NIGERIA ENERGY SECURITY AND EMISSIONS SCENARIOS TO 2050*

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PRESENTATION OUTLINE

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1. Acknowledgements

The Energy Commission of Nigeria, on behalf of the Federal Government and people of Nigeria wishes to express our profound appreciation to:

- The UK-Department of Energy and Climate Change (UK-DECC) for providing the technical and financial support for the development of the Nigeria Energy and Emissions Calculator (NEEC), as well as funding our trip to this conference;
- The British High Commission in Nigeria for facilitating the administrative and financial processes involved in the development of the NEEC;
- ITRI for organizing this conference in conjunction with the UK-DECC;
- Our numerous stakeholders home and abroad, most of whose contributions have been incorporated in the NEEC.

2. Introduction

- Energy is an essential ingredient for socio-economic growth of all nations
- The function of an energy system is to provide energy services in the industrial, transport, household and services sectors of the economy. Energy is therefore the oil that lubricates the engine of development and growth of national economies.
- Nigeria is fortunately well endowed with a variety of fossil and renewable energy types.
- However, supply of electricity is inadequate; while fuel petroleum product supply is not secured, since supply has been mainly from imports.

2. Introduction Cont'd…

- Since 2003, Nigeria has had 80% of its energy supply mix for grid-connected power generation, estimated at 11,000MW, from natural gas; while the outstanding 20% was from hydropower;
- Energy for transportation or motive power have been primarily from petroleum based fuels. About 75% of household use biomass (firewood) as heating fuel, 23% use kerosene and 2% use other fuels (LPG, coal and electricity);
- Total final energy consumption in 2012 was about 106.4 Million TOE made of hydro (0.6%), petroleum products (8.3%), coal (0.01%), natural gas (22.53%) and traditional biomass (68.52%) ;

2. Introduction Cont'd…

- Government has however, through national energy policy supported the diversification of the energy mix for driving the economy to include solar energy, wind, modern biomass and nuclear; while automotive fuel is to include biofuels at levels of E10 and B20.
- All forms of energy must however be produced and utilized efficiently using efficient technologies and best practices through active participation of the private sector in a liberalized energy sector.
- The challenge therefore in Nigeria is raising modern energy access to all by 2030 and beyond in an environmentally friendly manner and at affordable costs, i.e. challenge of the energy 'trilemma' (affordability, decarbonisation and energy security).

2. Introduction Cont'd…

Energy Resources in Nigeria

S/No.	Resource Type		Reserves	Production	Utilization
1.	Crude Oil		37.1 billion barrels (2013)	2.19 million barrels/day (2013)	445,000 barrels/day Domestic allocation; 22% capacity utilization of refineries in 2013
2.	Natural Gas		182.3 trillion SCF (2013)	2.325TSCF/day (2013)	82% utilized, 18% flared (2013)
3.	Coal and lignite		2.734 billion tonnes	insignificant	insignificant
4.	Tar Sands		31 billion barrels of oil equivalent	-	-
5.	Large Hydropower		11,250 MW	1,938 MW	0.52 Capacity factor (2013)
6.	Small Hydropower (≤ 30MW)		3,500 MW	60.58 MW	0.5 Capacity factor (2013)
7.	Solar Radiation		3.5 - 7.0 kWh/m^2/day	Excess of 20MWp of solar PV	Excess of 20MWp of solar PV
8.	Wind		(2-4) m/s at 10m height	20MW	-
9.	Biomass	Fuelwood	11 million hectares of forest and woodland	58.4 million tonnes/year	58.4 million tonnes/year
		Animal waste	245 million assorted in 2001	0.781 million tonnes of waste/day in 2001	Not available
		Energy Crops and Agric Residue	72 million hectares of Agric. Land and all waste lands	28.2 million hectares of arable land	8.5% of arable land cultivated
10.	Nuclear Element		Not yet quantified	-	30kW Research reactor

Source: i) NNPC (2013): Annual Statistical Bulletin; ii)TCN (2013): Annual Technical Report; iii) ECN (2005): Renewable Energy Masterpaln (REMP); iv) DPR (2014)

