附属書

A-1　関係機関・関係者リスト

Details of Technical Working Group

Group Leader (Chair Person)-Power Development Planning
Engr. E.O Ajayi, Director (ERD), FMP

Group Secretary-Power Development Planning
Mr. Austin O. Abegunde, DD (P) FMP

Group Coordinator
Dr. Sunday Owolobi, ACE (ERD) FMP

Group (Technical) Leader-Power Development Planning
Mr. Masatsugu Komiya, JICA Team

Group (Technical) Coordinator-Power Development Planning
Mr. Makoto Abe, JICA Team

Power Demand Forecast

[Technical Counterparts]
○ JICA Team :Mr. Tomoyuki Inoue
○ FMP :Dr. Sunday Owolabi (ERD)
TCN :Engr. Ishola B. A. (NCC)
TCN :Engr. Ikeli H. N. (Planning)
TCN :Engr. Charles Nnajide (NCC)
TCN :Engr. Obishai F. N. (MO)

[Assistance necessary from]
TCN-SO, TCN-MO, Gencos, Discos, NERC, REA, ISAP

Power generation planning (Thermal power development)

[Technical Counterparts]
○ JICA Team :Mr. Kyoji Fujii
○ JICA Team :Mr. Takeshi Hara
○ FMP :Engr. Eugene Ejeregbe
○ FMP :Engr. Anikpe Kenechukwu
JosiahTCN :Engr. Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
NDPHC, NERC, TCN-SO, NBET, NNPC, Gencos, ISAP

Transmission /Substation planning /Power system analysis

[Technical Counterparts]
○ JICA Team :Mr. Sudipto Bhowmik
○ JICA Team :Mr. Kazuaki Kondo
○ FMP :Engr. Philip Okpanefe (TSD)
○ TCN :Engr. Abba-Aliyu (Planning)
TCN :Engr. A. Nazif (Planning)
TCN :Engr. E. C. Umoh (NCC)

[Assistance necessary from]
NDPHC, TCN-SO, PTFP

Power sector policy

[Technical Counterparts]
○ JICA Team :Ms. Izumi Takai
○ FMP :Mr. A.A. Ayodele (TSD)
○ FMP :Engr. Abel Philipele (RRD)
ECN :Engr. J. S. Olayande
ECN :Mr. Sulu B. F. Ibrahim
TCN :Anumaka, Corporate Plan.
TCN :Paul Ilondu, Corporate Plan.

[Assistance necessary from]
ECN, NERC, NBET, BPE, NOTAP, PTFP, ICRC

Primary energy analysis

[Technical Counterparts]
○ JICA Team :Mr. Hideki Otake
○ FMP :Engr. Eneh Kingsley (ERD)
ECN :Engr. J. S. Olayande
ECN :Mr. Sulu B. F. Ibrahim
TCN :Engr. Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
ECN, NNPC, NGC, NAEC, FMARD, FMMSD, FMW, NIMET

Power generation planning (Hydro power development)

[Technical Counterparts]
○ JICA Team :Mr. Kaoru Nishiwaki
○ FMP :Engr. O.T, Owoeye (ERD)
TCN :Engr.Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
FMW, TCN-SO, NERC, NBET, ISAP

Economic and financial analysis

[Technical Counterparts]
○ JICA Team :Mr. Yusuke Harada
○ FMP :Mr. S.A. Dashi (P)
○ FMP :Engr. Ben Ayangeaor (ERD)
TCN :Engr. Abolomope R. O. (AC)
TCN :Engr. Ajibade M. A. (Planning)
TCN :Engr. Ogbu B. C. (MO)

[Assistance necessary from]
NPC-1, NERC, NBET, NGC, TCN-TSP, NBS, NPC-2, FMF, CBN

Environmental and social considerations

[Technical Counterparts]
○ JICA Team :Ms. Yuriko Kudo
○ FMP :Engr. Tony Umenyen (TSD)
○ FMP :Engr. Ekanem Effiong (DSD)
○ TCN :Olisa M. Okoli (HSE)
TCN :Ifeoma Nwachukwu (HSE)

[Assistance necessary from]
FME, NESRA, NPC-2, TCN

＊ ○:Main Counterparts

CBN: Central Bank of Nigeria
Discos: Distribution Companies
DSD: Distribution Services Department (FMP)
ECN: Energy Commission of Nigeria
ERD: Energy Resources Department (FMP)
FMARD: Federal Ministry of Agriculture and Rural Development
FME: Federal Ministry of Environment
FMF: Federal Ministry of Finance
FMMSD: Federal Ministry of Mines and Steel Development
FMP: Federal Ministry of Power
FMW: Federal Ministry of Water Resources
Gnenos: Generation Companies
GP D&C: Generation Planning and Data Control (TCN)
ICRC: Infrastructure Concession Regulatory Commission
ISAP: Initial Stakeholder Advisory Panel
NAEC: Nigeria Atomic Energy Commission
NBET: Nigeria Bulk Electricity Trading
NBS: National Bureau of Statistics
NDPHC: Niger Delta Power Holding Company
NERC: National Electricity Regulatory Commission
NESRA: National Environmental standards & Regulations Enforcement Agency
NGC: Nigerian Gas Company Limited
NIMET: Nigerian Meteorological Agency
NNPC: Nigerian National Petroleum Corporation
NOTAP: National Office for Technology Acquisition and Promotion (Ministry of Science and Technology)
NPC-1: National Planning Commission
NPC-2: National Population Commission
PTFP: Presidential Task Force on Power
REA: Rural Electrification Agency
RRD: Renewable and Rural Power Access Department (FMP)
TCN: Transmission Company of Nigeria
TCN-MO: TCN-Market Operation
TCN-SO: TCN-System Operation
TCN-TSP: TCN-Transmission Service Provider
TSD: Transmission Services Department (FMP)

A-2　PPA 価格と電力販売単価

A-2 (1) GenCo および IPP の PPA 価格

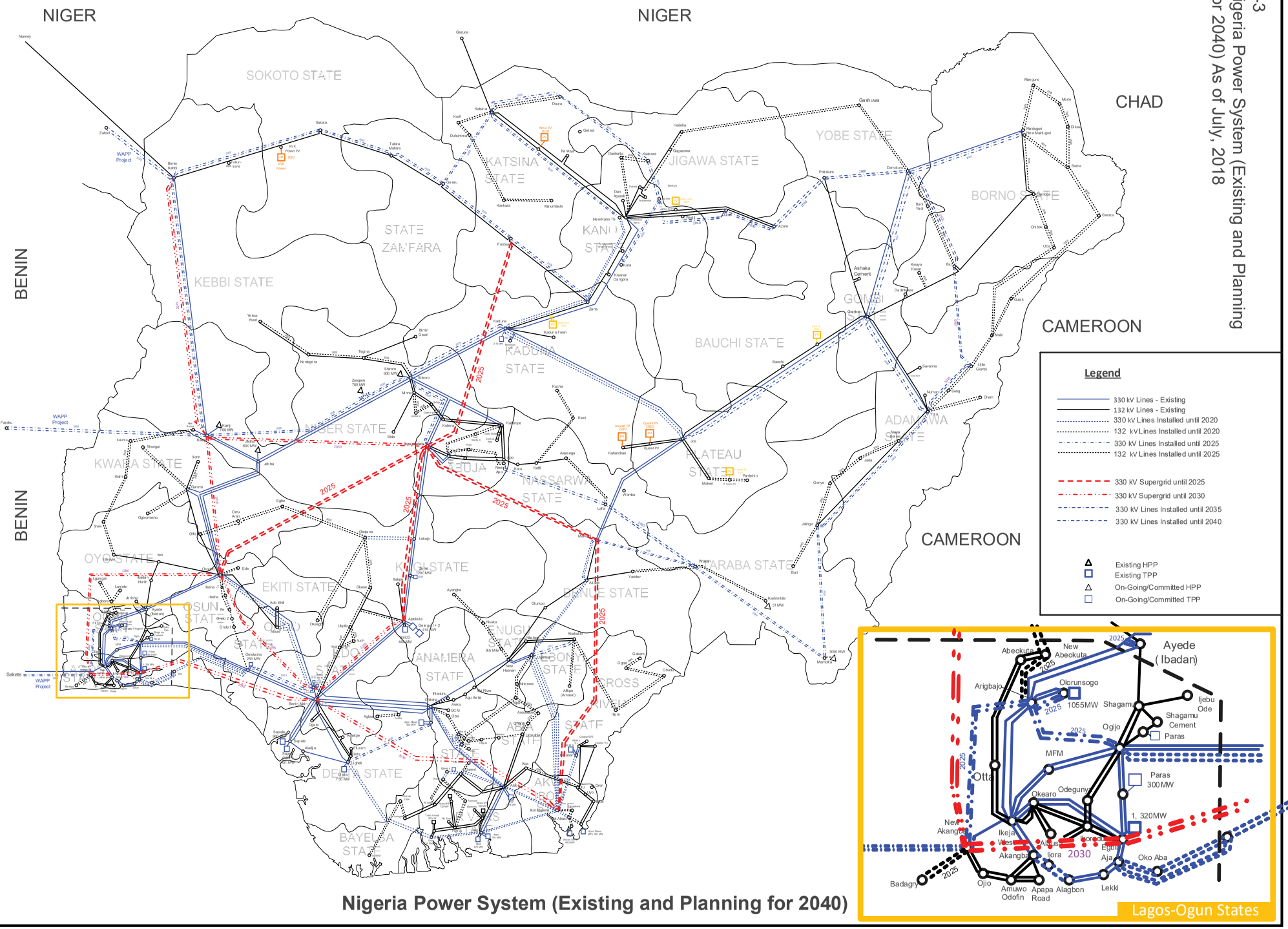
発電所	料金種別	単位	2012	2013	2014	2015	2016	2017	2018	2019
SUCCESSOR GenCo HYDRO										
	Capacity price	NGN/MW	4,571.33	4,739.84	4,456.76	4,677.21	4,677.59	4,677.59	4,677.59	4,677.59
	Energy price	NGN/MWh	1,005.67	1,043.28	994.40	1,069.52	1,070.49	1,070.49	1,070.49	1,070.49
SUCCESSOR GenCo THERMAL										
	Capacity price	NGN/MW	4,174.00	4,327.81	4,068.21	4,267.25	4,267.53	4,267.53	4,267.53	4,267.53
	Energy price	NGN/MWh	5,443.63	5,645.19	6,418.71	7,637.69	7,847.14	8,062.47	8,285.92	8,517.78
OMOTOSHO										
	Capacity price	NGN/MW			4,783.00	5,057.35	5,092.30	5,129.06	5,138.69	5,148.44
	Energy price	NGN/MWh			4,956.00	5,887.21	6,129.11	6,381.15	6,581.48	6,788.84
OLORUNSOGO										
	Capacity price	NGN/MW			4,783.00	5,057.35	5,092.30	5,129.06	5,138.69	5,148.44
	Energy price	NGN/MWh			4,956.00	5,887.21	6,129.11	6,381.15	6,581.48	6,788.84
NIPP THERMAL										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
AGIP OKPAI										
	Capacity price	NGN/MW	4,042.40	4,345.48	3,831.93	4,200.15	4,200.15	4,200.15	4,200.15	4,200.15
	Energy price	NGN/MWh	1,222.50	1,333.08	1,185.85	1,311.31	1,323.02	1,334.95	1,347.09	1,359.45
AFAM VI										
	Capacity price	NGN/MW	3,576.22	3,844.35	3,390.02	3,715.78	3,715.78	3,715.78	3,715.78	3,715.78
	Energy price	NGN/MWh	1,357.79	1,469.74	1,301.57	1,432.81	1,439.09	1,445.48	1,451.99	1,458.62
IBOM POWER										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
OMOKU										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
AES										
	Capacity price	NGN/MW	4,365.42	4,526.11	4,250.26	4,449.78	4,449.78	4,449.78	4,449.78	4,449.78
	Energy price	NGN/MWh								
TRANS AMADI										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
RIVERS IPP										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,303.00	4,494.68	4,502.30	4,510.05	4,517.95	4,525.98
	Energy price	NGN/MWh	5,443.63	5,706.29	6,755.59	8,705.49	8,973.62	9,251.02	9,538.03	9,834.98

A-2 (2) DisCo の Nominal Tariff (NGN/MWh)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Abuja	5,674.62	4,728.01	4,715.69	7,845.89	8,160.99	8,709.53	9,281.45	9,872.81
2	Benin	6,217.67	5,118.44	4,973.61	8,236.07	8,380.88	8,909.50	9,469.09	10,052.47
3	Enugu	6,069.57	5,015.83	4,920.75	8,167.05	8,383.36	8,943.43	9,532.41	10,143.95
4	Ibadan	7,161.95	5,923.00	5,798.89	9,763.89	10,082.92	10,806.63	11,568.95	12,362.95
5	Jos	6,714.11	5,552.06	5,452.62	9,243.31	9,624.66	10,345.79	11,097.09	11,873.00
6	Kaduna	6,977.06	5,691.26	5,542.81	9,229.21	9,511.32	10,093.63	10,702.27	11,331.54
7	Kano	5,355.13	4,440.28	4,457.95	7,361.71	7,711.27	8,233.95	8,773.01	9,324.94
8	Eko	5,788.03	4,831.24	4,766.20	8,140.28	8,513.34	9,196.81	9,905.22	10,633.83
9	Ikeja	4,504.32	3,834.59	3,823.86	6,597.97	6,948.80	7,570.30	8,210.59	8,865.91
10	Port Harcourt	6,368.04	5,226.33	5,174.24	8,585.09	8,927.03	9,504.00	10,102.30	10,717.50
11	Yola	7,140.64	5,873.62	5,917.75	9,649.02	10,061.09	10,753.78	11,479.56	12,232.01
12	Total	6,021.51	4,993.60	4,927.92	8,264.39	8,576.42	9,189.78	9,829.42	10,490.13

A-3 Nigeria Power System

(Existing and Planning for 2040)



Nigeria Power System (Existing and Planning for 2040)

A-4　合同調整委員会議事録等

2015 年 9 月 4 日
第一回 JCC（インセプションワークショップ）

TIME TABLE FOR 1ST JOINT COORDINATION COMMITTEE (INCEPTION WORKSHOP) ON THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

VENUE: MINISTER'S CONFERENCE ROOM
PLACE: 4TH FLOOR, FEDERAL MINISTRY OF POWER FEDERAL SECRETARIAT
DATE: *4TH SEPTEMBER, 2015.*

[General Session]

Time	*Event/Activity*	*Action by*
10:00-10:10	Opening Remarks from the Federal Ministry of Power	PS-FMP
10:10-10:20	Introduction	All
10:20-10:30	Key note address	Chief Representative– JICA Nigeria Office
10:30-10:40	Outline of the Project	Mr. Masatsugu Komiya, Mr. Makoto Abe
10:40-10:55	General discussion	All
10:55-11:00	Closing remarks	PS-FMP

[Technical Session]

Time	*Event/Activity*	*Action by*
11:30-11:40	Opening Remarks from Federal Ministry of Power	Director, ERD-FMP
11:40-11:50	Introduction	All
	~Presentation by JICA Team~	
11:50-12:00	Power Demand Forecasts	JICA Team
12:00-12:10	Power Generation Planning	JICA Team
12:10-12:20	System Planning and System Analysis	JICA Team
12:20-12:30	Environmental and Social Considerations	JICA Team
12:30-12:55	General discussion	All
12:55-13:00	Closing remarks	Director, ERD-FMP

Note:
FMP- Federal Ministry of Power, PS- Permanent Secretary, ERD- Energy Resources
TCN- Transmission Company of Nigeria, MD- Managing Director, SO – System Operations,
MO – Market Operations

Record of Discussion	
Project	The Project for Master Plan Study on National Power System Development in the Federal Republic of Nigeria (The First Field Work)
Venue	4th floor, Conference Room, Federal Ministry of Power, Federal Secretariat
Date	4 September, 2015 (Fri) 10:00-13:00
Attendance	FMP, JICA, JICA Team, TCN, WB, UNIDO, FME, NAPTIN, AFD, USAID, Refer to the Attendance List

【Contents】

The 1st JCC was opened by Permanent Secretary's (PS) remarks. PS emphasized importance of power sector development and appreciation of assistance from JICA and other donors related to the power sector.

After JICA Chief Representative presented a key note address to the invitee, presentations by the team were performed.

Points of discussions made among the parties are followings;

１． Outline of the Project

- Through the presentation, the team emphasized the importance of information sharing and coordination among the stakeholders for comprehensive power system development in Nigeria.
- The WB agreed collaboration with the captioned project not only the transmission master plan but also Hydro project and Gas Supply projects.
- PS emphasized that the expected peak demand is approx. 12,500MW and the key authority is TCN. Furthermore PS suggested that NCC should be in better position related to acknowledge the peak demand.

２． Power Demand Forecast

(1) Regarding the relation between Power system M/P and GHG

Q What kinds of countermeasures are considered for the reduction of GHG emission and woods and charcoal consumption in the power system master plan

A Regarding woods and charcoal consumption reduction, the consumption has the strong relation to deforestation. Most of the developing countries have some limitation to use woods and charcoal. As substitution energies, the promotion of LPG and coal briquette can be considered. In our model, the woods and charcoal consumption should be reduced.

(2) Regarding comparison between SimpleE model and FMP power demand model

Q FMP has a power demand forecasting model. Is it possible to compare SimpleE model and FMP power demand model? And how much cost SimpleE software.

