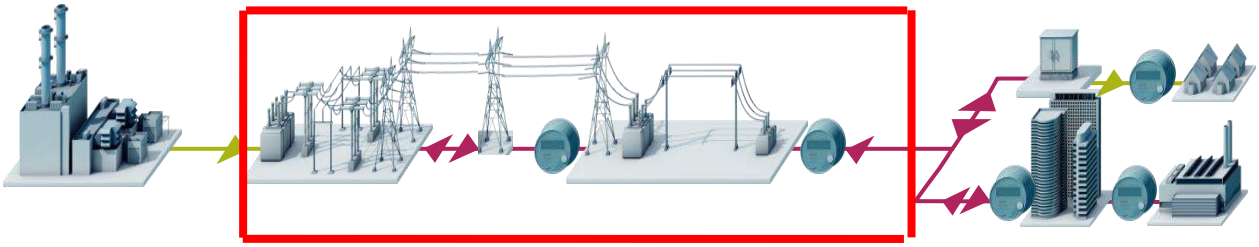
The TCN transmission system was adapted so that a total load of 7.1 GW is connected. In order to achieve this, new developments in Lagos (4x), Abuja (2x), Port Harcourt (2x) and Benin (1x) were implemented in the network model.

The results show that the TCN grid can fundamentally handle the load increase, considering a few boundary conditions:

- The transformer capacity has to be increased on selected substations in order to supply the increased load
- The Port Harcourt area need special attention with regards to line reinforcements and reactive power compensation (estimated 160 MVAr)
- On-load tap changer actions must be carefully investigated, since voltage performance in the overall TCN system is very sensitive.

Also the 33 kV sub-transmission networks of the distribution utilities are able to accommodate this 7 GW scenario with minor adaptations only. Finally, the 11 kV and LV distribution levels have shown to have suitable capacity in their existing status already, so that again only minor adaptations in individual cases will be required to implement the 7 GW scenario from generation via transmission and distribution to the actual end-customers.

3.2 Substation Projects & Operations



In this section, we describe the content of the scope foreseen for the transmission component of Siemens offer for phase #1. This content aims at complementing the current supply with approximately 1.5 additional GW.

Based on the list provided in paragraph 3.1, we propose a list of target projects comprising:

- Substations (330/132/33 kV and 132/33 kV),
- Mobile substations,
- Additional transformers
- Compensation unit in Port Harcourt

Important notes

a) We understand that at this stage, the Environmental Impact Assessment and feasibility studies are not completed. **Siemens kindly requests the intended completion time** for each target project to:

i. Confirm the actual executability for phase 1 or

ii. Reallocate some of these projects for phase 2.

b) The execution of the above-mentioned projects shall be run in parallel of the erection of the corresponding transmission lines **which is not covered by Siemens scope**. At this stage and as preliminary information, approx. **140 Km of new transmission lines shall be built**.

Substation Scope

In order to ensure maximum reliability, availability and flexibility Siemens considered **GIS** technology. More, Siemens will supply **containerized** (Power Portable) **Solutions** offering the main following benefits:

FIGURE 15: SIEMENS CONTAINERIZED SOLUTIONS

- Limited civil works (both in complexity and footprint)
- Quick installation and commissioning as all equipment and systems are pre-tested and pre-commissioned in factory

Our offer is inclusive of **mobile substations (132 kV)** liable to be quickly mobilized for temporary restoration of faulty lines for example.

We therefore segmented the list of target substation projects in 3 categories

- **330/132/33 kV GIS Substation** – Potential of up to 4 Substations
- **132/33 kV GIS Substation** – Potential of up to 7 Substations
- **Mobile 132 kV GIS Substation** – Potential of 11 Substations

Typical	Configuration	SLD Reference	Layout Reference
#1	**330/132/33 kV substation** GIS Double Bus Bar - 4 x OHL feeders - 2 X Transformer feeders - 1 x coupling bay	T3.1.4_SLD330_132-3	T3.2.1_Lay330_132-3
#2	**132/33 kV Substation** GIS Double Bus Bar - 2 x OHL feeders - 2 x Transformer feeders - 2 x 330 kv Feeders - 1 x Coupling bay	T3.2.2_SLD_132_33kV	T3.2.2_Lay132_33kV
#3	Mobile Substation 2 Semi-Trailers - 1 for HV equipment and Transformer - 1 for MV equipment and Control System	T4. Mobile Substation SLD and Layout	T4. Mobile Substation SLD and Layout

TABLE 2: TARGET SUBSTATIONS

Reference documents for the Substation Scope

The full description of a containerized 330/132/33 kV substation is available under annex **Transmission Systems #2**. The 132/33 KV configuration can be easily derived from it.

Final technical configurations are to be further refined - with TCN - in order ensure adherence to operational needs.

A. Compensation System

The compensation Unit in Port Harcourt will be performed with an MSC (Mechanically switched Capacitor) System.

FIGURE 16: PORT HARCOURT COMPENSATION UNIT

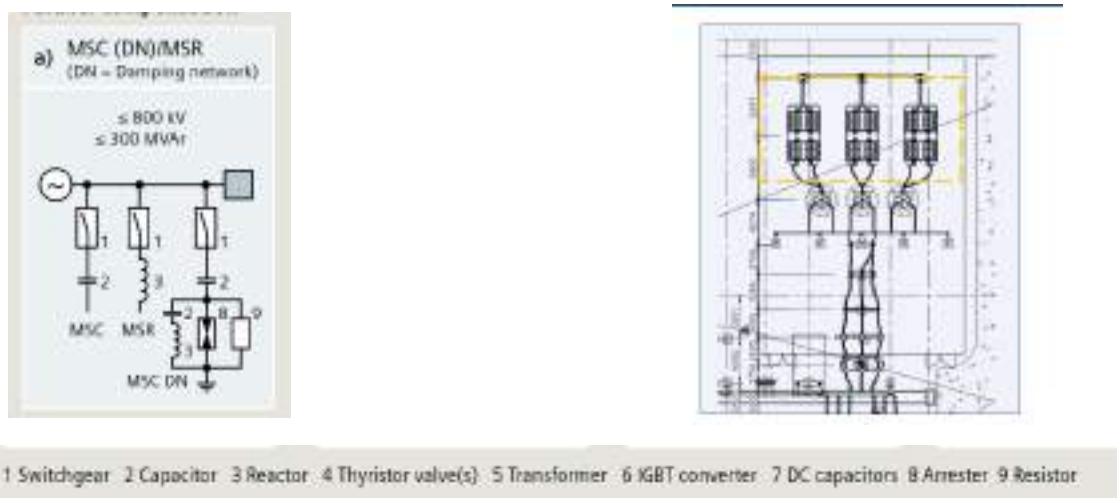
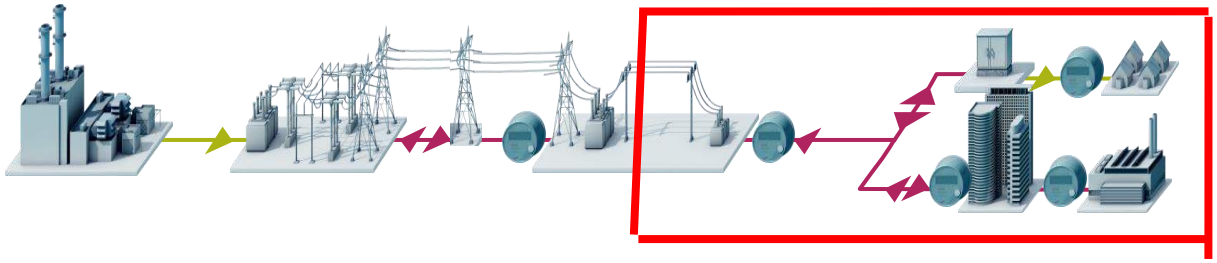


FIGURE 17: MSC EXAMPLE

3.3 Distribution Assets Projects for Discos



The power available at the 33 kV sub-transmission networks will flow through the distribution network of the Distribution Companies (Disco's) before reaching the consumers (households, industries, infrastructures and others). A state-of-the-art distribution network is key for a reliable electricity supply, personal safety and a performant billing system, required for recovery of the asset's investment and operation expenditures.

The Nigerian distribution network is a composition of 11 Disco's, whereas each of them covers 1 to 5 areas with a mixture of rural areas, large cities and, industrial areas.

In order to enhance the quality of the distribution network downstream of the sub-transmission network, the concept will consist of swift supply of equipment needed for replacement and, immediate expansion of as part of Phase 1, including upgradation of some substations. Further upgradation and, installation of new substations will occur in Phase 2. For the third phase, new substations will be scheduled as per long term strategy in line with expansion of the power generation and power transmission network.

The first phase of the project will cover the supply of equipment required by the Disco's for immediate use (OVCB, Auto-Reclosure, Distribution Transformer, 11kV Air Insulated Switchgear, Ring Main Unit and, Compact Sub Station).

This phase will be complemented with upgradation of existing substations in some Disco's. The upgradation will cover expansion/replacement of existing medium voltage equipment, replacement of distribution transformer with a more powerful one as well as, enhancement of the substation with an automation system and a communication facility.

During the upgradation period, a mobile substation is considered with the aim to avoid power supply interruption to consumers. Civil work for building adaptation, distribution transformer platform or outdoor platform will be considered for some substations.

The second phase will focus on a bulk expansion of new 33/11 kV injection substation with, a continuation of upgradation for remaining existing substations.

The equipment considered in this proposal are environmental independent, reliable, maintenance free, compact, service friendly, flexible and tested in accordance with the international IEC standard.

The expansion of the overhead lines at 33 kV level and 11 kV level is not part of this proposal.

Power Distribution

Phase 1 approach, swift supply and start upgradation for immediate bottleneck clearance.

1. Evaluate and Design

- Site visit to ascertain need of each substation with respect to Civil and Electricals requirement.
- Disco's need to be revalidated.
- Design to be prepared with the actual requirements, while keeping in mind the target of 25GW power generation.

2. Manufacture and Prepare

- Siemens to manufacture needed equipment for Upgradation.
- Brought outs (if any) will be procured.
- Site to be prepared with civil work adaptation, if required, including the Environment Health and Safety measures.

3. Supply, Installation and Commissioning

- Transport equipment to site.
- Erection, Commissioning and Testing will occur under the supervision of Siemens.
- Site training for operation and maintenance will follow with handover.

Siemens will supply the goods as per the Incoterm CFR Lagos.

Phase 2 approach, bulk expansion and automation of distribution infrastructure to increase the reach to the last mile with reliability.

1. Manufacture and Stock

- The network study carried out in Phase 1 will ascertain the expansion need to accommodate 25GW Scenario across all Disco's.
- Disco's need to be revalidated with the input received after network Study.
- Siemens to manufacture needed equipment for Mass Expansion.
- Equipment will be stored and delivered as per need.

2. Plan and Prepare

- Siemens with Disco's to plan and priorities the requirement of Substations.
- Land acquisition, if needed, to be secured by the Disco's.
- Site to be prepared with necessary civil work, including the Environment Health and Safety measures.

3. Installation and Commissioning

- Transport equipment to site.
- Erection, Commissioning and Testing will occur under the supervision of Siemens.
- Site training for operation and maintenance will follow with handover.

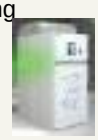
The typical offering for the Injection substation would be:

Outdoor AIS

1/ 33kV AIS OVCB
5x OVCB & Isolator

2/ Distribution Transformer

3/ 11kV AIS SWG
2x incomers
4x outgoing
1x Couple
1x Riser



Indoor AIS

1/ 33kV AIS SWG
2x incomers
4x outgoing
1x Couple
1x Riser

2/ Distribution Transformer

3/ 11kV 31.5kA AIS SWG
2x incomers
4x outgoing
1x Couple
1x Riser

Indoor GIS

1/ 33kV GIS SWG
2x incomers
4x outgoing
1x Couple/Riser

2/ Distribution Transformer

3/ 11kV AIS SWG
2x incomers
4x outgoing
1x Couple
1x Riser

Indoor Secondary

1/ 33kV RRL RMU or 11kV RRL RMU

2/ Distribution Transformer

Outdoor Secondary

1/ 33kV RRL RMU or 11kV RRL RMU

2/ Distribution Transformer

3/ Low Voltage Distribution

Benefits for Nigeria:

- Siemens is an international sound company experienced in large projects
- One basket supplier for generation, transmission, distribution and automation
- State-of-the-art equipment of high-end quality
- Losses saving by considering Siemens' early engagement and swift action
- World presence, onshore and offshore

Boundaries and Liabilities

- Government of Nigeria provides the access, authorizations, permits, customers clearance, local taxes and land (when required).
- Siemens brings the know-how, supply of the equipment and services.
- The overhead lines are not included in the scope of supply and scope of work.
- Freezed design for manufacturing is subject to approval from the responsible entity in Nigeria
- Supply of goods will be under the Incoterms CFR Lagos.
- The delivered goods are under a warranty period of 18 months after commissioning or 24 months after delivery whichever occurs first.
- The project will be under the Siemens terms and conditions for supply and services for third party.

Proposed Projects:

Eko Electricity Distribution Company ("Eko Disco")

Eko Disco covers the license area of southern part of Lagos state and Agbara in Ogun state. (Southern Lagos State (Ojo, Festac, Ijora, Mushin, Orile, Apapa, Lekki, Ibeju), Lagos Island (including Ajele areas) and Ogun state specifically Agbara). Eko Disco receives its bulk power supply from the following two Transmission sources: Akangba (330/132 KV) and Ajah (330/132 KV); and thereafter, through 10 nos. of 132/33 KV transmission stations. There are 40 Injection Substations with a total installed capacity of 1137.5MVA. There are 6000+ Distribution Substations with total installed capacity of around 2500 MVA.

For the phase 1, the following projects are identified:

S/N	Project	Products and Systems
1	Upgrade of Alagbon Injection Station from 2x15 MVA to 3x15 MVA.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Transformer Platform 5mx5m Civil Work - Outdoor Platform Civil Work - Building Adaptation 10mx5m
2	Lekki Injection Substation upgrade with 1x15 MVA	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU

		CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Transformer Platform 5mx5m Civil Work - Outdoor Platform Civil Work - Building Adaptation 10mx5m
3	Compact Substation 2.5MVA, 33/0.415 KV	Power cable (1 lot < 200 m) (10 Lots) CSS 33/.400kV 2.5 MVA (10 Nos)
4	Compact Substation 2.5MVA, 33/11 KV	33/11 TR ONAF 2,5MVA (30 Nos) Power cable (1 lot < 200 m) (30 Lots) 33kV RMU RRL (30 Nos) 11KV RMU RRL (30 Nos) Housing for CSS 33/11kV 2.5MVA (30 Nos)
5	Compact Substation 1MVA, 33/11 KV	33/11 TR ONAF 2,5MVA (10 Nos) Power cable (1 lot < 200 m) (10 Lots) 33kV RMU RRL (10 Nos) 11KV RMU RRL (10 Nos) Housing for CSS 33/11kV 2.5MVA (10 Nos)

TABLE 3: EKO DISCO PHASE 1 PROJECTS

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Construction of Surulere 2x15 MVA, 33/11kV, Ijora, Injection Station	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
2	Construction of Jakande 2x15 MVA, 33/11kV, Lekki, Injection Station	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
3	Construction of Bourdillon 2x25 MVA, 33/11kV, ISLAND BU, Injection Station	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 25 MVA SAS & RTU CRP x5 S/S accessories

		Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
4	Liashe 1x15 MVA injection State	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m

TABLE 4: EKO DISCO PHASE 2 PROJECTS

Ikeja Electricity Distribution Company ("Ikeja Disco")

Ikeja Disco is Nigeria's largest electricity distribution network. it covers parts of Lagos State namely Abule Egba, Akowonjo, Ikeja, Ikorodu, Oshodi and Shomolu.

