

Powering Nigeria for the Future



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Foreword

Over the last decade, Nigeria has been one of the shining stars in the African economy, given its status as one of the preferred destinations for global investments. However, in recent times, Nigeria's positive economic outlook has been severely affected. The GDP growth rate, which had a compound annual growth rate (CAGR) of 5.3% between 2011 and 2014, fell to 2.97% in 2015¹ and subsequently to – 0.36% in Q1 2016.² During this period, unemployment also grew from 6% in 2011 to 12.1% in Q1 2016.² This period of economic difficulty is expected to continue in the near term, given the drop in oil production and volatility in commodities prices globally.

In spite of the economic slowdown, there still exists significant potential for sustainable growth in Nigeria. There is a sizeable non-oil economy (driven by the services and agriculture sectors) which needs to become revenue and export-generating for the government. In addition, Nigeria's 46 million middle class population is one of the largest in Africa and is expected to be a key driver for consumption-led growth going forward.³ However, in order to emerge from the current situation, Nigeria needs to take specific steps towards building internal capabilities which will enable and support the economy. One area requiring immediate focus and investment is the power sector, where the low availability of power is currently a major obstacle. Nigeria's per capita power consumption is now only 151 kWh

per year, one of the lowest in the region and globally.⁴ The sector is currently inhibited by multiple factors such as value chain losses, limited transmission coverage and supply disruptions as well as theft and corruption (especially in distribution). Based on ongoing projects, the per capita power consumption in Nigeria will only reach 433 kWh per year in 2025.⁵ Given the requirements of the economy and the population, there is a critical need to drive higher power availability, and we believe a stretch target of 982 kWh per year (6.5 times the current level) by 2025 is realistic. This is based on benchmarking with other growth markets, like Vietnam.⁶

Reaching this goal will require a comprehensive transformation of the power sector in Nigeria, with three substantial 'leaps' over the next ten years, as outlined below:

- **Leap 1:** Accelerating growth in power generation capacity and improving utilisation
- **Leap 2:** Expanding the power transmission network and driving better efficiencies
- **Leap 3:** Establishing and scaling up efficient power distribution capabilities

This report identifies a total of ten levers within these three Leaps, which will play a critical role in further accelerating the ongoing journey towards a comprehensive transformation of Nigeria's power sector. This includes a mix of favourable policies,

implementation of new technology, faster project execution and improvement in operational efficiencies across the value chain. Executing these levers will also require significant involvement and alignment between the Federal Government of Nigeria, the Ministry of Power and the industry participants. In addition, the implementation needs to be well-planned and sequenced appropriately to derive the desired benefits. Overall, Nigeria has the potential to once again emerge as a shining star, not only within Africa, but in the global economy as well. Enhancing the availability of power over the next decade, based on robust generation, transmission and distribution capabilities, will help create a strong foundation towards unlocking this potential and powering Nigeria for the future.



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Oil woes: Can Nigeria's economy recover?

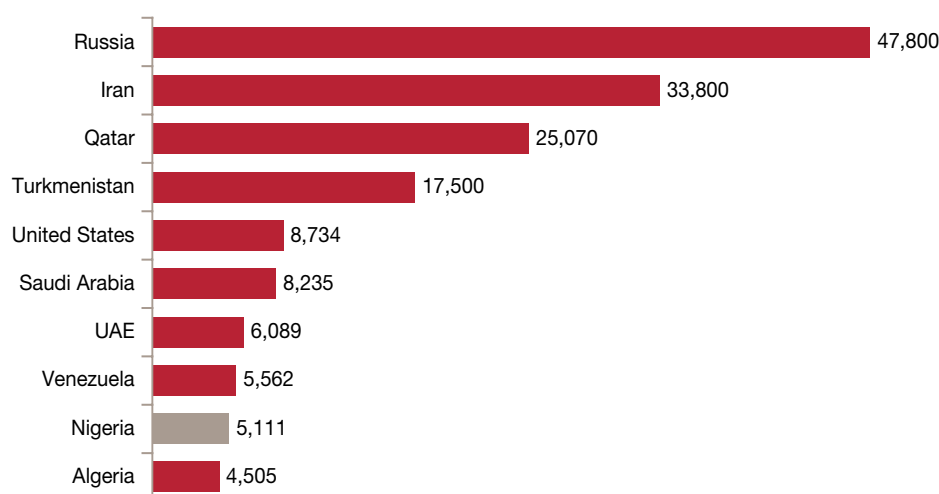
Since 2005 and until recently, Nigeria has been securing its position as one of the leading destinations for investment in Africa, thanks to a combination of a large and growing population, robust macroeconomic policies, strong commodity prices, demographic growth, resilient institutions and high capital inflows. Furthermore, a series of strategic national plans such as *Vision 20: 2020* and the *Transformation Agenda*, which

focused on strengthening infrastructure and employment, have spurred economic development. A rising star amongst global developing countries, Nigeria has been seen as an attractive destination for long-term investment.

In addition, revenues and taxes from the oil and gas sector have been providing substantial funding for critical public programmes across infrastructure, healthcare, education and agriculture.

Nigeria has the world's ninth largest natural gas reserves (accounting for more than 30% of Africa's discovered gas reserves), a position it has maintained for the last five years. It is also ranked eighth in OPEC's share of oil reserves in 2015 (see figures below).

Figure 1a: Natural gas reserves (billion cubic metres), 2015



Source: OPEC

However, in 2015, Nigeria's oil production as a percentage of OPEC production fell, reaching a low of 5.8% as compared to 7% in 2010.⁷ Revenues from oil exports dropped by more than 40% to reach US\$52bn in 2015 – dealing a devastating blow to government finances.⁸ A long history of mismanagement across the oil sector and the impact from the recent fall in oil prices also resulted in limited

funding for oil exploration and modernisation technology, further impacting the sector. The considerable reduction in oil exports also depleted Nigeria's foreign exchange reserves. Furthermore, restrictions imposed by the Central Bank to limit demand for foreign exchange in the official market resulted in a spill over to the parallel market, widening the gap between the official and parallel market exchange

Figure 1b: Share of OPEC oil reserves by country, 2015

Venezuela	24.9%
Saudi Arabia	22.1%
Iran	13.1%
Iraq	11.9%
Kuwait	8.4%
UAE	8.1%
Libya	4.0%
Nigeria	3.1%
Qatar	2.1%
Algeria	1.0%
Angola	0.7%
Ecuador	0.7%

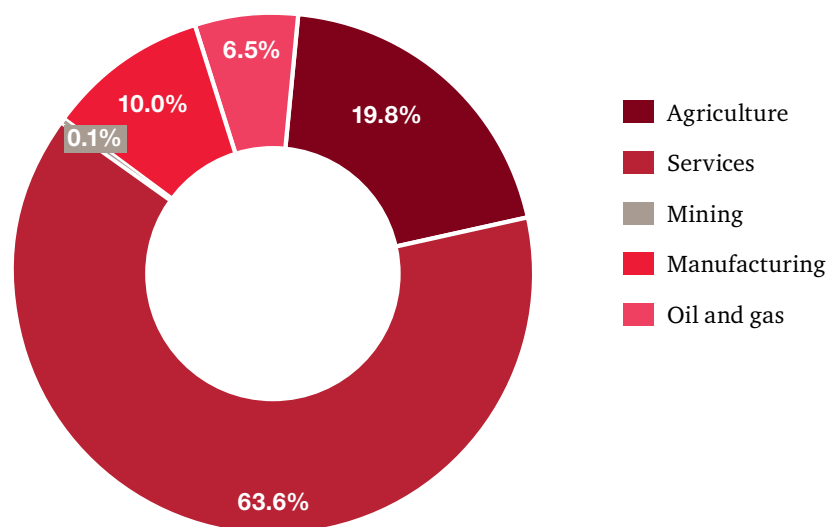
Source: OPEC

rate. Unemployment also grew from 6% in 2011 to 12.1% in Q1 2016, as investors started to re-assess their risk appetite.² Real GDP growth, which had a CAGR of 5.3% between 2011 and 2014, fell to 2.97% in 2015¹ and subsequently to – 0.36% in Q1 2016.² The most critical question now is whether, and how, will Nigeria emerge from this difficult situation?

More to Nigeria than oil and gas

Post rebasing of the Nigerian economy to 2010 prices (earlier pegged to 1990 prices), services and agriculture emerged as the two largest contributors to GDP – with a combined share of 83% in the first quarter of 2016 (see Figure 2). However, this sizeable non-oil economy needs to become revenue and export generating for the government. One step towards this is to improve tax collections from the non-oil sector to boost government revenues. Another critical step is to increase productivity in services and agriculture, ensuring that the growth in the services sector can be channelled as exports, and that increasing self-sufficiency in agriculture will stem imports.