A We can compare the two models completely. The cost of simple E is around 200USD per a

【Contents】

set. The software is established by The Institute of Energy Economics, Japan.

(3) Regarding methodology of demand forecasting

Q As demand forecasting approach, there is Top down approach and Bottom up approach. Which one is SimpleE?

A In Simple E model, the country wise power demand forecasts is implemented under social economic strategies, therefore, it can be said as Top down approach. Other hand, DISCO wise power demand forecasts are implemented accumulatively based on DISCO plans. Therefore, it is bottom up approach. In the case, it is important how to get the data and information from DISCOs.

(4) Regarding input and output data

Q Explain the input data and output data in Data sheet, Model sheet and Simulation sheet.

A The all data in data sheet are input data, however, the back color values in simulation sheet are input data and the red color values are forecasted values. The red color values are calculated internally in the model.

(5) Regarding technical transfer on power demand model

Q How to implement the technical transfer?

A According to my experiences in the similar projects, the technical transfer was implemented for four days. We were required 4 hours a day from 9:00 AM to 1:00 PM. The all members had their PCs and the seminar was in hand on style.

３． Power System Development Master Plan

(1) Explanation Summary (detail is referred to the presentation paper)

1) Flow Chart of Power System Development Planning for preparation of Power System Development Master Plan is shown below, it is very important to coordinate among various fields such as power demand forecast, primary energy policy, generation and network development plan, power system analysis, economic efficiency and environmental impact of power plant candidate sites, financial condition and power development policy.

2) The long term power system development plan is established for the coming 25 years by the least cost analysis method. The power plant candidate sites and network system are evaluated from economic and financial aspects. The evaluation results are reflected into the generation and network development plan. The generation and network development planning is carried out by using least cost method.

3) In this chart, the generation and network development plan should be drafted in harmony with many fields, such as demand forecasts, power system analyses, and selection of power plant candidates, network system, financial condition and power development policy.

【Contents】

4) Therefore, the generation and network development planning is conducted through close contact and discussions with the counterparts and good coordination among the related working groups.

5) The scenarios are determined based on the analyses and examinations of the actual power generation records and the actual demand and supply balance under the constraints and conditions.

6) Nigeria has to develop ten times capacity as much as existing power plants for the coming 25 years in order to meet the rapid growing demand. In other words, it is necessary to develop power plants of as much as 2,200MW every year.

7) Therefore, all necessary power plants cannot be invested and owned by FGN. Some of the power plants will need to be developed through other approaches such as IPP (domestic investors) and BOT (foreign investors), which options has already taken place in thermal power. Since some projects might not be developed in time, the mitigation measures of power shortage due to project delay should be considered in Master Plan. Generally, the new power plant site should be developed considering additional room of expansion of the plant in order to cope with the delay of power development and/or the higher than expected growth of power demand.

8) Fuel price with its hikes are set referring to the Nigerian long-term primary energy development plans and international market prices of oil, coal and gas.

9) The economic power system operation is simulated and fed back to the economic, social and environmental consideration study in order to clarify feasibility of each power plant development. The simulation is repeated, changing preconditions based on the results of evaluation of preconditions. Thus, the most economic scenario, best fuel mix of power sources, and long-term power development pattern are determined through Master Plan study by the following steps.

A) Verification of the data and information of every power plant

B) Establishment of the power development scenarios

C) Establishment of vision of power generation composition

D) Consideration of interconnection with neighboring countries

E) Evaluation of power plant candidates

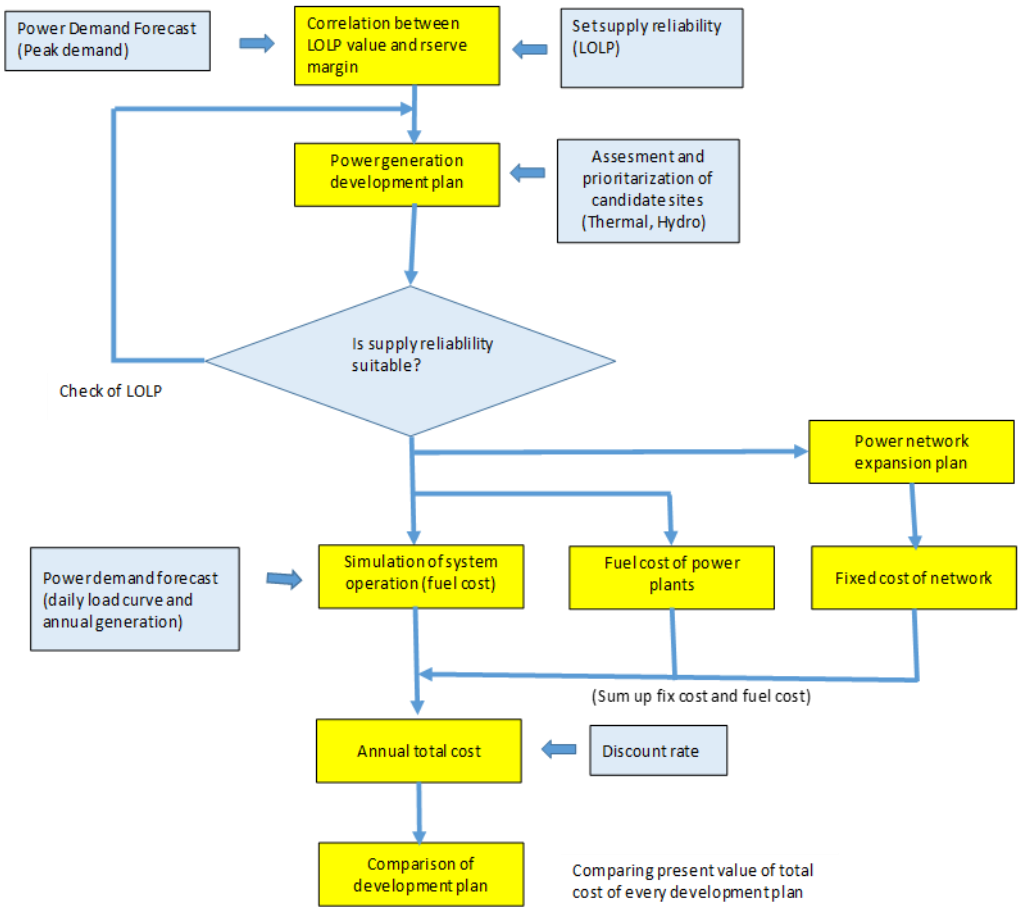
F) Review of power development scenarios and vision of power generation composition

G) Putting order of priority to the candidates of power development

【Contents】

H) Establishment of long-term power development plan for the coming 25 years based on the least cost analysis method

I) Master Plan should be revised every 5 year taking various circumstances into consideration（This is presenter's recommendation）



(2) Questionnaires etc. from FMP

Q Master Plan should be considered the implementation of nuclear power plants at Akwa Ibom state etc.

Master plan should be taken countermeasures of greenhouse gas emission reduction into consideration.

Nigeria has been exporting power to neighboring countries with interconnection lines.

A Greenhouse gas emission reduction is political matter. Target value such as 25% reduction compared to 2005 shall be flagged as governmental policy. We shall reflect the governmental policy in the Master Plan study.

【Contents】

(3) Transmission Planning and Analysis

In the presentation, necessity of coordination with TCN's 20 year Master Plan supported by WB is emphasized and following case studies were proposed.

i. 2020：Near term plan
ii. 2030：Mid term plan
iii. 2040：Long term plan

by taking WAPP (West African Power Pool) study into consideration.

(4) Environmental and social consideration: Summary of the presentation

1) Explanation of the JICA's Environmental and Social Consideration Guidelines

- It's applied to all JICA's projects.
- In the development of the master plan, SEA is implemented.
- Stakeholder meetings are very important in the JICA's guidelines.

2) The basics of SEA and overall process

- Information gathering at the early stage of the project, such as baseline data and laws, regulation, and policies (including climate change strategy) in terms of environmental and social aspects.
- IEE level survey for a hydropower pre-F/S.
- Multiple scenarios are compared to search for the best alternatives.
- Relevant cumulative impacts are investigated.
- Scoping of the environmental and social impacts is carried out.
- Stakeholder meetings are held as needed.

Attachment: JCC Program, Attendance List

The Project for Master Plan Study
on National Power Development
in
The Federal Republic of Nigeria

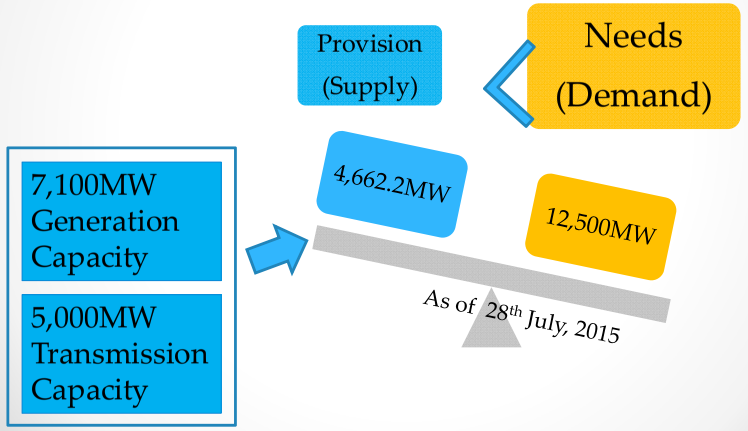
Outline of the Project

September 2015
Team Leader: Masatsugu Komiya
Dep. Team Leader/Project Coordinator: Makoto Abe

Contents

1. Background of the Project

Population: 170 Million
National Electrification: 45%~50%

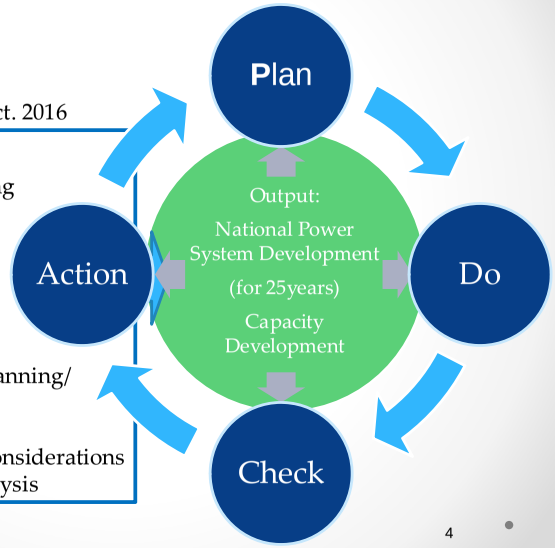


As of October, 2015

2.Project Overview

Target Area : Whole Nigeria
Target Year : 2015~ 2040
Work Period : Aug. 2015 ~ Oct. 2016

Input : Collaborative work
-Power development planning
-Power demand forecast
-Power generation planning (Thermal)
-Power generation planning (Hydro)
-Primary energy analysis
-Transmission, Substation planning/ Power system analysis
-Power sector policy
-Environmental and social considerations
-Economic and financial analysis



3.Basic policy in project implementation

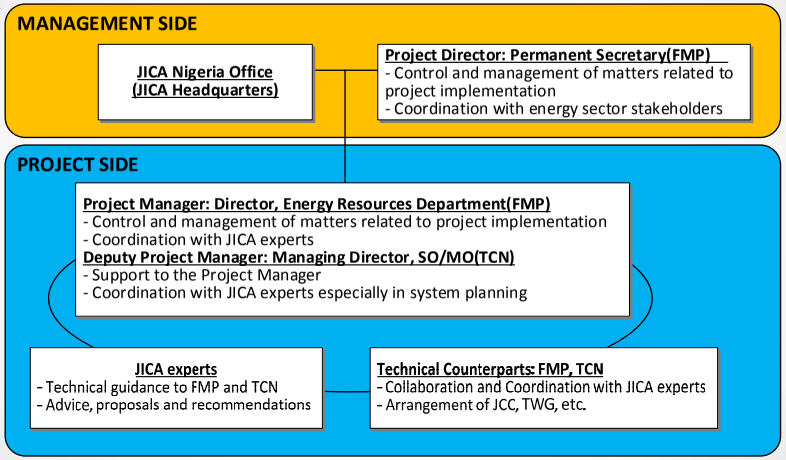
Policy 1: Consistency with Nigeria's development plan and energy policy

Policy 2: Corporation and Coordination with other Relevant Authorities and donors

Policy 3: Emphasis of Technical Transfer

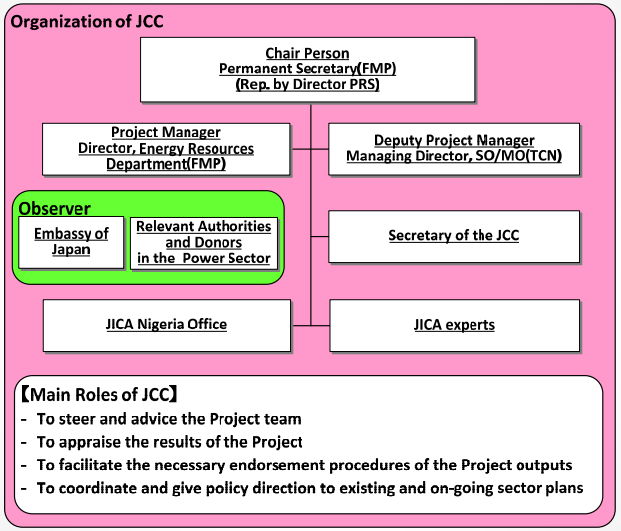
Policy 4: Coordination with Transmission System Expansion Plan

4. Project Organization



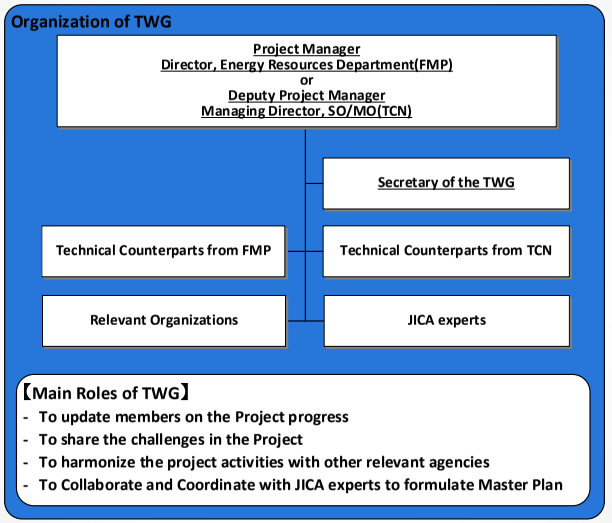
FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
SO: System Operation, MO: Market Operation
JCC: Joint Coordination Committee, TWG: Technical Working Group

5. Joint Coordination Committee(JCC)



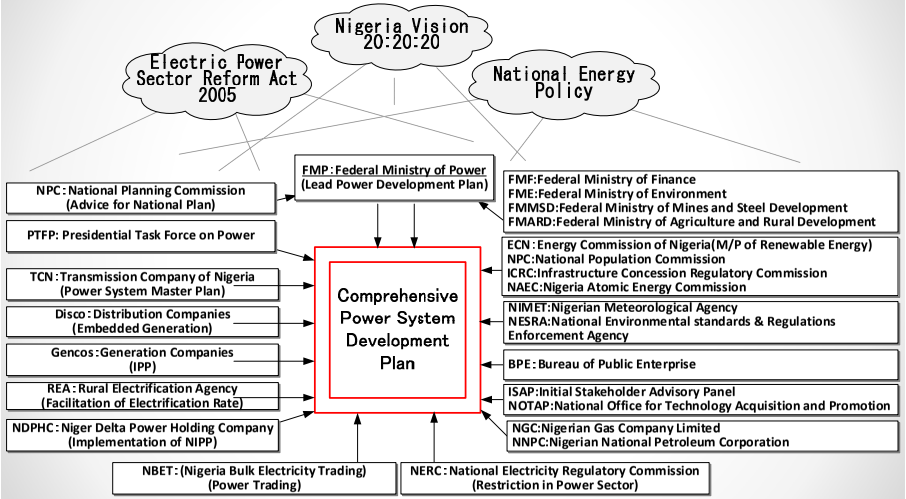
FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
PRS: Planning, Research and Statistics, JCC: Joint Coordination Committee
SO: System Operation, MO: Market Operation

6. Technical Working Group(TWG)

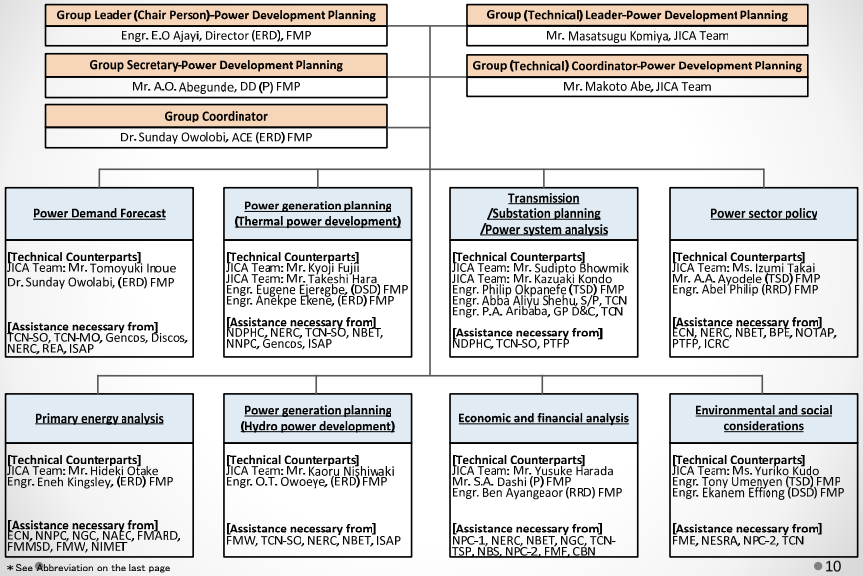


FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
PRS: Planning, Research and Statistics, TWG: Technical Working Group
SO: System Operation, MO: Market Operation