For the phase 1, the following projects are identified:

S/N	Project	Products and Systems
1	2 Nos. Busbar Extension at Agege Injection Substation.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 33/11 TR ONAF 15MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform Ehouse 33/11kV + TR + Cables
2	British Paints to be upgraded to 33kV supply (Ex. PTC Express 33kV feeder).1 x 2.5MVA 33/0.415kV is required	S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m 33kV RMU RRL 33/0,4 TR ONAN 2,5MVA
3	UAC Properties to be upgraded to 33kV supply. 1 x 2.5MVA 33/0.415kV is required	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m 33kV RMU RRL 33/0,4 TR ONAN 2,5MVA
4	Nosak Distilleries to be reconnected to the grid on	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m)

	33kV supply. 1 x 2.5MVA 33/0.415kV is required	Civil Work Transformer Platform 33kV RMU RRL 33/0,4 TR ONAN 2,5MVA
5	Chikki to be reconnected to the grid on 33kV supply. 2 x 2.5MVA 33/0.415kV is required.	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform (2 Nos) 33kV RMU RRL 33/0,4 TR ONAN 2,5MVA (2 Nos)
6	Facility Product Ltd to be upgraded to 33kV supply. Odoguyan TS. 1 x 1MVA 33/0.415kV is required.	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 33kV RMU RRL 33/0,4 TR ONAN 1 MVA
7	JD Footware to be upgraded to 33kV supply. Odoguyan TS, 1 x 1MVA 33/0.415kV is required.	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 33kV RMU RRL 33/0,4 TR ONAN 1 MVA
8	Isocare to be upgraded to 33kV supply. Odoguyan TS. 1 x 1MVA 33/0.415kV is required.	Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 33kV RMU RRL 33/0,4 TR ONAN 1 MVA
9	7.5MVA transformer to be replaced with new or 3x2.5 MVA transformer to be provided at Dangote Flour Mills.	33kV GIS 4panel 11kV AIS 8panels 33/11 TR ONAF 2,5MVA (3 Nos.) Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform (3 Nos)
10	7.5MVA transformer to be replaced with new or 3x2.5 MVA transformer to be provided at Tower Aluminum.	33kV GIS 4panel 11kV AIS 8panels 33/11 TR ONAF 2,5MVA (3 Nos) Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform (3 Nos)
11	Proposed Additional 15mva Transformer at Alapere Injection SS.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform

TABLE 5: IKEJA DISCO PHASE 1 PROJECTS

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Proposed LASPOTECH 1 x 2. 5mva Injection Substation WITH 5KM OF 33KV LINE AND 8KM OF 11KV LINES TO LINK THE EXISTING LINES	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 8panels 33/11 TR ONAF 2,5MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform * Overhead line not included in the scope.
2	Proposed Ijedodo 5 x 2.5mva 33/11kv inj. s/s with associated 33kV (4km) and 11kv feeders and 2 plots of land	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 7,5MVA (2 Nos) SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) * Land and overhead line not included in the scope
3	2 x 2.5MVA at TA Gardens	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 5panels 33/11 TR ONAF 2,5MVA (2Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
4	Bel Papyrus to be reconnected to the grid on 33kV supply. 1 x 2.5MVA 33/0.415kV and 2 x 2.5MVA 33/11kV are required.	33kV GIS 7panel 11kV AIS 5panels 33/11 TR ONAF 2,5MVA (2 Nos) 33/0,4 TR ONAN 2,5MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
5	Coca Cola to be reconnected to	33kV GIS 7panel

	the grid on 33kV supply. 3 x 2.5MVA 33/11kV is required and Bus extension is required.	11kV AIS 8 panels 33/11 TR ONAF 2,5MVA (3 Nos) SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform (3 Nos)
6	Proposed Abule Ijoko 1 x 15mVA 33/11kV Injection S/S. with associated 11kV feeders and 2 plots of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land not included in the scope
7	Proposed Agbede 2 x 15mva Injection substation.	33kV GIS 7 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos)
8	Proposed Pako 1 x 15MVA 33/11kV Injection Substation with associated 11kV feeders and 1 plot of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land not included in the scope
9	Proposed Olorunnisola 1 x 15mva 33/11kv inj. s/s with associated 33kV (14km) and 11kv feeders and 2 plots of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land and overhead line not included in the scope
10	Proposed Pedro 1 x 15mva	33kV GIS 4 panel

	Injection Substation Ex Oworo TS with 30 spans of 33kV line and 2 spans link up of 11kV line.	11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m *Overhead line not included in the scope.
11	Proposed Agiliti 15mva Injection Substation.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
12	Proposed Pipe line 1 x 15MVA 33/11kV Inj. S/S.with associated 11kv feeders and 2 plots of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land not included in the scope
13	Proposed Baruwa 1 x 15mva 33/11kv inj. s/s with associated 33kV (4km) and 11kv feeders and 2 plots of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land and overhead line not included in the scope
14	Proposed Obadore 1 x 15MVA 33/0.415kV Inj. S/S with associated 11kV feeders and 1 plot of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land and overhead line not included in the scope

15	Proposed Ilapo 1 x 15MVA 33/11kV with associated 11kV feeders.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m
16	Proposed Isheri Oshun 1 x 15MVA Inj. S/S with associated 11kV lines and a plot of land.	33kV GIS 4 panel 11kV AIS 8 panels 33/11 TR ONAF 15MVA SAS & RTU S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m * Land and overhead line not included in the scope
17	Proposed Additional 15mva Transformer at New Oworo Injection SS.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5 panels 33/11 TR ONAF 15MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
18	Proposed Additional 15mva Transformer at New Odogunyan Injection SS.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5 panels 33/11 TR ONAF 15MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
19	Proposed Additional 15mva Transformer at New 68 Military Injection SS.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5 panels 33/11 TR ONAF 15MVA CRP x5 S/S accessories

		Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
20	Additional 15mva Transformer at Ipakodo Injection.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5 panels 33/11 TR ONAF 15MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m

TABLE 6: IKEJA DISCO PHASE 2 PROJECTS

Ibadan Electricity Distribution Company ("Ibadan Disco")

Ibadan Disco covers the largest franchise area in Nigeria, made up of –Oyo, Ogun, Osun, Kwara and parts of Niger, Ekiti and Kogi states.

For the phase 1, the following projects are identified:

S/N	Project	Products and Systems
1	407 transformer replacement	33/0,4 TR ONAN 0,5MVA -204 Nos(Estimated rating) 33/0,4 TR ONAN 0,3MVA -203 Nos(Estimated rating)
2	436 new transformers	11/0,4 TR ONAN 0,5MVA -218 Nos(Estimated rating) 11/0,4 TR ONAN 0,3MVA -218 Nos(Estimated rating)
3	12 Nos of 33kV outdoor switchgear	33kV OVCBx12 CTx12 CRP x12
4	2.5 MVA, 33/11kV Transformer 8 nos	33/11 TR ONAF 2,5MVA (8 Nos)

TABLE 7: IBADAN DISCO PHASE 1 PROJECTS

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	6 Nos of (1x 15MVA)	33kV OVCBx5 CTx5 VTx2 (6 Sets)

	injection substation expansion	33kV Isolatorx5 (6 Sets) 11kV AIS 8panels (6 Sets) 33/11 TR ONAF 15MVA (6 Sets) SAS & RTU (6 Sets) CRPx 3 (6 Sets) S/S accessories (6 Sets) Control cables (1 lot < 5Km) (6 Sets) Power cable (1 lot < 200 m) (6 Sets) Civil Work Transformer Platform 5mx5m (6 Sets) Civil Work Outdoor Platform (6 Sets) Civil Work Building Adaptation 10mx5m (6 Sets)

TABLE 8: IBADAN DISCO PHASE 2 PROJECTS

Abuja Electricity Distribution Company ("Abuja Disco")

Abuja Disco has a franchise for the distribution of electricity across an area of 133,000 km2 in the Federal Capital Territory Abuja, Niger State, Kogi State and Nassarawa State.

For the phase 1, the following projects are identified:

S/N	Project	Products and Systems
1	Procurement and installation of 60No auto reclosers for smooth 33kv feeder control and fault management on all tee offs	Auto Recloser 3Ph 33kV (60 Nos)
2	Replacement of breaker a) Field bay 1 incoming + 3 outgoing (1250) b) Minna Power house- 1 I/C + 3 O/G c) Lokoja- 1 I/C + 3 O/G	11kV AIS 8panels (3 Sets) S/S accessories (3 Sets) Power cable (1 lot < 200 m) (3 Sets) Civil Work - Building Adaptation 10mx5m (3 Sets)
3	Procurement of 600 Nos 500kVA,11/.415kV Distribution Transformer & 33/.415 Kv 400 Nos	33/0,4 TR ONAN 0,5MVA (400 Nos) 11/0,4 TR ONAN 0,5MVA (600 Nos)
4	Upgrade of 7.5 MVA trafo to 2x15 MVA s/s at Apo resettlement	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 SS accessories

		Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work - Outdoor Platform Civil Work - Building Adaptation 10mx5m
5	Modernization of 3 Nos Injection S/s at B32, G22 and G24	33kV GIS 7panel (3 Sets) 11kV AIS 8panels (3 Sets) 33/11 TR ONAF 15MVA (3 Sets) SAS & RTU (3 Sets) Control cables (1 lot < 5Km) (3 Sets) Power cable (1 lot < 200 m) (3 Sets) Civil Work - New 20mx10m (3 Sets) Civil Work Transformer Platform 5mx5m (3 Sets)
6	Upgrade of Doma 2.5 MVA S/s to 5 MVA	33/11 TR ONAF 7,5MVA CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m Ehouse 33/11kV + TR + Cables
7	Switching Station with 33kV RMU	33/11 TR ONAF 2,5MVA Power cable (1 lot < 200 m) 33kV RMU RRL 11KV RMU RRL Housing for CSS 33/11kV 2.5MVA *Overhead line not yet included in the scope.

TABLE 9: ABUJA DISCO PHASE 1 PROJECTS

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Proposed construction of 2x15MVA, 33/11kv injection substation and 11kv feeders at lokongoma	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos)
2	Construction of 2x15MVA, 33/kv injection substation with associated 33kv overhead line, complete with 4No. Outgoing 11kv feeders at Aso pada	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories

		Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) * Overhead line not included in the scope.
3	Engineering, procurement and installation of 2x 15MVA 33/11kv (2 outgoing 33kv) injection substation at Kuje industrial layout 2 incoming, 4 outgoing and 1 BC	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos)
4	Proposed Installation of additional 1x7.5 MVA Injection Substation at Mpapa with 5kV 33kV O/H line	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 7,5MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform * Overhead line not included in the scope.
5	Proposed Construction of 2x15 MVA, Injection S/s at Kabusa	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos)
6	Construction of 2x15 MVA, 33/11kV Injection Substation in Kuje	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m

		Civil Work Transformer Platform 5mx5m (2 Nos)
7	Construction of 2x7.5 MVA Injection S/s at Jikwoyi	33kV GIS 7panel 11kV AIS 8panels 33/11 TR ONAF 7,5 MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos)

TABLE 10: ABUJA DISCO PHASE 1 PROJECTS

Kano Electricity Distribution Company ("Kano Disco")

Kano Disco covers three states of Kano, Jigawa and Katsina. geographical coverage of the company is 67,128 Km2. The company has the largest potential in terms of customer population with the combined population of the three states.

For the phase 1, the following projects are identified:

S/N	Project	Products and Systems
1	Installation of additional 1No. 15MVA Transformer at Abbatoir Injection S/S.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform *Ehouse 33/11kV + TR + Cables
2	Installation of additional 1No. 15MVA,33/11KV transformer at Jogana injection s/s, Kano	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
3	Proposed Installation of additional 1No. 15MVA,33/11KV transformer at Fadama injection	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels

	s/station, Katsina	33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
4	Installation of additional 1No. 15MVA,33/11KV transformer at Naibawa inj s/s,Kano	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
5	Installation of additional 1No. 15MVA, 33/11KV Transformer at Kawaji Injection S/S.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
6	Installation/upgrade of Additional 1No. 15MVA, 33/11KV Transformer at Mariri.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
7	Upgrading of Kofar Guga Injection S/S 2 x 7.5MVA, 33/11KV to 2 x 15MVA, 33/11KV, Katsina State.	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
8	Upgrading of Farm Centre 2 X 7.5MVA, 33/11KV Injection S/S to 2 x 15MVA, 33/11KV.	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 Control cables (1 lot < 5Km)

		Power cable (1 lot < 200 m) Civil Work - Outdoor Platform
9	Proposed installation of 55No. Auto reclosures on 33KV feeders	Auto Recloser 3Ph 33kV (55 Nos)
10	Installation of Localized SCADA system at Abattoir, Gongoni, Sharada, Farm Centre, Club, Zaria Road, Briscoe, Dan Agundi, IBB and Dutse Injection Substations	SAS (8 Sets) & RTU (8 Sets) CRP x5 (8 Sets) Control cables (1 lot < 5Km) (8 Sets)
11	Replacement of Obsolete/Aged 15MVA, 33/11KV transformers. (5No.)	33/11 TR ONAF 15MVA- (5 Nos)
12	Replacement of Obsolete/Aged 33KV out door breakers and transformer control panel. (10No.)	33kV OVCBx10 CTx10 CRP x10 Sets
13	Upgrade of 11KV breaker panels to SCADA compliance in 10No. Injection sub-stations.	11kV AIS 8panels – 10 Sets

TABLE 11: KANO DISCO PHASE 1 PROJECTS

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Construction of 2x15MVA,33/11KV injection s/s at Walalambe, along eastern bypass road, Kano with associated 33KV and 11KV lines.	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform * Overhead line not included in the scope.

TABLE 12: KANO DISCO PHASE 2 PROJECTS

Kaduna Electricity Distribution Company ("Kaduna Disco")

Kaduna Disco covers the North West states of Kaduna, Kebbi, Sokoto, and Zamfara

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	RANCHERS BEES STADIUM 1X15MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
2	MAIN OFFICE 1X15MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
3	HAYIN DANMANI 2X15MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
4	GORU 1X15MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m)

		Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
5	NEW-MAHUTA 1X15MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
6	KUDENDA 2X15MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
7	MILLENIUM CITY 2X15MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
8	ARGUNGU 1X15MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m

		Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
9	RIGASA RAILWAY 2X7.5 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 2,5MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
10	KALAMBAINA 2X7.5 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 2,5MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform (2 Nos) Civil Work Outdoor Platform
11	NEW-KATABU 2X15 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
12	SHIKA 2X15 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform

13	ZURU 1X7.5 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 7,5MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
14	GIDAN DARE (UNMANNED) 1X2.5 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 2,5MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform Civil Work Outdoor Platform
15	PALLADEN 1X15 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
16	JEGA 1X7.5 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 7,5MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m

		Civil Work Outdoor Platform
17	FADAMA 1X15 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
18	TAMAJE 2X7.5 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 7,5MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
19	TUKUR-TUKUR JUNCTION 2X15 MVA Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
20	RIBAH 1X7.5 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 7,5MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m

		Civil Work Outdoor Platform
21	MOTHERCAT 1X15 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
22	POWER STATION 1X15 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
23	KINKINAU 1X15 MVA Injection Substation	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Spares Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform

TABLE 13: KADUNA DISCO PHASE 2 PROJECTS

Enugu Electricity Distribution Company ("Enugu Disco)

Enugu Disco covers the five Eastern States of Nigeria which are: Abia, Anambra, Enugu, Ebonyi, and Imo.

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Upgrade of Ugwunwasike 1 x 15MVA 33/11KV Injection Substation to 1 x 15MVA & 1 X 7.5MVA	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 7,5MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
2	UPGRADING OF (Trans- Ekulu Inj. Sub.) 1 X 7.5MVA 33/11KV TO 15MVA 33/11KV	33/11 TR ONAF 15MVA CRP Control cables (1 lot < 5Km)

TABLE 14: ENUGU DISCO PHASE 2 PROJECTS

Port Harcourt Electricity Distribution Company ("PH Disco")

The Port Harcourt Electricity Distribution Company covers a part of the Southern Region which are: Rivers, Bayelsa, Cross River and Akwa Ibom.

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Construction of 2x15MVA, 33/11kv injection substation Calabar	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform
2	Construction of 2x15MVA, 33/11kv injection substation Alu	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA (2 Nos) SAS & RTU CRP x5 S/S accessories

		Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m (2 Nos) Civil Work Outdoor Platform

TABLE 15:PH DISCO PHASE 2 PROJECTS

Jos Electricity Distribution Company ("Jos Disco")

Jos Disco covers the States of Bauchi, Benue, Gombe and Plateau.

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Extend 33kV Bukuru Feeder and install 2.5MVA, 33/0.415kV Transformer at Grand Cereals (A division of UAC LTD) Bukuru Expressway Jos, Plateau State.	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 33/0,4 TR ONAN 2,5MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
2	Construction of 15MVA, 33/11kV injection substation at New GRA Makurdi, Benue State. This will de-load NNPC and District feeders.	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5 11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform
3	2.5MVA, 33/11kV Power transformer at Peugeot to Relief the Overloaded BSU 7.5MVA, 33/11kV injection Substation in Makurdi, Benue State	33kV OVCBx3 CTx3 VTx1 33kV Isolatorx3 11kV AIS 5panels 33/11 TR ONAF 2,5MVA CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform Civil Work Building Adaptation 10mx5m
4	Construction of 15MVA, 33/11kV Injection Substation	33kV OVCBx5 CTx5 VTx2 33kV Isolatorx5

		11kV AIS 8panels 33/11 TR ONAF 15MVA SAS & RTU CRP x5 S/S accessories Control cables (1 lot < 5Km) Power cable (1 lot < 200 m) Civil Work New 20mx10m Civil Work Transformer Platform 5mx5m Civil Work Outdoor Platform

TABLE 16: JOS DISCO PHASE 2 PROJECTS

Benin Electricity Distribution Company ("Benin Disco")

Benin Disco is responsible for retail distribution of electricity in Delta, Edo, Ekiti, and Ondo States with geographical coverage of 55,770 square kilometers. BEDC is the 4th largest Disco in distribution capacity and 3rd largest in number of households among the Distribution Companies (Discos).