Figure 2: Nominal GDP split, Q1 2016



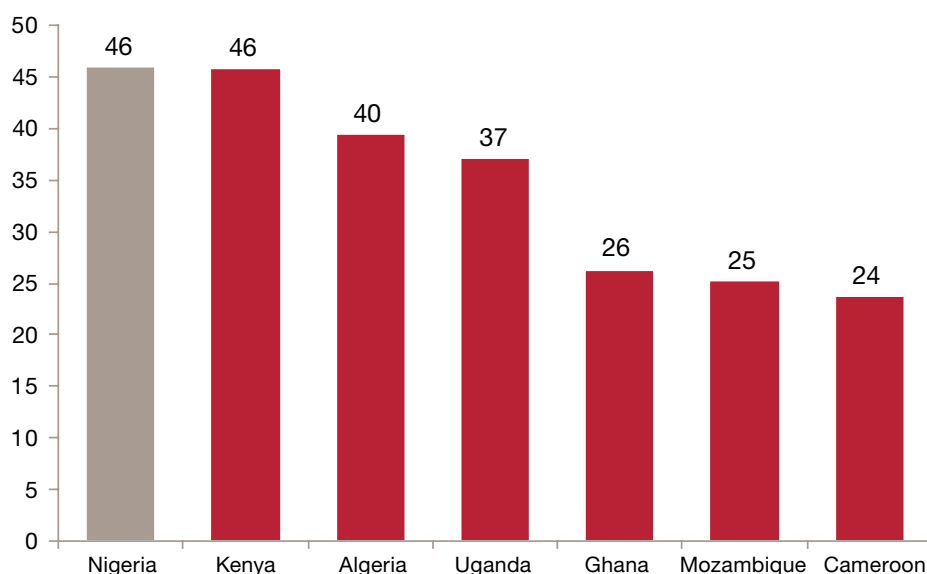
Source: Nigeria Bureau of Statistics (Q1 2016)
Note: Percentages calculated after rounding adjustments



The silver lining

Notwithstanding challenges faced over the last year, prospects for Nigeria's long-term growth are encouraging. With a population of approximately 182 million people, it is the seventh most populous country in the world.⁹ In 2015, Nigeria's 46 million middle class population was one of the largest when compared with countries across Africa (see Figure 3). Post GDP rebasing, Nigeria was named the largest market in Africa, surpassing South Africa in 2014 in terms of nominal GDP. It is also forecasted to be the ninth largest country in the world in terms of GDP (PPP) by 2050, increasing from a rank of 20 in 2014.¹⁰ To achieve this goal, Nigeria needs to unlock its underlying potential by taking specific steps to build capabilities and enable growth across multiple sectors.

Figure 3: Nigeria's middle class population (millions), 2015



Source: BMI Research

The transformative potential of the power sector

One such area requiring immediate focus and investment is the power sector. Cheap and abundant availability of power is a pre-requisite for economic development, with the potential to have a multiplier effect on growth. In addition, the power sector facilitates high capital spending which promotes investment and builds economic competitiveness. Take the example of India, where there is a strong commitment towards improving the business climate through addressing key bottlenecks in infrastructure. Here the

spotlight is on the power sector – where the government is seeking to attract investments worth US\$1trn by 2030.¹¹ This is a key reason India is currently one of the few emerging markets with promising growth prospects. In a similar fashion, Nigeria needs to also focus on attracting investments in power to re-energise economic growth and drive job creation as well as improve the living conditions for its residents.



The power sector: Lights off in Nigeria?

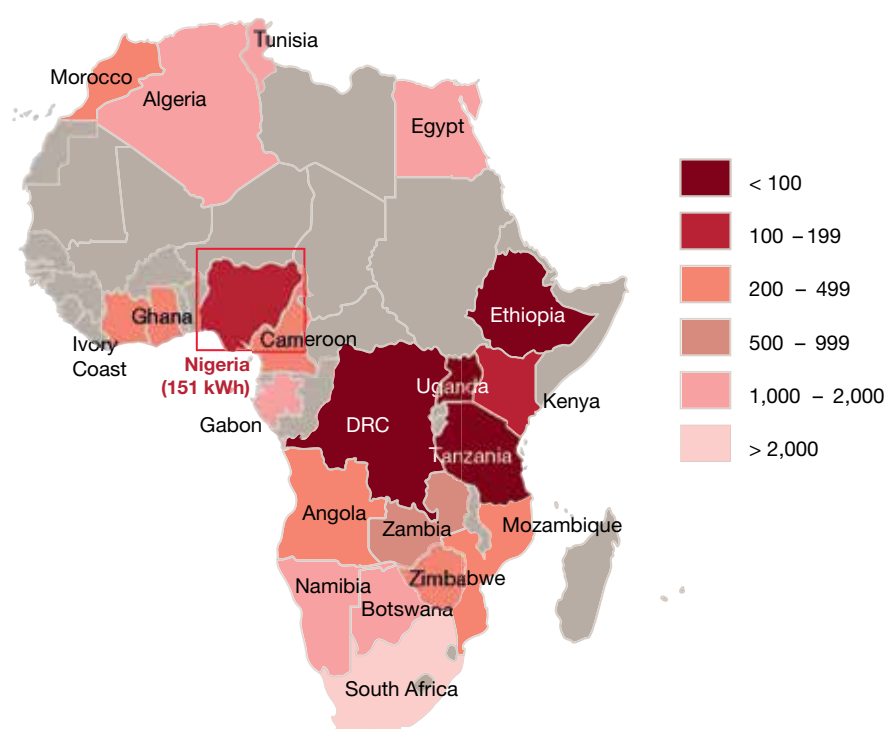
At present, less than half of Nigeria's population has access to grid-connected electricity. In 2015, power supply in Nigeria averaged 3.1 GW, which is estimated to be only a third of the country's minimum demand.¹² It seems counterintuitive that one of the largest oil producing and natural gas strongholds in the world struggles with providing power to its 182 million strong population. No one is immune to the failings of the power sector in

Nigeria – commuters have now adapted to dim and sparse street lighting, businesses have factored in the impact of power losses and residences struggle to receive adequate power supply.

To put the country's power sector in perspective, Nigeria has a per capita power consumption of only 151 kWh per year,ⁱ which is amongst the lower end of the spectrum in Africa (see Figure 4). Nigeria's population is three times that

of South Africa's, but it only has less than a third of South Africa's installed power generation capacity. It is not only Nigerian consumers who are suffering, but their businesses as well, as power cuts in Nigeria have an adverse impact on the overall economy.

Figure 4a: Annual per capita power consumption in selected African countries (kWh), 2015



Source: PwC Analysis, BMI Research, Nigeria Power Baseline Report (2015)

Figure 4b: What does power consumption per capita translate to?



• 2 hours of TV per day = 183 kWh a year



• 1 dishwasher load per day = 657 kWh a year



• 24 hours of refrigerator usage a day = 1,570 kWh a year

Source: One.org

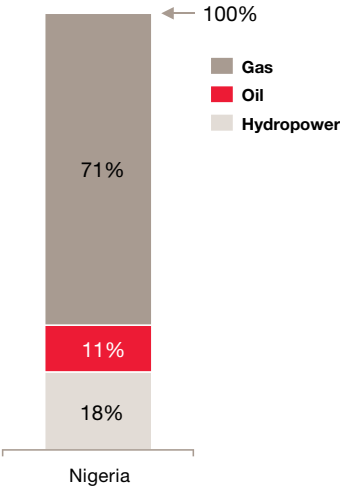
ⁱ Calculated as power distributed (KW) x 24 x 365/total population

Nigeria’s current power supply is from a mixture of sources. In 2015, thermal power – mainly oil and gas – constituted the majority of power generation, at 82%; hydropower made up a further

17.8%, with limited contributions by non-hydropower renewable sources making up the remainder (see figures below). While Nigeria’s power composition is relatively more

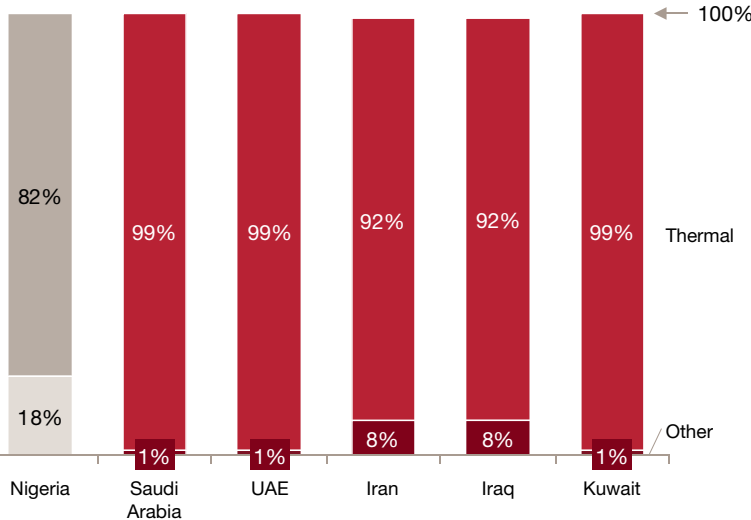
diversified than other OPEC countries, there exists significant scope for exploring alternative energy sources such as solar and wind power.