7. Assistance from Stakeholders



8. Details of TWG



*See Abbreviation on the last page

9. Overall Schedule

Assignment	Name	Year 2015					Year 2016									
		8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Team Leader /Power Development	Mr. Masatsugu Komiya	(12)					(12)			(12)				(12)		
Deputy Team Leader /Power Development	Mr. Makoto Abe	(21)					(30)			(21)				(14)		
Power Demand Forecast	Mr. Tomoyuki Inoue	(15)					(36)			(21)				(14)		
Generation Expansion Planning	Mr. Takeshi Hara	(21)														
Generation Expansion Planning	Mr. Kyoji Fujii						(15)		(12)	(24)				(14)		
Generation Expansion Planning	Mr. Kaoru Nishiwaki	(21)					(15)		(12)	(24)				(14)		
Primary Energy Analysis	Mr. Hideki Otake	(21)					(30)			(21)				(14)		
Transmission Network Expansion Planning /Power System Analysis	Mr. Sudipto Bhowmik	(21)					(30)			(21)				(14)		
Power Sector Policy	Ms. Izumi Takai	(14)					(37)			(21)				(14)		
Environmental and Social Consideration	Ms. Yuriko Kudo	(14)					(30)			(21)				(14)		
Financial and Economic Analysis	Mr. Hiroyuki Harada	(14)					(30)			(28)				(14)		
Substation Planning	Mr. Kazuaki Kondo	(21)					(30)			(21)				(14)		
Activity			◎JCC(1) ★TTW(1)					○TWG(1) ★TTW(2)			○TWG(2) ★TTW(3)			JCC(2) ◎ Seminar■ TTW(4) ★		□ Seminar in Japan
Documentation					△ Pr/R					△ It/R			△ Df/R			△ F/R

Abbreviation ◎JCC:Joint Coordination Co ○TWG:Technical Workin ★Technical Transfer ■Seminar in Nigeria □Seminar in Japan
△Ic/R:Incepation Report △Pr/R:Progress Report △It/R:Interim Repor △Df/R:Draft Final Repor △F/R:Final Report

Abbreviation

CBN:	Central Bank of Nigeria
Discos:	Distribution Companies
DSD:	Distribution Services Department (FMP)
ECN:	Energy Commission of Nigeria
ERD:	Energy Resources Department (FMP)
FMARD:	Federal Ministry of Agriculture and Rural Development
FME:	Federal Ministry of Environment
FMF:	Federal Ministry of Finance
FMMSD:	Federal Ministry of Mines and Steel Development
FMP:	Federal Ministry of Power
FMW:	Federal Ministry of Water Resources
Gnenos:	Generation Companies
GP D&C:	Generation Planning and Data Control (TCN)
ICRC:	Infrastructure Concession Regulatory Commission
ISAP:	Initial Stakeholder Advisory Panel
NAEC:	Nigeria Atomic Energy Commission
NBET:	Nigeria Bulk Electricity Trading
NBS:	National Bureau of Statistics
NDPHC:	Niger Delta Power Holding Company
NERC:	National Electricity Regulatory Commission
NESRA:	National Environmental standards & Regulations Enforcement Agency
NGC:	Nigerian Gas Company Limited
NIMET:	Nigerian Meteorological Agency
NNPC:	Nigerian National Petroleum Corporation
NOTAP:	National Office for Technology Acquisition and Promotion (Ministry of Science and Technology)
NPC-1:	National Planning Commission
NPC-2:	National Population Commission
PTFP:	Presidential Task Force on Power
REA:	Rural Electrification Agency
RRD:	Renewable and Rural Power Access Department (FMP)
TCN:	Transmission Company of Nigeria
TCN-MO:	TCN-Market Operation
TCN-SO:	TCN-System Operation
TCN-TSP:	TCN-Transmission Service Provider
TSD:	Transmission Services Department (FMP)

MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT
IN
THE FEDERAL REPUBLIC OF NIGERIA

Power Demand Forecasts

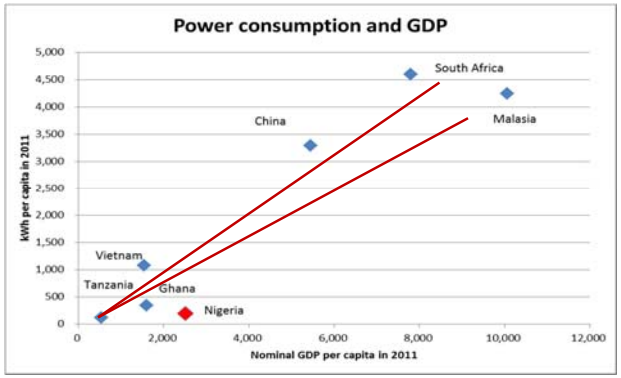
Contents

September 2015

1. Overviews

(1) Current Nigeria Power Consumption

- Nigerian power consumption per capita is 200 kWh in 2011, it is lower than other countiries.
- As other countries , there are Ghana 344 kWh, Vietnam 1,080 kWh in 2011.



(2) The required information to Power demand forecasts

The power demand forecasts are required when establishing Power system master plan. Especially, the followings are important.

Important information	Forecasting	Comments
Power demand	2015 to 2040	The whole country, Sector and DISCO wise
Peak demand	2015 to 2040	The whole country and DISCO wise
Generation	2015 to 2040	Main producers and Auto producers (generators for Independent grid)
Transmission & Distribution loss	2015 to 2040	The whole country and DISCO wise
Fuel source consumption	2015 to 2040	Oil products, Natural gas and Coal
Primary energy supply	2015 to 2040	The above + Import oil + Hydro + Bio + Renewable
GDP per capita	2015 to 2040	Nigeria, Ghana, Tanzania, South-Africa Saudi-Arabia, Malaysia, China, Japan
Power consumption per capita	2015 to 2040	Nigeria, Ghana, Tanzania, South-Africa Saudi-Arabia, Malaysia, China, Japan

(3) Consistency to the other Strategies and Plans

For keeping the consistency among the related strategies and plans in Nigeria, The followings are studied by the JICA team and C/P.

Strategy and plan fields	Study items
National Strategies	Nigeria Vision 20: 2020
Economic development strategy	Nigeria Economic Review and Outlook (2015-2017)
Power sector plan	(1) Electrification plan: 56% → ?? (2) Loss reduction plan: 9% ? (3) Shedding reduction plan: 20% → ?? (4) Auto generation estimation: 27% → ?? (5) Grid connection plan : Independent grid to TCN
Energy plan	National Energy Master plan 2014 By Ministry of Science and Technology
Renewable energy plan	National Renewable Energy and Energy Efficiency Policy (NREEEP) by Ministry of Science and Technology
Environment plan	Woods and charcoal consumption estimation

(4) Review of the Existing Power Demand Forecast

Existing Power Demand	Items	Study items
National Load Demand Study	Published	TCN April 2009
	Forecasted	2010 to 2033
	Power demand	Potential demand by national & region
	Methodology	Social & economic scenario approach
Analysis Of Nigeria's National Electricity Demand Forecast	Published	Mr. Ezennaya, others
	Forecasted	2013 to 2030
	Power demand	Residential, Industry and Commercial
	Methodology	Time Series Analysis
African Energy Outlook	Published	International Energy Agency
	Forecasted	Forecast 2014 to 2040
	Power demand	TCN + Auto generation consumption
	Methodology	Unknown

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2. Methodologies

(1)Technologies for demand forecasting models

a. Model methodologies used in World wide

Time-series forecasting model　　Elasticity approach model

Econometric model　　Social economic scenario model

b. Model building engine of the Study team

Simple .E : developed by The Institute of Energy Economics, Japan

Used OS/Soft : Windows XP, Vista, 7 and 8, MS-EXCEL add in Soft

c. Experiences of the model building by Simple. E

Year	Country	Project title
2015	Pakistan	Power system Master Plan
2015	Bangladesh	Power system Master Plan
2014	Tanzania	Power system Master plan
2012	Oman	EE&C Master plan project
2011	Kazakhstan	EE&C project finding survey project
2011	Serbia	EE&C Master plan project
2010	Syria	Power system Master plan
2010	Vietnam	Power system Master plan
2008	Saudi Arabia	EE&C Master plan project
2007	Vietnam	Energy Master pan

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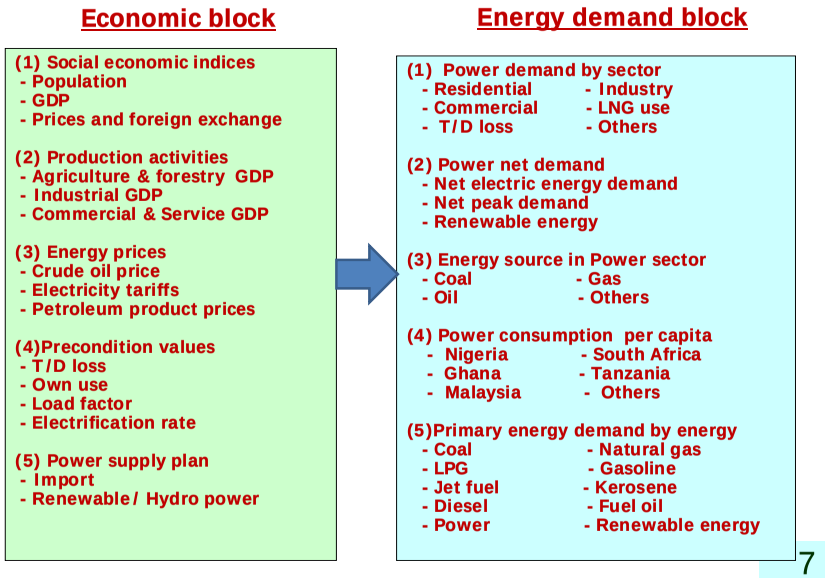
(2) Model flows of the Study team



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(3) Building procedures of power demand forecasting model

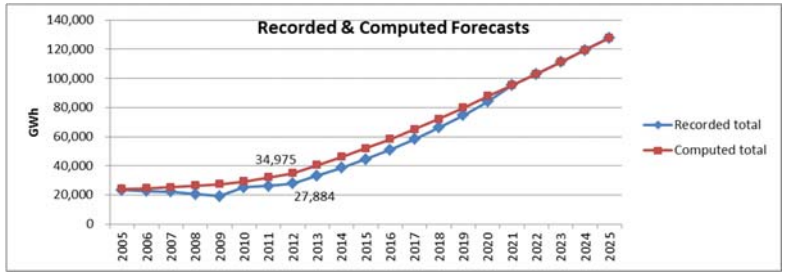
Population forecast sheet

Data sheet:	Model sheet:	Simulation sheet:
Population growth Economic Growth Power tariff Residential power dem Industry power dem LNG power dem Commercial power dem Public power dem T/D loss ---------- Net power demand Generation Peak demand	Elasticity calculation ln(Y)=a*ln(GDP) -b*ln(Tariff) + c Forecasting equation Yt = Yt-1 *(1+a*GDP) *(1+b*tariff) *(1+EE&C)	Actual term 2000-2013 Forecasting term 2014-2040

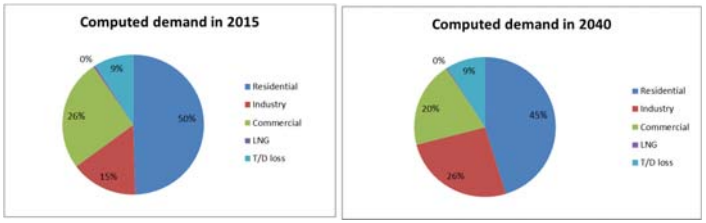
Growth sht　Compare sht　DISCO sht　Primary sht

8

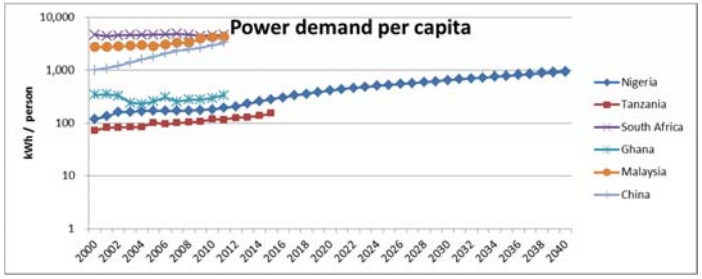
(4) Recorded & Computed power demand Forecasting



Source : Actual values are estimated by the Study team and , future values are tentative forecasted by the Study team



(5) Power comparison between Nigeria and Selected countries

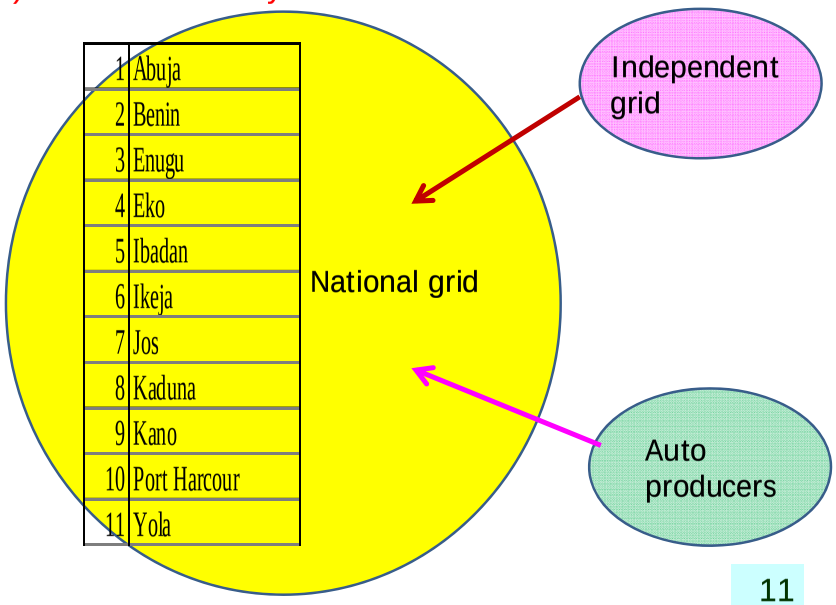


KWh / capita

	2000	2005	2010	2015	2020	2025	2030	2035	2040
Nigeria	120	173	183	283	418	533	654	791	949
Tanzania	73	102	119	153	0	0	0	0	0
South Africa	4,681	4,660	4,571	0	0	0	0	0	0
Ghana	346	259	299	0	0	0	0	0	0
Malaysia	2,720	2,857	4,136	0	0	0	0	0	0
China	993	1,784	2,944	0	0	0	0	0	0

Source : World Bank Database , future values of Nigeria are tentative forecasted by the Study team

(6) Power demand by DISCO



3. Joint works

(1) Collection of power demand data & strategies

Type	Data and Information as sample	Periods
Power data	Power consumption and Power tariff	2000-2014
	Power generation , Own use and T/D loss	2000-2014
	Load factor, Peak load and Reserve margin	2010-2014
Off grid	Off grid by region	2000-2014
DISCO data	Power consumption and number of customers by DISCO	2000-2014
	Peak demand & Load factor by DISCO	2000-2014
Future plan	Industry development Plans	
	Off grid to main grid and Renewable energy plans	

(2) Discussing the results of power demand forecasts

Type	Data and Information as sample
Power demand	Computed & Recorded power demand forecasts
	Sector wise contribution of power demand
	Future load factor, Peak load
Energy demand	Sector and energy wise contribution of the demand
	Future energy supply availability
Future images	Comparison of power consumption per GDP
	Comparison of power consumption per capita

(3) Schedule on the Power Demand

M /Y	Contents
Sep 2015	(1)Collection of power demand data & strategies (2) Discussing the methodology (3) Discussing the strategies on Power demand
Jan 2016	(1)Building the demand model (2)Discussing the preconditions of the forecasts (3)Discussing the results of the forecasts (4)Explaining the results to stakeholders
May 2016	(1)Collection of fuel energy demand data & strategies (2)Discussing the methodology (3)Building the fuel energy demand model (4)Discussing the preconditions on the fuel energy forecasts (5)Discussing the fuel energy demand forecasts (6)Explaining the results to stakeholders

Thank you

Appendix 1 : Power demand forecast items (tentative)

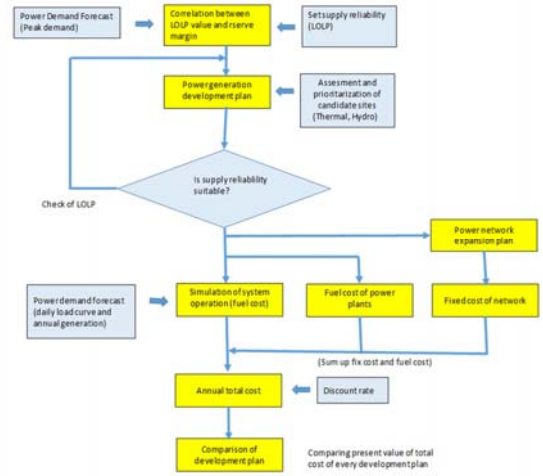
			2015	2020	2025	2030	2035	2040
Computed demand	Net demand(Energy)	GWh	51,989	88,467	136,018	203,988	289,292	392,776
	Net peak demand(Power)	MW	8,638	15,537	23,888	35,825	50,807	68,981
	Shedding at peak demand	MW	1,037	0	0	0	0	0
	TCN peak demand	MW	6,046	10,876	18,343	29,390	43,745	61,562
	Auto producer's peak demand	MW	2,591	4,661	5,545	6,435	7,061	7,419
Recorded demand	Recorded peak demand	MW	7,601	15,537	23,888	35,825	50,807	68,981
	TCN peak demand	MW	5,010	10,876	18,343	29,390	43,745	61,562
	Auto producer's peak demand	MW	2,591	4,661	5,545	6,435	7,061	7,419

			2015	2020	2025	2030	2035	2040
Capacity	Peak *1.2	GW	10	19	29	43	61	83

Appendix 2 : Indicators of Power demand (tentative)

			2015	2020	2025	2030	2035	2040
Social economic	Population	1000 persons	183,523	210,158	239,874	273,120	310,125	350,720
data	GDP (2005 price US$)	Billion US$	218	306	429	602	844	1,184
	Nominal GDP (US$)	Billion US$	628	1,027	1,697	2,751	4,431	7,135
	Electric energy Demand	GWh	51,989	88,467	136,018	203,988	289,292	392,776
	Power demand	MW	8,638	15,537	23,888	35,825	50,807	68,981
	GDP (2005 price US$) / capita	US$ per capita	1,188	1,456	1,789	2,203	2,721	3,375
Indicator	Nominal GDP (US$) / capita	US$ per capita	3,421	4,887	7,076	10,073	14,286	20,345
	Power demand / rGDP at 2005	kWh per US$	0.238	0.289	0.317	0.339	0.343	0.332
	Power demand / Nominal GDP	kWh per US$	0.083	0.086	0.08	0.074	0.065	0.055
	Power demand / capita	kWh per capita	283	421	567	747	933	1,120
	Power demand / Household	kW per HH	0.264	0.414	0.558	0.735	0.917	1.101

Master Plan Flow Chart



Power Generation Development Plan

K.NISHIWAKI

1) Verification of the data and information of every power plant

- Actual records of power generation and system operation,
- List of planned power plants including IPP and BOT,
- Plans of power exchange with neighboring countries,
- Plans for abolition and replacement of power plants and so on.

