Oando Clean Energy

PRE-FEASIBILITY ASSESSMENT

RENEWABLE ENERGY IN NIGERIA

Abridged version

Introduction

As the world actively pursues deliberate paths toward the creation of a more sustainable future, there is an increased emphasis on the role of state and non-state actors, corporate bodies and individuals in realizing the climate goals we have set ourselves. There is overwhelming evidence that the environmental damage caused by one country, industry, or a person affects all, to which effect we must all act together by taking responsibility for the creation of a greener planet. And there are rallying calls through the likes of the Sustainable Development Goals and the Paris Agreement, for all to step forward and act now.

Today, petroleum meets over 95% of global transportation demands; however, a sustainable world means the future of Energy companies will increasingly be based on a diversified portfolio that must include renewable energy in various forms, as oil and gas become less fashionable to investors and future workforce.

We are already witnessing a significant shift, across the world, in institutional investments, with some of the world's largest investment management firms and banks boldly reducing business dealings with or completely divesting from companies that do not have active plans to improve their Environmental, Social and Governance (ESG) metrics.

It is against this backdrop that Oando has made it's first foray into renewable energy, as the journey begins for the redefinition of the future of our business and our role in the achievement of a carbon neutral world.

This document presents a pre-feasibility study assessment of opportunities within Nigeria's renewable energy space, with specific look at the Solar Value Chain, Electric Vehicles (EV) and Waste to Energy (WTE). It encompasses preliminary research to analyze, determine and select the most technically and economically viable business scenarios for further studies and adoption.

Our belief; if as a nation we are to pivot substantially into renewable then we must start to create platforms that will enable the growth and diversification of sector players. One of the ways we can do this is via knowledge sharing. Our objective in sharing this pre-feasibility assessment is to act as the first stage of research for interested individuals and businesses to determine and select the most technically and economically viable space they can play in.

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Outline



SOLAR

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Executive Summary

Nigeria & Oando

Unstable global oil prices, an evolution of global and local polices in favor of "cleaner" energy sources, and a consequent shift in financiers' interest has accelerated the need for oil and gas companies, inclusive of Oando PLC to explore a portfolio diversification strategy towards renewable energy.

As the world transitions from fossil fuels into more renewable sources of energy (Solar, Wind, Geothermal, Tidal etc.), energy providers in the fossil fuel space must rapidly evolve to adapt to a new market reality or face disruption. A key part of that evolution is making deliberate efforts to gain an early understanding of the renewable energy value to determine opportunities and strategies for success.

Leveraging on the abundance of solar energy, growing financier interest in funding renewable energy projects in Africa as well as the FGN's interest in developing and executing solar power projects for rural and institutional electrification there are abundant opportunities for interested private actors to commit to an environmental sustainable Nigeria.

Introduction

The continued push for a world focused on Sustainable Development and the Energy Transition Act are increasingly tuning and shifting attention to transforming the global energy sector from fossil-based to zero-carbon by the second half of this century. The United Nations with its pledge to end poverty has provided an excellent roadmap aimed at protecting the planet and ensure prosperity for all by 2030.

The Oil and Gas industry is responding with operations models that seek to reduce carbon emissions, and with the Environmental, Social, and Corporate Governance-ESG framework, investors are putting increasing amounts of their funds in high sustainability and societal impact opportunities.

Renewables are essential in the drive towards universal access to affordable, sustainable, reliable and modern energy. Of the three end uses of renewable - electricity, heat, and transport - the use of renewable grew fastest with respect to electricity, driven by the rapid expansion of wind and solar technologies.

In Q1 2020, global use of renewable energy in all sectors increased by about 1.5% relative to Q1 2019, showing that renewable electricity has been largely unaffected while demand has fallen for other forms of energy.

The United Nations has set the pace with a plan that proposes an integrated approach to realize rapid results and progress, accelerating proven innovative solutions and partnerships. Over the next 10 years, the UN Climate Action targets:

Carbon Emissions; Absolute and per capita reductions of 25% by 2025 and 45% by 2030.