Figure 5a: Power composition – Nigeria, 2015



Source: BMI Research

Figure 5b: Power composition – Nigeria vs. select OPEC countries, 2015



Source: BMI Research



Evolution of the Nigerian power sector

Understanding the journey made over the last decade by the Nigerian power sector is critical in identifying the best way forward towards further improving power availability throughout the country (see Figure 6a). In 2005, under President Olusegun Obasanjo's leadership, a series of large-scale initiatives launched the power transformation journey. The National Electric Power Authority (NEPA), the sole provider of electricity, was replaced by the Power Holding Company of Nigeria (PHCN), which was unbundled

into six generation companies, 11 distribution companies (DisCos) and the Transmission Company of Nigeria. Furthermore, independent bodies such as the Nigerian Electricity Regulatory Commission (NERC) and the Rural Electrification Agency (REA) were formed to oversee progress and maintain transparency (see Figure 6b). Along the way, initiatives were launched to diversify the power sector through agreements to invest in hydropower, nuclear power and a range of renewable

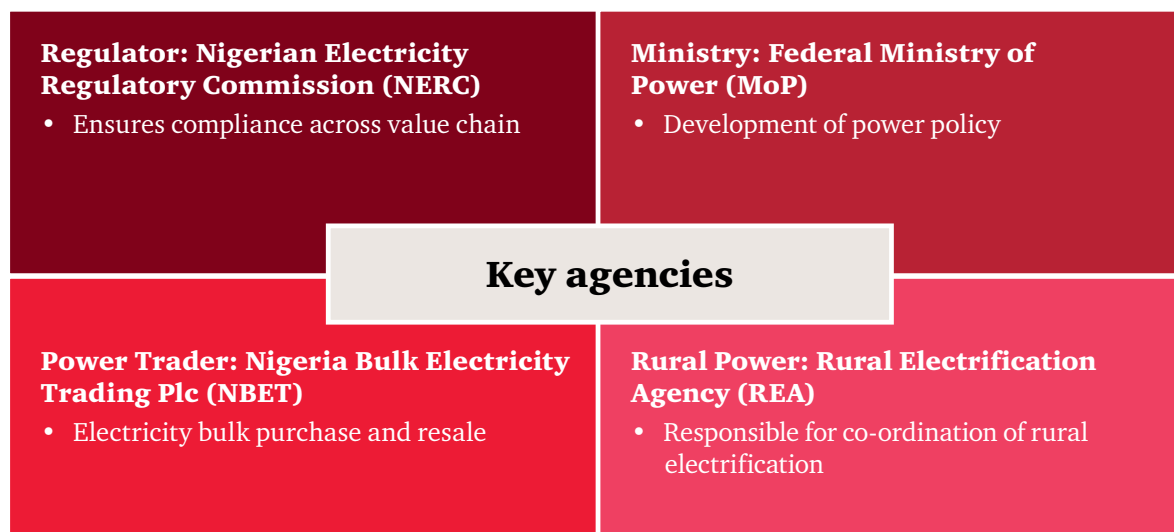
power sources. In 2010, a Roadmap for Power Sector Reform was developed, which privatised the generation and distribution companies, while transmission of electricity remained state-owned. In addition, the Nigeria Bulk Electricity Trading Plc (NBET) was formed to 'engage in the purchase and resale of electric power and ancillary services from independent power producers and from the successor generation companies'.¹³

Figure 6a: Understanding the Nigerian power sector





Figure 6b: Key power sector agencies



Source: Nigeria Power Baseline Report (2015)

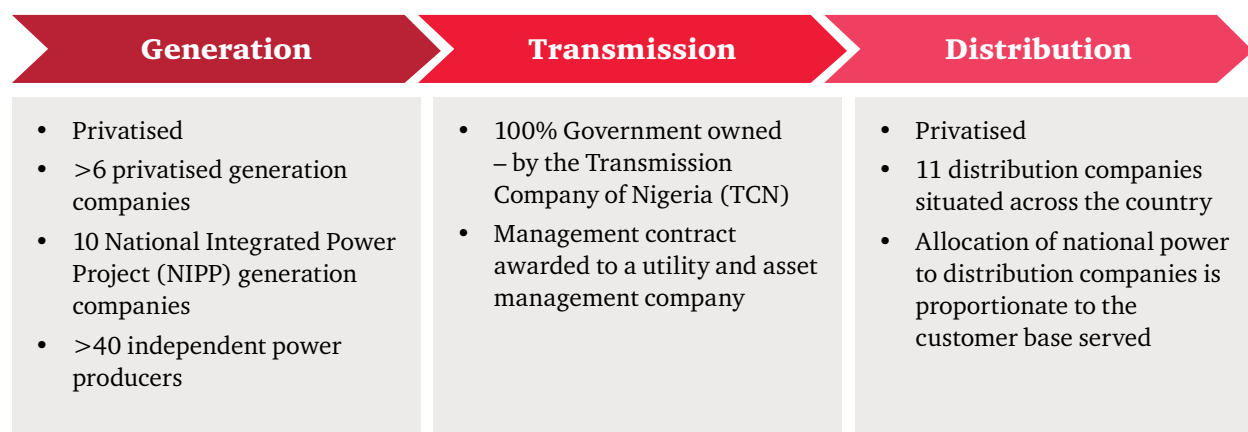
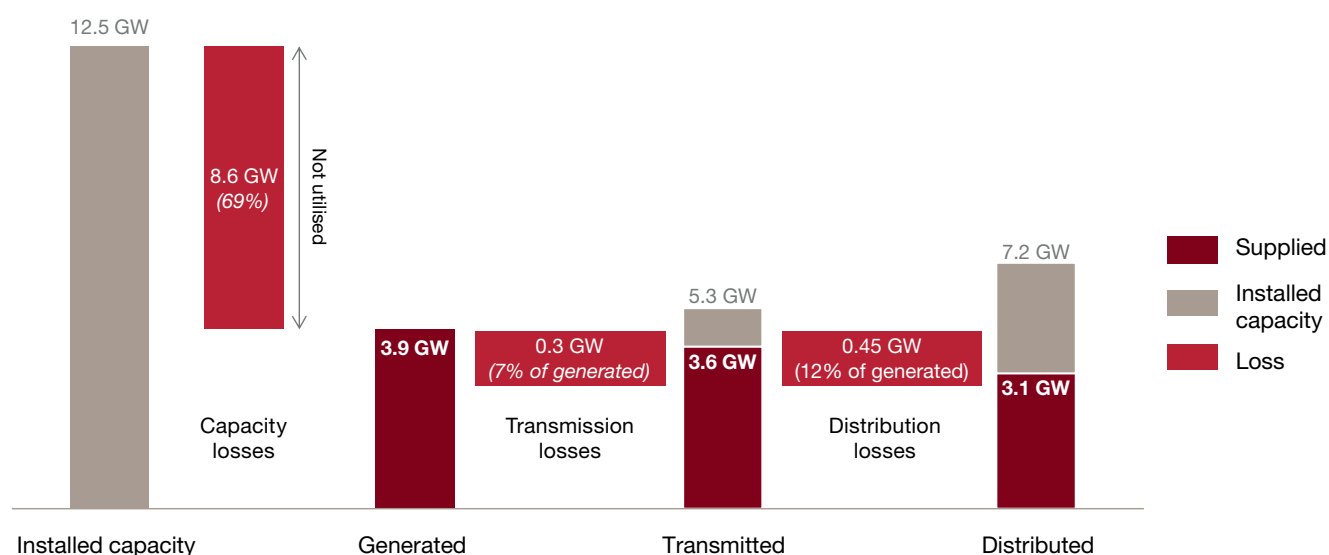
Reforms in the Nigerian power sector are among the most renowned efforts at privatisation on a national scale throughout Africa. They have demonstrated public and private sector commitment to improving the power eco-system through investment, increased competitiveness and de-regulation. However, there is still a long

way to go before Nigeria's power infrastructure capabilities will be on a par with other emerging economies. The immediate focus needs to be towards removing or at least reducing the key barriers to generating, transmitting and distributing power nationwide.

Barriers to adequate power provision

It is essential to understand Nigeria's power value chain in order to fully appreciate the extent of the current challenges faced and the opportunities for investors to play their part in the growth of this sector. A summary of the losses across Nigeria's power value chain, along with the categories of players in each segment, is depicted in Figure 7.

Figure 7: Installed capacity, supply and losses across the power value chain in Nigeria (GW), 2015



Source: Nigeria Power Baseline Report (2015)

A. Value chain losses

In 2015, as depicted in Figure 7, installed generation capacity (defined as the total available power generation capacity, assuming the power plants are operating at 100% efficiency) was estimated at 12.5 GW. Of this capacity, only 3.9 GW was actually generated – a capacity utilisation of only 31%. Exacerbating this loss, 7% of generated power (0.3 GW) was lost through the transmission process and a further 12% (of 3.9 GW) through distribution, resulting in a cumulative transmission and distribution loss of 19% of generated power. Overall, the net power available was 3.1 GW, which was only 25% of the installed generation capacity of 12.5 GW. These substantial losses across the value chain can be attributed to two key causes – technology limitations and outdated infrastructure.

In power generation, technology limitations can be significant, as power plants typically have a wide range of capacity utilisation rates depending on the technology used, as well as the age and condition of the infrastructure. Nigeria's power generation capacity utilisation is at the lower end of this range, which is unacceptable given the country's urgent need for power. On the other hand, other developing countries such as Brazil and India have relatively higher average utilisation rates of approximately 50%–60% as a result of significant efforts to attract investment in new technologies. Over the next decade, Nigeria must look towards improving capacity utilisation (currently at 31%) significantly by investing in new and efficient power generation technology, as well as revamping existing power plants. This is explored further in the 'The leap forward' section.

Power transmission and distribution (T&D) losses in Nigeria further reduce generated power output by 19%. While this is lower than a few other developing markets where T&D losses are greater than 20%, the benchmarks set by countries such as South Africa, Malaysia, Peru and Ukraine are much better (see Figure 8). These losses are heightened in rural areas, where infrastructure tends to be older, and maintenance is irregular. Transmission and distribution losses also result from issues such as limited funding and short-sighted policies which fail to encourage improvements in technology. The possible levers to address these challenges are discussed later in this report.