2) Establishment of the power development scenarios

- Demand forecast scenarios（High, Base, Low）
- Limitation of capacity of transmission lines
- Delay of development
- Water flow fluctuation of hydropower stations
- Conformity with energy resources development and supply plan
- Power exchange with neighboring countries through interconnections
- Fuel price hike
- Constraint and condition of IPP and BOT plant operation

4)Consideration of interconnection with neighboring countries

- Interconnection with neighboring countries will be planned for implementation taking the study on interconnection plan among WAPP countries into account.

3) Establishment of vision of power generation composition

- The most economic composition is sought by changing the development ratios of various types of fuel (coal-fired thermal, combined cycle thermal and hydropower etc.) with which new development is deemed feasible, and comparing the total annual costs, consisting of fixed costs and variable (fuel) costs, in the various development ratios of each power source.
- The power generation composition with the least cost operation is determined by finding out the most economic combination of power sources among the various power development scenarios also based on the results of risk study of each scenario.

5) Evaluation of power plant candidates

・Selection of sites

The information for economic evaluation is collected and put in order, such as location, available capacity of units (kW), types of fuel, development period, construction cost, fuel cost and so on.

・Economic evaluation

Comprehensive economic evaluation is carried out by comparing cost of power generation of each development site.

6) Review of power development scenarios and vision of power generation composition

- The power development scenarios and vision of power generation composition are reviewed.

8) Establishment of long-term power development plan for the coming 25 years

- The least cost power development plan for the coming 25 years is determined to achieve the appropriate power source composition or best fuel mix in the year of 2040.

7) Putting order of priority to the candidates of power development

- The candidates are prioritized considering the economic efficiency, diversification and security of primary energies, conditions of existing power plants and interconnection with neighboring countries.

9) Master Plan should be revised every 5 year taking various circumstances into consideration

・Achievement ratio of power development shall be delayed.

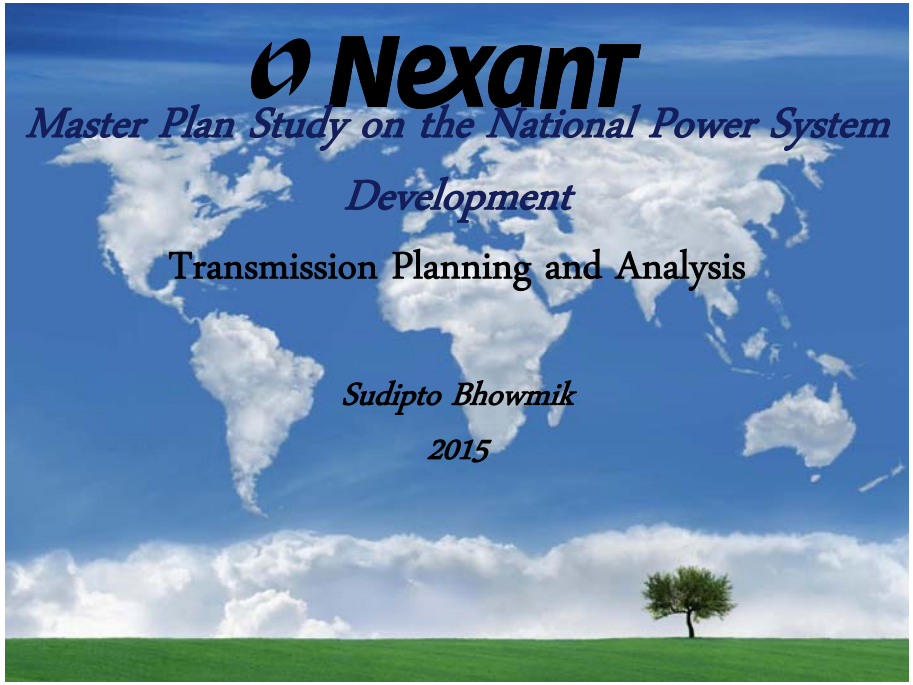
・Circumstances alter cases such as fuel price, new development procedures and change of economic fabric etc.

・Budget and business situation

Thank you, see you again.

Schedule of Transmission planning

1. Project Mobilization and Data collection
2. Establishment of Base Case Data Sets from TCN and Osogbo
3. Data cleanup and verification for clean base case
4. Coordination with TCN transmission master plan from World Bank
5. Coordination with Generation, Load forecast and Substation group



Schedule of Transmission planning

1. Inputs from NERC and NBET regarding project completion probability
2. Preliminary presentation of Data collection
3. Creation of 3 future case studies
   i. 2020 : Near term plan
   ii. 2030 : Mid term plan
   iii. 2040 : Long term plan
4. Inclusion of WAPP plans

Objective

- Development of the Transmission System for 25 years timeline in order to support the "Master plan study" being developed by JICA
- The primary focus is Generation adequacy
- Coordinate with the plan operation based TCN's 20 year master plan (World Bank).
- All analysis will be carried out using PSS®E
- Any additional developmental need for transmission upgrades will take into consideration feasibility and reliability

Relevant Organizations

1. **TCN**: Bulk of simulation data including Transmission upgrade queues , their probability and priority
2. **NERC**: Relevant Generation upgrades
3. **NBET** :Relevant Generation upgrades
4. **World Bank**: Data verification and coordination
5. **NDPHC**: Transmission upgrades

Data Request

- Power Flow data for present and future year in PSS/E format
- Detailed generator data
- Detailed data regarding voltage control devices and schedule
- Definition and limits of the power transmission interfaces.
- Contingencies: definition and their corresponding limits
- Reports on historically observed Transmission and Voltage problems and their associated data

Data Request 2

- Recent/Planned transmission or generation upgrades
- Restrictions on sites for installation or transmission upgrades
- System load forecasts
- System diagrams (existing)
- Information on transmission upgrades probability
- Current Grid codes and operating procedures, for both national and regional systems.

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT

Environmental and Social Considerations (ESC)

Sept. 4, 2015 Yuriko Kudo

JICA ENVIRONMENTAL AND SOCIAL GUIDELINES

Basic Principles in the Guidelines

1. A wide range of impacts must be addressed.
2. Measures for environmental and social considerations must be implemented from an early stage to a monitoring stage.
3. JICA is responsible for accountability when implementing cooperation projects.
4. JICA asks stakeholders for their participation.
5. JICA discloses information.
6. JICA enhances organizational capacity.
7. JICA makes serious attempts at promptness.

The Master Plan applies:

- SEA (Strategic Environmental Assessment)
- IEE (Initial Environmental Examination) for pre-F/S (Hydropower)
- Stakeholder meetings

OUTLINE

1. Principles of JICA's Environmental and Social Guidelines
2. What is Strategic Environmental Assessment (SEA) ?
3. How to integrate Environmental and Social Consideration (ESC) into the Plan
4. Schedule of the study: SEA and IEE
5. Strategy for ESC
6. JICA's Checklist for ESC

WHAT IS STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)?

Analytical and participatory approach that aims to integrate environmental considerations into policies, plans, and programs, and evaluate the inter linkages with economic and social considerations."

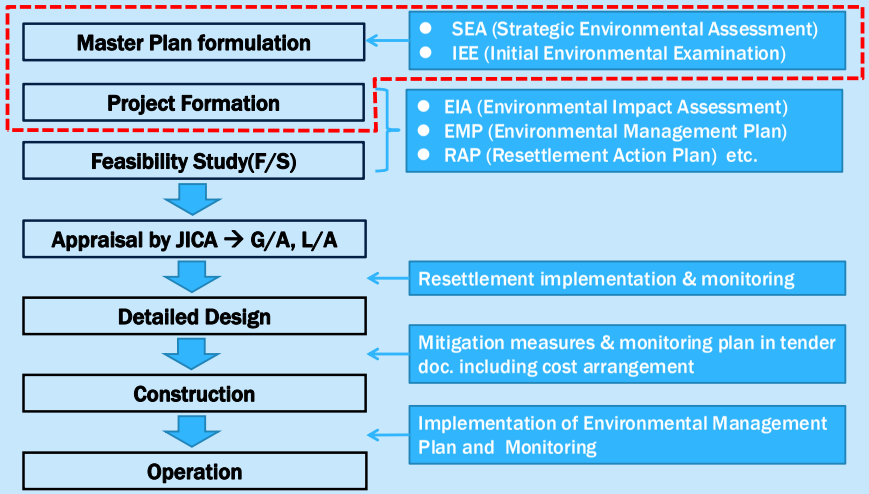
OECD/DAC, "Applying Strategic Environmental Assessment: good practice guidance for development cooperation" (2006)

A good quality SEA process ...

- Informs planners, decision makers and affected public on the sustainability of strategic decisions
- Facilitates the search for the best alternative
- Ensures democratic decision making process
- Enhances the credibility of decisions
- Leads to more cost- and time-effective EIA at the project level

IAIA, SEA Performance Criteria (2002)

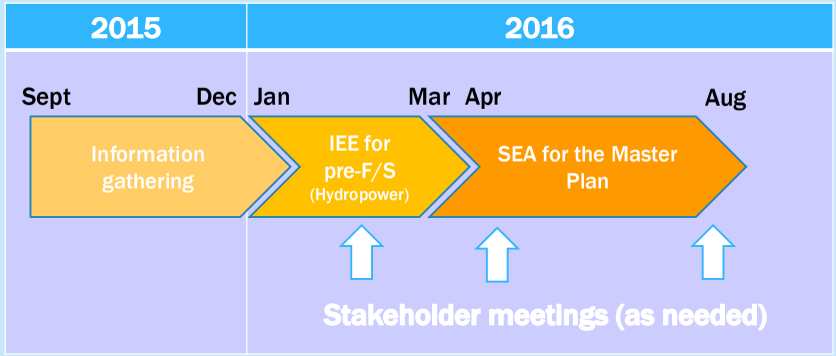
HOW TO INTEGRATE ESC INTO THE PROJECTS (JICA REQUIREMENTS)



STRATEGY FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

- Confirm contents and means of conducting SEA with C/P
- IEE level investigation for pre-F/S (Hydropower)
- Overall process for SEA:
  1. Investigate multiple scenarios to be compared
  2. Investigate relevant cumulative impacts
  3. Scoping of environmental and social impacts
  4. Stakeholder meetings (as needed)

SCHEDULE OF THE STUDY: SEA AND IEE



JICA'S CHECKLIST FOR ESC
THERMAL POWER STATION, HYDROPOWER, TRANSMISSION LINES

Category	Major Environmental Items (Impacts)
Permits and Explanation	(1) EIA & Environmental Permits
	(2) Explanation to local stakeholders
	(3) Examination of Alternatives
Pollution Control	(1) Air Quality (2) Water Quality (3) Waste (4) Soil contamination (5) Noise & Vibration (6) Subsidence (7) Odor
Natural Environment	(1) Protected Areas (2) Ecosystem (3) Hydrology (4) Topography and Geology
Social Environment	(1) Resettlement (2) Living & Livelihood (3) Heritage (4) Landscape (5) Ethnic Minorities and Indigenous Peoples (6) Working Conditions
Others	(1) Impacts during Construction (2) Monitoring (2) Impacts on Global Environmental Issues (e.g. global warming)


WE WOULD APPRECIATE YOUR COOPERATION
THANK YOU!
Yuriko Kudo
Yr-kudo@intl.yachiyo-eng.co.jp

2016 年 2 月 4 日
第一回 TWG（プログレスワークショップ）

TIME TABLE FOR 1ST TECHNICAL WORKING GROUP (PROGRESS WORKSHOP) ON THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

VENUE: BOARD ROOM (ROOM 510), 5TH FLOOR, CORPORATE HEADQUARTERS, TRANSMISSION COMPANY OF NIGERIA
PLACE: PLOT 441, ZAMBEZI CRESCENT, MAITAMA, ABUJA
DATE: *4th FEBRUARY, 2016.*

Time	*Event/Activity*	*Action by*
10:00-10:10	Opening Remarks from the Federal Ministry of Power	Permanent Secretary, Federal Ministry of Power, Works and Housing
10:10-10:20	Introduction	All
10:20-10:30	Key note address	Director, Energy Resources and Development
10:30-10:45	Technical Working Group (TWG) Progress Workshop	Mr. Makoto Abe
10:45-11:00	TWG Workshop on Power Demand Forecasts	Mr. Tomoyuki Inoue
11:00-11:15	Generation Expansion Plan	Mr. Kyoji Fujii
11:15-11:30	Environmental and Social Considerations (ESC)	Ms. Yuriko Kudo
11:30-12:00	Opinion exchange regarding TWG General discussion	TWG members All
12:00-12:10	Closing remarks	Permanent Secretary, Federal Ministry of Power, Works and Housing

Note:
FMP- Federal Ministry of Power, PS- Permanent Secretary, ERD- Energy Resources and Development

面談議事録	
業　務　名	ナイジェリア国電力マスタープラン策定プロジェクト（第二次現地調査）
場　　所	TCN ボードルーム（5F）（後に講堂に移動）
日　　時	2016 年 2 月 4 日（木）10:00～12:30
参加者	Attendance List 参照

【議事概要】

主要機関ステークホルダーを対象に、Technical Working Group Workshop（プログレスレポート説明）を実施した。

１．開催挨拶

TCN の CEO、JICA 鹿野氏、電力省 ERD の Director より挨拶があった。

２．コンサルタントチームによるプレゼンテーション

以下、４つのプレゼンテーションを行った。

- マスタープラン策定プロセスの概要（YEC 阿部）
  *途中、参加者人数が多いため講堂に移動
- 需要予測（井上）
- 電源開発計画（不二葦）
- 環境社会配慮（工藤）

３．質疑応答

(1) TWG について

Q：　TWG の活動は、マスタープラン策定後もアップデートのために継続的に実施していくことがよいと考えている。このような活動についてどう思うか。（YEC）

TWG の活動は非常に有用な機会として認識している。今後もこのような形でマスタープラン改定を進めていくこと良い。（ERD Director）

A：　マスタープラン検討のプラットフォームとして、TWG システムを活用してもらいたい。（JICA）

(2) 需要予測について

Q：　ECN、Tractebel、JICA の３つの比較について前提条件をしらべたい。

A：　３つの予測の前提条件は、ほぼ同じである。GDP で言えば 7%となっている。３つの違いは手法によるものである。ECN と Tractebel は原単位による予測で、JICA のモデルは弾性値による予測である。原単位による予測手法を使うには、中進国や途上国では注意する必要がある。先進国では GDP に対する原単位は減少傾向にあるが、中進国や途上国では上昇傾向になる。そのうえ電力は最終エネルギーの中に占める割合も上昇するので、

【議事概要】

この２つの要件を入れないと予測結果は低く出てくる。JICA の予測は弾性値による予測であるが、一般的に弾性値による予測は、原単位予測よりも高く出てくる。ECN の高い需要予測は、原単位の上昇を高く設定しすぎたものと思われる。（YEC）

Q： 2015 年のセクター別;構成比と 2040 年のセクター別構成比が変わらない理由はなにか。
A： 人口の伸び率が高いこと、電化率が上昇することによるものである。一般的にセクター別構成比において、家庭部門は年とともに徐々に小さくなる傾向にあるが、ナイジェリアでは人口の伸び率が現状で 3%、2040 年でも 2%と高いので、家庭部門の電力消費割合が小さくならない。そのため、2040 年でも 50%ほどのシェアを占めることになる。（YEC）

Q： 再生可能エネルギー（RE）のポテンシャルについて詳しく説明してほしい。
A： 先に示したように Off-grid の 2040 年時点での比率は 20%である。このほとんどが小水力、太陽光、風力、バイオといった RE である。さらに on-grid での大規模水力の割合が 20%程度あるので、合計で全電源の 40%が 2040 年時点で RE を使うことになる。この比率は 2030 年の EU 諸国とほぼ同じである。RE の比率の増加は、近年では気候変動の観点から求められている。（YEC）

Q： MAED や Message といった既存の予測ソフトを使わない理由はなにか。
A： MAED や Message といったソフトは、広く使われていて有名なソフトである。ただ、これらのソフトは多くのデータを必要とするので、ODA などのように全体実施期間が 1 年程度で、結論を出す必要があるプロジェクトではデータ収集が大きいと時間がかかり、期間内で電力予測を出すことが難しい。今回の JICA が使用した Simple.E は、3、4 か月の作業で結論が出るので、MAED や Message よりは利便性がよいといえる。

(3) 環境社会配慮について
ナイジェリアが COP21 にて公表した INDC に従った計画策定をしてほしい旨、環境省からコメントがあった。質疑応答は以下の通り。
Q：スコーピングにおける判断基準はなにか。
A：マスタープラン段階におけるスコーピングは定性的なものであり、これまでに収集したナイジェリアの基本情報や各発電方式の一般的な情報を基に実施している。詳細な環境影響については、当然ながら各プロジェクトの EIA にて実施され、ここではマスタープランに含まれてくる発電方式がどのような影響を及ぼすか共通認識を持つことを念頭に置いている。（YEC）
Q：シナリオにおける環境面での評価は何を指すか。
A：気候変動や大気汚染等について、シナリオ毎に影響評価を行う。環境面、コスト面を含

【議事概要】
め、バランスの取れた開発計画が重要である。（YEC） 以上

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb 4/16. Location: TCN. Board Room - 5th Floor.