For the phase 2, the following projects are identified:

S/N	Project	Products and Systems
1	Installation of Localized SCADA system at 5 Nos of Injection Substations	SAS and RTU – (5 sets) CRP – (5 sets) Control cables (1 lot < 5Km) – (5 sets)

TABLE 17: BENIN DISCO PHASE 2 PROJECTS

3.4 TCN National SCADA / EMS & Telecommunication

3.4.1 Executive Summary

Real time visibility of transmission grid is crucial for monitoring and dispatching existing transmission assets by National Dispatch Center. Therefore, availability of actual data from primary substation equipment to RTU's, functioning communications between RTU's / Substation Automation systems and Dispatch Center are necessary for successful grid operation. Constantly keeping SCADA system updated and healthy, the know-how of personnel up-to-date and applying managed upgrading and maintenance strategies in-time guarantee smooth operation, protection of previous and future investments while provide piece of mind to TCN through quality operational and business decisions.

Current situation and challenges:

- Lack of real-time status visibility for major portion of transmission grid due to lost communications between control center and the field.
- Insufficient local control on critical transmission substations due to outdated control hardware and automation infrastructure
- Lack of solid Maintenance concepts as well as high qualified resources.

As result, rehabilitation of SCADA/EMS system and Telecom Network as the most critical component within the entire Electricity Transmission Grid should be treated with highest priority (Phase 1).

Proposed Solution:

In order to improve the operation of the transmission grid, Siemens suggests the followings:

1. Renewal of data transport technology at the core- and backhaul layer of the fiber optic network with MPLS based multiplex systems.
2. Upgrading existing control center software to the latest state-of-the-art technology (Siemens Spectrum Power™ 7) which is independent from the IT hardware vendors. This gives the possibility to select the IT Hardware from variety of well-known vendors as well as secure future expansions / replacements.
3. Upgrading IT Hardware with the standard and latest state-of-the-art technologies.
4. Design a telecommunication upgrade / migration strategy considering industry trends, control center requirements and existing infrastructure
5. Enablement of TCN personnel as well as local service providers through comprehensive classroom and on-job trainings
6. Gold maintenance and support with start of full Operation by TCN

Benefits:

- Increasing grid visibility in short-time.
- Protect previous and future investments, advancing & optimizing current business processes with minimum time and efforts.

- Quick utilization of upgraded system and new features with minimum efforts
- Avoid continuing current unpleasant situation by entering long process of new tendering and implementation processes.
- Avoid complex process of data migration from existing system to new control center (unknown hidden challenges which might be raised by new vendor)
- Faster project starts due to existing knowledge in TCN and Siemens
- Tailor made and comprehensive enablement of TCN staff and local companies for further expansions, maintenance and support
- Tailor made Maintenance and Support in order to assure system sustainability
- Reliable protection of transmission assets.

Advantages of being part of overall Nigeria Electrification Roadmap

- Synchronization among related work streams (National Control Center, Telecommunication, Substation etc.)
- Integrated and comprehensive enablement program for Nigerian experts
- Consolidated job creation program for Nigeria
- Smooth orchestration among local companies who are excepted to do onshore works for Nigeria Electrification Roadmap
- Creation of sustainable local ecosystem from local companies for maintenance and service activities
- Unified regulatory/government support within the Nigeria Electrification Roadmap
- Higher potential for creation of local Training Center
- Intensive know-how transfer under the major electrification roadmap

Project Execution milestones

#	Milestone	Est. Duration	Responsible
1	**Detailed Site surveys** • Site surveys of all substations to be connected with detailed assessment of required equipment and works for substation adaptation & telecommunication • Site Survey report with BOQ for required equipment and works	4 months	Local Partner / EPC
2	**System Design** • Detailed Design of substation & telecommunication works	6 months	Siemens

	• Control Center System design		
3	**System Implementation** • Substation Adaptation works • Telecommunication works • Control Center System implementation	18 months	Local Partner / EPC Siemens and/or under its supervision
4	**System Commissioning**	8 months	Siemens / Local Partner / EPC
5	**Warranty starting with PAC**	12 months	Siemens / Local Partner / EPC
6	**Gold maintenance with start of Full Operation by TCN**	60 months	Siemens

TABLE 18: PROJECT EXECUTION MILESTONES

Note: Detailed scope and responsibilities between Siemens / local partner / EPC and TCN needs to be detailed in the deep-dive workshops after approval of the overall program by Nigerian government.

Exclusions:

- Civil works as control center buildings, auxiliary systems and fiber optic cable installations are out of Siemens scope. According to TCN, they will be handled as separate projects.
- Telecommunication infrastructure
- Onshore activities in non-secure regions
- Repair / dismantling of existing equipment, Substation Automation, Protection and retrofits

Requirements from TCN:

- Full access to all sites (Control centers, substations etc.) according to our implementation schedule
- Actual As-built documentation of existing implementations
- Telecommunication System has to be in place and should be capable for the new Control Center requirements.
- TCN to support with establishment of remote secured connections between Siemens delivery centers and TCN control centers for required remote project execution, maintenance and services

3.5 Proposed Solution

3.5.1 Overall Solution Architecture and short description

To meet TCN requirements, we have collected and analyzed the specific demands and tailored a best fitting solution from our broad range of products and applications for automation, communication and control centers.
The following figure gives an overview of the program. The blue indicated parts belong to the National/Regional Control Center level and comprise Energy Management systems, RTUs and respective Wide area communication systems (e.g. MPLS-, PLC-, UHF- systems). This Solution overview also contains the different communication technologies used in the network and are introduced in the following sections.

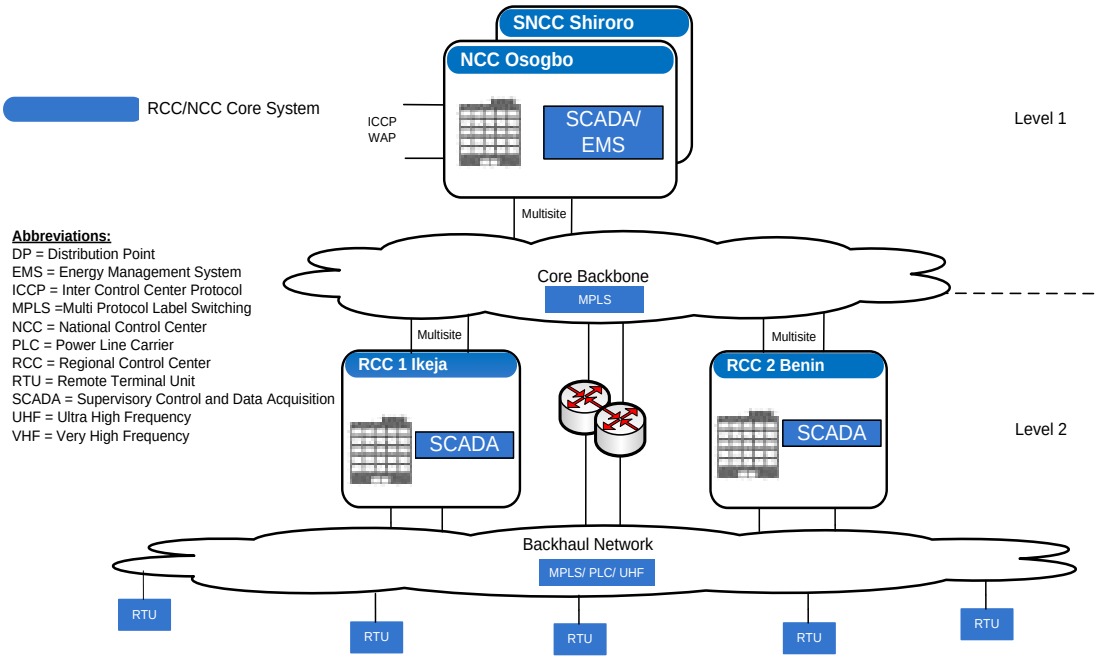


FIGURE 18: SIEMENS SOLUTION OVERVIEW

The communication architecture shall be designed in a hierarchical approach. MPLS Technology is used at the fiber optic Core Backbone area and provides high speed IP-data communication for SCADA-, Voice and protection data.
At the Backhaul Level MPLS, New generation IP based Power Line carrier and UHF/VHF technology will be used to connect RCC RTU from the network edge to the Backhaul network.

3.5.2 SCADA/ EMS

Siemens is pleased to propose its SCADA/EMS solution to support the Nigerian Electrification Roadmap. The **drafted** solution is based on our industry-recognized, best-of-breed platform Spectrum Power™ 7 designed for dispatch control and operation of the largest and most complex electric networks in the world with the current track record of more 70 contracted projects over last 7 years backing with experiences of > 1800 control center installations.

The Spectrum Power™ 7 based SCADA/EMS will provide following new features in comparison to the currently operating Spectrum Power™ 4 based SCADA/EMS**:**

- Hardware and vendor independent solution with improved high redundancy and availability.
- LINUX-based servers and the Web-based modern User Interface with 3D capabilities covering all requirements for situational awareness running on LINUX- as well as MS Windows-clients.
- Integration and enhancements of IT security according to international regulations and standards.
- Data model designed on worldwide accepted CIM standard, providing CIM interfaces.
- Handling of renewable generating resources.
- Transmission Network Application and interfaces according ENTSO-E rules and recommendations.
- Service Oriented Architecture capabilities.

The drafted SCADA/EMS solution is designed for dispatch control and operation of TCN electrical network from the four Control Centers (also called “sites”) in Osogbo, Shiroro, Ikeja and Benin City. The entire functionality of the drafted SCADA/EMS solution is distributed between national and regional transmission control levels as well as between mentioned sites.

The National Transmission Control Level will consist on the National Control Center (NCC) in Osogbo and the Supplementary National Control Centre (SNCC), which is the backup facility for NCC, in Shiroro. The National Transmission Control Level is responsible for the monitoring and controlling the national grid (330 kV and part of 132 kV transmission network) as well as for the generation scheduling and dispatch all over the country. The Regional Transmission Control Level will consist on RCCs in Shiroro (combined with SNCC), Benin City and Ikeja and is responsible for the monitoring and controlling the regional networks (132 kV and circuit breakers on outgoing 33 kV feeders at transmission substations). Both Transmission Control Levels together with the future optional Market Operator as well as with the additional Distribution Control Level, comprising eleven Distribution Control Centers (DCC), are displayed in the diagram below.

For purposes of increasing redundancy and availability the NCC and SNCC are designed as complete independent redundant system and they would be able to manage a power system independently in case another site is permanently not accessible. At the same time NCC and SNCC are designed in peer-to-peer multisite configuration to be able to manage a power system also cooperatively increasing redundancy on the National Control level. For purposes of increasing redundancy and availability the HW of RCCs is designed in redundant configuration as well.

Precondition: For purpose of proper multisite functionality the sites have to be connected with redundant high-speed communication TCP/IP link providing the bandwidth of 1 Gbit/s.

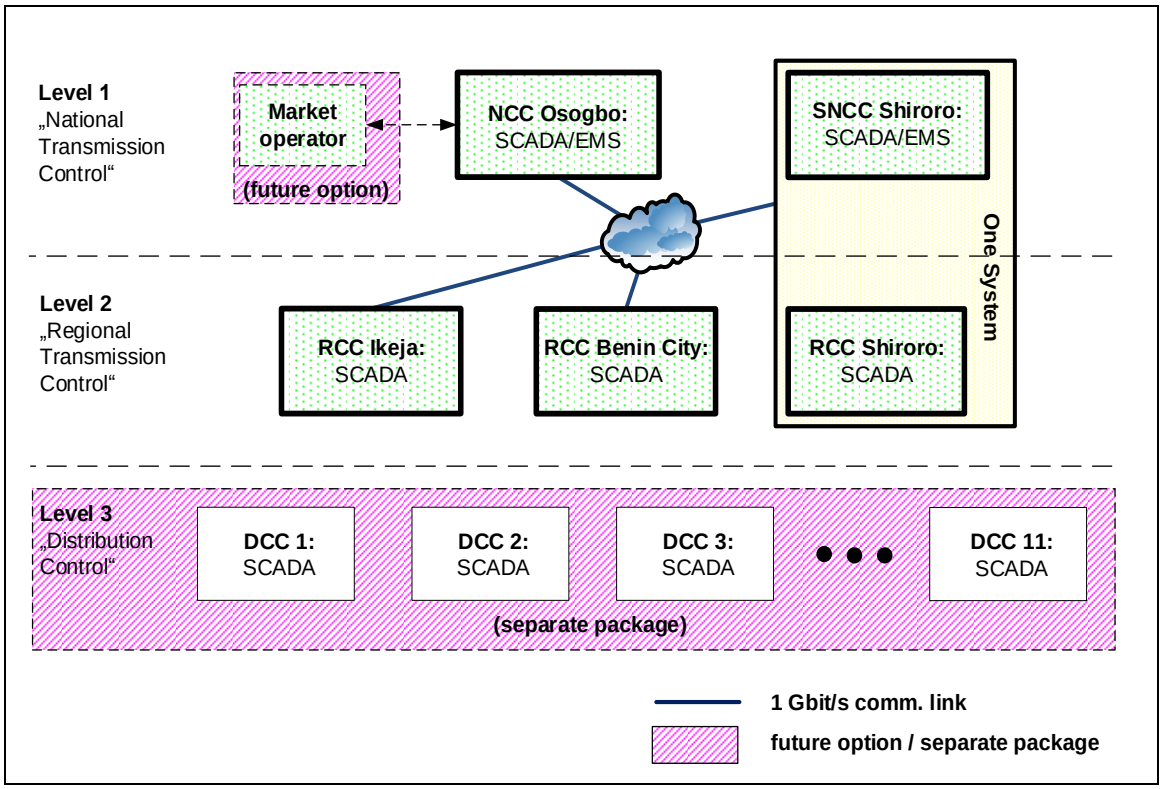


FIGURE 19: OVERALL ARCHITECTURE OF THE DRAFTED SCADA/EMS SOLUTION

The entire drafted SCADA/EMS solution comprises following modules, functions and features:

- **Data Acquisition Frontend System (IFS)**
  - With fully integrated Spectrum Power™ network health monitoring (Spectrum-LAN);
  - With ability to communication diagnostics, including monitoring and listening mode as well as automatic switching between redundant lines;
  - With engineering by means of centralized information model manager (IMM).
- **Ultra-high-performance & full-featured SCADA**
  - With unified handling of all switching, manual updating and tagging operations;
  - With network control interlocking features, monitoring of spontaneous network alterations;
  - With possibility of complex switching operations like busbar change and line switching;
  - With freely placed jumpers, cuts, grounds, and mobile generators;
  - With guided operator alarming via graphics;
  - With topological network coloring and interactive topological tracing.
- **Web-based User Interface (UI)** provides the dispatchers in the control centers with ergonomic displays, as well as support for a video projection system and digital displays.

Web-based technology guarantees low maintenance efforts due to centralized software patching.

- **Information Model Management (IMM)** enables the user to enter and maintain all power system related engineering data in a CIM-based central repository.

- **Historical Information System (HIS)** is used for short-/mid-/long-term data archiving. Connected to the HIS's standardized interfaces Jaspersoft BI Professional is included for fast and easy report creation as well as Web-access.

- **Transmission Network Analysis (TNA)** features the latest advancements in the widely implemented suite of network applications, which allow for state-of-the-art grid security monitoring (State Estimation, Power Flow Calculation, Contingency Analysis, Short-Circuit Calculation). Models for future primary devices of the electrical grid like FACTS and HVDC are integrated in the TNA.

- **Operator Training Simulator (OTS)** with particularly flexibility for setting up training cases and scenarios based on real-time or archived data. Besides the network model (same as in SCADA/TNA) it includes models for the dynamic behavior of generating units.

- **Automatic Generation Control (AGC)** provides the Generation Dispatch functionality including NERC compliant Load Frequency Control capable of multi-area control, the Reserve Monitor and the Production Costs Monitor.

- **Joint Resource Optimization & Scheduling (JROS)** provides the Forecasting & Generation Scheduling functionality including Short-/Mid-Term Load Forecast, Coordination of Hydro and Thermal Generation, optional handling of Wind- and Solar generation, as well as Interchange Scheduling.

- Optional interfaces with external applications via **Web-services** in the framework of a Service Oriented Architecture (SOA).

- **Cyber security features** inherent to Spectrum Power™ 7 provide strict control on system access and authorizations for both users and consoles. Firewalls and security mechanisms protect the secure zones of the system against cyber-attacks and intrusion.

- **Backup and restoration tools** are provided to facilitate disaster planning and recovery.

Both sites on National Control Level would provide following functional blocks:

- Process Interface/ ICCP,
- SCADA / EMS,
- User Interface,
- Information Model Management tool.
- Operator Trainings Simulator (only in NCC in Osogbo).

RCC in Ikeja and RCC in Benin would provide following functional blocks:

- Process Interface/ ICCP,
- SCADA,

- User Interface.