Figure 8: Value chain losses, 2015

Country	Total power capacity (GW)	Utilisation factor (% of installed capacity)	TD losses (% of power generated)
Nigeria	12.5	31%	19%
Brazil	121.7	55%	21%
Ecuador	5.4	49%	15%
Egypt	27.0	63%	16%
India	254.7	55%	22%
Malaysia	28.5	53%	14%
Mexico	62.3	55%	27%
New Zealand	9.5	54%	10%
Norway	32.3	47%	9%
Peru	9.7	47%	13%
South Africa	44.2	66%	10%
UK	85.0	48%	8%
Ukraine	55.2	40%	10%
Vietnam	24.5	73%	33%

Source: Nigeria Power Baseline Report (2015), BMI Research, PwC Analysis

B. Limited transmission coverage

The transmission sector is the only segment of the power value chain that is government owned. While it is managed and maintained by a private contractor, the government-owned Transmission Company of Nigeria (TCN) has the final word on decisions involving expansion of installed infrastructure. The existing transmission network comprises mostly 300kV circuits and substations. There are approximately 32 work centres spread across the country; although most are concentrated in the south. Furthermore, the transmission grid covers only 40% of the country – a limitation that is a significant growth barrier for the power sector in Nigeria.¹⁴ Going forward, Nigeria needs to attract new investments to increase geographic coverage in power transmission. In ‘The leap forward’, we explore a few examples of countries that have successfully attracted power investment and look at how their strategies may be replicated in Nigeria.

C. Supply disruptions

Supply disruptions due to violence are an additional challenge observed across the power value chain in Nigeria. Militant groups recognise the impact of disruptions on the economy – as evident through rampant violence targeted at oil and gas pipelines in the north and south of Nigeria, which in turn impacts power generation. While this situation has improved over the last year, investors remain cautious with exploration activities and expanding pipeline infrastructure (which has also been curbed due to the oil price drop).

D. Theft and corruption

Theft and corruption are other important concerns in the power sector – particularly for the distribution segment. Without sophisticated tracking systems to pinpoint illegal connections, electricity theft reduces profits for DisCos and limits available electricity for paying customers.

This is exacerbated by rampant corruption in revenue collections, which are largely manual. We discuss potential solutions for this in the report.

Overall, these challenges need to be adequately addressed in order to reap the positive effects of a well-functioning power sector – which is critical for the revival of the Nigerian economy. The focus needs to be on significantly improving availability and access to power over the next decade, by further accelerating the transformation journey started in 2005. Examples of successful transformational approaches (in power generation, distribution and transmission) adopted by other countries are provided in the ‘The leap forward’ section, and similar strategies can be adapted for Nigeria. However, we first need to evaluate what Nigeria should realistically target to achieve by 2025. This is outlined in the next section.





Vision 2025: What's the goal?

In order to evaluate the power gap in Nigeria and identify the goal for 2025, we have selected 'power consumption per capita' as a suitable indicator of measurement, as this depicts the end impact to the consumer, and is also aligned to the current need and focus. By considering this metric for Nigeria,

and comparing it across other growth markets, it is evident that Nigeria is one of the lowest ranked; having a per capita power consumption of only 151 kWh annually (see Figure 9). For this list, we have considered countries with a per capita GDP (at current prices) between

US\$2,000 and US\$4,000; this is to ensure that we compare Nigeria to other countries with a similar range of economic capacity. Further we have filtered out countries with a population less than 20 million, as comparisons with these nations may not be relevant.

Figure 9: Per capita power consumption (annual) for key growth markets (non-exhaustive)

Country	Power consumption per capita in kWh (2015)	Population in millions (2015)	Power consumption per capita in kWh (2025)	Population in millions (2025)	Increase in power consumption per capita (multiple)
Ukraine	3,234	44.8	4,157	42.4	1.3
Uzbekistan	1,621	29.2	1,805	33.3	1.1
Egypt	1,877	91.5	2,493	108.9	1.3
Vietnam	1,465	93.4	2,677	102.1	1.8
Indonesia	910	258.0	1,393	285	1.8
Morocco	873	34	1,240	37.7	1.4
Philippines	682	101.0	962	116.2	1.4
Sri Lanka	588	21.0	1,009	21.4	1.7
Nigeria	151	182.0	433	230	2.9
Average (excl Nigeria)	1,213		1,818		1.5

Source: BMI Research, Nigeria Power Baseline Report (2015), Directorate General of Electricity Indonesia, PwC Analysis

The current availability of power in Nigeria may become a significant bottleneck for broader economic growth. To address this gap and overcome the challenges mentioned in the previous section, Nigeria needs to focus more on developing new infrastructure and enhancing existing capabilities across the value chain. However, based on current trends, the situation is not expected to improve significantly. Assuming that all power generation projects currently in the pipeline (total projected installed capacity of 32.8 GW) in Nigeria will be completed on schedule and that

efficiency rates and losses across the value chain will remain constant, Nigeria's power consumption per capita is expected to reach 433 kWh in 2025.⁵ In spite of the three-fold increase from 2015 to 2025, Nigeria will still remain one of the lowest amongst the peer-set depicted in the figure above. To even reach the average of the other sample countries within the list above (1,818 kWh per capita), Nigeria will need to grow at a 12x multiple over the next ten years – which is a very high target, and may not be immediately feasible or realistic.

To arrive at a realistic target for Nigeria, we have examined what the other growth market economies have achieved over a ten to 15-year period, starting from a similar starting point vis-à-vis annual power consumption per capita. The timeframe has been chosen as it is the minimum required for a major transformation of the sector by improving existing operations and building new capabilities, as seen in cases such as Vietnam.

Figure 10: Change in annual per capita power consumption for key growth markets (non-exhaustive)

Country	Power consumption per capita in kWh (year in brackets)	Power consumption per capita in kWh (year in brackets)	Increase in power consumption per capita (multiple)	Time period (years)
Vietnam	159 (1995)	1035 (2010)	6.5	15 years
Egypt	199 (1972)	618 (1987)	3.1	15 years
Indonesia	163 (1990)	501 (2005)	3.1	15 years
Sri Lanka	169 (1992)	416 (2007)	2.5	15 years
Morocco	163 (1975)	357 (1990)	2.2	15 years
Philippines	236 (1971)	311 (1986)	1.3	15 years

Source: The World Bank, PwC Analysis

The country analysis depicted in the table above shows that Vietnam had one of the largest jumps in per capita power consumption, increasing by 6.5 times over a period of 15 years. We believe that a similar growth trajectory of a 6.5 times increase in annual per capita power consumption can be a suitable 'stretch target' for Nigeria going forward. Anything above this mark will not be realistic. However, we believe that the endeavour should be to achieve

the target within a shorter time frame (ten years instead of 15), given that Nigeria currently is in a stronger economic position than Vietnam in 1995 (with a higher GDP per capita). Also, there have been substantial improvements in technology over the last 20 years (2015 vs. 1995) which will further help Nigeria accelerate towards the identified target.



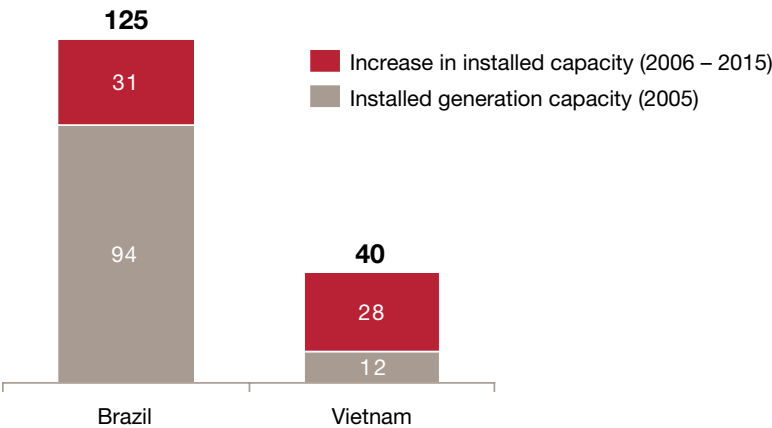
Breaking down the overall goal

The goal is to increase Nigeria’s annual per capita power consumption by 6.5 times in ten years, from 151 kWh in 2015 to 982 kWh per capita by 2025. This is an additional uplift of 125% above the projected consumption of 433 kWh per capita in 2025. We believe this can be achieved by driving improvements across a combination of three key variables: (1) installed capacity (2) utilisation factor and (3) transmission and distribution (T&D) losses. To identify realistic targets for each of the variables, we have considered benchmarks in other growth markets, for a suitable comparison.

Installed generation capacity:

We believe that Nigeria should target an increase in installed generation capacity by 40 to 45 GW over a ten-year period. Amongst growth markets, sizeable increases have been observed in Brazil and Vietnam (see Figure 11), where installed capacity has increased by 31.1 GW and 28.3 GW respectively between 2005 and 2015. This was driven by comprehensive power development plans, which were supplemented with aggressive public and private investment. For Nigeria, especially given that 32.8 GW of power generation projects are already in the pipeline, we consider the stretch target of a 40 to 45 GW increase in capacity (over ten years) to be realistic.

Figure 11: Increase in installed capacity in selected countries (GW), 2005 – 2015

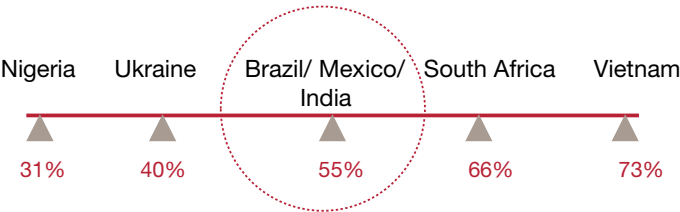


Source: Asian Development Bank (ADB) – Assessment of Power Sector Reforms in Vietnam, US Energy Information Administration (EIA), Ministry of Mines and Energy – Brazil

Capacity utilisation:

Here, we believe a target of 55% by 2025 (from the current 31%) will be a suitable stretch target. This will put Nigeria’s utilisation capacity on par with markets such as Brazil, Mexico and India, which have undertaken extensive efforts and investments in improving power diversity and modernising their power generation capabilities. This is also in line with Nigeria’s growing focus on technological improvement within the sector (see Figure 12).