Purpose: Briefing by JICA on 25 yr. Least Cost Power Gen. Plan.
(JICA Power System Master Plan Project (Technical Working Group Workshop))

No.	Name	Title	Organization
1	Engr. EA. Anumaka	GM CCP/TSP	TCN
2	Dashi, I.A.	ACAO	FMP
3	Adegbola F.O	PCS	FMP
4	Abegunde A.O	Deputy Director(P&S)	FMP
5	Ayodele, A. A.	Ast Director (PRS)	FMoP
6	Ladi M. Orok	CAO	FMP
7	Iniobong Abasi-Awe	Assistant Director	Dept. of Climate Change Fed Min of Env.
8	Amaechi C. Aloke	DD (Power)	BPE
9	KYRAN O'SULLIVAN	LEAD ENERGY SPEC	WORLD BANK
10	Nuhu L. Sada	D - PRS	FMPWH (Power)
11	DIPAK SARMA	MD SO/MO	TCN
12	HACK KAST	ADVISOR TCN.	TCN.
13	HIDEKI OTAKE	TWG PE Analysis, JICA	JICA
14	ANIKPE K. J.	ACEE (ERD) FMOP	FMOPW&H (Power)

Attendance List

Date: Location:

Purpose:

No.	Name	Title	Organization
1	Mrs Foluke Oni	DDC (Climate change)	Min. of Power
2	Maurice Smith	Transmission Advisor	NIAF
3	Dr. Tochi Nwachukwu	Special Assistant to President on Power	office of Vice President
4	Barka Jafaru	Advisor Power Mkt	NIAF
5	Engr. Yusuf Abdullahi	Mgr Networks, ESRS	NERC
6	Engr. FARUK YUSUF	AD (RRI) FMP	FMoP
7	Dr Yusuf A.O	PM (RE, R&D)	NERC
8	Gabriel Agidani	Consultant	JICA
9	Adesoji ADEYOLA	Snr Prog. Manager	AFD
10	Masaaki Shikano	Project Formulation Advisor	JICA Nigeria
11	Simeon Atakula	Senior Power Adviser	NIAF
12	~~Albert~~ O Mould-Shalom	DD (TCN)	BPE
13	ILIYA H VONGJEN	ACE (TCN & LABOUR)	BPE
14	Engr David Ekeoma	EE I (TRD)	FMP

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb. 4, 2016 Location: TCN Board Room 5th Floor

Purpose: JICA Power system Master plan project (Technical Working Group Workshop)

No.	Name	Title	Organization
1	Dr. Owolabi Sulu	Asst. Chief Power Engr	Min of Power
2	Engr. O.T. Owoeye	Assist. Director	Min. of Power
3	Engr. S.B. AYANGBADE	PRIN. ELECT. ENGR.	POWER
4	Engr. Abel, Philip	Electrical Engineer	Power
5	Onu, Ogbonnaya Montell	Mechanical Engineer?	Power
6	Engr. Kabiru M. Adamu	Prin. Mgr. (Tech.)	TCN-MO
7	Dr. Mikaila Z. Y.	CSO	ECN
8	Ewaen Agbonaghagbon	IT	ECN
9	Ogunfeyimi Gbadigo	PTO (DSD)	FMoP
10	BASSEY, UMOBANG-S	SOU	FMoF Environment
11	CIROMA JOSEPH	GM, TCN-PMU	TCN-PMU
12	KYRAN O SULLIVAN	TEAM LEADER	WORLD BANK
13	LEKE PETERS	ALM (P) PMU	TCN-PMU
14	ABUTU E	PM (Planning)	TCN

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Location:

Purpose:

No.	Name	Title	Organization
1	Ifeoma A. Nwachukwu	~~MS~~ Mrg(E&S)	TCN
2	J. T. Akande	AGM(CR$E)	TCN
3	Odi[illegible]	STO	FMP
4	CHIKWELUEM OKWUDIRI	SAO	FMP
5	Eugene Ejeregbe	ACE	FMP
6	Engr P.A. Aribaba	ACM (Planning)	TCN
7	Christabel Chukwuemeka	AM(GenPlan)	TCN
8	Uyouko S.E.	AGM(T)	TCN
9	Engr. Ajibade M.A	PM(Planning)	TCN
10	Emeka Ifenkwe	Offr I (PSPD)	TCN
11	Alaji Ibrahim	Offr II (PSPD)	TCN
12	E. M. Okoduwa	PEO	Ministry of Budget and National Planning
13	Adedun O. A	SPO	Ministry of Budget & National Planning
14	Yuriko Kudo	JICA Study Team	YEC

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb 4, 2016 Location: TCN Boardroom 5F

Purpose: JICA Power System Master Plan Project (Technical Working Group Workshop)

No.	Name	Title	Organization
1	FRED ODIKA	ASST. DIRECTOR	FED. MIN. OF ENVIRONMENT
2	Iniobong Abiola-Awo(Mrs)	Asst Dir	Fed Min of Env.
3	Shehu Abba-Aliyu	Asm(PSP)	TCN/SO
4	E.CLARK	SPM	PIFR
5	IGBA MATHIAS	HTO.	Fed. Min. of Power.
6	SIBYLLE HAASE	HEAD OF RENEWABLE ENERGY	GIZ (NBSP)
7	ADEBITI 'KUNLE	DIRECTOR (PROC.)	FED. MIN. OF POWER
8	J.O. EVWIERHOMA	DEP. DIR (POWER)	FMOP
9	Kabir M. Grokpo	CAO	fmp
10	ANIKPE K.J.	ACEE (ERD)	FMOP W&H
11	Yusuke Harada	Analyst	JICA Study T
12	ADAMU A. SANI	SM (T)	TCN - PMU
13	MURAYO OSIYEMI	GM	PowerTech
14	Sudipto Bhowmik	Sr. Consultant	YEC/NEXANT

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: 04/02/2016 Location:

Purpose:

No.	Name	Title	Organization
1	Kyoji Fujii	JICA Expert (Generation)	Yachiyo Engineering
2	KAORU NISHIWAKI	Hydro Expert	YEC
3	Makoto Abe		
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

TECHNICAL WORKING GROUP (TWG)

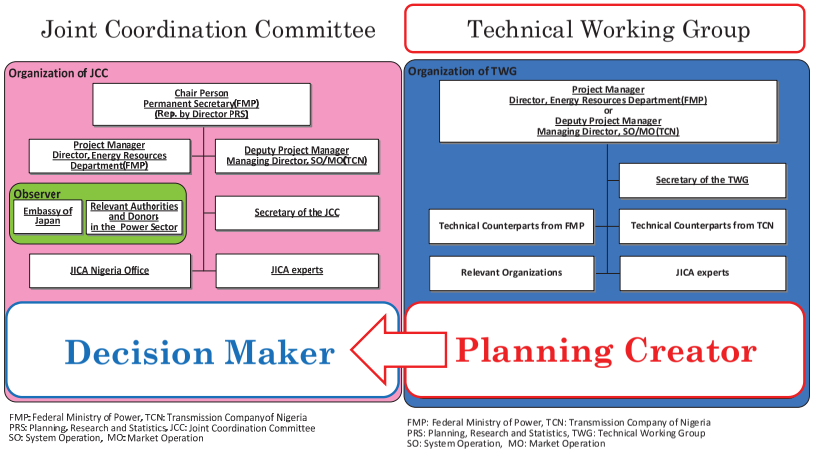
PROGRESS WORKSHOP

4th February 2016

JICA Study team

CONTENTS

1. ROLES OF JCC AND TWG

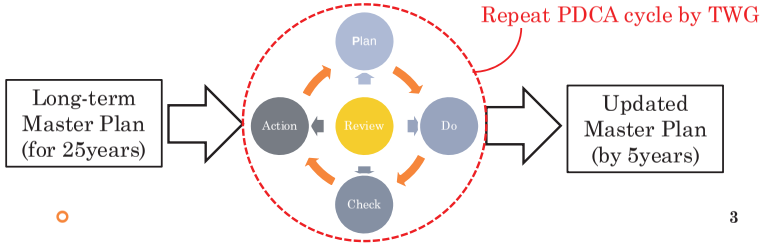


FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
PRS: Planning, Research and Statistics, JCC: Joint Coordination Committee
SO: System Operation, MO: Market Operation

FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
PRS: Planning, Research and Statistics, TWG: Technical Working Group
SO: System Operation, MO: Market Operation

2. OBJECTIVES OF TWG AND JCC

P⇒ Formulation of National Power Development Plan(JICA+TWG)
D⇒ Implementation
C⇒ Raising Challenges, Difficulties in Groups(TWG)
A⇒ Countermeasures(TWG)
Decision made(JCC)
P⇒ Update Master Plan by TWG(TWG)



3. Structure of TWG

Details of Technical Working Group

As of 6th Jan. 2016

Group Leader (Chair Person)-Power Development Planning
Engr. E.O Ajayi, Director (ERD), FMP

Group Secretary-Power Development Planning
Mr. Austin O. Abegunde, DD (P) FMP

Group Coordinator
Dr. Sunday Owolobi, ACE (ERD) FMP

Group (Technical) Leader-Power Development Planning
Mr. Masatsugu Komiya, JICA Team

Group (Technical) Coordinator-Power Development Planning
Mr. Makoto Abe, JICA Team

Power Demand Forecast

[Technical Counterparts]
○ JICA Team :Mr. Tomoyuki Inoue
○ FMP :Dr. Sunday Owolabi (ERD)
TCN :Engr. Ishola B. A. (NCC)
TCN :Engr. Ikeli H. N. (Planning)
TCN :Engr. Charles Nnajide (NCC)
TCN :Engr. Obishai F. N. (MO)

[Assistance necessary from]
TCN-SO, TCN-MO, Gencos, Discos, NERC, REA, ISAP

Power generation planning (Thermal power development)

[Technical Counterparts]
○ JICA Team :Mr. Kyoji Fujii
○ JICA Team :Mr. Takeshi Hara
○ FMP :Engr. Eugene Ejeregbe
○ FMP :Engr. Anikpe Kenechukwu
JosiahTCN :Engr. Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
NDPHC, NERC, TCN-SO, NBET, NNPC, Gencos, ISAP

Transmission /Substation planning /Power system analysis

[Technical Counterparts]
○ JICA Team :Mr. Sudipto Bhowmik
○ JICA Team :Mr. Kazuaki Kondo
○ FMP :Engr. Philip Okpanefe (TSD)
○ TCN :Engr. Abba-Aliyu (Planning)
TCN :Engr. A. Nazif (Planning)
TCN :Engr. E. C. Umoh (NCC)

[Assistance necessary from]
NDPHC, TCN-SO, PTFP

Power sector policy

[Technical Counterparts]
○ JICA Team :Ms. Izumi Takai
○ FMP :Mr. A.A. Ayodele (TSD)
○ FMP :Engr. Abel Philipele (RRD)
ECN :Engr. J. S. Olayande
ECN :Mr. Sulu B. F. Ibrahim
TCN :Anumaka, Corporate Plan.
TCN :Paul Ilondu, Corporate Plan.

[Assistance necessary from]
ECN, NERC, NBET, BPE, NOTAP, PTFP, ICRC

Primary energy analysis

[Technical Counterparts]
○ JICA Team :Mr. Hideki Otake
○ FMP :Engr. Eneh Kingsley (ERD)
ECN :Engr. J. S. Olayande
ECN :Mr. Sulu B. F. Ibrahim
TCN :Engr. Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
ECN, NNPC, NGC, NAEC, FMARD, FMMSD, FMW, NIMET

Power generation planning (Hydro power development)

[Technical Counterparts]
○ JICA Team :Mr. Kaoru Nishiwaki
○ FMP :Engr. O.T. Owoeye (ERD)
TCN :Engr.Aribaba P. A. (Planning)
TCN :Engr. Emeka Chiatula
TCN :Engr. Eric Hampashi (NCC)
TCN :Engr. Olayanju J. O. (MO)

[Assistance necessary from]
FMW, TCN-SO, NERC, NBET, ISAP

Economic and financial analysis

[Technical Counterparts]
○ JICA Team :Mr. Yusuke Harada
○ FMP :Mr. S.A. Dashi (P)
○ FMP :Engr. Ben Ayangeaor (ERD)
TCN :Engr. Abolomope R. O. (AC)
TCN :Engr. Ajiba de M. A. (Planning)
TCN :Engr. Ogbu B. C. (MO)

[Assistance necessary from]
NPC-1, NERC, NBET, NGC, TCN-TSP, NBS, NPC-2, FMF, CBN

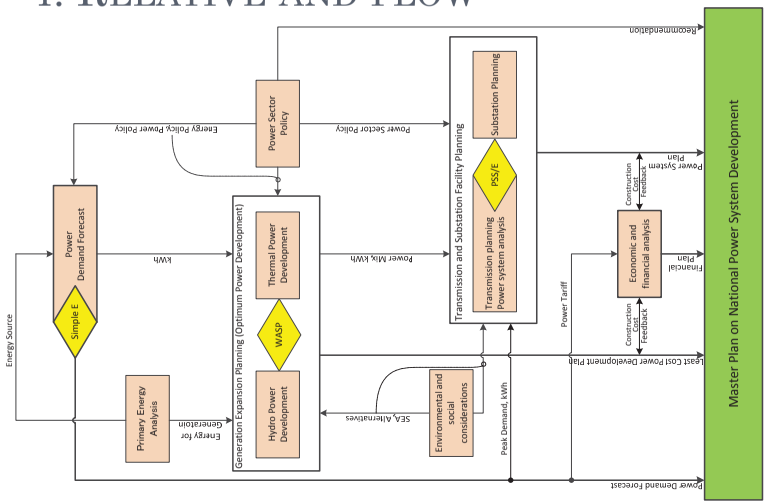
Environmental and social considerations

[Technical Counterparts]
○ JICA Team :Ms. Yuriko Kudo
○ FMP :Engr. Tony Umenyen (TSD)
○ FMP :Engr. Ekanem Effiong (DSD)
○ TCN :Olisa M. Okoli (HSE)
TCN :Ifeoma Nwachukwu (HSE)

[Assistance necessary from]
RME, NESRA, NPC-2, TCN

* ○:Main Counterparts

4. Relative and flow



5. Tasks of TWG (General)

Task	JICA Team	Nigerian Counterparts
■ General		
• Arrangement with related organizations	–	Responsibility
• Data collection	Combined	Collecting
• Data analysis	Analysis	Confirmation
• Basic data for Master Plan	Data-base	Confirmation
• Simulation	Methodology	Technical transfer
• Formulation of Master Plan	Formulation	Collaboration
• Manual for update Master Plan	To be made	Utilization
• Review and Update Master Plan		Continued