2. Introduction Cont'd…

Nigeria's Energy Supply and The Economy

S/N	ITEMS	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.	Electricity generation (billion kWh)	22.03	23.9	24.22 (503)* (10,695)**	23.8	23.3	21.27 (562)* (18,603)**	20.8	25.02	27.7 (619)* (20,407)**	29.6
2,	Energy Consumption per Capita (kgoe/Capita)	151.3	125.5	132.6 (680)* (1,780)**	87.1	81.4	80.8 (670)* (1,830)**	83.1	77.8	73.6 (670)* (1880)**	65.7
3.	Electricity Consumption/capita (kWh/Capita)	174.6	176.4	181.4 (563)* (2596)**	167.6	161.2	142.9 (571)* (2782)**	135.2	157.1	165 (592)* (2933)**	175.9
4.	GDP/Capita (US$/Capita)	620.7	658.0	826.3 (2314)* (8,492)**	1030.3	1223.5	1286.3 (2540)* (9550)**	1,106.8	1440.7	1470.6 (1281)* (7520)**	1513.4
5.	Energy Intensity (kgoe/ US$)	0.244	0,191	0.161 (0.294)* (0.210)**	0.085	0.067	0.063 (0.264)* (0.192)**	0.075	0.054	0.050 (0.550)* (0.250)**	0.043
6.	GDP Growth Rate (%)	9.6	6.6	6.5	6.0	6.5	6.0	7.0	8.0	7.4	6.6
7.	CO2/population (tonnes CO2/cap)	0.37 0.86* 3.96*	0.39 0.88 4.05	0.40 0.91* 4.22**	0.35 0.92* 4.31**	0.30 0.92* 4.40**	0.33 0.96* 4.42**	0.27 0.93* 4.26**	0.29 0.91* 4.43**	0.33 0.93* 4.50**	0.38 0.95* 4.51**

Sources: CBN (2005-2012), NCC, Osogbo (2009 -2012),
****Africa Average - IEA (2007, 2010, 2013, 2014)***
*****World Average - IEA (2007,2010, 2013, 2014)***

3. Objectives of NEEC

The objectives set out at the beginning of the project are:

- To develop an interactive user-friendly tool that allows non-experts to develop their own combination of levels of change in different technologies and sectors of the economy to explore different energy and emissions scenarios out to 2050;
- To build in-house capacity to develop the tool.

4. NEEC Modelling Approach

- The UK DECC developed 2050 pathways in 2009
- The pathways calculator is aimed at helping countries analyse how to reduce emissions while meeting their energy needs.
- It has the capacity to take into account all the different structures in the country's energy.
- The tool looked at what might be practically and physically deliverable in each sector over the next 40 years under different assumptions.
- The Pathways Calculator then allows users of the tool to explore their own choices.

4. NEEC Modelling Approach

- Officials of UK-DECC introduced the Nigerian to the he calculator over a period of one week (18th – 22nd November, 2013);
- The UK-DECC, British High Commission in Nigeria and the Energy Commission of Nigeria signed Memorandum of Understanding on Friday 22nd November 2013
- Thereafter, the Nigerian was set up and began developing the 1-pagers (scenarios);
- Sent drafts of 1-pagers to UK-DECC by email, which they reviewed and advised further;
- Regular meetings by telephone to discuss updates, challenges and way forward;
- One-day (21st August 2014) stakeholders workshop in Abuja to discuss 1-pagers and receive input from energy and environment experts stakeholders to improve scenarios;

4. NEEC Modelling Approach

- Nigerian Team visited UK-DECC over the period 15th – 27th September 2014 to get training on excel; version, improvements of the 1-pagers and structure of the energy system;
- Nigerian Team returned home to continue working on the excel version;
- Team and UK-DECC continued to exchange emails and have telephone meetings to discuss progress, challenges and way forward;
- UK-DECC officials visited Team in Abuja from 17th – 21st November, 2014 to help improve excel work;
- Finally we got the excel work completed and ready for connection to the website;
- Adapted UK-2050 Calculator for the NEEC.

5. Projection of Energy Demand and Supply

- Global Assumptions
  - Economic growth – assumed average GDP growth rate of 7% per annum over the study period of 2010 – 2050
  - Population growth from 159.3 million in 2010 to 403.9million in 2050.
  - Government has set ambitious goals to re-position Nigeria from its position (25^{th} in 2013 **)** in the world's GDP ranking to be among the top 20 most developed countries in the world by year 2020. This requires huge amount of energy.