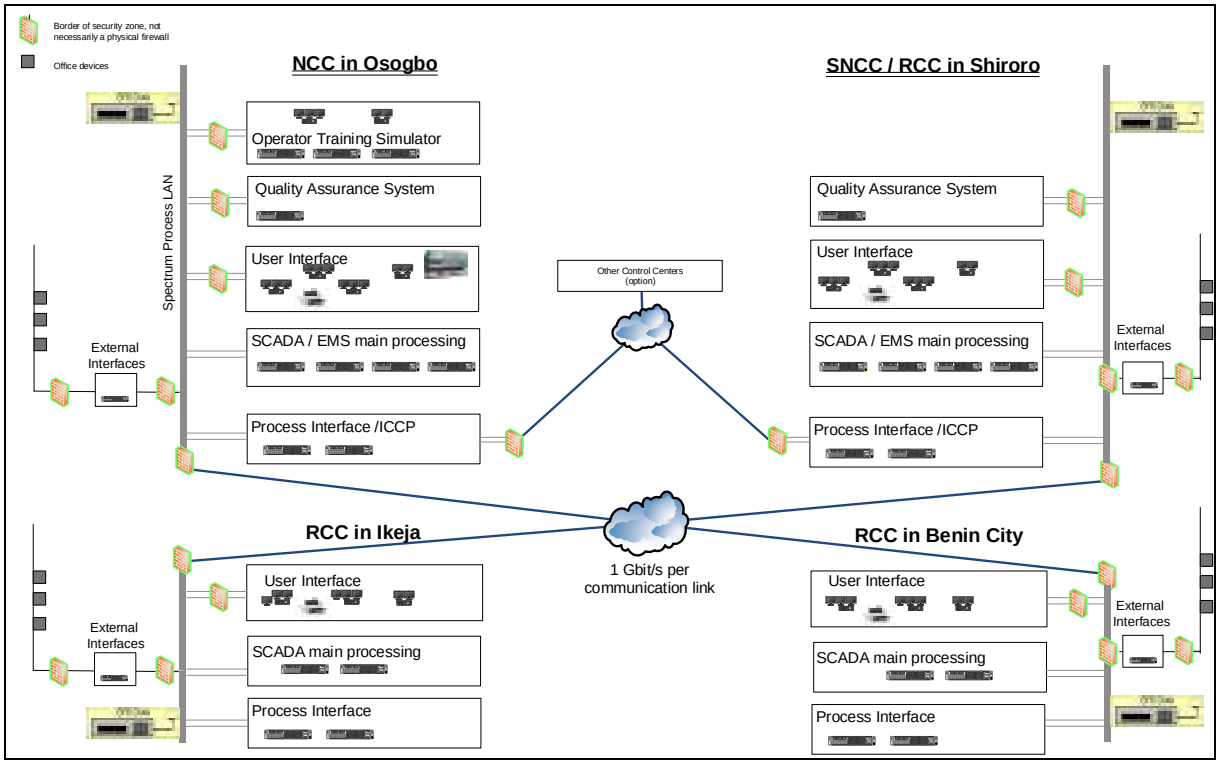


FIGURE 20: DETAILED ARCHITECTURE OF THE DRAFTED SCADA/EMS SOLUTION

Our offer includes:

Software: Standard Spectrum Power™ 7 platform with SCADA/EMS functionality including modules mentioned above.

Hardware: Computing Environment required to support the Software.

Services:

- Solution planning, implementation and testing at factory (incl. setup & configuration), data migration from the current system, installation, commissioning and selected testing onsite using PM@SIEMENS delivery methodology.
- The services related to the training of TCN personal (to be defined).

Our offer does not include:

Software: Other standard Spectrum Power™ 7 modules besides those, which are explicitly mentioned for SCADA/EMS functionality.

Services: Any services not explicitly mentioned in our documents.

Our offer is limited to:

Software:
- Standard Spectrum Power™ 7 platform in English language.
- Standard Spectrum Power™ 7 platform with SCADA/EMS functionality including modules explicitly mentioned in our description.
- Standard Spectrum Power™ 7 platform features related to Cyber Security.

Services:
- The services related to “Point-to-Point tests” will be limited to the few exemplary tests since the data migration will be achieved by proven scripting methods and the conversion errors should not occur. Therefore, the complete point-to-point test might not be necessary.
- The services related to “Cyber Security” will be limited to the standard product specific measures and will not include any cyber security assessments and/or risk management.
- Any services will be limited to the scope of supply explicitly mentioned in our description.

3.5.3 Telecommunication

For telecommunication Siemens proposes state-of-the-art packet-based solutions to bring that advantages of IP services into all areas of the communication network. Our proposal considers a hierarchical approach to ensure smooth migration options. The highest layer is formed by a Backbone Core Layer. This layer of the network ensures a high-speed packet switching rate and fast redundancy switchover in case of a failure. In this layer also IP routing functionality can be provided to route traffic to the respective Control Centers.

The Backhaul layer of the network provides traffic aggregation functionalities from the various substations. At this layer different communication technologies like MPLS, PLC, UHF/VHF are used.

In the following sections we invite TCN for an introduction into the different technologies as solutions proposed by Siemens. Through its extensive experiences, Siemens is able to propose an integrated solution approach from its wide product and partner range.

3.5.4 Multi-Protocol Label Switching (IP/MPLS)

As per the customer requirements for the fiber optic backbone a pure IP/MPLS end-to-end solution is the best option for next-generation mission-critical network operators. The IP/MPLS system will operate the fiber optic network and shall be made available for this technology.

Using IP/MPLS means, the customers can always deliver any application with any service to any end point.

IP/MPLS End-to-End approach provides comprehensive service capabilities:

- Layer 1 point to point circuit Emulation (P2P CES)
- Layer 2 Point to Point E-Line, Point to Multipoint E-LAN and E-Tree
- Layer 3 Virtual Private Networks (VPRN)
- Or a flexible combination

In packet-based transport networks mechanisms for traffic differentiation and prioritization are paramount. The proposed IP/MPLS solution is well prepared and offers functionalities for traffic management:

- Quality of Service with different mechanisms (e.g. DSCP, 802.1q,EXP)
- Redundancy protection mechanisms (e.g. RSVP, LAG, FRRP)

We are convinced that a full end-to-end IP/MPLS solution approach provides great benefits for IP-data applications as well as mission-critical protection traffic. These are described below:

- A persistent IP/MPLS approach reduces the complexity with regard to integration, planning/design, test and operations significantly – only one technology needs to be supported by the customer departments.

- Furthermore IP/MLPLS offers the possibility to implement and operate the network with considerably less operational effort because of its various automated procedures and tools.

- IP/MPLS offers the possibility to protect individual hops (links and nodes) of a MPLS LSP. By this the network can be implemented with less restrictions and it is possible to cover more failure scenarios.

On basis of our partnership with our preferred partners (e.g. Nokia) we can provide and engineer best in class and utility grade IP/MPLS systems. We would propose the service aggregation router series

FIGURE 21: 7705 SAR ROUTER

3.5.4.1 Services for Multi-Protocol Label Switching (IP/MPLS)

For the proposed IP/MPLS Backbone/Backhaul network we can provide Engineering, design, FAT, Training and commissioning support services in corporation with our partners (e.g. Nokia).

3.5.5 Siemens IP PowerLine Carrier Communication

At the edge of the network, and beyond the reach of fiber optic cable range PLC technology shall be used to connect RCC RTU substations. Siemens provides best in class PLC technology to connect remote substations on basis of IP protocols efficiently to the Control Centers.
With high performance capabilities of “PowerLink IP” we can bring IP based services into the edge of the grid to provide the advantages of IP based communication technology also into these areas of the network.
The new “PowerLink IP” system has a packet-based architecture with a software defined modem. It is optimized to fulfill the communication requirements of modern substation devices. “PowerLink IP” can also be operated with an integrated tele-protection signaling system iSWT3000 for interfacing to distance protection relays.

FIGURE 22: POWERLINK IP

3.5.5.1 Services for PowerLink IP

For PowerLink IP we can provide Engineering, design, FAT, Training and commissioning support services.

3.5.5.2 UHF/VHF Radio

To reach remote Substations we also propose UHF/VHF radio technology. Latest IP based UHF/VHF radio systems in Point to Point or Point-to Multi-Point communication structure provides very effective solutions for SCADA connection of distant substation locations in rural areas. Respective frequencies for operation of the UHF/VHF radio system are required to be made available by TCN.

FIGURE 23: APRISA SR+

3.5.5.3 Services for UHF/VHF

For VHF/UHF we can provide Engineering, design, FAT, Training and commissioning support services in corporation with 4RF.

3.5.5.4 VoIP Telephone System

For telephone communication we propose the IP Telephone System UNIFY Openscape 4000. The Openscape 4000 is a converged PBX for Enterprise Voice which allows for smooth migration from legacy to new IP based voice services. The powerful system scales up to 12,000 users and allows for a central hosting of VoIP applications at the control center level.
The Active-Standby dual node architecture ensures fast switchover in case of a failure and no calls are lost.

FIGURE 24: OPENSCAPE 4000 ECOSERVER

3.5.5.5 Services for PABX system

For the PABX system we can provide Engineering, design, FAT, Training and commissioning support services in corporation with Unify.

3.5.6 Remote Terminal Units (RTU)

For the Nigeria Electrification Roadmap, we have selected the Siemens RTU SICAM A8000 family. The applications for the SICAM A8000 series comprise the various use cases in transmission and distribution automation. The RTU SICAM A8000 will be used as data concentrator in order to send all relevant information acquired from the substations to the different Control Centers.

The collection of the information from the field will be done via communication bus between the RTU and the existing ID devices, if they are supporting TCP/IP protocols like IEC -61850. Otherwise the information will be connected hard-wired to the RTU and send it to the control center via IEC-101/104 protocol.

FIGURE 25: EXEMPLARY SIEMENS RTU A8000

3.5.7 Training

A comprehensive and interactive training program in order to optimally meet the expectations of TCN for a sufficient know-how transfer and establishment of competencies for the operation of advanced, open, expandable and modular Transmission control centers will be provided.

This will include general classroom trainings e.g. in our Training Centers in Germany and/or Austria on the various technologies and products provided as well as on-the-job trainings at TCN sites for the specific solutions implemented for TCN.

3.5.8 Maintenance & Support

Based on SIEMENS integrated solution concept we are pleased to present to you our suggestion of the Maintenance & Support concept for TCN.

To fulfill TCN needs as best as possible we have selected service package “Gold” from our extensive Master service agreement (MSA) portfolio in order to provide it for a duration of 60 months after the warranty phase for the Transmission Control Centers.

This Gold Maintenance & Support package covers Corrective Maintenance, Preventive Maintenance as well as provision of Patch Management Software packages. Corrective Maintenance is delivered remotely, Preventive Maintenance can be delivered as an on-site service on demand.

The Software Subscription Agreement (SSA) offer includes provision of the latest Software versions of Spectrum Power 7. That includes new software versions, patches and 3rd-Party Software patches.

3.5.9 Preconditions

- We require full Access to all relevant sites according to our implementation schedule
- Provision of existing equipment actual as-built documentation
- Provision of actual Signal Lists, Single Line Diagrams, Station Layouts, Cable Lists, Terminal Connection Drawings and Bay wise Adaptation Designs

Disclaimer: the named partners in this project are meant as preferred partners and are subject to change due to revised requirements which might be defined at later stages.

3.5.10 National Metering Infrastructure

A National or centralized "advanced revenue" smart metering system is an enabler for security of revenue to ensure proper payback for the 'distributions companies' (Disco's) to 'Nigerian Bulk Electricity Trading Company (NBET), as well as to MAP's and their respective investors. Disco's currently receive only 45% of total revenue (average aggregate technical and commercial collection losses, ATC&C, are 55%), whilst only paying 28% on average for electricity received from Transmission Company of Nigeria (TCN) to NBET and further on to power generating companies.

By centralizing the Smart Metering solution, government and private institutions such as MAP's, Disco's, NBET, NERC, TCN and GENCO's can gain valuable insight in load consumption data so that strategic planning is made easier and more accurate – reducing unnecessary costs for grid upgrading and new infrastructure. Also, revenue protection is ensured and due to the nature of the centralized system, each MAP and Disco is ensured their revenue, alongside NBET and investors so that all parties enjoy the security of revenue – making investment into the Nigerian Electricity infrastructure a "risk free" reality.

Siemens is therefore pleased to offer our state-of-the-art Smart Metering solution to Nigerian Electrification Program to support the Nigerian Electrification Program. Our solution is based on our industry-recognized, best-of-breed smart metering platform: EnergyIP. With over 100 utilities running EnergyIP to manage over 75M meters, our solution is designed to handle the largest and most complex electric / water / gas metering installations in the world.
The scope of the proposed solution is as follows:

- Implementation of a National Advanced Revenue Smart Metering Systems as a centralized multi-tenanted system that performs the following:
  - Ring fences TCN and the 11 Disco's as well as their specific MAP's
  - Provides an MDMS platform that is cost effective to the DISCO's due to Economy of Scale
  - Provides prepaid revenue security for the Energy Sector. This will allow the DISCO's to use a "Pre-Pay" smart metering system to manage all customer accounts, such as; MDAs; MDs; Residential; and Others
  - Integrates existing HES
  - Provides STS vending integration and management
  - Provides Data analysis and reporting, such as for assessing vital TCN data on the Disco 33KV circuits.
  - Provides load data to NERC for tariff management
- The Nigerian Government proposes the setting up a "Special Purpose Vehicle (SPV)" which will own and control the funding and finance of the new system, as well as receive the income from the consumers so that all stakeholders such as DISCO's and NBET are paid their rightful dues

- Nigeria has approximately 4 million meters currently deployed. These are mainly STS prepaid meters, with some manually read meters and smart (AMR) meters.

- The current target for NEW meters to be deployed by the various MAP's in 4.8 million meters. Current estimates are that this figure will be close to 6 million meters.

Our offer includes:

Software:The EnergyIP Platform sized for 5M Smart Meters, including our UDIS Head-End System (HES), Meter Data Management (MDM), Prepay (PPES), an STS vending platform provided by Syntell and Siemens' Field Deployment tool (AMC). 3rd-party software required by the Siemens applications is also included

Hardware: Computing Environment required to support the Software.

Services: Solution configuration, integration and on-premise deployment for all the solution components using PM@SIEMENS project delivery methodology. Training on the Software applications listed above and field installation and maintenance procedures using our AMC application. Also, managed services on the system for 5 years

Our offer does **not** include:

Meters, data concentrators, hand-held units, and any communication equipment related to the smart meter / AMI field area network, nor, any field installation works of the meters and data concentrators nor any changes to the TCN / DISCO back-office systems, including the TCN / DISCO Customer Information Systems and Billing **Systems**.

Our offer is **limited** to:

- Two existing 3rd Party HES per DISCO and one for TCN integrated into the Siemens system

- STS Meters that are registered with the STS Association and confirm to all STS prepaid meter standards

- One CMS per DISCO and one for TCN integrated into the Siemens system

- One central 3rd party payment gateway for consumer payments. This will include online payments such as Credit Card and Debit Card, EFT payments, mobile payments etc. Cash payments will be processed through 1,100 point of sale devices (100 per DISCO).

Based on the metering technology deployed, as well as future meter type deployment, the Economic Focus of the DISCO's in terms of their meter management is as follows:

FIGURE 26: SOLUTION ARCHITECTURE DIAGRAM

Figure 27 – Proposed Solution Architecture summarizes the solution components and interfaces (in green) included in our offer to Nigerian Electrification Program.

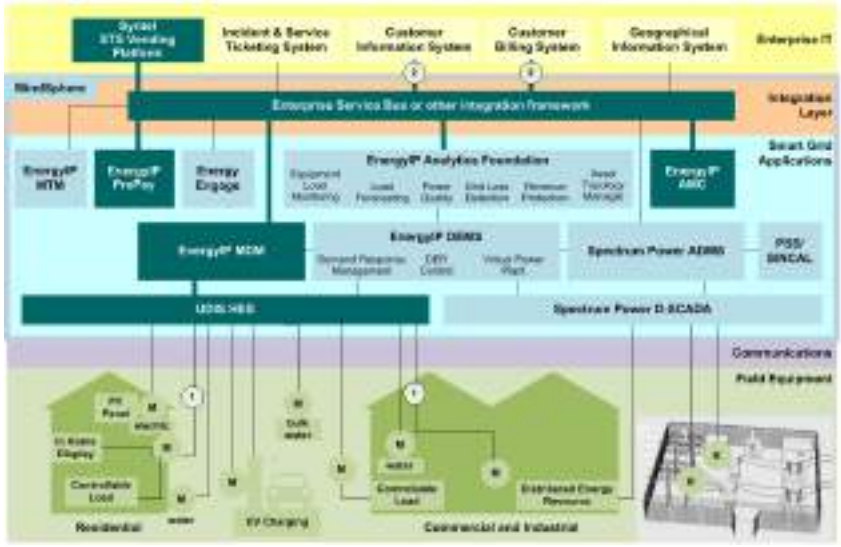


FIGURE 27 – PROPOSED SOLUTION ARCHITECTURE (WITH INTERFACES)

Per Figure 27 – Proposed Solution Architecture above, our offer includes:

Software:

- Siemens EnergyIP platform covering PROD, TEST (QA), and DEV customer environments designed to manage a meter population of 5M
- Siemens EnergyIP Meter Data Management (MDM) application with the following adapters:

  - FlexSync Adapter for CIS integration
  - UUA Adapter for HES integration
- Siemens UDIS Head-End System (HES) application
- Siemens EnergyIP PrePay (PPES) application
- A vending platform to support PPES provided by Syntell
- Siemens Asset Management Center (AMC) to manage Field Deployment Work
- 3rd-party Software required to support the applications above (e.g. Oracle RDBMS)

Hardware:

- Computing Environment for back-end software applications described above.