Electricity Consumption; Per capita reductions of 20% by 2025 and 35% by 2030.

Renewable Energy; 40% by 2025 and 80% by 2030 of consumed electricity.

Commercial Air Travel; Per capita emissions reductions of 10% by 2025 and 15% by 2030.

Climate Neutrality; 100% of unavoidable carbon emissions are offset yearly from 2019 via certified carbon credits.

Operational Efficiencies; demonstrated long term economic benefits from the Plan implementation.

Sustainable Development Co-Benefits; demonstrated increase in climate smart infrastructure and other sustainable development benefits to local communities from Plan implementation.

This report provides an assessment of the solar power value chain, its technologies, opportunities and potential obstacles.

The Photovoltaic (PV) Value Chain

Poly-silicon Manufacturing	Poly-silicon Processing	Wafer Cutting	Solar Cell Production	PV Module Production
Quartzite rock is mined and processed into high purity MG-Si and then into Poly-Si	Polysilicon rock is melted at ~1,400 ℃ until it forms a white-hot liquid.	The Crystal Ingotis first saw -cut into equal cylindrical lengths before being wire-cut into the squared wafer	The polysilicon wafer is converted into solar cells through the addition of phosphorus and bus bar circuitry	Solar cells are strung together in a panel modeling and assembly line
The processes involved are:	The processes involved are:	The processes are:	The processes are:	The processes are:
Carbon Reduction Acid Treatment	**Charging Melting Growing Cooling**	**Cutting Squaring Slicing**	**Texturing Diffusing Coating Printing**	**Stringing Soldering Laminating Framing Inspecting Packing & Shipping**
The Processes are power intensive and require an Arc-Furnace	The Processes are power intensive and require a Quartz Crucible	The processes require precision cutters for proper shape configuration	The processes require specialized equipment set in a sterile environment	The process requires heavily automated robotics
Quartzite (Silica), Carbon (coke), Hydrochloric Acid, Hydrogen	Graphite, Silicon Crystal, Boron	Silicon Carbide	Silicon Film, Silicon nitride, Phosphorus	Titanium Dioxide, Ethylene Vinyl Acetate, Mylar or Tedlar sheets, Steel or Aluminum

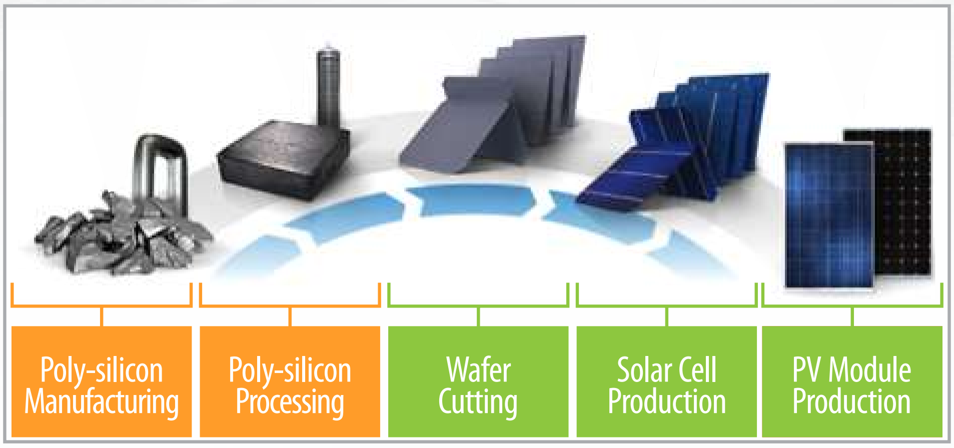
END USE APPLICATION

Grid Power (Solar Farms)

Rooftop (Off-Grid Power)

Solar Products

High Level Market Entry Strategy



END USE APPLICATION

Distribution, Solution Architecture, System Aggregation, Installation and Energy Generation

UPSTREAM

- Oligopolistic
- Global incumbents increasing capacity
- High Entry barriers
- Tough Quality expectations
- High Electrical Power requirement
- **Complexity:** ○○○○○
- **Capital:** △△△△△