Figure 12: Capacity utilisation (%), 2015



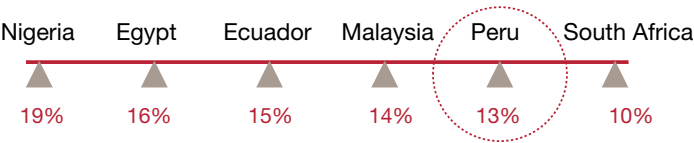
Why are India, Mexico and Brazil good benchmarks for capacity utilisation?

Brazil, Mexico and India	Nigeria	Gap
<ul style="list-style-type: none"> Strong concerted efforts to improve power diversity (public + private sector participation) 	<ul style="list-style-type: none"> Beginning to adopt alternative forms of power 	<ul style="list-style-type: none"> Nigeria’s power sector is mostly thermal-based and not as diversified as the benchmarked markets
<ul style="list-style-type: none"> Consistent investment in modernising the power generation sector 	<ul style="list-style-type: none"> Investment in modernisation is considered secondary to capacity expansion 	<ul style="list-style-type: none"> Nigeria needs to have a dual focus on modernisation and technological improvement along with capacity expansion

Source: Nigeria Power Baseline Report (2015), BMI Research, PwC Analysis

- T&D losses:** Here, a target of 13% seems to be a realistic one for Nigeria, on par with that of Peru, where government participation and policy has a significant bearing on transmission and distribution, similar to Nigeria. Also Peru has effectively utilised Public-Private Partnerships (PPPs) to drive growth, which seems aligned to Nigeria’s direction towards encouraging private investments (see Figure 13).

Figure 13: Average T&D losses (%), 2015



Why is Peru a good benchmark for T&D losses?

Peru	Nigeria	Gap
<ul style="list-style-type: none"> Even though T&D activities are 100% privatised, state regulations and policies are significant determinants of growth 	<ul style="list-style-type: none"> T&D activities owned by TCN, with a management contract awarded to a private player 	<ul style="list-style-type: none"> T&D privatisation is more advanced in Peru
<ul style="list-style-type: none"> PPPs in the transmission sector to boost infrastructure 	<ul style="list-style-type: none"> Nigeria needs to significantly expand transmission coverage throughout the country 	<ul style="list-style-type: none"> Significantly more PPPs in Peru’s transmission sector than in Nigeria

Source: Nigeria Power Baseline Report (2015), BMI Research, PwC Analysis

In summary, our ten-year stretch targets for the three variables are as follows:

1. Generation capacity addition of 40–45 GW
2. Capacity utilisation of 55% and
3. T&D losses of 13%.

The growth scenarios are developed based on a combination of these three variables.



Growth scenarios

We have identified five probable scenarios towards achieving the stretch target, as outlined below. Each scenario adjusts one or more variables (installed generation capacity, utilisation and T&D losses). The base case represents the

projected state of Nigeria's power sector in 2025 based on projects currently planned and ongoing developments, without considering any improvements in current efficiency levels.

Figure 14: Scenarios for achieving the per capita power consumption target of 982 kWh per year, by 2025

Scenario	Variables			Output
	Installation capacity (GW)	Utilisation factor (%)	TD losses (%)	Annual per capita power consumption (kWh)
Base case	45.3	31%	19%	433
Scenario 1	45.3	55% ↑	19%	769
Scenario 2	45.3	31%	13% ↓	465
Scenario 3	45.3	55% ↑	13% ↓	826
Scenario 4	102.7 ↑	31%	19%	982
Scenario 5	53.9 ↑	55% ↑	13% ↓	982

Even though Scenario 4 meets the desired target, we believe it is not feasible given the significantly large addition in installed capacity (more than double) and the corresponding required capital expenditure. This leaves us with Scenario 5 as the most realistic approach for Nigeria to achieve the target power consumption per capita of 982 kWh, by improving all the three variables. While the benchmarks have been chosen to

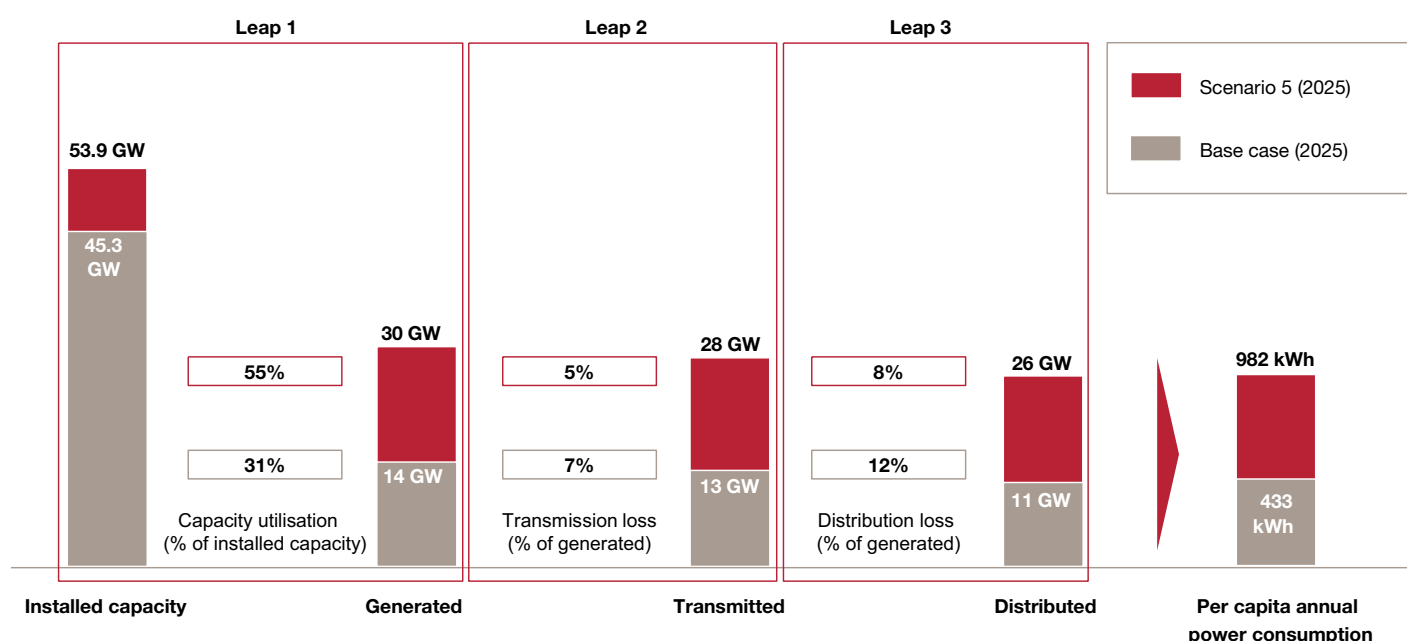
ensure the target is achievable; executing the changes required depends upon several factors and will not be without its challenges. In the subsequent section, we will explore key major levers for Nigeria to drive significant improvement – across power generation, transmission and distribution; in order to achieve the goals depicted in Scenario 5.



The leap forward

In this section, we outline some of the potential approaches which Nigeria can consider, along with successful examples of power sector growth in other developing economies. As mentioned in Scenario 5, meeting the target per capita power consumption of 982 kWh per year will need the following shifts, as shown below.

Figure 15: The Nigerian power sector in 2025 (Base case vs. Scenario 5)



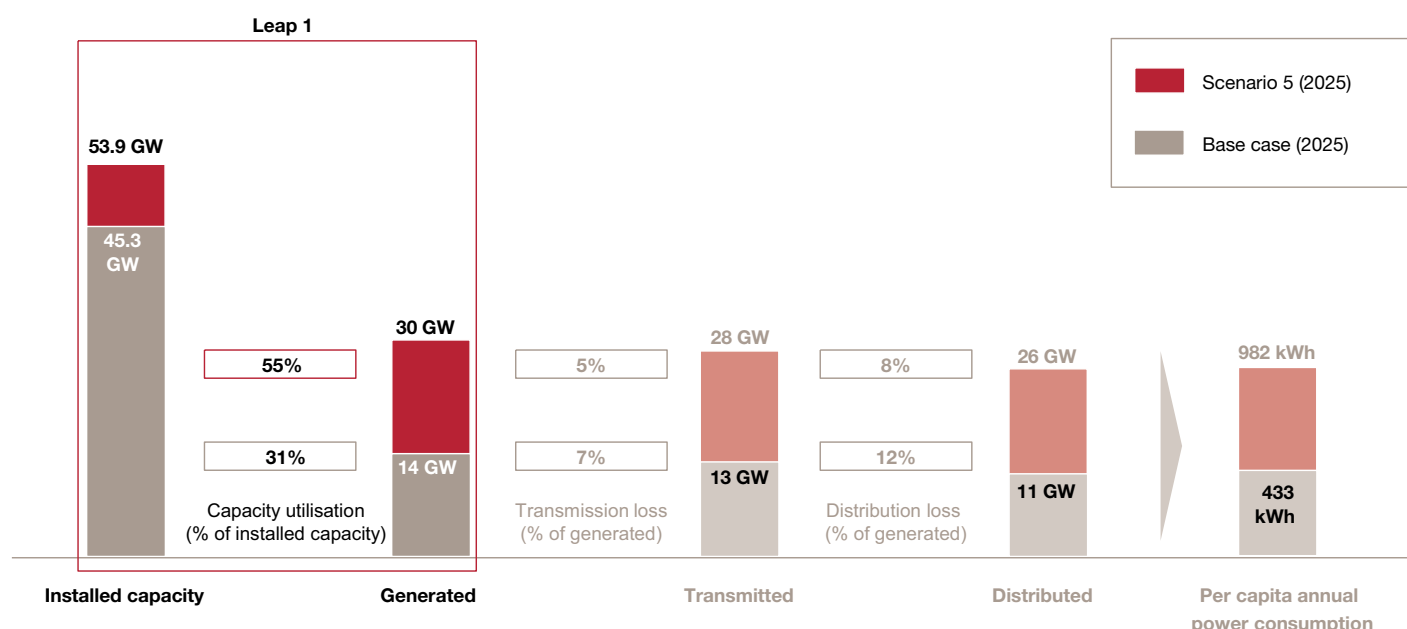
For the power sector, achieving the stretch target (6.5 times increase in annual per capita power consumption) by 2025, will require significant involvement and alignment between the Federal Government of Nigeria, the Ministry of Power and the industry participants (e.g. power generation, transmission and distribution companies, technology providers, equipment manufacturers, funding agencies and even engineering, procurement and construction companies) towards driving a