Services:

- Solution configuration and on-premise deployment for all the solution components using PM@SIEMENS project delivery methodology.
- Solution Integration, via our standard APIs, with:
  - Nigerian Electrification Program Customer Information System to import the asset model into MDM, PPES, HES, and AMC.
  - Nigerian Electrification Program Customer Billing System to synchronize billing data with MDM and PPES.
  - Nigerian Electrification Program Vending System to synchronize top up transactions with PPES
- Training on Solution applications above.
- Training on Meter and Data Concentrator field installation and maintenance procedures using AMC

Network Diagram / Deployment View Diagram

The figure below presents the network diagram where our proposed solution will be deployed into Nigerian Electrification Program's IT landscape. The production (PROD) environment is found at the Main Site on the diagram with a DEV and QA (a.k.a. TEST) environments. The proposed solution includes a DR back-up site. The diagrams in the next section represent details around the EnergyIP HES, MDM, PPES and Analytics servers.

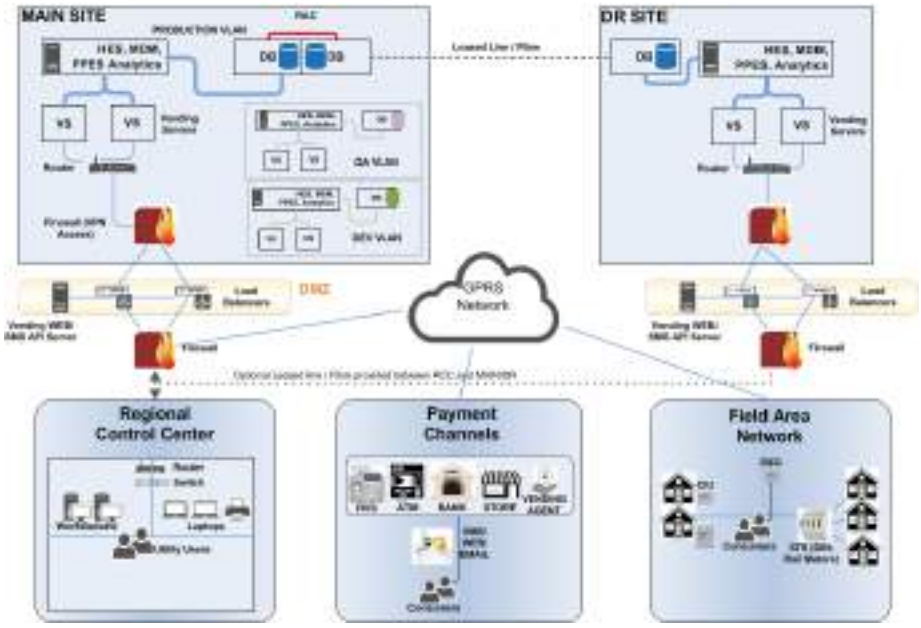


FIGURE 28: NETWORK DIAGRAM

The diagram presents a field area network (FAN) which is connected to the main site via GPRS. It also illustrates Utility Users accessing the solution from Regional Control Centers. Finally, the network diagram includes 3rd-party vending servers connected to various Payment Channels.

The diagram presents a field area network (FAN) which is connected to the main site via GPRS. It also illustrates Utility Users accessing the solution from Regional Control Centers.

The following section describes typical location overview of deployed applications and AMI netwo

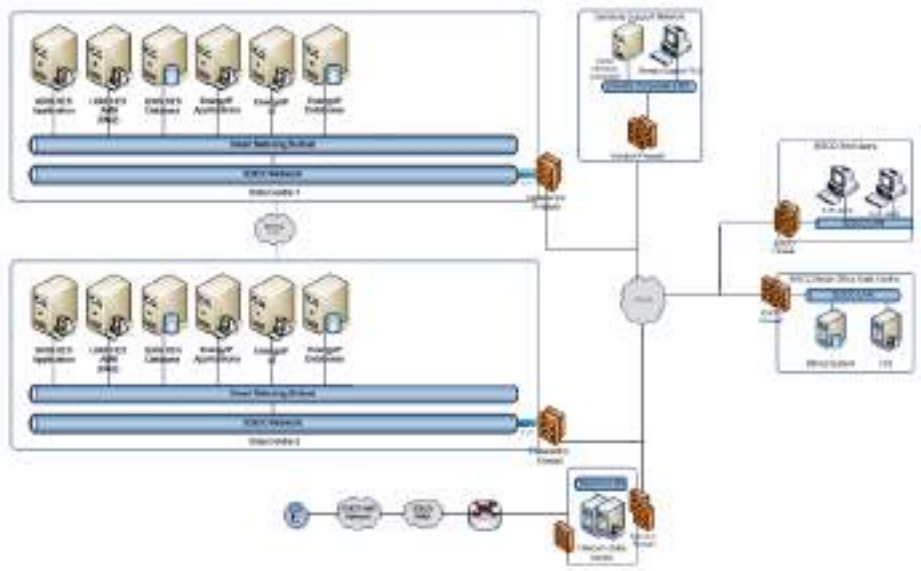


FIGURE 29 - LOCATION OVERVIEW

How the Solution Works

How EnergyIP PrePay and the On-Line Vending Sytem Works

The architecture diagram below presents the major interfaces between the EnergyIP platform, PrePay, the Meters, the On-Line Vending platform provided by external partner and the end-customer.

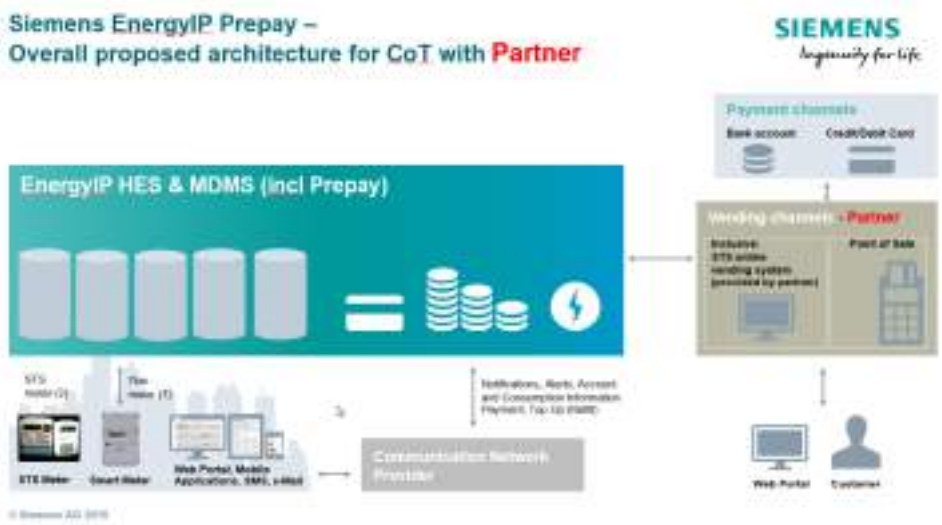


FIGURE 30 – MAJOR INTERFACES BETWEEN ENERGYIP PLATFORM AND THE ON-LINE VENDING PLATFORM

The solution has been designed to manage two types of prepayment customers:

- Smart meter customer: A customers connected via Smart meters (thin meter) to the HES
- STS customer: A standalone customer not connected to the HES. Uses STS meters (thick meter)

The EnergyIP Prepay application would include a web-portal. The Self Care GUI supports the users with intelligent pop-up help and guidance information for correct input. This allows even inexperienced users to manage their account themselves. As a consequence, customer experience becomes very positive and support required from service desk is significantly reduced.

User self-care supports a wide range of use cases, such as:

- Dashboard: account balance, assigned meter(s), status and recent consumption values
- View account: all details for consumption and payments in graphical and list from
- View historic energy consumption for each meter in graphical and list from
- View customer, meter data and payment/billing data
- View and update settings in customers preferences
- Initiate ad-hoc payments in case Online or EFT Payment Service Provider integrated

As a supplement to information available via self care GUIs, customers are provided with notifications via e-mail and/or SMS/text messages in case of customer relevant events e.g. low balance warning, automatic payment, meter reconnect, etc.

3.5.11 Power System Simulation for Nigeria

It is a key prerequisite for the success of the Nigeria Electrification Roadmap, and for the effective and efficient operation and development of the Nigerian power sector in general, that the electrical utilities in the transmission and distribution levels have state-of-the-art competences and tools for the modeling, analysis, planning and optimization of the electricity networks. In this context, Siemens PTI offers this concept for "Power System Simulation for Nigeria".

The idea of the Power System Simulation (PSS) for Nigeria concept is to support all Nigerian transmission and distribution utilities (i.e. TCN, Abuja EDC, Benin EDC, Eko EDC, Enugu EDC, Ibadan EDC, Ikeja EDC, Jos EDC, Kaduna EDC, Kano EDC, Port Harcourt EDC, Yola EDC) in implementing state-of-the-art processes and tools, and to develop the related staff to world class expert levels in power system modeling, analysis and optimization. In order to achieve this objective, the Power System Simulation for Nigeria concept comprises:

- **Know-how transfer**
  Developing the key competences through explicit trainings and also on-the-job coaching

- **Power system modeling and simulation software**
  Installing the basis for state-of-the-art power system planning – licenses for Siemens PTI's renowned Power System Simulation (PSS®) software suite, as well as Maintenance & Support

- **Power system consulting support**
  Enabling the Nigerian electricity network operators to fully use and exploit the benefits of the Power System Simulation for Nigeria concept – support in building system models and mastering concrete planning tasks

- **Sustained support and services for four years**
  Providing a sufficient time frame to thoroughly implement the Power System Simulation for Nigeria concept

In total, the Power System Simulation for Nigeria package will provide Nigeria's transmission and distribution utilities with 25 PSS E licenses (including 12 existing licenses with TCN), 140 PSS SINCAL licenses (including 2 existing licenses with Eko EDC), 4 years of maintenance and support for all software licenses, 36 software trainings and 14 person-years of coaching and consulting support.

It is noted that Siemens PTI's PSS software suite offers various possibilities and features for easy integration into the utilities' IT environment, in order to facilitate comprehensive and end-to-end planning processes and activities. Also dedicated services and interfaces for data exchange with systems like SCADA (supervisory control and data acquisition) systems, EMS (energy management systems), DMS (distribution management system), NIS (network information systems) or GIS (geographic information systems) can be provided in separate offers, depending on the specific third-party solutions.

Key benefits of the Power System Simulation for Nigeria concept are:

- **Boosting network planning competence** and capacity in the Nigerian power transmission and distribution sectors
- Enabling one **integrated power system planning process** across Nigeria
  - Improved quality by consistent, transparent data management within PSS Suite
  - Easy integration into utility IT, e.g. SCADA (via optional interface or snapshot)
  - Increased efficiency by reduced interfaces in planning environment
- Installing one **future-oriented and flexible planning environment**
  - Network planning and operation across voltage/system levels becomes ever more important (e.g. due to renewables, security constraints, efficiency)
  - Comprehensive functionality and continuous innovation
  - Proven performance of PSS Suite
- **Simple and efficient logistics** in using and maintaining the planning tools
  - One strategic partner for supply and support of all network planning software
  - Financially attractive package pricing for complete solution

3.5.12 System Development Studies for Phases 2 and 3 of the Nigeria Electrification Roadmap

Nigeria's power system faces severe challenges to meet the demand of the Nigerian people and economy – both the actual demand (considering also significant amounts of "suppressed demand"), and even the demand that is already connected to the system. The existing system is constrained by an imbalance between power generation and consumption. While >13 GW of power generation capacity is available, only between 3 and 4 GW is reaching final customers (households, commercial and industrial users) on average, with a peak operating capacity of 5.2 GW achieved in 2018 (versus 5.1 GW in 2016). The facts that the "wheeling capacity" in the national transmission network is between 7 and 8 GW according to TCN, and the actual distribution capacity in 11 kV and LV in today's existing systems is up to 11 GW as per previous investigations by Siemens, hint at certain bottlenecks and misalignments especially in the transmission and distribution networks in today's situation.

Phase 1 of the Nigeria Electrification Roadmap will increase the operational capacity of the Nigerian power system to 7 GW from generation via transmission and distribution networks to the actual end-customers, by addressing immediate bottlenecks and "quick-win" projects. In the subsequent **Phase 2**, the existing capacity of the 11 kV and LV distribution networks should be enabled completely – which requires a detailed analysis of remaining bottlenecks

and shortfalls in TCN's transmission network and the 33 kV networks of the Distribution Companies. Different operating conditions are to be considered, in order to also improve the stability and reliability of the Nigerian power system. Thorough system studies for Phase 2 will ensure that up-to-date and accurate system models for the networks under investigation will be available, and comprehensive steady-state analyses of relevant operating conditions will derive the lists of recommended projects and measures for the reinforcement and expansion of the networks to achieve the target of 11 GW system operating capacity. In addition to these steady-state studies, also the dynamic characteristics in the transmission level will be modeled and the dynamic performance will be evaluated, in order to ensure system stability.

It is expected, and also supported by previous investigations, that a limited number of projects and measures will be sufficient to meet this target in medium-term future.

Subsequently, in **Phase 3** the Nigerian power system is to be developed up to a system operating capacity of 25 GW in the long term. To achieve this target, a strategic and well-coordinated program will have to be defined and implemented in both the generation, transmission and distribution levels of the Nigerian power system. System studies for this Phase 3 of the Nigeria Electrification Roadmap will define relevant operating scenarios for the complete system.

- For the generation system, recommendations on the expansion of the generation capacity and on the development of the generation mix will be derived – also considering the role and potential of renewable energy sources appropriately.

- Detailed studies for the national transmission network will define suitable network configurations that will support both the domestic demand within Nigeria and also international interconnections with neighboring countries appropriately. The concrete list of projects and measures to achieve the 25 GW target will be compiled.

- For all distribution companies, comprehensive plans for the development of the 33 kV networks will be derived that will support adequate capacity and reliability for power injection into the 11 kV distribution level. The concrete list of projects and measures per Distribution Company to achieve the 25 GW target for Nigeria will be compiled.

- For the actual 11 kV distribution level, 6 pilot areas (2 each with urban, semi-urban and rural characteristic) will be selected and recommended network structures and configurations will be developed, that can serve as blueprints for the development of the distribution level.

These system development studies are an integral part of the Nigeria Electrification Roadmap and will form the basis for the actual projects and measures in Phases 2 and 3.

3.5.13 Technical Training

Challenges

- Better link Education to Industry through the dual vocational education and training approach.
- The Siemens NG Electrification roadmap results in high demand of a skilled workforce.

Proposed Solutions – Big Picture

- Combination of vocational and industry-specific training addresses the skill gap in Nigeria.
- Definition of demand-driven, job profile-related, industry-linked and competency-based qualification framework, learning pathways and training programs.
- Strengthening and revitalization of preselected Nigerian Public Vocational Schools and Higher Education Institutes with focus on Curricula enrichment, teaching methodology (train-the-trainer).
- Technical short-term training programs for electrification roadmap personnel that meets the demand of future operations, maintenance and field service.

Proposed Solution – 1st Wave

Delivery of industry-specific short-term Training Courses

1. Objectives

Main aim is to have local employees project-ready at the right time, i.e. local employees shall be able to fulfill the new job requirements based on the project implementation roadmap. Subsequently local workforce is up-skilled based on industry-demand.

Furthermore this avoids additional cost which would occur if Siemens or Siemens subcontractor employees are required in Nigeria for project implementation, operation and maintenance.

2. Approach

The conducted Disco training needs questionnaire shows dedicated skill demand in seven main competence areas

i. Soft Skills

ii. Computer Technology and Software

iii. Basics Power and Electrical Installation

iv. Technology 1: Distribution Equipment, Transformers, Switchgears, Switching Components

v. Technology 2: Energy Management and Metering

vi. Technology 3: Distribution Automation and Control

vii. Health Safety and Environment: Electrical Rehabilitation

Based on the questionnaire results as well as further interviews and research in the near future we will come up with an entire portfolio of short-term programs in all respective areas spread over 3 years.
Each short-term course will be provided in all 3 years, but with different frequency (due to project timeline and number of employees requiring training in respective area).