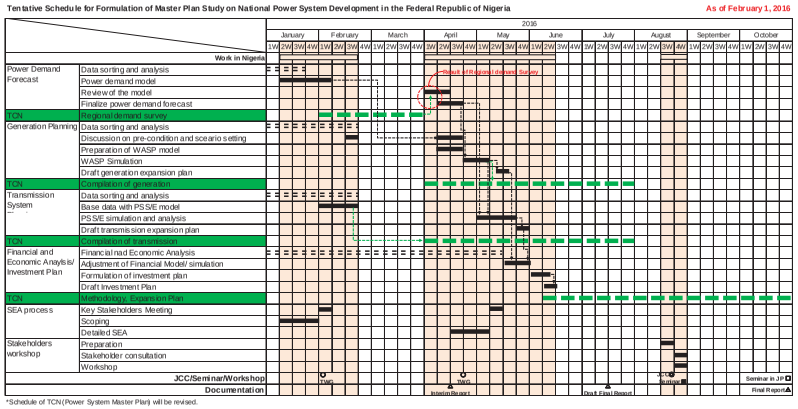
6. Tasks in TWG (Group)-1

Task	JICA Team	Nigerian Technical Counterparts
■ Power Demand Forecast		
• Review of method for power demand forecast	Review	–
• Formulation of power demand forecast	Methodology, Formulation	Formulation, Review, Update
■ Primary energy		
• Energy supply, demand and organizations	Review	Review
• Energy outlook	Study	Study
■ Economic and financial analysis		
• Social and Financial status	Review	–
• Investment Plan	Study, Formulation	Formulation, Review, Update

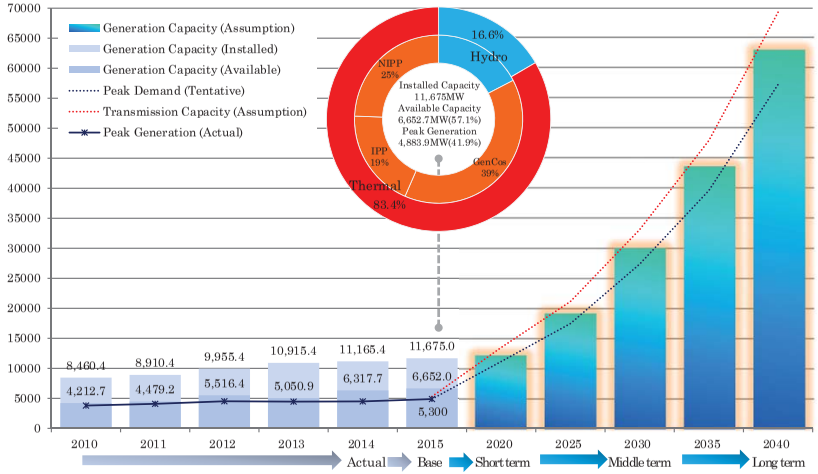
7. TASKS IN TWG (GROUP)-2

Task	JICA Team	Nigerian Technical Counterparts
■ Power generation Planning		
• Analysis of existing, planned expansion plan for power plants	Review	–
• Study of optimization of power development plan	Simulation	Review, Update
■ Power system(Transmission, Substations)		
• Analysis of existing, planned expansion plan for power system	Review	–
• Simulation	PSS/E Model	Review, Update
■ Environmental and Social Considerations		
• Regulation framework	Review	–
• Implementation of SEA	Assistance	Implementation
■ Power Sector Policy		
• Organizational and legal framework, legislation, power tariff and other Power Sector policy	Review, Recommendation	–

8.TENTATIVE SCHEDULE



9. ACTUAL AND ASSUMPTION



10. ISSUES TO BE MEASURED BY TWG

- Information Sharing
- Adequate Data Management
- Re-structure TWG (if necessary)
- Periodical Technical Working Group Meeting
- Periodical Update of Master Plan

Thank you for your attention

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MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT
IN THE FEDERAL REPUBLIC OF NIGERIA

TWG Workshop on Power Demand Forecasts

January 2016

Contents

1

1. Procedures of Power demand forecasts

1.1 Schedule on power demand forecasts

MM /YY	Contents
Sep 2015	(1)Collecting demand data & strategies (2) Discussing methodology (3) Discussing strategies on power demand
Jan 2016	(1)Building Demand model (2)Discussing Preconditions and Results on the forecasts (3)Explaining Tentative results in TWG (4)Implementing Regional survey by end of March
April 2016	(1)Revising DISCO's power demand (2)Discussing DISCO's power demand (3)Explaining Results to Stakeholders

Note : Regional survey is studied by TCN and Fitchner

2

1.2 Discussing Social Economic & Power demand

Nigerian C/P
FM of Power, Works & Housing
TCN & NCC

JICA
Study Team

	Ministry and Authority	Visited Date
TCN	Transmission Company of Nigeria	19th Jan 2016
REA	Rural Electrification Authority	19th Jan 2016
ECN	Energy Commission of Nigeria	20th Jan 2016
NBS	National Bureau of Statistics	20th Jan 2016
MBNP (NPC)	Ministry of Budget and National planning	21st Jan 2016
NNPC	Nigerian National Petroleum Corporation	21st Jan 2016
NERC	Nigerian Electricity Regulatory Commission	27th Jan 2016
NBET	Nigeria Bulk Electricity Trade	29th Jan 2016

1.3 Power demand Forecasting schemes

Population & GDP forecasts

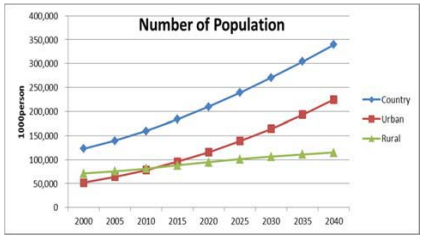
Data Sheet	Model sheet	Simulation sheet
Population growth Economic Growth Power tariff Residential demand Industry power demand Commercial demand Public power demand T/D-loss ---------- Net power demand Generation Peak demand	Elasticity calculation ln(Y)=a*ln(GDP) -b*ln(Tariff) + c Forecasting equation Yt = Yt-1 *(1+a*GDP) *(1+b*tariff) *(1+EE&C)	Actual power demand 2000-2014 Forecasting period 2015-2045 Forecasted demand Sectoral demand Country demand Country Peak Regional demand Regional peak

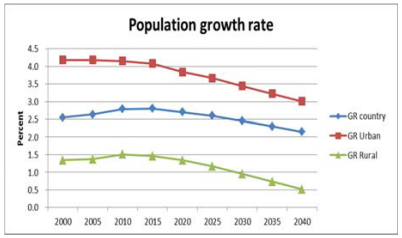
DISCO wise Power demand Forecasts

Note: Methodology is Econometric model

2. Forecasts on Population, GDP and Oil prices

2.1 Population Forecasts





Source: United Nations : World Population Prospects 2012 Division

a. Total population is 340 million in 2040
b. Growth rate is 2.80 % in 2015 and it is 2.15 % in 2040.
c. Urban share is 52% in 2015 and 66% in 2040.
d. Growth rate of population is still high in 2040.

2.2 GDP growth rate

Scenario of GDP	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040
Base GDP	5.0%	7.0%	7.0%	7.0%	7.0%
High GDP	6.0%	9.0%	9.0%	9.0%	9.0%
Low GDP	4.5%	5.0%	5.0%	5.0%	5.0%

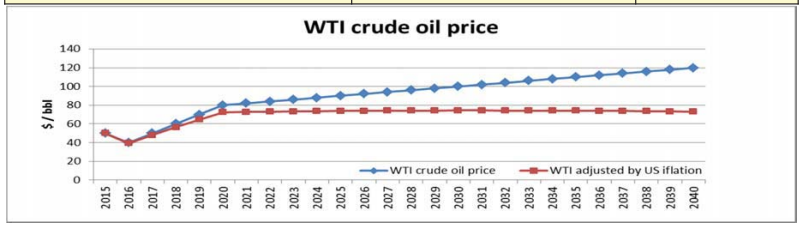
References : Strategy and Economic outlook

Documents	Organizations	Growth rates	Periods
Vision 20 2020	Nigeria Gov	13% per year	2015 - 2020
GDP outlook	NBS	6% per year	2015 - 2017
GDP outlook	NPC	5% per year	2015 - 2020
Economic outlook 2015	AfDB	7% per year	2015 - 2020
Economic outlook April 2015	IMF	6% per year	2015 - 2020

a. Base case growth rate from 2015 to 2020 is forecasted by NPC
b. Base case average growth rate from 2020 to 2040 are 7% due to population growth and achieving non oil sector diversification.
c. High case is almost implementing Vision 2020.
d. Low case is continuing current economic situation.

2.3 Crude oil price outlook

Organization	Publication	Latest version
International Energy Agency (IEA)	World Energy Outlook（WEO)	2015 version
Organization of the Petroleum Exporting Countries(OPEC)	World Oil Outlook	2014 version
Energy Information Agency (EIA, USA)	International Energy Outlook	2014 version
The Institute of Energy Economics, Japan(IEEJ)	Asia/ World Energy Outlook	2015 version



a. **Source:** Actual data from BP statistics.
b. Recent data from The Institute of Energy Economics, Japan
c. Brent oil price is nearly same to WTI price. (Brent = WTI + $5/bbl)

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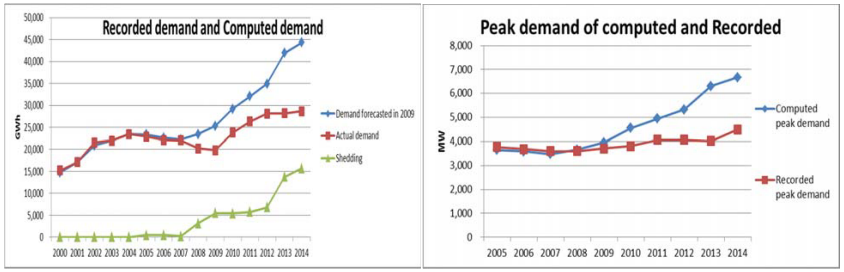
3. Country Wide Power Demand Forecasts

3.1 Recorded demand and Computed demand



a. Recorded demand means “With constrain demand” and computed demand is “Without constrain demand”.
b. “Forecasted demand in 2009” is studied by Tractebel
c. Actual demand is 95 % of power generation (Own use is 5%)
d. Shedding = Computed demand – Recorded demand
e. Power demand in Model is forecasted with Computed demand

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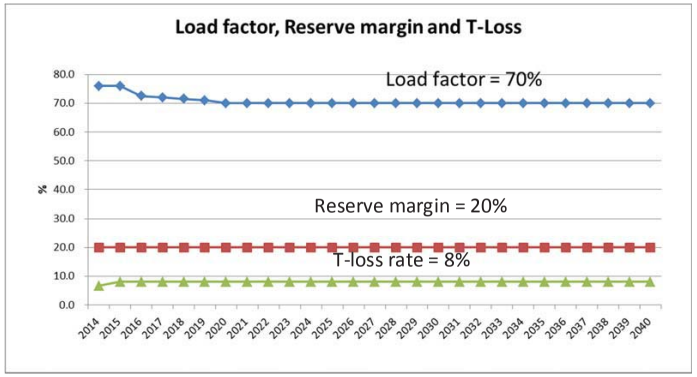
3.2 T- loss, Load factor and Reserve margin



a. **Source:** Preconditions in “MYTO Model 2012”
b. Future load factor is 70% to peak demand
c. Reserve margin is 20% to peak demand
d. T-loss is 8% to power send out.

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3.3 Sectoral power demand (GWh) as JICA forecasts

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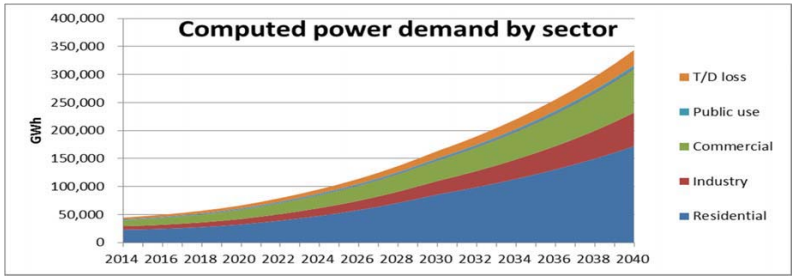
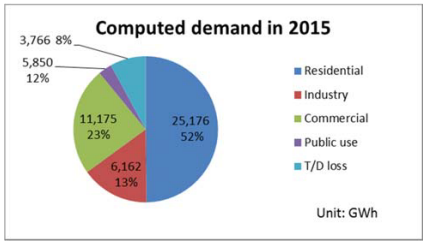
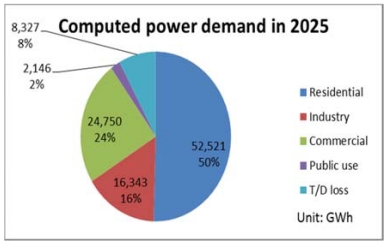


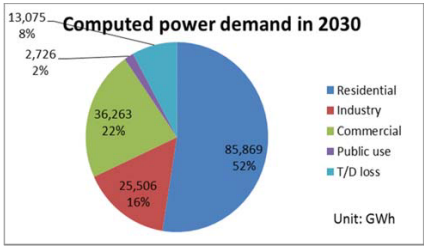
Sector	Unit	2015	2020	2025	2030	2035	2040
Residential	GWh	23,500	32,200	52,500	85,900	121,800	172,000
Industry	GWh	6,700	9,900	15,300	24,200	38,100	60,000
Commercial	GWh	11,300	16,400	24,700	36,300	53,100	77,700
LNG	GWh	400	700	1,000	1,300	1,700	2,100
Public use	GWh	1,400	1,700	2,100	2,700	3,500	4,400
T/D loss	GWh	3,800	5,300	8,300	13,100	19,000	27,500
Computed total	GWh	47,100	66,300	104,100	163,400	237,100	343,700

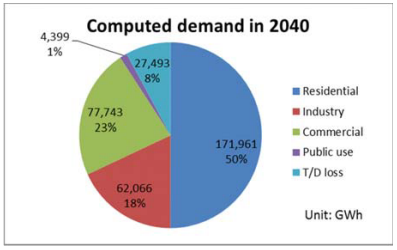
	2020/15	2025/20	2030/25	2035/30	2040/35	2040/15
G.R. (%)	7.1	9.5	9.4	7.7	7.7	8.3

3.4 Sectoral demand shares from 2015 to 2040

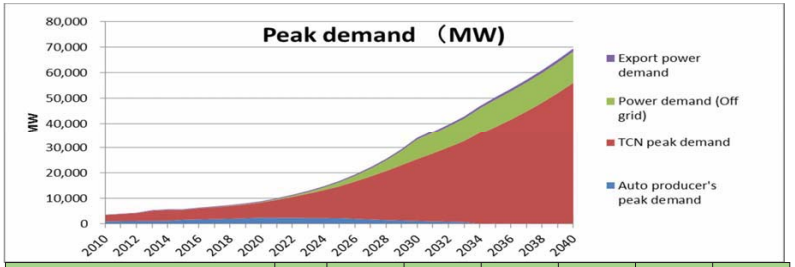








3.5 Peak demand as JICA Forecasts

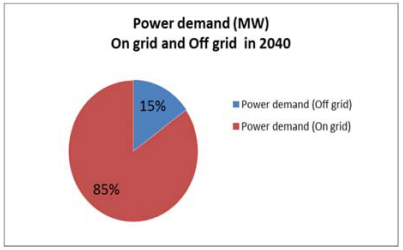


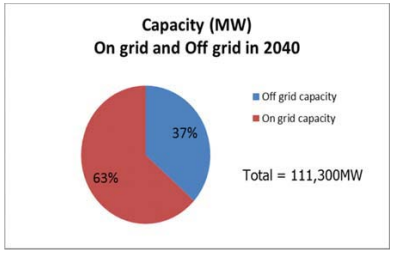
		2015	2020	2025	2030	2035	2040
Gross peak demand	MW	7,300	11,100	17,500	27,400	39,800	57,700
Required capacity	MW	8,700	13,300	21,000	32,900	47,800	69,200
Domestic peak demand	MW	7,100	10,800	17,000	26,700	38,700	56,000
TCN peak demand	MW	5,500	8,400	14,700	25,500	38,700	56,000
Auto producer's peak demand	MW	1,600	2,400	2,200	1,200	0	0

	2020/15	2025/20	2030/25	2035/30	2040/35	2040/15
G.R. (%)	8.9	9.5	9.4	7.7	7.7	8.6

Source of Off grid power demand : Energy Efficiency Policy 2015
Source of Export : MYTO II MODEL - 2012

3.6 On grid and Off grid contribution as JICA Forecasts





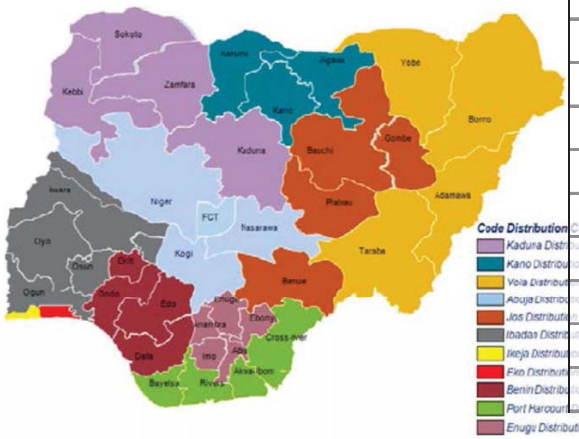
Renewable	Unit	2015	2020	2030	2040
SHP	MW	60	1,600	8,200	
Solar	MW	20	1,300	6,800	
Bio	MW	0	600	3,200	
Wind	MW	10	100	300	
Total	MW	90	3,700	23,000	
JICA Estimates	MW	100	600	25,800	40,700

Countries	Year	Target
UK	2020	30%
France	2030	40%
Germany	2025	40%
Spain	2020	40%
US.Calfornia	2030	50%
Japan	2030	25%?