comprehensive transformation throughout. We believe that this transformation will require the industry to make three substantial 'leaps' over the next ten years, as outlined below:

- **Leap 1:** Accelerating growth in power generation capacity and improving utilisation
- **Leap 2:** Expanding the power transmission network and driving better efficiencies
- **Leap 3:** Establishing and scaling up efficient power distribution capabilities

Leap 1 – Accelerating growth in power generation capacity and improving utilisation

Figure 16: Leap 1 – Power generation (Base case vs. Scenario 5)



One of the leaps required to reach the target over the next ten years is to transform the power generation segment by increasing installed capacity to 53.9 GW and to simultaneously improve capacity utilisation to 55%. Nigeria is already attracting growing interest in power generation with capacity expected to increase from 12.5 GW in 2015 to 45.3 GW 2025 on the basis of current projects. The need here is to accelerate this growth and add a further 8.6 GW of capacity within this time frame, while also increasing utilisation to 55%. Some of the levers to achieve this include:

A. Attracting investments through favourable policies:

There is a need to set in place a conducive policy environment to encourage leading power generation players to invest more in Nigeria, across different sources – whether thermal, solar, wind, hydropower etc. Creating the right environment may also require customisation of policies based on source, allowing development of a diversified power generation landscape in Nigeria, which will further strengthen the sector and the economy in the long run.

B. Implementing efficient power generation technologies:

The right choice of technology is one of the levers which will help improvement in capacity utilisation from 31% to 55%. The selection policy/process therefore needs to consider multiple factors such as performance efficiency and risk of outdated technology, in addition to price. Here, one possible approach is to evaluate options from a ‘Total Cost of Ownership’ perspective rather than the ‘Lowest Price’ approach, in order to maximise long-term benefits to the sector.

C. Faster execution of power projects:

Optimising execution lead time is critical to ensure that the power generation infrastructure is ready and functioning within the required time frame of ten years. A case in point is the Mambilla project, which began in 2003 and is yet to deliver due to a range of issues. Avoiding delays, especially in areas such as land acquisition, project clearances, procurement and

construction, should be given utmost importance. To facilitate this, the government and industry players need to put in place a joint tracking mechanism to monitor progress and facilitate escalation to the right stakeholders whenever necessary.

D. Maintenance and overhauling of failing infrastructure:

In order to drive growth in capacity utilisation, the immediate focus should be on replacing or repairing existing equipment, which is failing and prone to breakdowns. In addition, regular, proactive maintenance processes need to be institutionalised to reduce the occurrence and impact of breakdowns.

These are some of the levers which will help in achieving Leap 1 over a ten-year period. Similar approaches have been taken undertaken by other developing countries, which can serve as case studies for learning. Selected examples in (A) attracting investments through favourable policies and (B) implementing efficient power generation technologies are highlighted here:

Case study: Leap 1A | Attracting investments through favourable policies

Implementing investment-promotion strategies to spur development of power generation in India¹⁵

India has embarked on a comprehensive journey to enable foreign investment in power generation across various power sources.



Goal

- To spur investment in the power generation sector through a range of investment-promotion strategies



Approach

- Initiated ambitious government programs (Ultra Mega Power Projects, Rajiv Gandhi Grameen Vidhyutikaran Yojana and the Accelerated Rural Electrification Programme)
- Formed a working group in 2011 to formulate a strategy for investment in line with power diversification
- Integration of resource utilisation and planning under the Central Electricity Authority – supported by regulatory commissions across many states
- Power-source specific strategies:
 - 1) Solar producers – waiver of grid usage charges for solar power generators for ten years
 - 2) Hydro producers – permitted 100% foreign FDI and zero customs duty on import of necessary capital goods



Impact (to date)

- With subsidies, producers are able to sell power at competitive rates and negotiate power purchase agreements with long-term price certainty
- Attracted a range of foreign investors and increases in installed capacity are already underway (e.g. 16 GW of tendered solar projects to be operational by 2017)
- Increase in Power Purchase Agreements.



Case study: Leap 1B | Implementing efficient power generation technologies

Investments in technology to improve generation efficiencies in the Middle East¹⁶

Multiple countries in the Middle East have been focusing on efficiency gains from new technology as a core

component of expansion. These strategies targeted improvements in efficiency gains from new technology,

thereby enhancing their power generation outcomes and efficiency over a ten-year time frame.



Goal

- To invest in new power generation technology to improve installed capacity and generation efficiency



Approach

- Implemented centralised power generation strategies which prioritised adoption of modern power plant technology applications (e.g. an increased share of combined cycle gas turbines and open cycle gas turbines in new plant installations)
- Took into consideration the following elements: fuel availability and logistics, infrastructure requirements for new technology, demand profile and network configuration
- Benchmarked technology options globally and regionally to assess potential impact



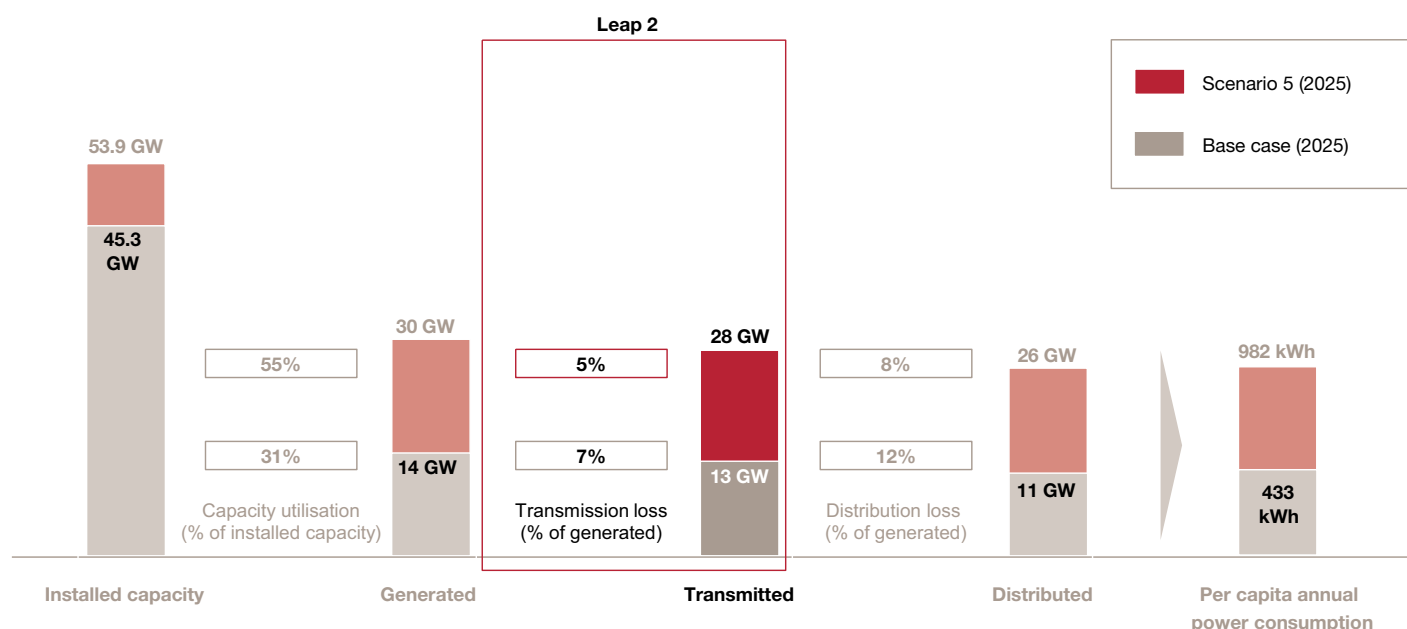
Impact (to date)

- During the period 2003–13, generation efficiency increased from roughly 28% to 44% in Bahrain and from roughly 32% to 47% in Oman



Leap 2 – Expanding the power transmission network and driving better efficiencies