3. Target Group / job profiles

The training courses mainly address blue-collar workforce, but due to a specific request we will also provide training programs for white-collar workforce.
Mainly we up-skill the following job-profiles:

i. Distribution Substation Operators

ii. Linesmen

iii. Revenue Collector/ MDM Engineer

iv. Engineering & Design Engineers

v. Radio Operators

vi. Protection and Control Engineers

vii. Electrical Fitters and Cable Jointers

4. Courses

For each of the seven competence areas various short-term courses are provided. The content is designed based on the demanded skills and subsequently packaged in short modules (min 3 – max 10 working days). This allows the responsible HRs to customize course packages due to each employee's needs. These industry-specific, short-term courses are delivered as in-person training - and not as online learning.

5. Location and region

The courses are run in 3-4 Nigerian regions (Lagos, Abuja and others). For the location, we suggest a two-tier way forward: On the one hand the training courses
are run in already-existing training centers from the relevant industry like **Siemens Technical Academy (STA)** and **National Power Training Institute of Nigeria (NAPTIN).**
On the other hand, they are run in existing infrastructure of vocational schools and/or

polytechnics.

The benefits of facilities like STA and NAPTIN are that they have skilled trainers as well as the required equipment at least partially in place, hence easy and fast to start with.

Equally important, if not even more important, are the benefits for vocational schools and/or polytechnics as training locations. Even though the teachers/faculties of the selected institutes do not run the programs as trainer they attend the courses as observer. Henceforth they are up-skilled too. With respect to equipment (please see also below), the equipment shall be handed-over to the respective state-owned institute at the end of the training project. Subsequently the institute is equipped to provide existing courses based on the latest needs and equipment or even to add
new course of studies and new professions.

6. **Trainer**

STA and NAPTIN have already trainers with the right skill set employed, or else know where to find suitable freelancers. For the vocational schools and/or polytechnics set-up freelancers need to be hired to run the short-term courses.
If required, Siemens will provide Train-the-Trainer programs for the newly hired Freelancers.

7. Equipment & infrastructure

Based on the design of the short-term courses we provide equipment and infrastructure requirements. STA and NAPTIN shall have equipment – at least partially - in place but will definitely need additional equipment to comply. For the vocational schools and/or polytechnics set-up the complete equipment needs to be provided to them. The rooms shall meet in general technical training room requirements.

8. Rollout-plan & implementation

We provide you a rollout-plan and manage the implementation over approx. 3 years.

9. Outlook: Long-term approach

After completion of the industry-specific, short-term courses the new hard ware (equipment) as well as the new ‘soft-ware’ (teachers’ domain skills) is completely transferred to the vocational schools and/or polytechnics.
These educational institutes are subsequently enhanced to either have the latest technology for existing course of studies and new professions or start new ones.
As already mentioned above in the ‘Proposed Solutions - Big Picture’ these outcomes strengthen and revitalize preselected Nigerian Public Vocational Schools and Higher Education Institutes. They will be further supported with curricula enrichment and Dual Vocational and Education teaching methodology via train-the-trainer.

Benefits

- Project with High Social Value, improving Nigeria's social stability, competitiveness in workforce development and economic development prospects
- Localization of training on global industry standards and value add to public educational system
- Introduce a Role model for linking education to industry by the dual system approach Technical Vocational Schools in Nigeria
- Support social stability by means of job creation and employability

Siemens Deliverables:

- Curriculum
- Short-term courses design
- Trainer profiles
- Infrastructure and equipment requirements
- Vocational schools and/or polytechnics as well as industry training centers assessment
- Train-the-trainer (if required)
- Rollout concept
- Implementation

Government Deliverables:

- Infrastructure at vocational schools and/or polytechnics
- Contract with freelance trainers
- Equipment at Vocational schools and/or polytechnics
- Equipment at industry training centers: funding and transfer at the end of the project to be decided
- Funding (design, rollout and implementation phase)

FIGURE 31: BENEFITS OF THE PROPOSED VET

3.6 Phase 1 Commercial Proposal

#	Scope	Description	Budget Price (€'000) Siemens	Budget Price (€'000) Non-Siemens scope	Total (€'000)
1	**Transmission Assets Upgrade (Phase 1)**	Engineering, Procurement, Erection and Commissioning of: - Containerized GIS Substations x 11 - mobile substations x 10 - Additional Transformers - Compensation system x 1 (MSC) (list as per section 3.1) + Transmission Lines (estimated length 140 Km out of Siemens Scope)	280,000	50,000	**330,000**
2	**Distribution Assets Upgrade (**only phase 1 projects**)**	• Supply of goods – products and systems (14 Stations) • Upgrade of existing substation (26) • Engineering, Procurement, construction, Installation and commissioning of mobile substation (3)	250,004	0	**250,004**
3	**Grid Automation**	Renewal of data transport technology at the core- and backhaul layer of the fiber optic network with MPLS based multiplex systems			**To be advised**
		Upgrading existing control center software to the latest state-of-			**To be advised**

		the-art technology (Siemens Spectrum Power™ 7) which is independent from the IT hardware vendors.			
		Upgrading IT Hardware with the standard and latest state-of-the-art technologies.			**To be advised**
		Design a telecommunication upgrade / migration strategy considering industry trends, control center requirements and existing infrastructure			**To be advised**
		Enablement of TCN personnel as well as local service providers through comprehensive classroom and on-job trainings			**To be advised**
		Gold maintenance and support with start of full Operation by TCN			**To be advised**
4	**National Metering Infrastructure**	Software: The EnergyIP Platform sized for 5M Smart Meters, including our UDIS Head-End System (HES), Meter Data Management (MDM), Prepay (PPES), an STS vending platform provided by Syntell and			**To be advised**

		Siemens' Field Deployment tool (AMC). 3rd-party software required by the Siemens applications.			
		Hardware: Computing Environment required to support the Software			**To be advised**
		Services: Solution configuration, integration and on-premise deployment for all the solution components using PM@SIEMENS project delivery methodology. Training on the Software applications listed above and field installation and maintenance procedures using our AMC application. Also, managed services on the system for 5 years			**To be advised**
5	**Power System Simulation**	New Software licenses (PSSE and PSS SINCAL) for TCN	192	0	192
		Software M&S for TCN	182	0	182
		Training and Technical Services Support for TCN	1,355	0	1,355
		New Software licenses (PSSE and PSS SINCAL) for 11 Discos	1,411	0	1,411
		Software M&S for 11 Discos	848	0	848
		Training and Technical Services Support for 11 Discos	1,814	0	1,814
		Total	**5,802**	**0**	**5,802**
		System development studies for 25GW	1,002	0	1,002

		transmission, sub-transmission and distribution grid capacity			
		Sub Total	**6,804**	**0**	**6,804**
6	**General Technical Training**				
	Grand Total				

TABLE 19: PHASE 1 COMMERCIAL PROPOSAL

Note: The quantity and prices are all ex-work factory and are subject to change after detailed project scoping and design. Budget prices contained here exclude the following:

i. **Taxes, duties and other logistics costs**
ii. **Project management costs**
iii. **Costs of rights of way, ESIA, EIA, and other required licenses or permits**

4. Proposed Phase 2 Projects

Phase 2 Objectives are to increase grid capacity to 11GW, achieve further reduction in ATC&C losses and maintain optimal grid stability and reliability.

4.1 Phase 2 Technical Proposal

The objective of this phase is to increase the grid capacity from 7GW (expected to be realized from phase 1) to 11 GW. In this phase,

i. Transmission and distribution assets upgrade including NTEP 2
ii. Distribution SCADA for Disco's
iii. 40MW embedded power project in Abuja
iv. Gas Processing projects to ensure fuel availability

4.1.1 Transmission and Distribution Systems

Following the successful implementation of the phase 1 projects and eventual results, phase 2 focusses on expansion of the transmission and distribution network from 7GW to about 11GW to make more power available to the people. The projects to be executed in this phase will be guided by the results of the network studies to be carried out by Siemens Power Technology Institute in the phase 1.

However, some transmission projects have already been identified by the TCN which shall be considered in this phase. This relates to the North East Transmission Infrastructure Projects 2 (NTEP 2). We trust that the Siemens modular technical concept is very suitable for network extension in security sensitive areas, especially due to the limited resource needed for on-site execution.

As background information NTEP2 projects comprises approximately:

i. 830 Km of HV lines
ii. 11 x 132/33 kV Substations
iii. 6 x132/33 kV substations extensions

For this application, Siemens intends to deploy a similar GIS containerized concept whenever possible. Detailed technical and commercial proposal will be submitted at later time for the projects.

4.1.2 Grid Automation: Distribution SCADA for Disco‘s

4.1.2.1 Executive Summary

Like transmission, visibility of distribution grid specially in critical points (e.g. Injection stations) is vital for smooth grid operation as well as quality of power delivery to end-consumers. Having accepted level of visibility requires collecting data from intelligent field devices through reliable communication system. On the other hand, largely distributed and high quantities of distribution substations as well as limited budget of Disco’s requires smart investment planning over the years.

Current situation and challenges:

- Lack of real-time monitoring for major portion of distribution injection stations
- Lack of solid Maintenance concepts as well as high qualified resources.

Proposed Solution:

Considering above mentioned points, Siemens suggest the following lean approach to Disco’s:

1. At first step, implementing distribution SCADA with monitoring functionality only. Control and DMS functionalities can be added at later stages.
2. Design and engineer a lean telecommunication system based on 3G/4G Radio Communication technologies
3. Replacement of old and non-communicative protection relays with the-state-of-the-art intelligent and digital protection relays
4. Enablement of Discos’ personnel as well as local service providers through comprehensive classroom and on-job trainings
5. Gold maintenance and support with start of full Operation by Disco’s

In a nutshell, Siemens suggest Disco’s - as first step – to start with standard distribution SCADA limited to monitoring functionality connecting critical injection stations (phase 2 of Nigeria Electrification Roadmap). At this phase of the roadmap we recommend similar systems for all 11 x Disco’s.

As phase 3 and after, each Disco can gradually expand the systems with control and DMS functionalities as well as connect more stations over the time. This will give Disco’s personnel the opportunity to collect experiences by operating the systems and define expansion and extension requirements more accurate, targeted and based on daily requirements of Disco’s. In addition, interconnections between Distribution and Transmission control centers can be established at later stages as well.

In order to support the above-mentioned journey, Siemens propose its latest state-of-the-art technology (Spectrum Power™ 7) which is independent from the IT hardware vendors. This gives the possibility to select the IT Hardware from variety of well-known vendors as well as secure future expansions / replacements.

Benefits:

- Increasing grid visibility in short-time.
- Protect previous and future investments, advancing & optimizing current business processes with minimum time and efforts.
- Tailor made and comprehensive enablement of Disco staff and local companies for further expansions, maintenance and support
- Tailor made Maintenance and Support in order to assure system sustainability

Project Execution milestones

#	Milestone	Est. Duration	Responsible
1	**Detailed Site surveys** • Site surveys of all substations to be connected with detailed assessment of required equipment and works for substation adaptation & telecommunication • Site Survey report with BOQ for required equipment and works	4 months	Local Partner / EPC
2	**System Design** • Detailed Design of substation & telecommunication works • Control Center System design	6 months	Siemens
3	**System Implementation** • Substation Adaptation works • Telecommunication works • Control Center System implementation	18 months	Local Partner / EPC Siemens and/or under its supervision
4	**System Commissioning**	8 months	Siemens / Local Partner / EPC
5	**Warranty starting with PAC**	12 months	Siemens / Local Partner / EPC
6	**Gold maintenance with start of Full Operation by Disco's**	60 months	Siemens

TABLE 20: PROJECT EXECUTION MILESTONES

Note: Detailed scope and responsibilities between Siemens / local partner / EPC and Disco's needs to be detailed in the deep-dive workshops after approval of the overall program by Nigerian government.

Exclusions:

- Civil works
- Telecommunication infrastructure
- Onshore activities in non-secure regions
- Repair / dismantling of existing equipment and retrofits

Requirements from Disco's:

- Full access to all sites (Control centers, substations etc.) according to our implementation schedule
- Actual As-built documentation of existing implementations
- Telecommunication signal coverage to be assured for all RTU points
- Disco's to support with establishment of remote secured connections between Siemens delivery centers and Discos' control centers for required remote project execution, maintenance and services

4.2 Proposed Solution

4.2.1 Overall Solution Architecture and short description

To meet Discos' requirements, we have collected and analyzed the specific demands and tailored a best fitting solution from our broad range of products and applications for automation-, communication solutions and control centers.
The following figure gives an overview of the program. The orange indicated parts belong to the Distribution Control Center level and comprise SCADA systems, RTUs and respective communication systems (e.g. 3G/4G mobile data routers).

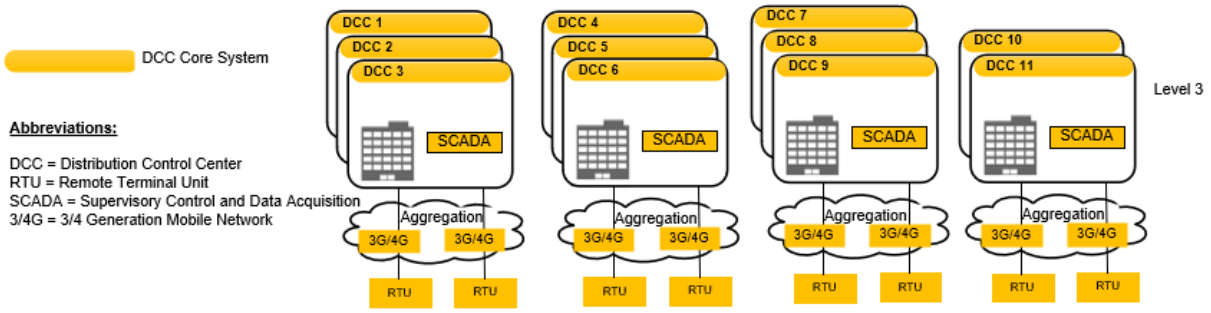


FIGURE 32: SIEMENS SOLUTION OVERVIEW

3G/4G public cellular radio technology is used to connect RTUs to the Distribution SCADA systems. With the proposed communication solution, it is possible to use another mobile telecommunication network as a backup in case one telecommunication network is out of service.

4.2.2 Distribution SCADA

Siemens is pleased to propose our SCADA solution for Nigerian Distribution Companies to support the Nigerian Electrification Roadmap. The drafted solution is based on our industry-recognized, best-of-breed platform Spectrum Power™ 7 designed for dispatch control and operation of the largest and most complex electric networks in the world with the current track record of more 70 contracted projects over last 7 years backing with experiences of > 1800 control center installations.

Spectrum Power™ 7 makes use of all significant technical trends, whether it is the growing efficiency of workstations and servers, the ever more complex IT integration and network environment, relational databases or standardized interfaces. Spectrum Power™ 7 is designed as modular component-oriented platform with SOA-capabilities. Its architecture can be scaled up or down to suit any size or configuration of a network control system and with all possible combinations of application programs, thus fitting the requirements of Nigerian Distribution Companies. Regardless of size or functionality requirement, Spectrum Power 7 can expand or adapt readily to any changes. Spectrum Power™ 7 provides cutting-edge technology for your future requirements. The Spectrum Power™ 7 based SCADA will provide among others the following features:

- Hardware and vendor independent solution with improved high redundancy and availability.
- LINUX-based servers and the Web-based modern User Interface with 3D capabilities covering all requirements for situational awareness running on LINUX- as well as MS Windows-clients.
- Integration and enhancements of IT security according to international regulations and standards.
- Data model designed on worldwide accepted CIM standard, providing CIM interfaces.
- Service Oriented Architecture capabilities.

The drafted SCADA solution is designed for dispatch control and operation of the electrical distribution networks assigned to the areas of responsibility of the Nigerian Distribution Companies of Kaduna, Kano, Yola, Jos, Abuja, Ibadan, Ikeja, Eko, Benin, Port Harcourt and Enugu. That solution is designed identically for all mentioned companies and will differentiate in sizing of the distribution networks as well as in type and amount of deployed protocols for the communication with the field equipment.

The drafted SCADA solution represents the third level of the control hierarchy of Nigerian Power System is displayed in the diagram below.