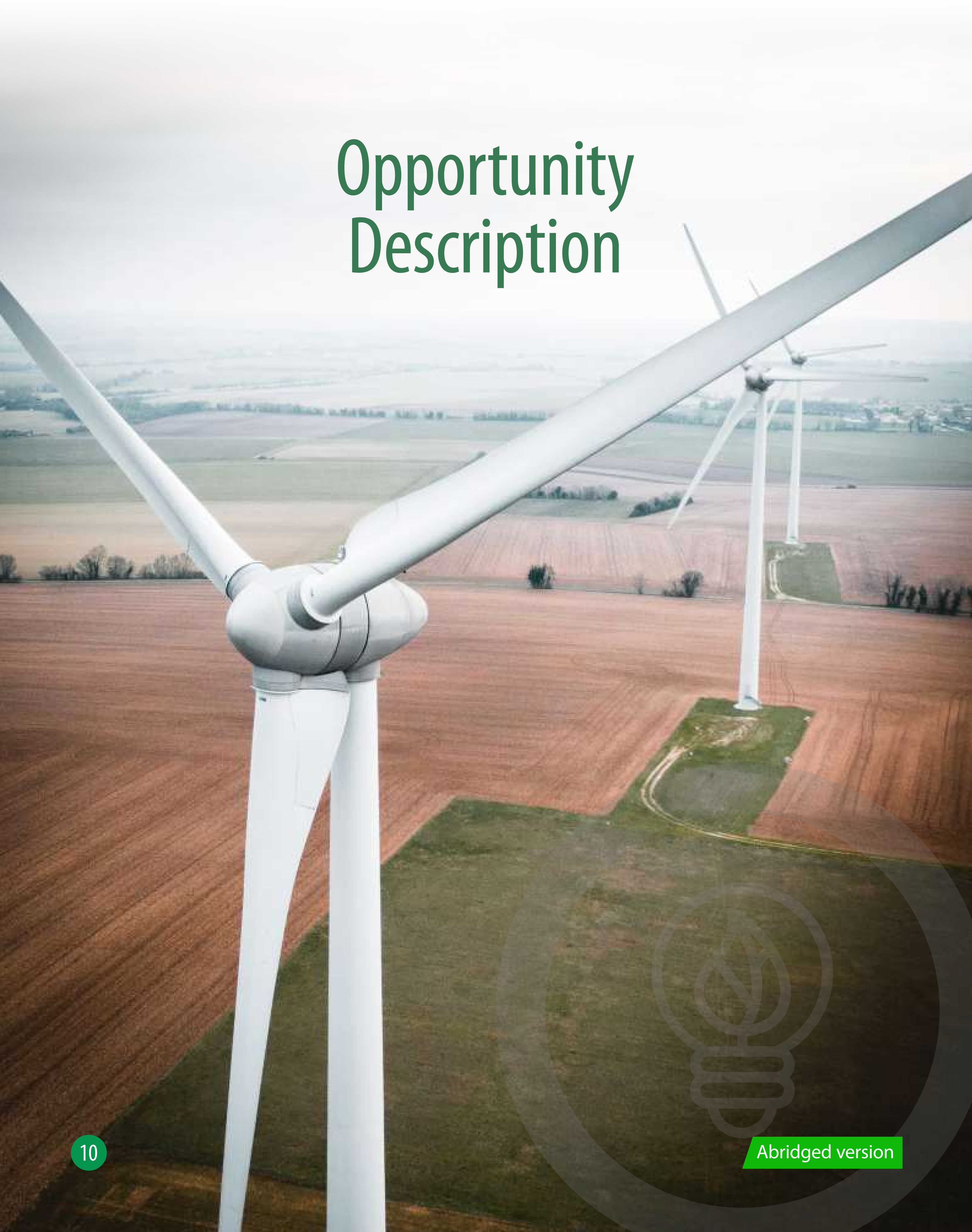
MIDSTREAM

- Dependent on supply of high-quality polysilicon
- Global incumbents increasing capacity
- Cutting edge technology and process requirements
- Tough Quality expectations
- PV Module Production Easiest Entry Point
- **Complexity (Wafer + Solar Cell):** ○○○○○ **(PV Module):** ○○○○○
- **Capital (Wafer + Solar Cell):** △△△△△ **(PV Module):** △△△△△