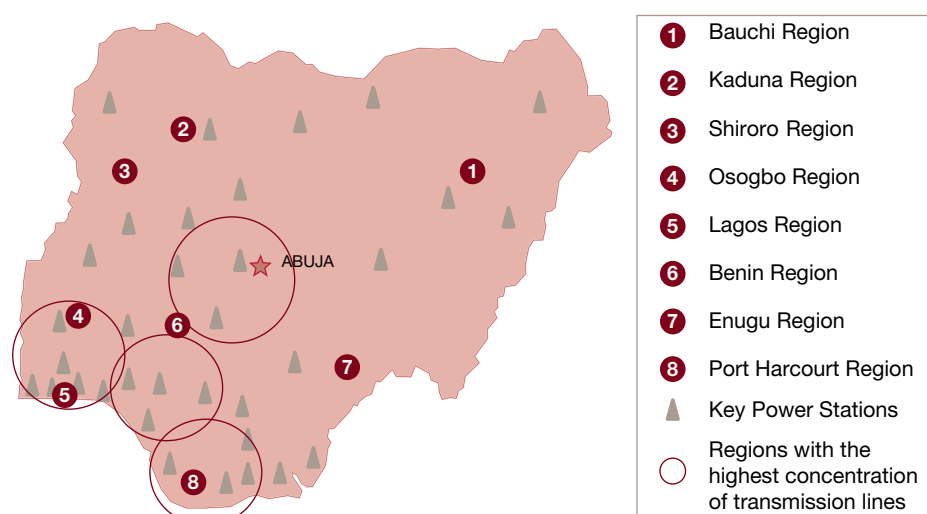
Figure 17: Leap 2 – Power transmission (Base case vs. Scenario 5)



Nigeria's power transmission network is the only segment of the power value chain that is state-owned. It has outdated infrastructure prone to leakage and weak network coverage across the country. There are eight transmission regions in Nigeria (see Figure 18); with lines concentrated in the South, largely a result of persistent violence in the North. Efforts to enhance network coverage have been slow – with only a handful of expansion projects, at the end of 2015. These projects, however, are mostly located in the South – three in the Enugu Region, one within the Port Harcourt Region and one to improve transmission within the capital, Abuja.

To achieve Leap 2, the transmission sector needs to rapidly expand its network coverage, while simultaneously upgrading infrastructure to improve efficiencies. Some of the major levers to achieve this are:

Figure 18: Transmission regions in Nigeria (2015)



Source: PwC Analysis, TCN Website, Investors' forum for privatisation of PHCN successor companies

A. Attracting investments via public private partnership:

Currently, limited funding is a core barrier faced by the government-owned Transmission Company of Nigeria. One of the possible solutions is entry into public-private partnerships (PPPs). Not only would PPPs make the procurement and installation of power transmission infrastructure and technology more affordable, but it would also help deploy global best practices and capabilities within the country. However, Nigeria may face challenges in fulfilling PPP projects if attributes such as regulatory uncertainty, political interference, corruption and unsophisticated risk allocation are not thoroughly addressed in time. An efficient solution used by many developing countries with a challenging business environment is to customise PPP contracts that anticipate major risks and provide guarantees against them.

B. Rapidly scaling up transmission infrastructure:

The government and other agencies need to play a central role in conceptualising and prioritising projects for increasing transmission lines in Nigeria, especially in the under-penetrated regions. This will help increase the geographic coverage of power transmission and substantially improve reach within the country. However, given the implementation-related challenges, special oversight should be provided throughout the project lifecycle to ensure timely completion. In addition, provisions for added security and protection may be required in certain areas, to safeguard against potential attacks. Furthermore, options such as implementation of off-grid solutions in select regions may be considered (based on a cost-benefit analysis), especially in distant rural areas.

C. Improving efficiencies through adoption of new technology:

Going forward, investment in new technologies will significantly help in reducing transmission losses, and these need to be evaluated in detail and selected based on a total cost-benefit analysis. For example, one area for consideration is the use of integrating technologies to help manage the connection between multiple (and varied) power generation sources and the transmission infrastructure, in an efficient manner. Also, High Voltage Direct Current (HVDC) transmission technology is being tested in many regions globally, and may be a suitable option for improving transmission efficiency.



In the following case studies, we explore examples of successful implementation of levers (a) attracting investments via public-private partnership and (c) improving efficiencies through adoption of new technology:

Case study: Leap 2A | Attracting investments via public-private partnership

Using PPPs to attract investment in the power transmission sector in Cambodia¹⁷

Cambodia’s electrification rate has traditionally been low. Over time, the state-owned transmission authority, Electricite du Cambodge, has entered into a series of public-private partnerships with guaranteed loans

from the Asian Development Bank (ADB). Consequently, transmission infrastructure coverage has increased over the last decade. For a country that ranks 127/189 in the 2016 World Bank Ease of Doing business report, it is a

testament to the fact that an imperfect business environment need not be an impediment to investment – provided the contractual structure is well developed and guards against risk.



Goal

- To develop the 220 kV and 230 kV transmission line in Cambodia, enhancing network coverage through attracting large-scale investments and technical assistance



Approach

- Partnership with international development banks and funds to alleviate instability concerns and attract investors
- Promotion of flexible contractual terms, depending on local requirements and preferences of operators and investors
- Initiatives to limit risks – e.g. options for investors to receive pegged exchange rates for the project duration
- Strong federal backing to contribute to a transparent and priority-driven PPP selection process



Impact (to date)

- Increased transmission coverage – with a double circuit 220 kV transmission line (110 km), from the Vietnamese border to Phnom Penh, and a 230 kV transmission line from Kampot to Preah Sihanouk



Case study: Leap 2C | Improving efficiencies through adoption of new technology

Utilisation of HVDC technology to improve power transmission capabilities in Namibia¹⁸

In Namibia, the transmission system operator, NamPower, commissioned a 970 km transmission line to stabilise power networks and ensure reliable power transfer within the South African

Power Pool network. HVDC technology was used to minimise losses over the proposed distance, with the voltage rating for overhead transmission set at 350 kV for the first time. This

demonstrates the successful integration of new technology into improving weak transmission lines.



Goal

- To improve power transmission between Zambia, Namibia and South Africa and strengthen the South African Power Pool network



Approach

- Construction of a HVDC transmission connection, consisting of a transmission line, transformers and HVDC converter stations over 970 km which was co-financed by a consortium
- Implemented through separate contracts for different components
- Adopted HVDC light technology with a 350 kV bipolar HVDC line



Impact (to date)

- Improved stability – HVDC technology provided voltage and reactive power support to the network, processing load changes and voltage fluctuations
- Economic impact – improved supply security, reduction of transmission losses
- Higher flexibility – as electricity can be moved in either direction depending on the demand from the connected countries



Case study: Leap 2C | Improving efficiencies through adoption of new technology

Transforming the power transmission sector in Brazil¹⁹

This is an example where the PPP method was used to launch an international bid to develop an integrated power management system for the Brazilian grid operator. The

operator facilitated an international bid that resulted in strengthened integration systems across the transmission sector.



Goal

- To procure new technology to update the existing transmission network and improve customer service



Approach

- Launched an international public bid, won by a consortium in 2009
- Comprehensive discussions on scope and other contractual details to reduce risks and ensure timely delivery
- Installation of a comprehensive power management system with sophisticated architecture and hardware



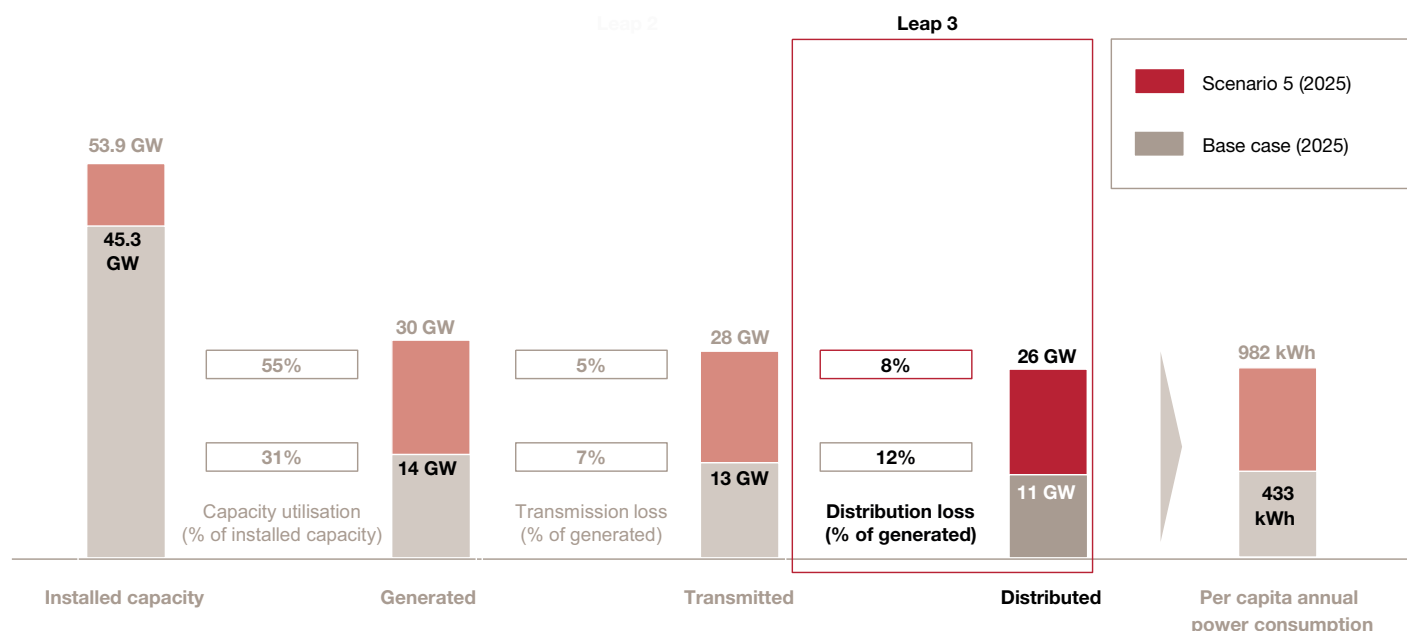
Impact (to date)

- Reduced operating expenses for the power grid operator Operador Nacional do Sistema Elétrico (ONS)
- Ability to capture real-time data has enhanced customer service
- Reduced blackouts in key regions (Rio de Janeiro, Brasília)



Leap 3 – Establishing and scaling up efficient power distribution capabilities

Figure 19: Leap 3 – Power distribution (Base case vs. Scenario 5)



The primary challenge towards achieving Leap 3 is the impact of unprofitable operations on the ability of distribution companies to invest in scaling up and implementing efficient technologies. Leakages in revenue collection lead to lower profits, which in turn impact future investments. Currently, only 50% of the power customers in Nigeria are metered.²⁰ For many of the remaining customers (without meters), payments are approximated and have been said to favour the customer. In addition, most of the collections are manual, providing a large scope for mismanagement and corruption. It is also an inefficient use of resources, considering that revenue collectors have to make repeated visits to collect a single payment. Lastly, losses due to illegal connections are quite prevalent and typically remain undetected for years in Nigeria.