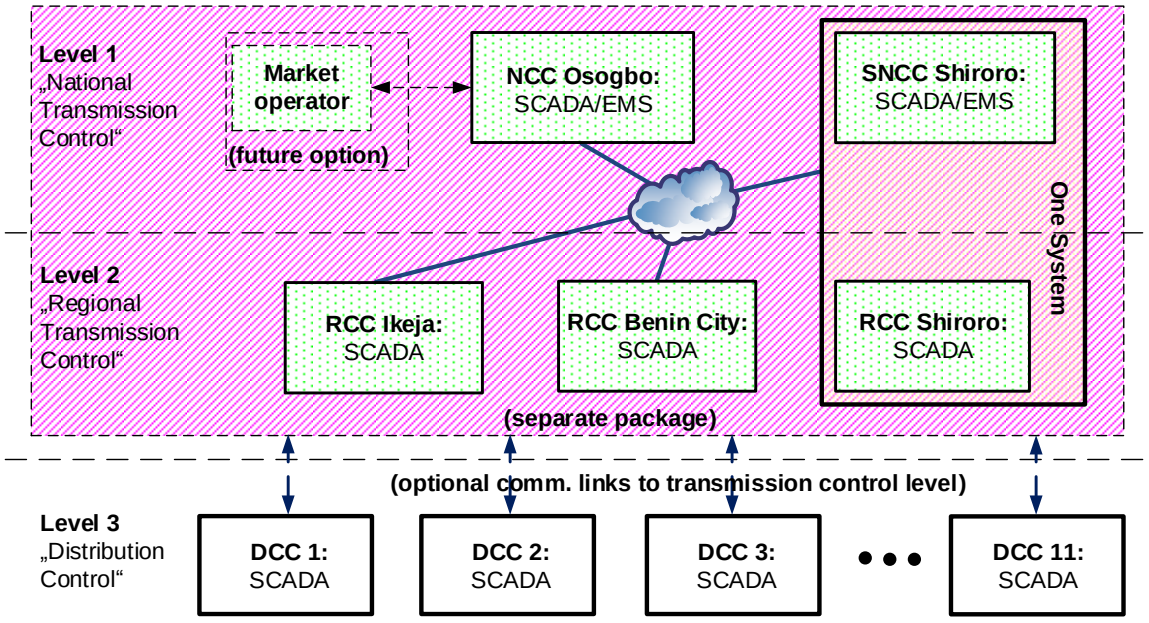


FIGURE 33: OVERALL ARCHITECTURE OF THE DRAFTED SCADA/EMS SOLUTION

For purposes of increasing redundancy and availability all Distribution Control Centers (DCCs) are designed as complete independent redundant system and they would be able to manage their electrical networks independently.

The main functionality of the drafted SCADA solution comprises following:

- **Data Acquisition Frontend System (IFS)**
  - With fully integrated Spectrum Power™ network health monitoring (Spectrum-LAN)
  - With ability to communication diagnostics, including monitoring and listening mode as well as automatic switching between redundant lines
  - With engineering by means of centralized information model manager (IMM)
- **Ultra-high-performance & full-featured SCADA**
  - With unified handling of all switching, manual updating and tagging operations;
  - With network control interlocking features, monitoring of spontaneous network alterations;
  - With possibility of complex switching operations like busbar change and line switching;
  - With freely placed jumpers, cuts, grounds, and mobile generators;
  - With guided operator alarming via graphics;
  - With topological network coloring and interactive topological tracing.
- **Web-based User Interface (UI)** provides the dispatchers in the control centers with ergonomic displays, as well as support for a video projection system and digital displays. Web-based technology guarantees low maintenance efforts due to centralized software patching.

- **Information Model Management (IMM)** enables the user to enter and maintain all power system related engineering data in a CIM-based central repository.
- **Historical Information System (HIS)** is used for short-/mid-/long-term data archiving. Connected to the HIS's standardized interfaces Jaspersoft BI Professional is included for fast and easy report creation as well as Web-access.
- Optional interfaces with external applications via **Web-services** in the framework of a Service Oriented Architecture (SOA).
- **Cyber security features** inherent to Spectrum Power™ 7 provide strict control on system access and authorizations for both users and consoles. Firewalls and security mechanisms protect the secure zones of the system against cyber-attacks and intrusion.
- **Backup and restoration tools** are provided to facilitate disaster planning and recovery.

FIGURE 34: EXAMPLE SCADA USER INTERFACE

Our offer includes:

Software: Standard Spectrum Power™ 7 platform with SCADA functionality limited to network monitoring only and including modules mentioned above.

Hardware: Computing Environment required to support the Software.

Services:
- Solution planning, implementation and testing at factory (incl. setup & configuration); data engineering for up to 100 distribution substations per Distribution Company; installation, commissioning and selected testing onsite using PM@SIEMENS delivery methodology.
- The services related to the training of Disco's personal (to be defined).

Our offer does **not** include:

Software: Other standard Spectrum Power™ 7 modules besides those, which are explicitly mentioned for SCADA functionality.

Services: Any services explicitly mentioned in our documents.

Our offer is **limited** to:

Software:

- Standard Spectrum Power™ 7 platform in English language.
- Standard Spectrum Power™ 7 platform with SCADA functionality including modules explicitly mentioned in our description.
- Standard Spectrum Power™ 7 platform features related to Cyber Security.

Services:

- The services related to “Point-to-Point tests” will be limited to the few exemplary tests and to the DCC sites only.
- The services related to “Cyber Security” will be limited to the standard product specific measures and will not include any cyber security assessments and/or risk management.
- All services will be limited to the scope of supply explicitly mentioned in our description.

4.3 Telecommunication

For telecommunication Siemens proposes state of the art packet-based solutions to bring that advantages of IP services into all areas of the communication network. Our proposal for the DCC communication network considers the usage of local 3G/4G mobile telecommunication networks. For the operation it is required to rent these connections from local telecommunication service providers. Network coverage is a precondition for the operation of this network.

4.3.1 3G/4G Radio Communication

For interconnection of RTU to the respective Distribution Control Centers we envisage IP based 3G/4G Radio communication technology.

RUGGEDCOM RX1400 is a Multiprotocol Intelligent Node which combines Ethernet switching, routing, and firewall functionality with various wide area connectivity options. The device has IP40 degree of protection, does not use internal fans for cooling and supports -40° C to +85° C extended temperature range.

The RUGGEDCOM RX1400 can be used for cellular connections. The dual SIM card slots enable cellular provider redundancy, allowing selection of the best performing network or redundancy<y switchover in case of an outage of one telecommunication service provider

FIGURE 35: 3G/4G WIRELESS ROUTER RX1400

4.3.1.1 Services for 3G/4G communication solution

For the proposed 3G/4G access network we can provide Engineering, design, FAT, Training and commissioning support services.

4.4 Remote Terminal Units (RTU)

For the Nigeria Electrification Roadmap project, we have selected the Siemens RTU SICAM A8000 family. The applications for the SICAM A8000 series comprise the various use cases in transmission and distribution automation. The RTU SICAM A8000 will be used as data concentrator in order to send all relevant information acquired from the substations to the different Control Centers.

The collection of the information from the field will be done via communication bus between the RTU and the existing ID devices, if they are supporting TCP/IP protocols like IEC -61850. Otherwise the information will be connected hard-wired to the RTU and send it to the control center via IEC-101/104 protocol.

FIGURE 36: EXEMPLARY SIEMENS RTU A8000

4.5 Protection Devices

Siemens will supply state-of-the-art digital protection relays from its SIPROTEC-5 and/or Reyrolle families for replacing the old protection relays within the existing medium voltage substations for the 11 Distribution Utilities as part of the Nigeria Electrification Roadmap project. The type and quantity of the Protection devices shall be defined by Disco's .

Protection devices which are going to be provided under this program taking over protection functionalities, are required to be connected to the respective CTs and/or VTs, which is not in SIEMENS scope.
SIEMENS shall provide to the client the data sheets of the relays of which he is in charge to deliver. The client shall provide the suitable quantity and type of CT/VT protection/measuring cores applicable for carrying the modified burden along with the CT/VT calculation indicating that desired modification is feasible and accepted by the client.

4.6 Power System Simulation Software (Optional) – Phase 3

The Power System Simulation for Nigeria concept provides all Nigerian Distribution utilities with adequate software tools for the modeling, planning and optimization of their power networks. Also, dedicated trainings ensure that this software will be used efficiently, and coaching and consulting activities support the utilities to model their systems, to run appropriate studies and to build respective competence in their own teams. This project runs for a four years duration.

4.6.1 Training

A comprehensive and interactive training program in order to optimally meet the expectations of Disco's for a sufficient know-how transfer and establishment of competencies for the operation of open, expandable and modular Distribution SCADA systems will be provided.

This will include general classroom trainings e.g. in our Training Centers in Germany and/or Austria on the various technologies and products provided as well as on-the-job trainings at Disco's sites for the specific solutions implemented for Disco's.

4.6.2 Maintenance & Support

Based on SIEMENS integrated solution concept we are pleased to present to you our suggestion of the Maintenance & Support concept for Disco's.

To fulfill Disco's needs as best as possible we have selected service package "Gold" from our extensive Master service agreement (MSA) portfolio in order to provide it for a duration of 60 months after the warranty phase for the Disco's.

This Gold Maintenance & Support package covers Corrective Maintenance, Preventive Maintenance as well as provision of Patch Management Software packages. Corrective Maintenance is delivered remotely, Preventive Maintenance can be delivered as an on-site service on demand.

The Software Subscription Agreement (SSA) offer includes provision of the latest Software versions of Spectrum Power 7. That includes new software versions, patches and 3rd-Party Software patches.

4.6.3 Preconditions

- We require full Access to all relevant sites according to our implementation schedule
- Provision of existing equipment actual as-built documentation
- Provision of actual Signal Lists, Single Line Diagrams, Station Layouts, Cable Lists, Terminal Connection Drawings, Protection Relay settings and Bay wise Adaptation Designs
- Disco's to provide type and quantities of required protection relays.

Disclaimer: The named partners in this project are meant as preferred partners and are subject to change due to revised requirements which might be defined at later stages.

4.7 Embedded Power Generation Projects

Additional embedded small-scale conventional power generation to support special electrification requirements after removal of grid constraints

Small-scale power generation can be used to fulfill specific needs such as delivering power to remote areas or for supplying power to special "eligible" customers as in the industry, or commercial sector, after removal of grid constraints. The first pilot project proposed is:

- 40 MW conventional generation in Abuja region (e.g. SGT A45)

Abuja, the capital city of Nigeria, is located within the Federal Capital Territory (FCT) the seat of the federal government at the very center of the country. It is one of the fasted growing cities in the world, having experienced a rapid population increase in the past decade, which has been coupled with a steady economic growth particularly within its key tourism and hospitality sectors. However, with this growth in its resident population and number of businesses, comes an increase in the electric power demand in the city and its surrounding suburban districts.
Therefore, there is a clear motivation to improve the local electricity supply by building new power generation capacity, and since the gas and T&D infrastructure are already in place and considering its location as the seat of the federal government, it is best positioned for immediate actions to be taken by the government to move the project forward.

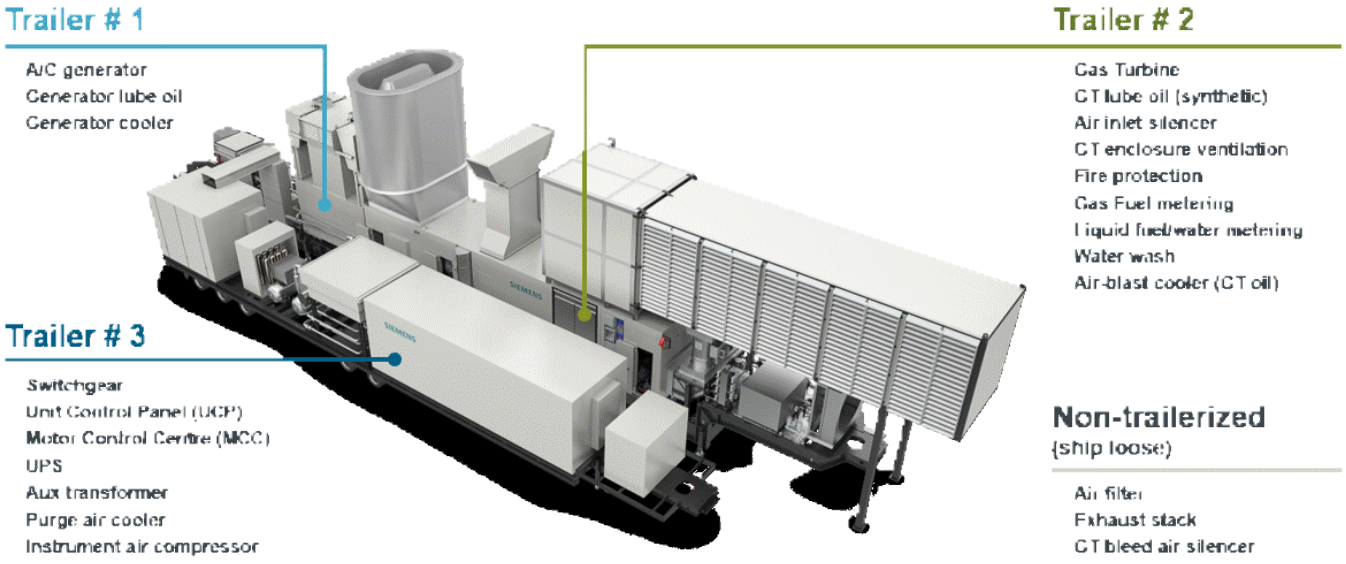


FIGURE 37: SGTS-A45

The deployment of SGTs-A45 is intended for Abuja to quickly upgrade and improve the energy situation for its people and economy. The SGT-A45 achieves significantly higher power output and fuel efficiency than any other mobile gas turbine unit. It has a modular design, consisting of three trailer-mounted modules to minimize the number of items that must be installed on site. The systems on each trailer are self-contained to reduce the number of interconnections to be completed on site.

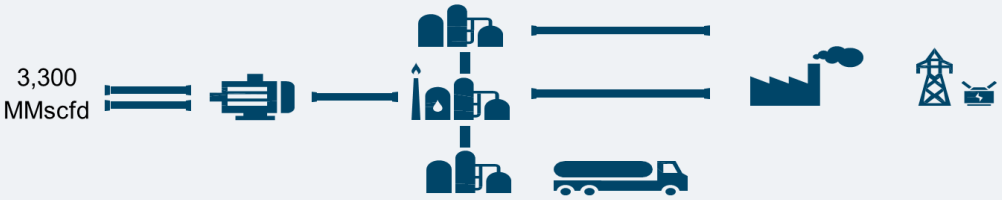
4.8 Gas Processing to Power Solutions

Nigeria has developed a detailed roadmap to end routine gas flaring and to leverage the full potential of gas for power generation. Over 130 flare sites have been identified for flaring down projects so far (distributed in the Niger Delta, onshore and offshore). Collecting the flare gas would significantly decrease the fuel import dependency and would substantially contribute to carbon emission reduction as well as reducing public health hazards.

Treated flare gas use (up to 3,300 MMscfd) would be enough to power up to 15 GW of baseload high-efficient Combined Cycle Gas Turbine (CCGT) power plants across the country depending on the collected flare gas quality. Siemens offers an integrated solution from flare gas capturing via conditioning and transport to power plants.

Siemens proposes a Gas processing facility for 300MMscfd from existing flare gas assets for the generation of ~1.2GW of electricity within 36-48months.