DOWNSTREAM

- Low Entry Barrier
- Partnership Support
- Funding Support
- Multiple Supply Chains
- Low Tech Requirement
- **Complexity:** ○○○○○
- **Capital:** △△△△△

Opportunity Description

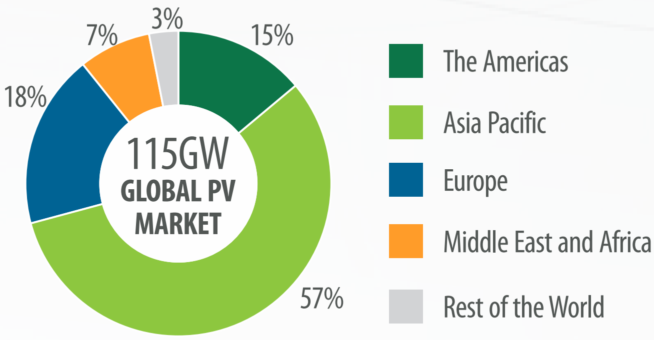


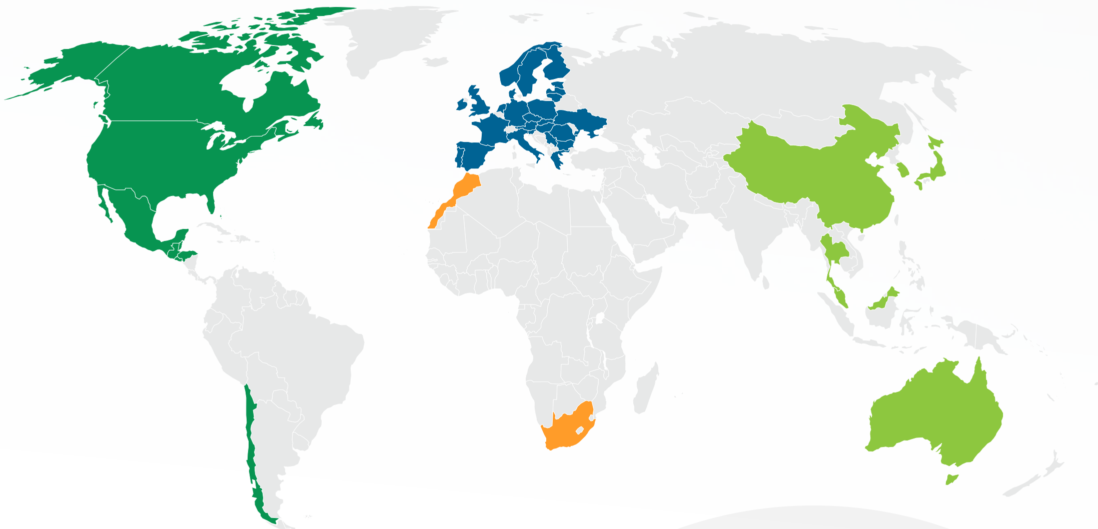
Global PV Market

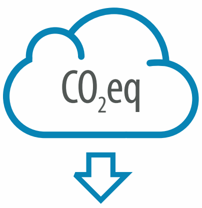
The Global PV market is currently valued at **$76 billion**	It is forecasted to grow to about **$120 billion** between 2023-2025.	**627GW** installed Globally	**~100GW** Growth expected year on year