Source : National Renewable Energy and EE&C policy, April 2015 P36

4. Region wise power demand forecasts

4.1 Distribution companies



1	Abuja
2	Benin
3	Enugu
4	Eko
5	Ibadan
6	Ikeja
7	Jos
8	Kaduna
9	Kano
10	Port Harcour
11	Yola

4.2 DISCO wise electrification rate and electrified population

			2014	2015	2020	2025	2030	2035	2040
Electrification rate	Abuja	%	**54**	57	76	**100**	100	100	100
	Benin	%	**80**	82	90	**100**	100	100	100
	Enugu	%	**71**	73	86	**100**	100	100	100
	Ibadan	%	**80**	81	90	**100**	100	100	100
	Ikeja+EKO	%	**99**	99	100	**100**	100	100	100
	Jos	%	**40**	42	56	75	**100**	100	100
	Kaduna	%	**41**	44	58	76	**100**	100	100
	Kano	%	**36**	38	49	62	79	**100**	100
	Port Harcour	%	**61**	64	80	**100**	100	100	100
	Yola	%	**30**	32	42	56	75	**100**	100
	Total	%	57	59	71	85	95	100	100
Electrified Population	Abuja	1000 persons	5,041	5,484	8,331	12,632	14,441	16,463	18,711
	Benin	1000 persons	13,632	14,337	18,387	23,473	27,000	30,966	35,332
	Enugu	1000 persons	14,207	14,978	19,530	25,378	28,127	31,069	34,240
	Ibadan	1000 persons	15,612	16,420	21,059	26,902	30,928	35,437	40,449
	Ikeja+EKO	1000 persons	11,549	11,895	13,765	15,861	18,234	20,841	23,704
	Jos	1000 persons	8,943	9,737	14,858	22,608	34,319	38,943	44,017
	Kaduna	1000 persons	8,532	9,257	13,869	20,715	30,866	34,856	39,222
	Kano	1000 persons	9,160	9,894	14,499	21,168	30,828	44,753	50,892
	Port Harcour	1000 persons	10,803	11,647	16,910	24,431	28,065	32,148	36,653
	Yola	1000 persons	4,497	4,885	7,361	11,072	16,582	24,793	27,750
	Total	1000 persons	101,977	108,533	148,568	204,242	259,390	310,270	350,969

- Current electrification rate is 57% and almost 100% in 2030
- Some DISCOs are 100% up to 2025, and some are 100% in 2030
- Kano and Yola are 100% in 2035

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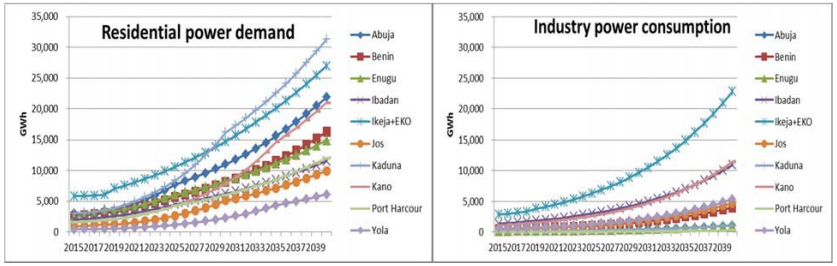
4.3 DISCO wise sectoral power demand as JICA Forecasts



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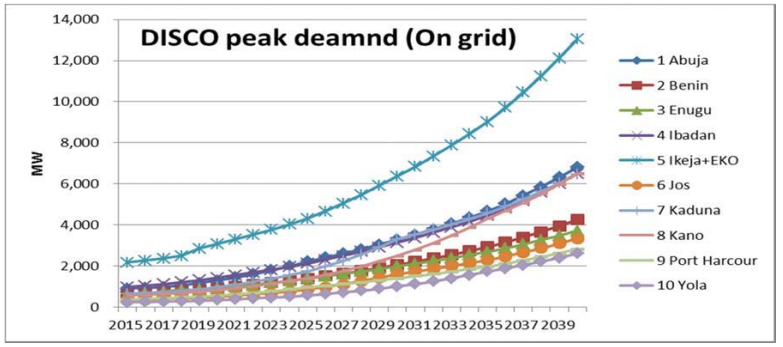
4.4 DISCO wise peak demand and capacity (On grid)



Note : Lagos = Ikeja + Eko

Total(MW)	2015	2020	2025	2030	2035	2040
Peak	**7,400**	**11,000**	**17,000**	**27,000**	**39,000**	**56,000**
Capacity	**8,700**	**14,000**	**21,000**	**33,000**	**48,000**	**70,000**

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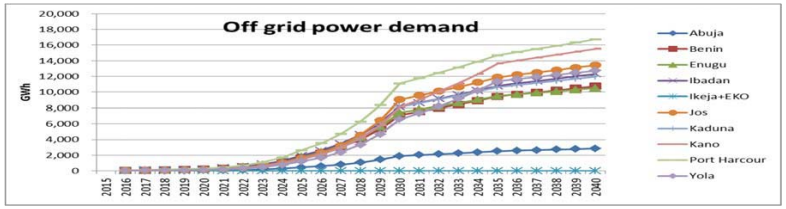
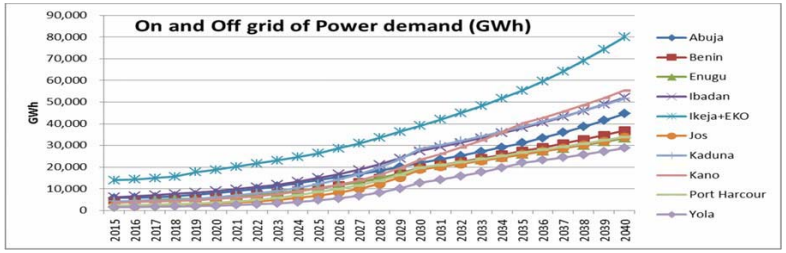
4.5 DISCO wise power demand (Off grid)



Original Forecasts: National Renewable Energy and EE&C policy, April 2015 P36

Off grid in DISCO = Total off grid *(1- DISCO electrified pop / Total electrified pop)



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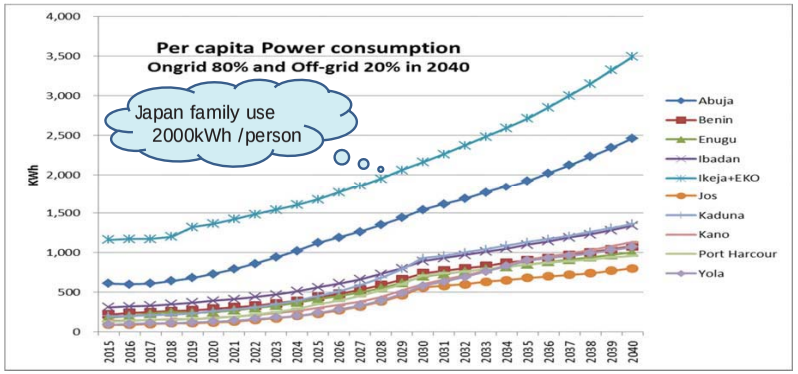
4.6 Per capita power consumption (On+Off grid)



(ON + off grid power consumption) / population

Capacity(MW)	2015	2020	2025	2030	2035	2040
On grid	8,700	14,000	21,000	33,000	48,000	70,000
On & Off	9,200	14,300	27,000	59,000	85,000	111,000

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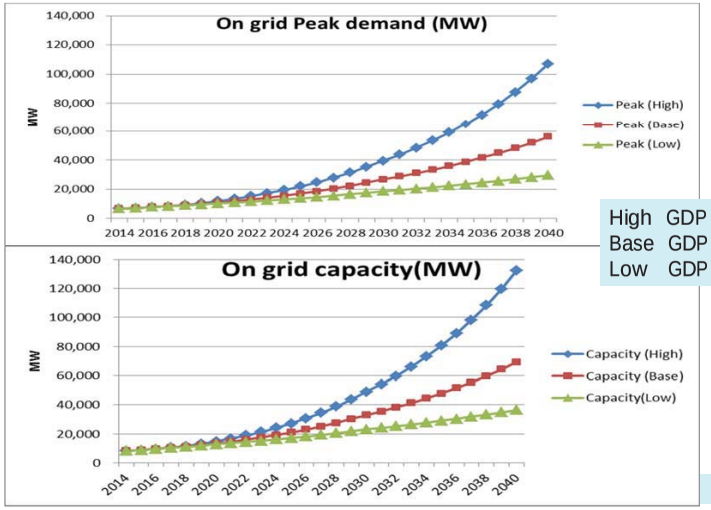
5. Comparison of Nigeria Power Demand

5.1 High, Base, Low cases



High GDP 9%
Base GDP 7%
Low GDP 5%

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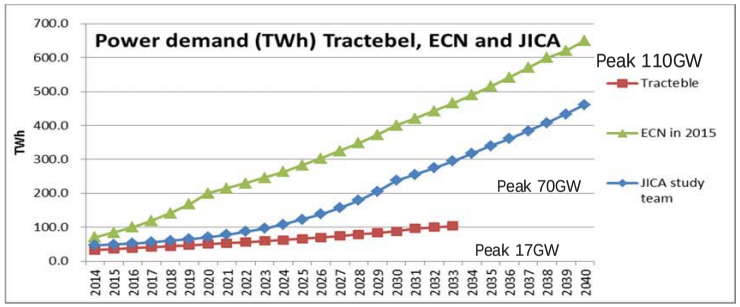
5.2 Tractebel, ECN and JICA



Source :

Tractebel: National Load Demand Study in 2009

JICA Study team : Base case (GDP 7% / year) in 2016

ECN 2015: National calculator 2050 published in 2015

(Greater effort case, GDP 7% / year)

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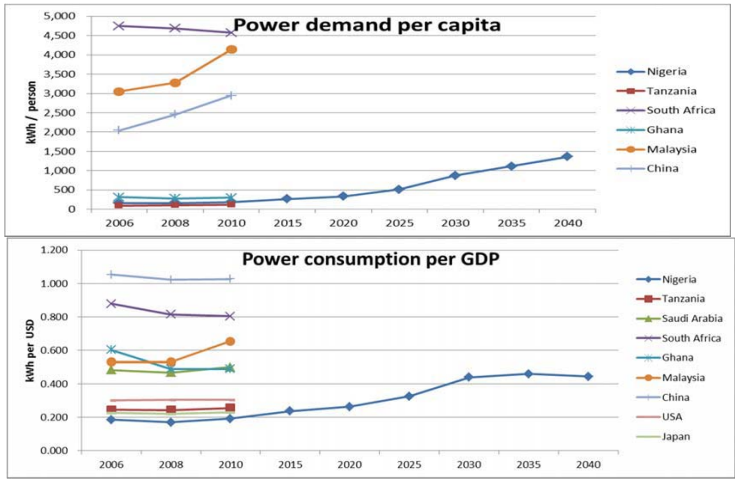
5.3 Per capita power consumption and per capita GDP



Source of Country's data is World Bank data base

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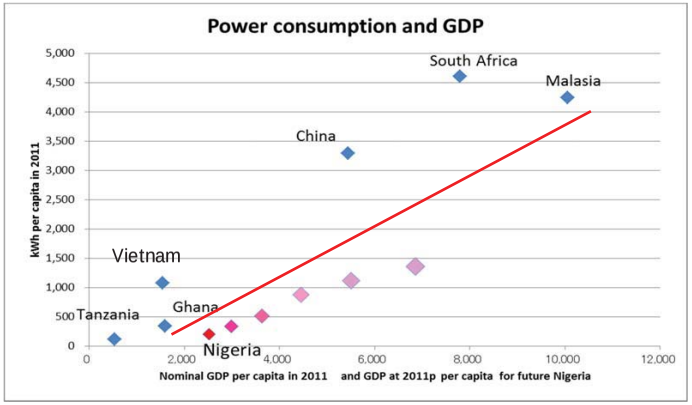
5.4 Per capita power demand vs per capita GDP



The points of the countries are at 2011
GDP per capita in all countries are 2011 prices
Nigeria points are 2011, 2020, 2025, 2030, 2035 and 2040.

Source of Country's data is World Bank data base

Waiting for the Data

1. Power tariff estimation from NERC. (Already get)
2. Disco wise peak demand from TCN-NCC. (Not yet)
3. Regional power demand survey from Fichtner. (Not yet)

Thank you

THE PROJECT
FOR
MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT
IN
THE FEDERAL REPUBLIC OF NIGERIA

Generation Expansion Plan

4th February 2016
JICA Study Team

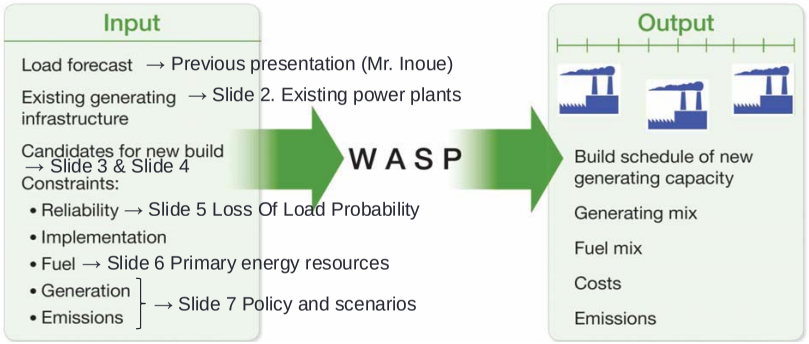
Contents

1. Methodology

1.1 Analytical tool used for power development planning

W A S P

Wien Automatic System Planning Package



Source: IAEA (Aug.2009) "Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments"

1. Methodology

1.2 How WASP works?

- An optimal power development planning software named WASP (Wien Automatic System Planning Package, Version 4.0.3) developed by IAEA is used to seek the least cost power development plan that is a combination of various types of plants and development patterns.
- In WASP, a power development plan that has the least Objective Function (see below for details) within the limitation of LOLP and reserve margin is sought through the calculation.
- OF = C − SV + O&M

where,

- OF : Objective Function
- C : Construction Cost
- SV : Salvage Value
- O&M : Operation & Maintenance Cost

2. Existing power plants in Nigeria

Category	Power Plant	Type	Installed Capacity (MW) (On site capacity, * under construction)		Available Capacity (MW)
FGN Successor Companies (Hydro)	Kainji	Dam Hydro	760	80MWx4, 100MWx2, 120MWx2	444
	Jebba	Dam Hydro	578	96MWx6	431
	Shiroro	Dam Hydro	600	150MWx4	508
	Sub Total		**1,938**		**1,383**
FGN Successor Companies (Thermal)	Egbin	Gas (Steam turbine)	1,320	220MWx6	941
	Afam (IV& V)	Gas fired GT	728	75MWx6, 138MWx2	3
	Delta	Gas fired GT	900	25MWx12, 100MWx6	463
	Sapele	Gas (Steam turbine)	660	110MWx6	219
	Gerugu	Gas fired GT	414	138MWx3	328
	Olorunsogo I	Gas fired GT	336	42MWx8	277
	Omotosho	Gas fired GT	336	42MWx8	280
	Sub Total		**4,694**		**2,511**
NIPP	Olorunshogo	Combined cycle	700	GT:112.5MWX4, ST:125MWx2	260
	Alaoji	Combined cycle	450 (1,021)*	GT:112.5MWx4, ST:285MWx2	158
	Gerugu	Gas fired GT	435	145MWx3	159
	Ihovbor	Gas fired GT	450	112.5MWx4	374
	Omotosho	Gas fired GT	450	112.5MWx4	306
	Sapele	Gas fired GT	450	112.5MWx4	184
	Calabar	Gas fired GT	(563)*	112.5MWx5	234
	Gbarain	Gas fired GT	(225)*	112.5MWx2	0
	Omoku	Gas fired GT	(225)*	112.5MWx2	0
	Egbema	Gas fired GT	(338)*	112.5MWx3	0
	Sub Total		**2,935**		**1,675**
IPP-A (Existing)	River	Gas fired GT	180	180MWx1	0
	Omoku (GT)	Gas fired GT	150	25MWx6	0
	ASCO	Gas fired GT	140	140MWx1	0
	Trans-Amadi (GT)	Gas fired GT	100	25MWx4	0
	Okpai	Combined cycle	480	150MWx3	230
	Ibom	Gas fired GT	188	112MWx1, 38MWx2	91
	Afam VI	Combined cycle	600	150MWx4	587
	AES	Gas fired GT	270	30MWx9	175
	Sub Total		**2,108**		**1,083**
Grand Total (Thermal + Hydro)			**11,675**		**6,652**