5. Projection of Energy Demand and Supply …Cont'd

Energy demand sectors and supply technologies

Energy demand sectors

- Residential
  - Cooking, lighting and appliances
  - Cooling
- Service
  - Cooking, lighting and appliances
  - Cooling
- Transport
- Industry

Non-energy sectors

- Volume of waste & recycle
- Agriculture and land use
- Types of fuel from biomass

Energy supply sectors

- Bioenergy
- Nuclear
- Coal
- Gas
- Oil
- Wind
- Solar PV
  - Grid Connected
  - Stand Alone
- Concentrated Solar
- Hydroelectric power
  - Large
  - Small

5. Projection of Energy Demand and Supply …Cont'd

2050 Pathways ...

Demand

- **Level 1**: assumes highest level of energy demand or activity requiring energy
- **Level 2**: describes a level energy demand that is lower than Level 1 that is achievable by applying a level of effort that is likely to be viewed as ambitious but reasonable by most or all experts.
- **Level 3**: describes energy demand level lower than in Level 2 but which might be achieved by applying a very ambitious level of effort that is unlikely to happen without significant change from the current system; it assumes significant technological breakthroughs.
- **Level 4**: describes a level of energy demand than in Level 3 that could be achieved with effort at the extreme upper end of what is thought to be physically plausible by the most optimistic observer.

Supply

- **Level 1**: assumes little or no efforts is deployed
- **Level 2**: describes what might be achieved by applying a level of effort that is likely to be viewed as ambitious but reasonable by most or all experts.
- **Level 3**: describes what might be achieved by applying a very ambitious level of effort that is unlikely to happen without significant change from the current system; it assumes significant technological breakthroughs.
- **Level 4**: describes a level of change that could be achieved with effort at the extreme upper end of what is thought to be physically plausible by the most optimistic observer.

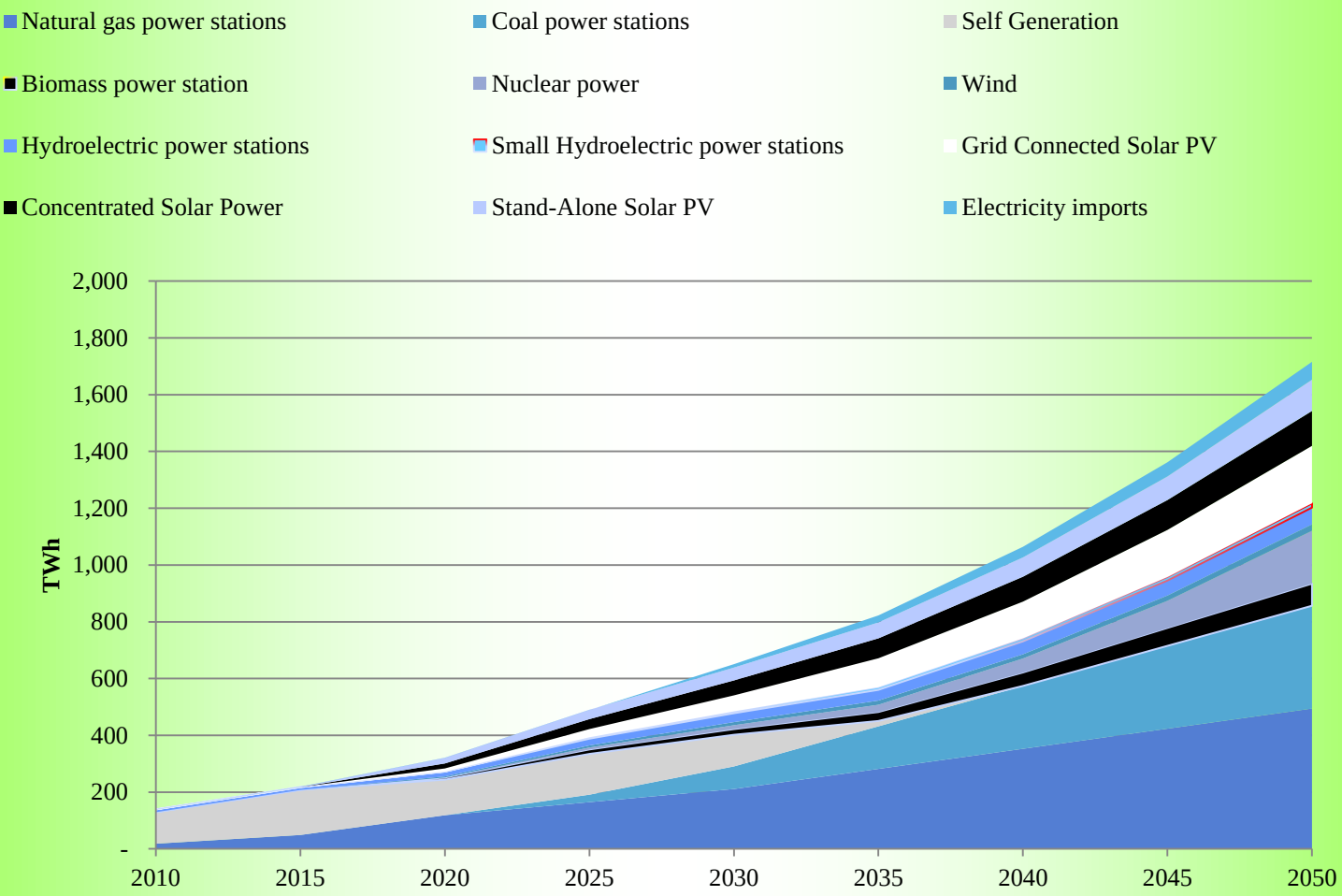
5. Projection of Energy Demand and Supply …Cont'd