All these factors severely impact the profitability of distribution companies and inhibit their ability to invest in infrastructure maintenance and technology modernisation. Going forward, to achieve Leap 3, the following levers can be considered:

A. Blocking revenue leakage through automation:

Distribution companies in Nigeria can consider automation at various stages to reduce the incidence of revenue leakage. One such example is the adoption of smart meters, following the lead of other developing countries. Several successful pilot initiatives have been observed across Latin America and Southeast Asia, which have encouraged distribution companies to roll out large-scale adoption. However, procurement and installation costs of smart meters are significantly more than regular meters; hence the case for adoption in Nigeria should be carefully evaluated.²¹ Costs and benefits are unique for each country, and therefore we believe that pilot initiatives across key distribution regions in Nigeria should be implemented to first determine the business case. The benefits, however, are clear – when integrated with payment alternatives to manual collection, smart meters will lead to better collection efficiencies and further cost saving through resource optimisation. Furthermore, system integration and effective monitoring mechanisms will enable distribution companies to identify and act on unauthorised connections to reduce power theft.

B. Scaling up distribution infrastructure in alignment with transmission expansion:

Currently the distribution capacity in Nigeria is higher than transmission capacity, hence scaling up of infrastructure may not be immediately required. However, expansion in distribution infrastructure needs to be planned in advance, and in sync with power transmission projects to ensure the end benefit to the customer. This will require interaction and coordination between the Transmission Company of Nigeria and the power distribution companies, to ensure alignment in planning and execution.

C. Reducing losses by improving distribution infrastructure:

Distribution losses are often caused by faulty or outdated equipment which impacts technical performance. To manage this, distribution companies need to have a sustained focus on managing physical assets with pre-planned strategies (and budgets) for maintenance and upgrade of critical infrastructure in a timely manner.

Case study: Leap 3A | Blocking revenue leakage through automation

Increasing revenue collection through a smart metering pilot deployment, for a utility company in Malaysia²²

Tenaga Nasional Berhad (TNB), the national utility company in Malaysia, successfully implemented smart metering pilot projects in Malacca and Putrajaya in 2014. Subsequently, a large-scale roll out has been proposed.



Goal

- To successfully pilot a smart metering system and analyse the potential for large scale roll out in the country, with the first phase to be rolled out in 2017



Approach

- Pilot was conducted in two areas; Malacca and Putrajaya, across 1,000 households
- Direct benefits that were considered over the long term – improvement of revenue collection, reduction in electricity theft and emphasis on energy efficiency



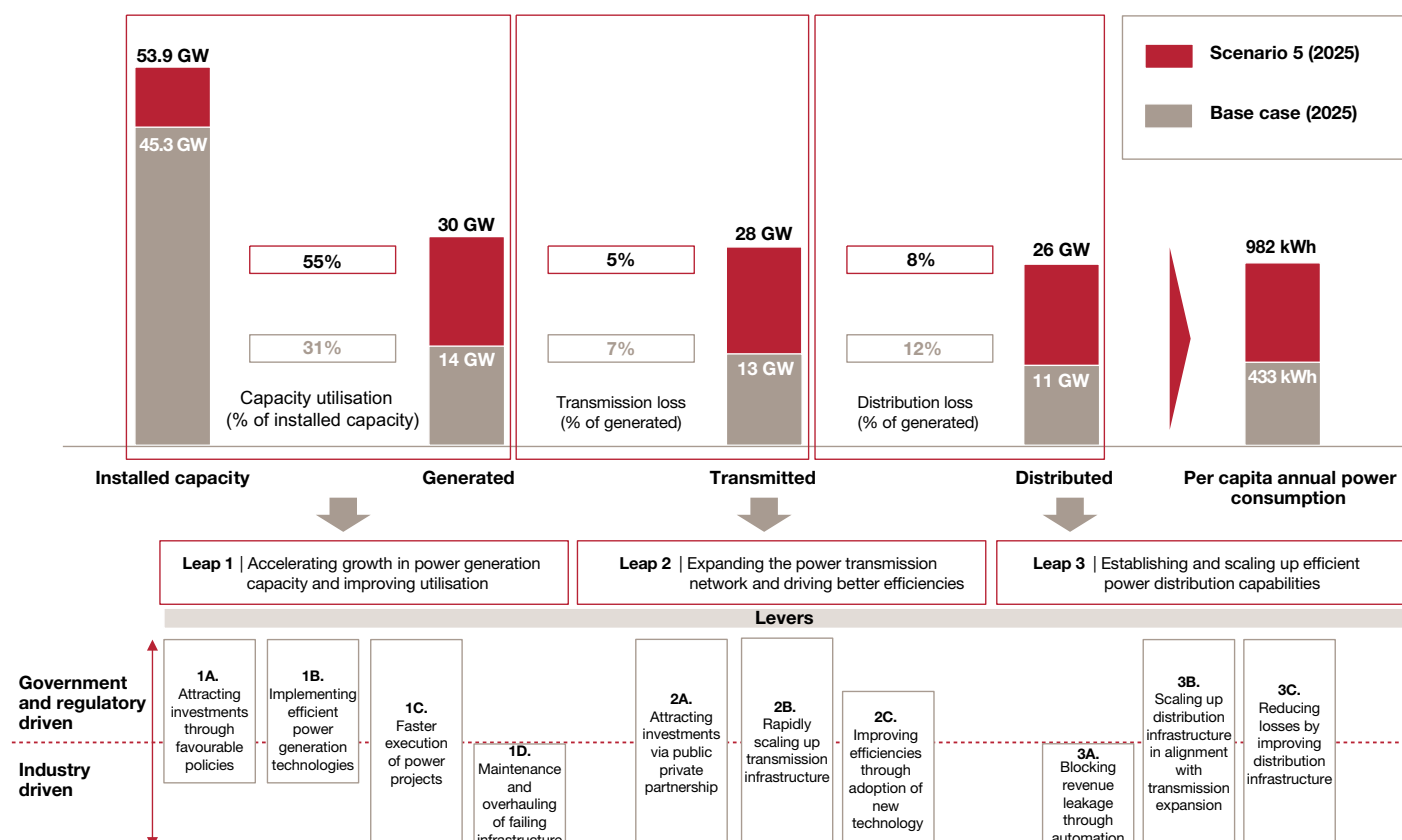
Impact (to date)

- Successful pilot program of smart meters which seamlessly transmits data to TNB for billing and monitoring
- Survey results demonstrated high customer interest in adopting smart metering technology across a wide demographic
- On the basis of the survey results, TNB announced that it plans to install more than 8 million residential smart meters within the next ten years.



Powering the future

Figure 20: Roadmap towards achieving annual per capita consumption of 982 kWh by 2025 (Scenario 5)



For Nigeria to achieve the stretch target of an annual per capita power consumption of 982 kWh by 2025, the country will need to improve several aspects along its power value chain. These include scaling up generation, transmission and distribution capacity; as well as driving efficiencies in utilisation, and reducing transmission and distribution losses.

The ten levers analysed in this report within the three identified Leaps will play a critical role in further accelerating Nigeria's journey towards a comprehensive transformation of the power sector. Government, regulator and industry participants will all play core roles: with the government and regulator taking the lead to create the right investment climate and set favourable policies in place, whilst

industry participants focus on implementing new technology, faster project execution and improving operational efficiencies. Figure 20 provides a summary of the shifts required in the Nigerian power sector along with an indicative view on the extent of implementation ownership required by the stakeholders (government and regulator vs. industry participants), for each of the ten levers identified. In some cases, both need to contribute equally.

In addition to assigning roles and ownership, successful execution of these levers will require careful planning and sequencing, with key dependencies identified. For example, revamping the existing infrastructure and implementing efficient processes across the value chain can be a more

immediate task for existing players, supported by new participants with key expertise, bringing near term benefits. As these improvements take place, the longer and more complex process of policy formulation and attracting new investments for scaling up can be considered independently by the government, regulator and other agencies, in order to lay the platform for the next phase of enhancement of building and operationalising the new projects to power Nigeria for the future. Whilst there is no single short-term solution to Nigeria's power challenges, there are a number of opportunities for companies to bring their global skills and expertise to the table and participate in the journey of powering Nigeria's long-term growth.

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