3. On-going/planned generation projects (Thermal and Renewable)

POWER PLANT	Capacity (MW)	Location	TYPE OF IPP	Fuel Type	Land	TCN Evacuation Approval	Gas/Fuel Supply/Energy Yield Report	ESIA	STATUS
Bresson A.S	90	Magboro, Ogun State	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations concluded awaiting regulatory approval
Century Power	495	Okija, Anambra State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations concluded and PPA initialed gas supply issues to be resolved
Proton Energy	150	Sapele, Delta State	GREENFIELD	Gas	YES	YES	NO	NO	Negotiations ongoing, gas supply issues to be resolved
Mobil (Qua Iboe IPP)	530	Qua Iboe, Akwa Ibom	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations concluded, PCOA Pending
Oma Power (Geometric)	500	Osisioma, Abia State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations concluded awaiting gas supply input
MBH Power	300	Itamope, Ikorodu, Lagos State	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations ongoing
Ethiope Energy (Rockson Energy)	1000	Sapele, Delta State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations ongoing, gas supply issues to be resolved
Yellowstone	350	Ajaokuta, Kogi State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations ongoing, gas supply issues to be resolved
Ibom Power	191	Ikot Abasi, Akwa Ibom	BROWNFIELD	Gas	YES	YES	YES	NO	Negotiations concluded awaiting regulatory approval
NDPHC NIPPs	4575	10 projects	BROWNFIELD	Gas	NO	NO	NO	NO	Negotiations ongoing, gas supply issues to be resolved
Zuma Energy (Coal)	1200	Ajaokuta, Kogi State	GREENFIELD	Coal	YES	YES	YES	YES	Negotiations Ongoing
Nigeria Solar Capital Partners (NSCP)	100	Bauchi	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Pan Africa Solar	54	Kankia, Katsina State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
LR Aaron Group	100	Gwagwalada, F.C.T	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Rook Solar Investment	100	Atakumosa West LGA, Osun State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Nova Solar	90	Katsina State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
KVK Power (Nig) PVT Limited	50	Yabo LGA, Sokoto State	GREENFIELD	Solar	NO	YES	YES	YES	Negotiations Ongoing
Synergent PowerShare	50	Kaduna	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Motir Seasphire	1200	Enugu State	GREENFIELD	Solar	YES	NO	NO	NO	Negotiations Ongoing
Giganorth	281	Yobe State	GREENFIELD	Solar	YES	YES	YES	NO	Negotiations Ongoing
TOTAL	11,406								

3. On-going/planned generation projects (Hydro)

Project name	Installed capacity (MW)	Type	Location	Status	Expected completion
Kashimbilla	40	Dam	Taraba	Under construction	2015
Gurara-I	30	Dam	Niger	Dam completed Not operable without transmission line	Dam:2011 Transmission: Under planning
Zungeru	700	Dam	Niger	Under construction	2017
Mambilla	3,050	Dam	Taraba	EPC contract signed in 2014	2020
Gurara-II	360	Dam	Niger	Bid preparation	N/A

4. Variable candidates for future expansion

■ Thermal candidates

	Capacity	Efficiency*	Cost**	Plant life
Simple cycle gas turbine	100MW class	30.8%	$980/kW	30 years
	200MW class	34.7%	$680/kW	30 years
Combined cycle	300MW class	51.4%	$980/kW	30 years
	500MW class	54.0%	$941/kW	30 years
	1,000MW class	55.1%	$842/kW	30 years
Coal fired conventional	300MW class	40.7%	$2,500/kW	40 years
	700MW class	42.1%	$2,000/kW	40 years
	1,000MW class	43.0%	$2,000/kW	40 years

[Remarks] *: HHV base
[Source] **: "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants" (US-EIA), Gas Turbine World Handbook

■ Hydro candidates

Potential hydro sites which are identified through a study named "*Screening for Hydropower Options with Associated Water Resources Development in the Niger Basin*" assisted by the World Bank and conducted by Tractebel Engineering will be used for the Project. Out of 64 sites identified by the WB study, 20 to 30 sites which have high ranking scores and large capacity will be selected for hydro candidates for the Project.

5. Reliability criteria-LOLP (Loss of Load Probability)

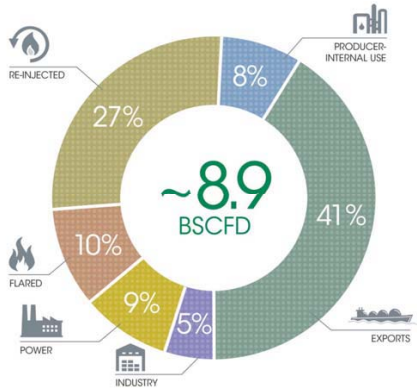
- The LOLP (Loss Of Load Probability) is used as the indicator for evaluating the reliability of power supply, and the power development plan which satisfies the target LOLP will be compiled.
- LOLP is defined as probable duration of time when power supply capacity falls short of power demand due to capacity outage as follows.
  - O_i: Capacity outage amount that causes supply shortage
  - P_i: Probability that capacity outage of O_i happens
  - t_i : Time when capacity outage O_i continues

  Hence,
  - $LOLP = \sum P_i \cdot t_i$
- LOLP is widely applied throughout the world as a standard of power supply reliability: NERC (North American Electric Reliability Corporation) adopts a LOLP of 1 day / 10 years, while PLN in Indonesia adopts 1 day / year, and CEB (Ceylon Electricity Board) adopts 3 days/year.
- In this Project, it is intended to adopt LOLP 1 day / year as the target reliability standard.

6. Primary energy resources and availability

6.1 Natural gas reserve in Nigeria

- Proved natural gas reserve in Nigeria is 180.1 Tcf and Reserves-to-Production (R/P) ratio is more than 100 years at end of 2014 (BP Statistical Review 2015).
- Natural gas used for power generation accounts for 9% of total gas consumption. (Nigeria Power Baseline Report)
- Still, natural gas is a promising source of power generation in Nigeria.



[Source] "Nigeria Power Baseline Report" (Sep.2015) Advisory Power Team, Office of the Vice President

6. Primary energy resources and availability
6.2 Coal reserve in Nigeria

S/No	Mine Location	State	Type of coal	Estimated Reserve [Mmt]	Proven Reserve [Mmt]	Depth of Coal [m]	Mining Method(s)
1	Okpara*	Enugu	Sub-bituminous	100	24	180	Underground
2	Onyeama*	Enugu	Sub-bituminous	150	40	-	Underground
3	Ihioma	Imo	Lignite	40	N/A	20-80	Surface
4	Ogboyoga	Kogi	Sub-bituminous	427	107	20-100	Surface and underground
5	Ogwashi Azagoba Obomkpa	Delta	Lignite	250	63	15-100	Surface and underground
6	Ezimo	Enugu	Sub-bituminous	156	56	30-45	Surface and underground
7	Inyi	Enugu	Sub-bituminous	50	20	25-78	Surface and underground
8	Lafia/Obi	Nassarawa	Bituminous (cokable)	156	21.42	80	Underground
9	Oba/Nnewi	Anambra	Sub-bituminous	30	N/A	18-38	Underground
10	Afikpo/Okigwe	Ebonyi/Imo	Sub-bituminous	50	N/A	20-100	Underground
11	Amasiodo	Enugu	Bituminous (cokable)	1,000	N/A	563	Underground
12	Okaba*	Kogi	Sub-bituminous	250	73	20-100	Surface and underground
13	Owukpa*	Benue	Sub-bituminous	75	57	20-100	Surface and underground
14	Ogugu/Awgu	Enugu	Sub-bituminous	N/A	N/A	N/A	Underground
15	Afuji	Edo	Sub-bituminous	N/A	N/A	N/A	Underground
16	Ute	Ondo	Sub-bituminous	N/A	N/A	N/A	Underground
17	Doho	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
18	Kurumu	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
19	Lamja	Adamawa	Sub-bituminous	N/A	N/A	N/A	Underground
20	Garin Maigungu	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
21	Gindin Akwati	Plateau	Sub-bituminous	N/A	N/A	N/A	Underground
22	Jamato Koji	Kwara	Sub-bituminous	N/A	N/A	N/A	Underground
Total				2,734	461		

7. Power development scenarios
7.1 Energy sector policy in Nigeria

- **National Energy Master Plan 2014**
  - **Chapter 4 Coal and tar sands/Bitumen**
    - The nation shall ensure adequate supply of coal to meet the energy requirements of the country in a cost effective and sustainable manner.
  - **Chapter 5 Nuclear Energy**
    - The nation shall promote the development of nuclear energy and undertake all activities related to peaceful uses of nuclear energy in its entire ramification.
  - **Chapter 6 Renewable Energy**
    - ***Hydro***: The nation shall fully harness the hydropower potential in the country for electricity generation.
    - ***Solar***: The nation shall aggressively pursue the integration of solar energy into the nation's energy mix, which should be base on the established potentials and available technologies nationwide.
    - ***Wind***: The nation shall commercially develop its wind energy resource and integrate this with other energy resources into a balanced energy mix.
  - **Chapter 8 Electricity**
    - The nation shall pursue measures to ***diversify energy sources*** for electricity supply.
    - The nation shall ***ensure a sustainable supply of gas*** for electricity generation.

7. Power development scenarios
7.1 Energy sector policy in Nigeria (cont'd)

NATIONAL RENEWABLE ENERGY AND ENERGY EFFICIENCY POLICY (NREEEP)

- Renewable electricity targets

	Short term 2015	Medium term 2020	Long term 2030
Large hydro (MW)	2,121	4,549	4,627
Small hydro (MW)	140	1,607	8,174
Solar (MW)	117	1,343	6,831
Wind (MW)	55	631	3,211
Biomass (MW)	5	57	292
% of Renewables with Large hydro	10%	18%	20%
% of Renewables without Large hydro	1.30%	8%	16%

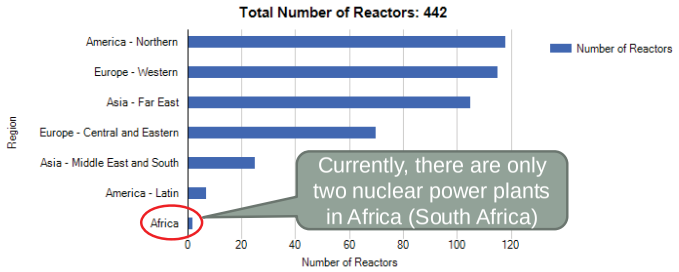
7. Power development scenarios
7.2 Scenario setting

	Capacity Share			Evaluation		
	Gas	Coal	Hydro and Renewable	Cost	Energy Balance	Environment
Scenario-1 (Conservative)	70%	10%*1	20%			
Scenario-2 (More coal)	60%	20%*2	20%			
Scenario-3 (No coal)	75%	0%	25%			

*1: A 1,000MW coal fired power plant consumes 3 million ton of coal for one year, 90 million ton for 30years. Considering the proved reserve of 461million ton, the reserve can accommodate up to 5,000MW coal fired power plants.
*2: More proved coal reserve needs to be identified.

Nuclear power in Nigeria?

◆ Nuclear power plants in the world (as of Jan. 2016, IAEA statistics)



◆ Comparison of unit construction cost

Type	Capacity	Unit Const. Cost
Nuclear	1,100MW	$ 5,600/kW
Combined cycle	1,000MW	$842/kW
Coal fired conventional	1,000MW	$2,000/kW

[Source] "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants" (US-EIA), Gas Turbine World Handbook

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT

Environmental and Social Considerations (ESC)

Feb. 3, 2016
JICA Study Team

OUTLINE

1. What is Strategic Environmental Assessment (SEA) ?
2. SEA in power planning
3. Activities in TWG for ESC
4. Scoping of environmental and social impacts
5. Data for SEA
6. Next SEA work plan

WHAT IS STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)?

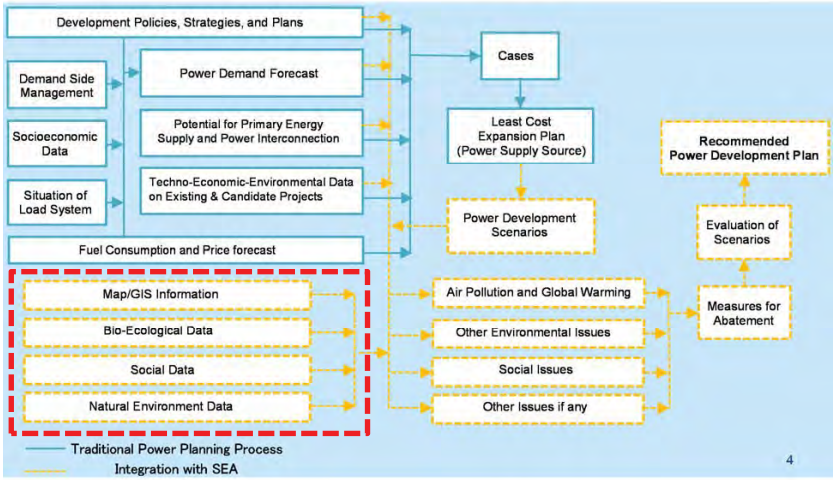
Analytical and participatory approach that aims to integrate environmental considerations into policies, plans, and programs, and evaluate the inter linkages with economic and social considerations."

OECD/DAC, "Applying Strategic Environmental Assessment: good practice guidance for development cooperation" (2006)

- Overall process for SEA:
  - ✓ Investigate multiple scenarios to be compared
  - ✓ Investigate relevant cumulative impacts
  - ✓ Scoping of environmental and social impacts
  - ✓ Stakeholder meetings (as needed)

3

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) IN POWER PLANNING



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ACTIVITIES IN TECHNICAL WORKING GROUP (ESC)

- Group Meeting 1 (Jan. 19, 2016)
  - SEA process
  - Stakeholder analysis -1
- Group Meeting 2 (Jan. 25, 2016)
  - Stakeholder analysis -2
  - Scoping discussion

5

SCOPING FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

Potential impacts of the power system development
(Environmental pollution & Natural environment)

A+/-: Significant positive/negative impact
B+/-: Positive/negative impact to some extent
C: Positive/negative impact unknown
D: No impact

Item	Thermal power		Hydro power	Renewable energy		Transmission lines	Substations
	Gas	Coal		Wind	Solar		
1.Environmental pollution							
Air quality	B-	A-/B-	D	D	D	D	D
Water quality	A-/B-	A-/B-	A-/B-	D	D	D	D
Wastes	B-	A-/B-	B-	D	D	D	D
Soil contamination	B-	B-	D	D	D	D	D
Noise and vibration	A-/B-	A-/B-	D	B-	D	D	D
Ground subsidence	C	C	C	C	C	C	C
Odour	D	D	D	D	D	D	D
Bottom sediment	D	D	B-	D	D	D	D
2.Natural environment							
Protected areas	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D
Ecosystem	B-/D	B-/D	A-/B-	B-/D	B-/D	B-/D	B-/D
Hydrology	B-	B-	A-/B-	D	D	D	D
Topography and geology	B-/D	B-/D	A-/B-	D	D	D	B-/D

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SCOPING FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

Potential impacts of the power system development
(Social environment and other issues)

Item	Thermal power		Hydro power	Renewable energy		Transmission lines	Substations
	Gas	Coal		Wind	Solar		
3.Social environment							
Resettlement	B-	B-	A-/B-	B-	B-	B-	B-
Poverty	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Ethnic Minorities/Indigenous People	C	C	C	C	C	C	C
Regional economy	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Land Use/Natural Resources	B-/D	B-/D	A-/B-	B-/D	B-/D	B-	B-
Water Use	B-/D	B-/D	A-/B-	B-/D	B-/D	D	D
Existing Social Infrastructure and Institution	B-/D	B-/D	A-/B-	B-/D	B-/D	B-	B-/D
Misdistribution of Benefit and Damage	B-	B-	B-	B-	B-	B-	B-
Local Conflict of Interest	B-	B-	B-	B-	B-	B-/D	B-
Cultural heritage	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D
Landscape	B-	B-	B-	B-	B-	B-	B-
Gender/Children's right	B+/D	B+/D	B+/D	B+/D	B+/D	B+/D	B+/D
HIV/AIDS and diseases	B-	B-	B-	B-	B-	B-	B-
Working environment	B-	B-	B-	B-	B-	B-	B-
4. Other							
Accidents	B-	B-	B-	B-	B-	B-	B-
Electromagnetic waves	D	D	D	D	D	B-	D
Climate change	B-	A-/B-	C	D	D	D	D

DATA FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

- Environmental regulations related to power sector
- CO2: Nigeria's Intended Nationally Determined Contributions in COP21
- Biodiversity and protected area data/maps
  - National parks, internationally protected areas etc.

... And more data necessary for detailed SEA

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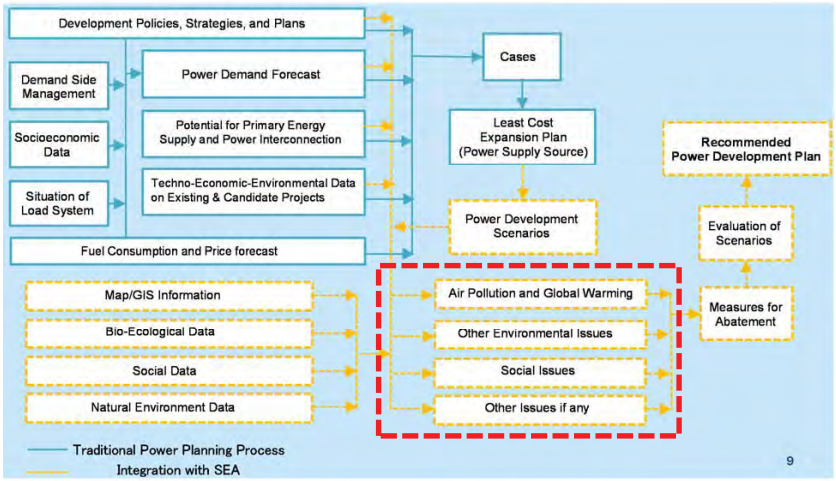
NEXT SEA WORK PLAN



WE WOULD APPRECIATE YOUR COOPERATION

THANK YOU!

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