Electricity Demand in TWh using NEEC (Level 1)

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050
Transport	0	2	2	3	3	4	4	5	5
Industry	31	38	47	56	62	92	136	199	293
Cooling	45	72	101	131	164	197	233	272	312
Lighting, appliances & cooking	38	69	123	225	324	431	526	621	723
Total	**115**	**181**	**272**	**416**	**553**	**724**	**900**	**1,097**	**1,333**

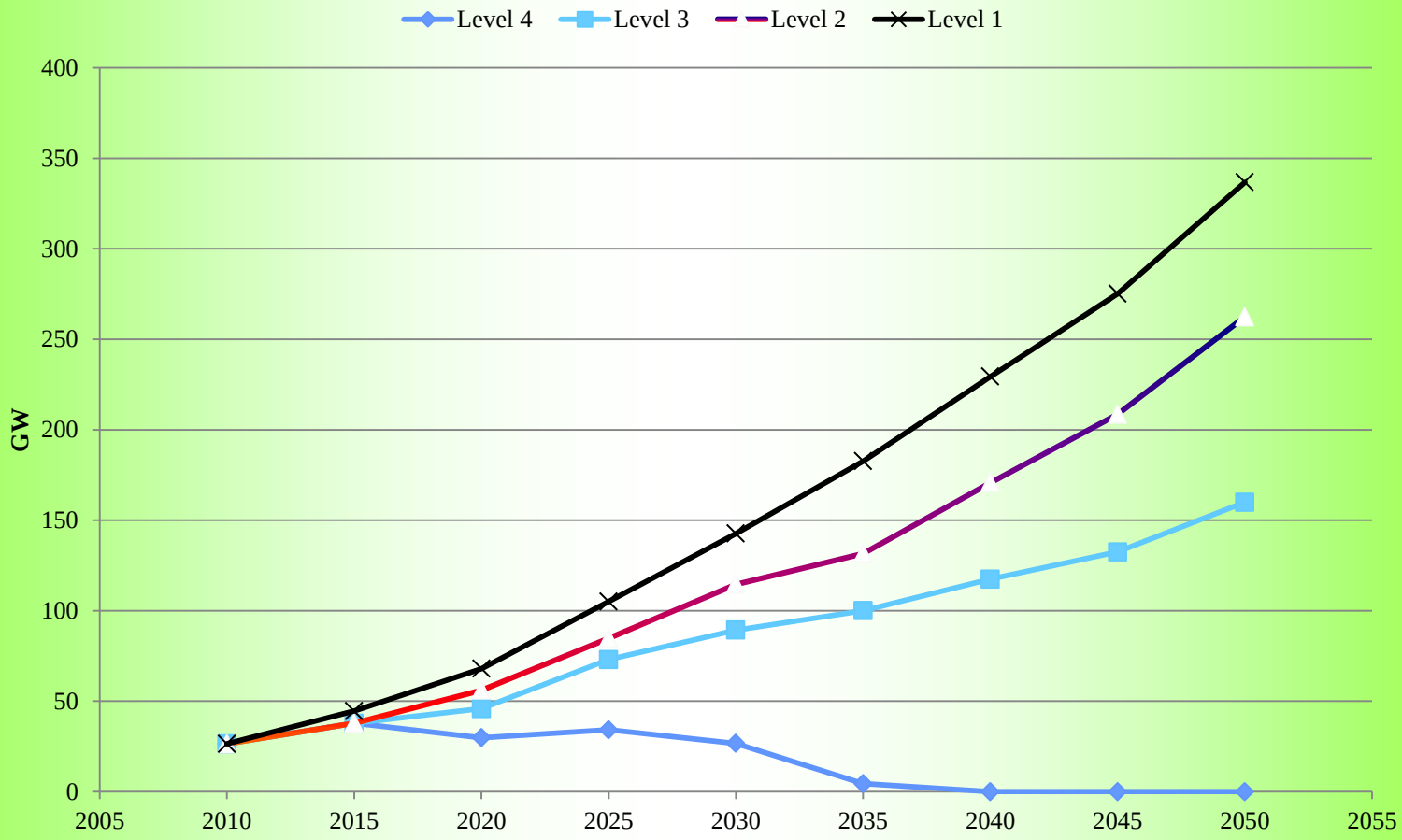
5. Projection of Energy Demand and Supply …Cont'd