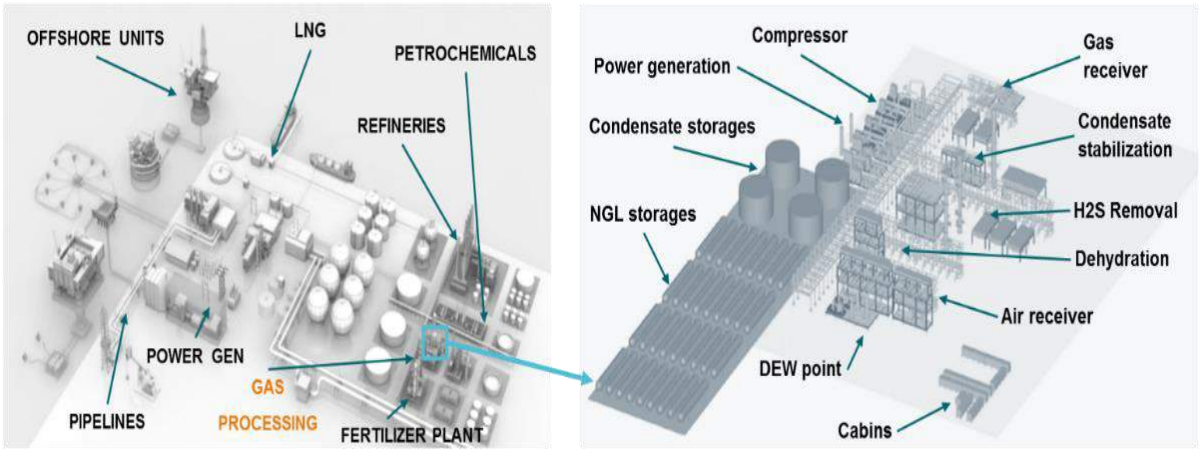
- **Treated Gas Value Chain:**
  Monetize the gas (LPG & Condensate) to maximize revenue streams for the Government of Nigeria with 3-4 years payback time



Siemens can provide…
- … highest efficient technology and modular solutions
- … creation of a consortium to lead the entire turnkey projects
- … financing support
- … utilization of local Nigerian sourcing, training & local jobs to stimulate the economy
- … optimized schedule and fast track execution with single interface

Opportunity for Nigeria
- 84 mil. t reduction
- $9 bn $/a revenue
- Fuel for 15 GW power generation
- 50,000 Jobs

FIGURE 38: TYPICAL GAS VALUE CHAIN



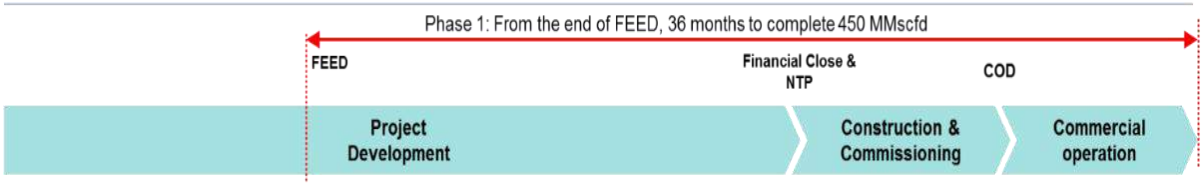


FIGURE 39: PROJECT PLANT LAY OUT

Pilot projects:

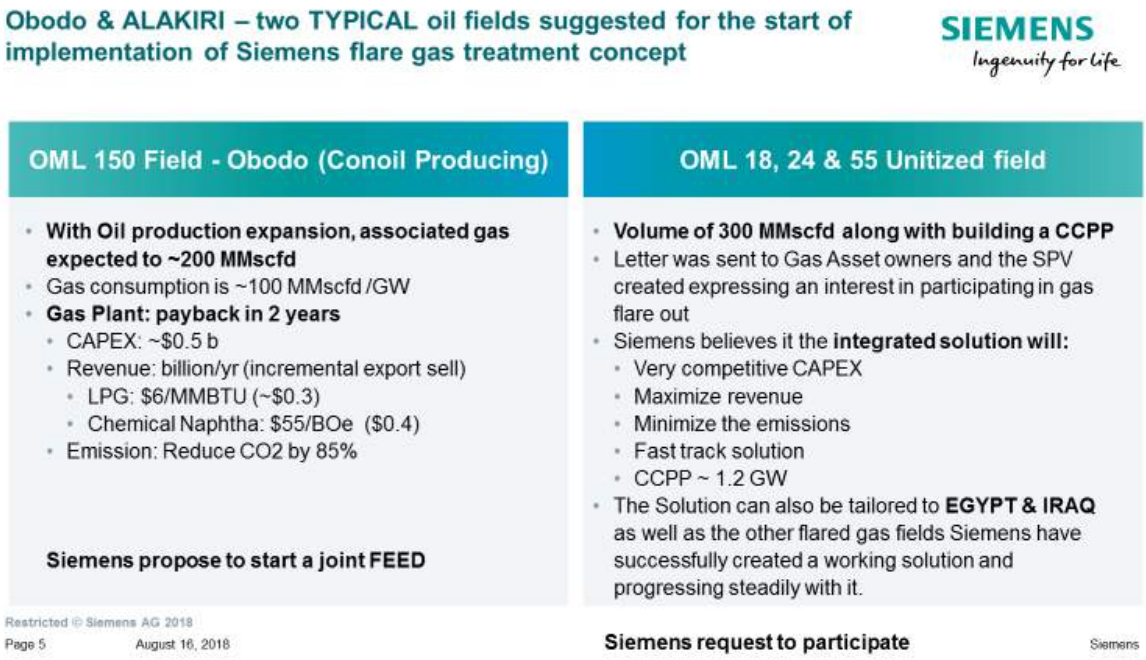


FIGURE 40: OBODO AND ALAKIRI OIL FIELDS

Other potential pilot projects:

Dangote EWOGGS and Gas Management Platform

DANGOTE East West Offshore Gas Gathering System EWOGGS FEASIBILITY and Concept Selection Study for 3 BCF of Gas an opportunity and a gas source for about 12 GW of Power

- Overall Pipeline System capacity -3BCF/Day.
- 2 x 38 inch (OD) x 550 KM Pipelines each with a capacity of 1.5 BCF /Day.
- New Build Platform OML 72 as pipeline start point, gathering Gas from the hub with OML 52/70/71/72.
- Seven Gas Receiving and and two Gas withdrawal tie-in points (Subsea) along the pipeline route based on potential gas sources and off-take points.
- Gas injection Pressure is about 80-120 barg.
- Gas arrival pressure is at Lekki FTZ Lagos at 45 barg.
- Pipe secification:ANS 900XXX Grade xxxx
- Onshore Gas Receiving Facility of Lekki FTZ = 2 x 1.5 BCF/Day.
- Pipeline and Gas Receiving Facilities will be installed in two phase
- Project Phase 1; Pipeline to deliver 1.5 bcf/day timely for Dangote industries and Nigeria Power and industrial needs.
- Pipeline 2 is demand driven.
- Project Phase 2; Will involve Sales Gas spur lines and connections to other off-takers e.g. WAGP, Ogidingben, ELPS.
- Potential gas source for Power Generation as well. Siemens supporting some scopes on the EWOGGS and the GAS MANAGEMENT PLATFORM.

Typical Gas Gathering System:

Siemens propose using Dresser-Rand reciprocating compressors for gas gathering (Wet Bank and Dry Bank).

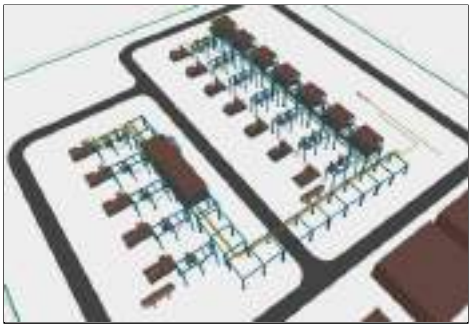
a. Preliminary configuration of compressors, each with rating 1 MW:

   i. Degassing Station Wet Bank

   - LP Compressor: 3 X 33%
   - MP Compressor: 4 X 25%

   ii. Degassing Station Dry Bank

   - LP Compressor: 1 X 100%
   - MP Compressor: 2 X 50%
   - HP Compressor: 2 X 50%



b. Process scrubbers to remove entrained liquids from entering compressor

c. Interstage air coolers to reduce temperature of compressor discharge

d. 3-phase separator to remove water, condensates from gases.

Typical Acid Gas Removal

- Siemens suggest using MDEA absorption technology for the acid gas removal system
- 1 X 100% Amine Contact Tower
- 1 X 100% Amine Still Tower
- Amine Reboiler with thermal oil as heat source, heat exchangers and flash vessels
- Feed gas enters the bottom of the contact column and contacts the rich amine entering from the top of the column
- Acidic gases (H2S and CO2) are absorbed by amine and exits the bottom of the column as lean amine
- Regeneration of the amine takes place in the

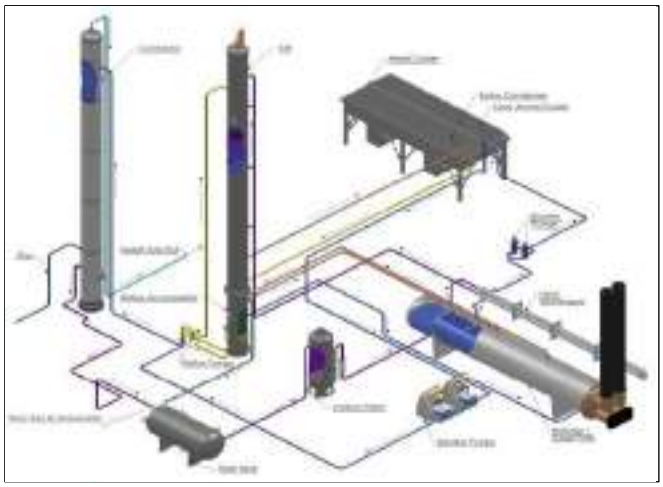


FIGURE 41: ACID GAS REMOVAL SOLUTION

Typical Dehydration Solution

- Siemens suggest using molecular sieve adsorption technology for the dehydration system.
- 3 X 50% Carbon Steel molecular sieve absorbers
- 1 X 100% Carbon Steel with SS316 cladding regeneration gas separator
- 1 heater and 1 cooler for regeneration
- Carbon steel piping and switching valves, electrical and instrumentation
- Feed gas enters the top of the dehydration units and flows downwards through a molecular sieve bed

FIGURE 42: DEHYDRATION SOLUTION

4.9 Phase 2 Commercial Proposal

Budgetary price estimates for the following projects will be submitted at a later:

i. Distribution SCADA for the 11 Discos
ii. Gas Processing to Power Projects.

The below table consists of budgetary price estimates for 40MW Embedded power project.

#	Scope	Proposed Solutions	Estimated Quantity	Budgetary Price
1	**New Power Generation Projects**	40MW embedded power – Abuja Disco	1xSGT-A45	$770 - $815/kW depending on the scope of supply, location etc.

5. Phase 3: Increasing grid capacity from 11GW to 25GW

The objective of this phase is to increase the grid capacity from 11GW (expected to be realized from phase2 1 and 2) to 25 GW. In this phase, focus will be on the following projects:

i. Additional Transmission and Distribution assets upgrade based on network studies and load demand
ii. Large Scale Power Project

5.1 Large scale power generation projects

New power generation to support central and northern regions

Nigerian National Petroleum Corporation (NNPC) is already in the process of developing AKK Pipeline Project and the establishment of power plants in Abuja, Kaduna, and Kano states. Siemens is happy to support the Power Plant Projects, particularly to speed up this process to build new power capacity in Northern Region and Lagos Area of Nigeria.

The aim is to support the establishment of power projects within the AKK Areas in Northern Nigeria and Lagos Area:

The Potential Projects are:

- Abuja: +1350 MW,
- Kaduna: 1350 MW,
- Kano: +1350 MW,
- Lagos (Agura): +450 MW.

Additional projects (e.g. Independent Power Producer (IPP) projects) are required to close the capacity gap to 25 GW. These projects could be for example in the Lagos region or any other location where demand for additional power is especially high.

FIGURE 43: PROPOSED POWER PROJECTS

All the Projects above are based on the SGT-2000E technology, as it shows excellent start-up and part-load behavior (fast start-up in ~17.5 minutes / optional <12 minutes), has outstanding fuel flexibility, (e.g. natural gas. low-calorific gases, crude and heavy fuel oil), has a service-friendly design (can be offered with one major overhaul in lifetime only), has more than 17 million of equivalent operating hours, and a fleet reliability of above 99%. On top of that, it is already used in Geregu I, II, Azura Edo IPP, and Afam V.

NNPC Project ABUJA
- ✓ 3x SCC5-2000E (2+1) GT and ST Packages
- ✓ 1350 MW *
- ✓ > 50% Efficiency *

NNPC Project KADUNA
- ✓ 2x SCC5-2000E (2+1) GT and ST Packages
- ✓ 900 MW *
- ✓ >50% Efficiency *

NNPC Project KANO
- ✓ 3x SCC5-2000E (2+1) GT and ST Packages
- ✓ 1350 MW *
- ✓ >50% Efficiency *

NNPC Project Agura
- ✓ 2x SSC5-2000E GasTurbine Packages
- ✓ 328 MW *
- ✓ >34% Efficiency *

* At specified site conditions, fuel: NG

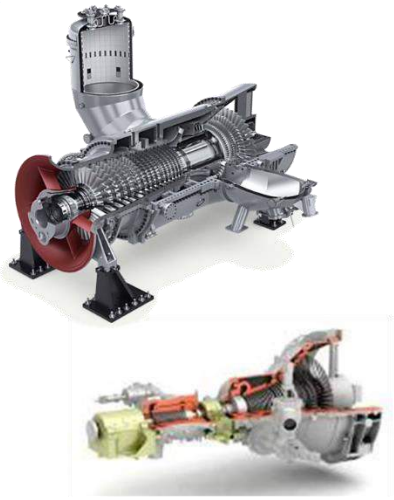


FIGURE 44: RECOMMENDED SIEMENS SOLUTIONS

5.2 Phase 3 Commercial Proposal

#	Scope	Proposed Solutions	Estimated Quantity	Budgetary Price
1	**New Power Generation Projects**	Big Power projects – Abuja, Kaduna and Kano.	Full EPC Combined cycle power plants: 18x SGT5-2000E and 8x Steam Turbine generator sets)	Average €700/kW
		Big Power projects – Lagos (Agura)	Full EPC Small Open Cycle 2x SSC5-2000E	€600/kW

TABLE 21: PHASE 3 COMMERCIAL PROPOSAL

These above prices are subject to changes based on additional information on the specific projects, location, financing and contractual terms and conditions.

6. Operations and Maintenance Support

Siemens provides sufficient customer service support throughout the lifecycle of products and systems along the energy chain.

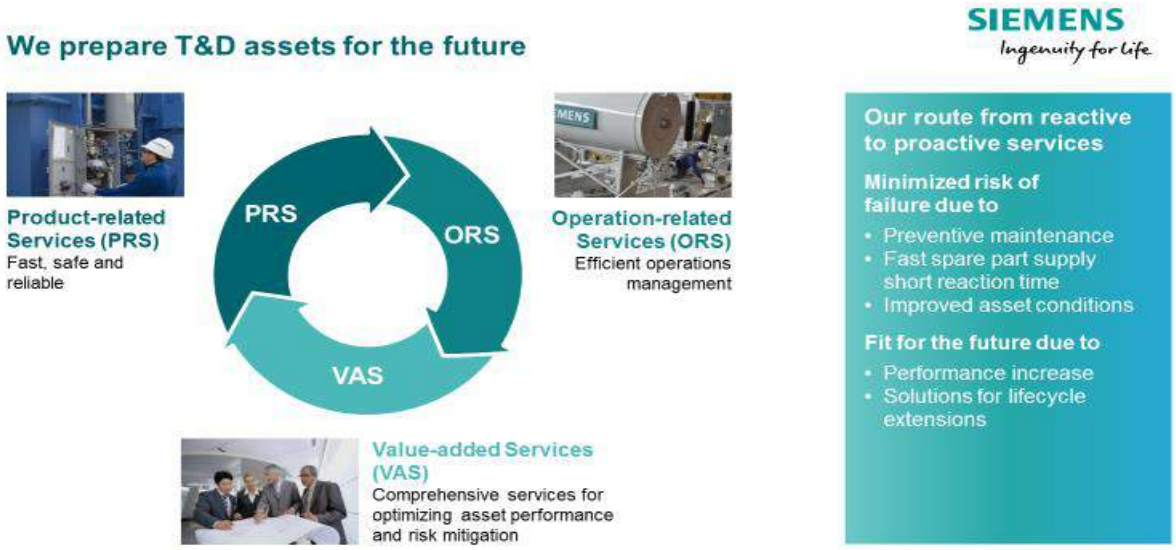


FIGURE 45: OPERATIONAL AND MAINTENANCE SUPPORT

For the Nigeria Electrification Roadmap, Siemens proposes the provision of after sales service and maintenance support for the TCN and Disco's. in the respective sections of the project proposal, support services to be provided for a period of up to 60months after the commissioning have been considered. However, Siemens service and support solution will cover the following:

FIGURE 46: ENERGY MANAGEMENT CUSTOMER SERVICES PORTFOLIO

FIGURE 47: SIEMENS ASSET MANAGEMENT PORTFOLIO

Detailed technical proposals will be provided at a later time.

7. Acknowledgement

The Federal Government of Nigeria hereby acknowledges the receipt of the Technical and Commercial Proposal for the Nigeria Electrification Roadmap submitted by Siemens.

The contracting party of the Federal Government of Nigeria for this project shall be:

Name of Agency/Special Purpose Vehicle……

Address:

…….

……..

Contacts Person(s): …

Name: ……

Designation: ……

E-Mail: ……

Mobile: ……

Name: ……

Designation: ……

E-Mail: ……

Mobile: ……

The proposal having been reviewed is hereby approved for consideration towards its implementation.

Approved for consideration this …. Day of …… 2019.

Name: ……

Designation: ……

Date: ……

Signature: ……

Abbreviations

BOQ	Bill of Quantity
CIM	Common Information Model
DMS	Distribution Management System
EMS	Energy Management System
FAT	Factory Acceptance Test
HIS	Historical Information System
ICCP	Inter-control Center Communications Protocol
IFS	Independent Frontend System
IMM	Information Model Manager
IP	Internet Protocol
JROS	Joint Resource Optimization & Scheduling
LSP	Label-switches Path
Mbps	Mega Bit per second
MPLS	Multi-Protocol Label Switching
MSA	Master Service Agreement
OTS	Operator Training Simulator
PAC	Provisional Acceptance Certificate
PLC	Power Line Communication
RMU	Ring Main Unit
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SOA	Service Oriented Architecture
SSA	Software Subscription Agreement
TNA	Transmission Network Analysis
UHF	Ultra High Frequency
UI	User Interface
VHF	Very High Frequency

VPN	Virtual Private Network