TOP PV MARKETS 2019

CHINA	30,0 GW
E U	16,0 GW
USA	13,3 GW







720 Mt Co_2 emissions avoided in 2019

627GW were installed all over the world by the end of 2019

CHINA is the world's **#1** PV market

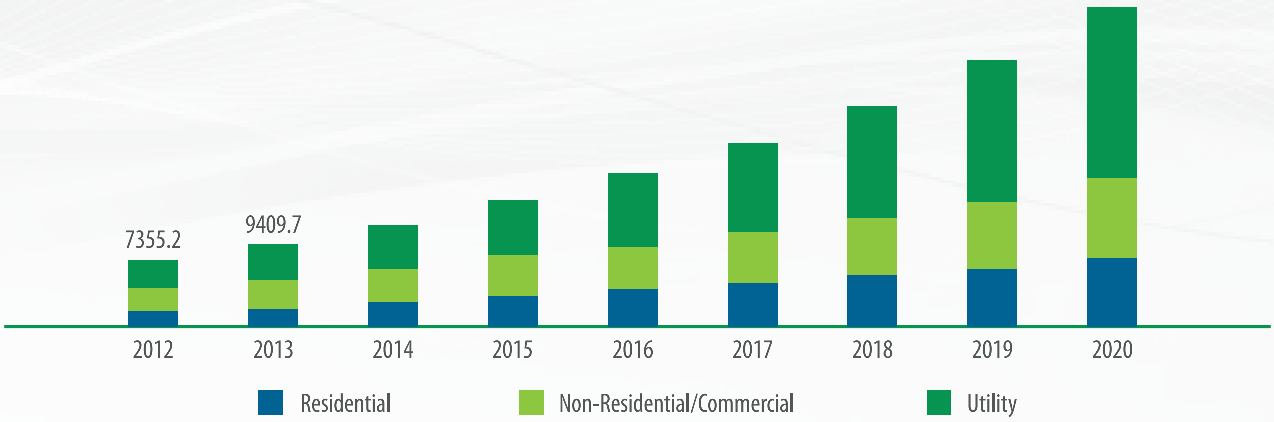
18 countries installed at least **1GW** of PV in 2019

09 countries have installed at least **10GW** of cumulative capacity at the end of 2019