Power Supply in TWh using the NEEC Calculator (Level 4)



5. Projected Energy Demand and Supply …Cont'd

Ability of electricity supply to meet demand (capacity addition)



5. Projection of Energy Demand and Supply …Cont'd

Extract out the quantities that are imported (TWh)

Level 4

Vector	2010	2015	2020	2025	2030	2035	2040	2045	2050
Uranium	0	0	0	21	41	79	152	294	568
Electricity	0	0	0	0	12	25	0	0	0
Bioenergy	0	0	0	0	0	0	0	0	0
Coal	0	0	0	0	0	0	32	99	171
Oil	0	0	0	0	0	0	0	0	0
Gas	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**21**	**53**	**104**	**184**	**392**	**738**

Level 1

Vector	2010	2015	2020	2025	2030	2035	2040	2045	2050
Uranium	0	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0	0
Bioenergy	0	0	0	0	0	0	0	0	0
Coal	0	0	0	0	0	0	0	0	0
Oil	0	0	393	1240	2106	3052	4148	5253	6728
Gas	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**393**	**1240**	**2106**	**3052**	**4148**	**5253**	**6728**

5. Projection of Energy Demand and Supply …Cont'd

Power Demand in MWyr using the NEEC (Level 1)

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050
Transport	119	179	238	298	357	417	476	536	596
Industry	3,557	4,357	5,309	6,426	7,076	10,444	15,497	22,692	33,372
Cooling	5,156	8,255	11,526	14,984	18,641	22,513	26,615	30,964	35,579
Lighting, appliances & cooking	4,326	7,874	13,979	25,706	36,979	49,129	60,008	70,837	82,405
Total	**13,159**	**20,665**	**31,053**	**47,413**	**63,054**	**82,503**	**102,597**	**125,030**	**151,951**

5. Projection of Energy Demand and Supply …Cont'd

Power Supply in MWyr using the NEEC (Level 1)

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050
Natural gas	2,099	5,596	13,522	18,775	24,057	32,129	40,202	48,281	56,354
Coal	-	-	-	2,998	9,069	17,088	25,183	33,203	41,222
Self Generation	12,641	18,085	14,267	16,347	12,768	2,115	-	-	-
Biomass	-	-	899	1,799	2,248	3,598	5,396	7,195	8,994
Nuclear	-	-	-	799	1,519	2,958	5,676	10,953	21,186
Wind	-	-	420	839	1,259	1,679	1,679	2,099	2,518
Hydropower s	1,139	1,139	1,943	2,740	3,544	4,341	5,145	5,942	6,745
Small Hydropower	32	32	32	523	768	1,013	1,258	1,504	1,749
Grid Connected Solar PV	-	-	1,232	3,301	6,417	11,633	14,751	18,918	23,084
Concentrated Solar Power	-	-	1,997	3,998	5,995	7,996	9,993	11,993	13,991
Stand-Alone Solar PV	3	105	2,281	3,721	5,158	6,387	7,765	9,474	12,591
Electricity imports	(60)	(60)	(60)	(60)	1,378	2,816	4,254	5,692	7,130
Total	**15,854**	**24,897**	**36,533**	**55,780**	**74,181**	**93,754**	**121,302**	**155,253**	**195,565**

6. Analysis of Emissions

The energy projections in the NEEC have a wide range of environmental implications, in terms of local impacts and the much broader issue of global climate change. These can include:

- energy-related greenhouse-gas emissions, such as from power generation and transport; local pollution, particularly in growing urban areas; indoor air pollution, as the widespread traditional use of solid biomass for cooking continues;
- deforestation and land degradation as the result of unsustainable practices to cater for fuelwood and charcoal consumption;
- other forms of environmental degradation, such as from open-cast mining or oil spills resulting from oil theft or sabotage;

6. Analysis of Emissions

- a range of environmental considerations linked to new hydropower projects (especially those with reservoirs);
- emissions from the venting or flaring of natural gas.

Though Nigeria, being a developing country with low emissions per capita, has no emission limits, as policy adviser to government, we have included the issue of emissions in our analysis to be able to engage in informed debate prior to giving policy recommendations.

6. Analysis of Emissions

		2010	2015	2020	2025	2030	2035	2040	2045	2050
	Greenhouse gas emissions (MtCO2e) @ Level 1									
1	Fuel Combustion	324	441	458	555	617	648	790	975	1,190
2	Industrial Processes	28	33	40	49	59	71	86	106	28
3	Solvent and Other Product Use	-	-	-	-	-	-	-	-	-
4	Agriculture	23	23	22	22	22	22	22	21	21
5	Land use, land use change & forestry (LULUCF)	2	10	17	23	27	30	32	34	36
6	Waste	13	11	8	6	5	3	3	2	1
7	Other	-	-	-	-	-	-	-	-	-
	TOTAL	**390**	**518**	**545**	**655**	**730**	**774**	**933**	**1138**	**1276**
	Greenhouse gas emissions /cap (tCO2e) @ Level 1									
	Tonnes CO2e	**2.45**	**2.83**	**2.63**	**2.79**	**2.75**	**2.58**	**2.82**	**3.11**	**3.16**

7. Challenges of the Modelling Project

We encountered a lot of challenges right from inception to the end of the project. The challenges include:

- Understanding the modelling methodology
- Constituting the Team
- The concept of the scenarios
- Understanding data requirements, collection and analysis
- The Excel work
- The webtool
- Finance

With the help of the UK-DECC, we have been able to overcome the challenges except for the webtool that is still outstanding. We expect this to be resolved soon.

8. Conclusion

- The demand for modern energy and electricity in Nigeria will continue to grow in view of its growing population and the desire for fast industrialization and improvement in the standard of living;
- Given that our energy access is low, we need to upscale our energy infrastructure to power socio-economic development;
- We need to develop our energy infrastructure to in a way that will avoid the unsustainable pathways of countries that have developed before us;
- We have adapted the UK-2050 Calculator to develop the NEEC. The calculator will assist in the strategic planning and coordination of national policies on energy;
- The model gives flexibility in analysing policies to be adopted in addressing the challenge of energy 'trilemma' in Nigeria as well as help in informed debate with stakeholders on pathways implementation;
- We are happy to have acquired the expertise to adapt the UK-2050 Calculator to produce NEEC and subsequent updates in will be much easier for us.
- Once more, we express our profound appreciation to the UK-DECC and the British High Commission for their tangible support.

Nigeria Energy and Emissions Calculator

- Website:
  www.nigeria-energy-and-emissions-calculator.org

- Email: nigeria2050@mail.energy.gov.ng

Thank You

AND GOD BLESS!