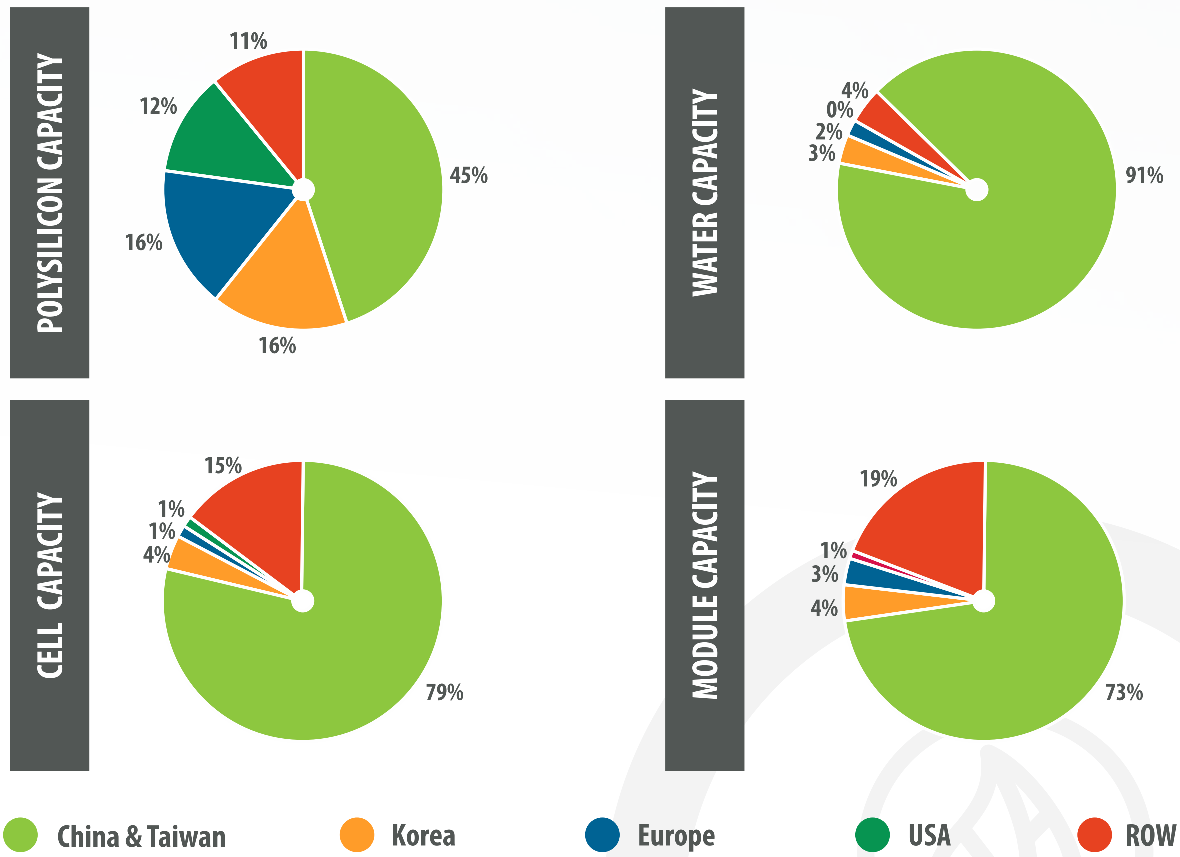
SOLAR PV PER CAPITA 2019 Watt/capita

1st GERMANY	595
2nd AUSTRALIA	585
3rd JAPAN	497

Global PV Market



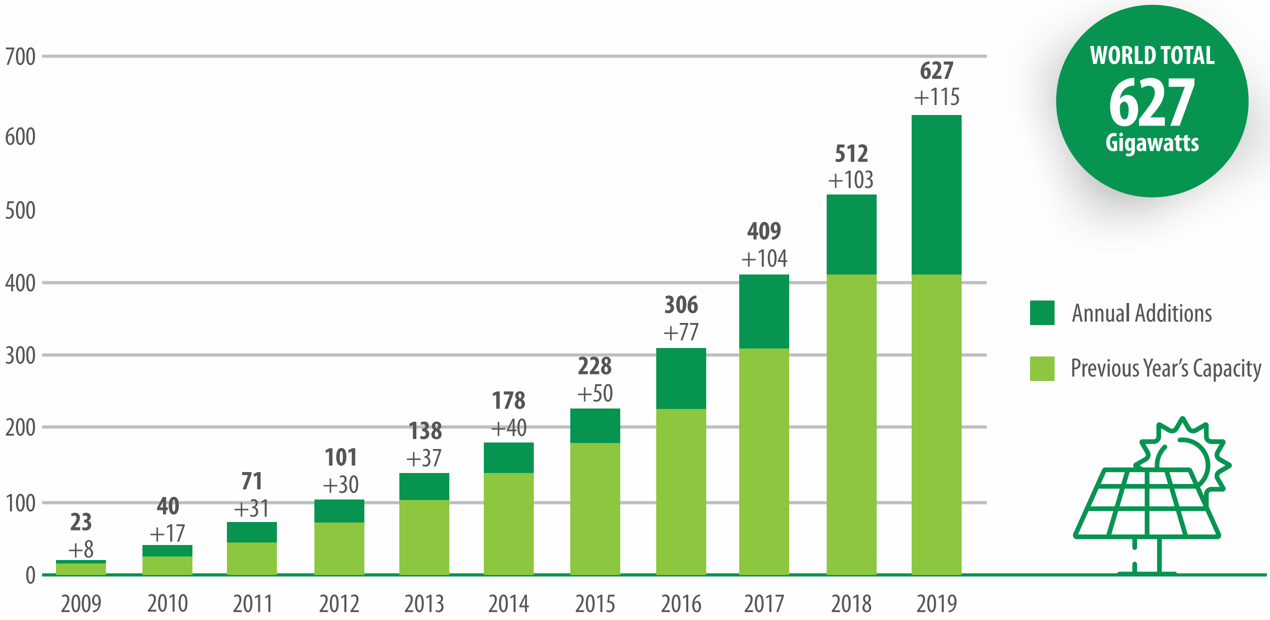
UTILITY ACCOUNTS FOR >50% OF ALL INSTALLED PV



UTILITY ACCOUNTS FOR >50% OF ALL INSTALLED PV

The Growth of Solar

SOLAR PV GLOBAL CAPACITY AND ANNUAL ADDITIONS (2009 - 2019)

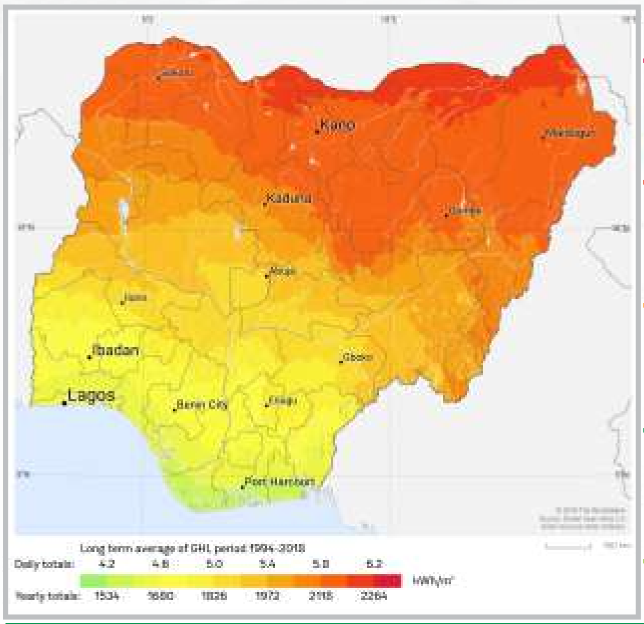


Note: Data are provided in direct current (DC)
Totals may not add up due to rounding.

Source: Becquerel Institute and IEA PVPS
RENEWABLE 2020 GLOBAL STATUS REPORT

- The adoption of solar power continues to rise year on year.
- There is however a projected drop in additions due to the COVID-19 Pandemic which has stalled several projects

Solar Power and Energy Mix Developments in Nigeria



12,522MW Installed power Generating Capacity (Mainly Hydro and Gas)

28MW Installed Solar Power Generation

~6,000MW Actual Generation Performance

~24,000MW Estimated Actual Demand Required for consumption

~12,000 – 18,000 MW Opportunity for electricity generation

Some Information & Trends in the Nigerian Power Sector:

- Transmission Infrastructure Insufficient
- Planned Power Plants
- Market Status (Free) +
- The Mini-Grid Sector to Expand Rapidly 2020 + (WB)
- Several Grants, Loans and Funds Available
- Focus has been on Universities Power Independence, Rural Electrification and Grid Improvement
- Power Africa (USTDA) to Support Projects + Broker Partnerships
- Multi-Year Tariff Order by NERC to Enable New Developments

Opportunities Exist for:

- Distributed power generation (Micro & Mini Grid Projects)
- Residential homes, clusters and urban developments
- Rural Electrification
- Institutional Electrification

Solar Power Trends In the Nigerian Power and Electrification Market Space (Recent + Ongoing)

PROJECT	CAPACITY	LOCATION	SPONSOR
Construction of off-grid/on-grid renewable energy (solar) micro utility	TBD	Imo, Taraba, & Bayelsa State	MOP
Supply and Concession of Solar mini-grids	40, 60, 90 KW	Benue, Sokoto, & Kaduna State	MOP
Provision and Installation of Solar Hybrid Mini Grid	TBD	Benue State	MOP
Community Electrification (PowerGen – Kenya - 10 planned)	~70-100 KW each	Niger State	World Bank + REA
Rural Mini-grid Acceleration Scheme – 24 Planned	</= 1MW	Niger, Oyo, Anambra, Delta, & Edo State	REA + EU
Mini-Grid Projects (14 PPAs with NBET – Stalled since Final Extension in July 2018)	1125MW total	Multiple Locations	FGN + NBET
Energizing Education Program – 37 Universities + 7 Teaching Hospitals planned	89.6MW total	Universities & Teaching Hospitals	World Bank + REA
Energizing Education Program – Metka Project executed (4 Universities planned)	7.5MW	Bayero University, Kano State.	World Bank + REA

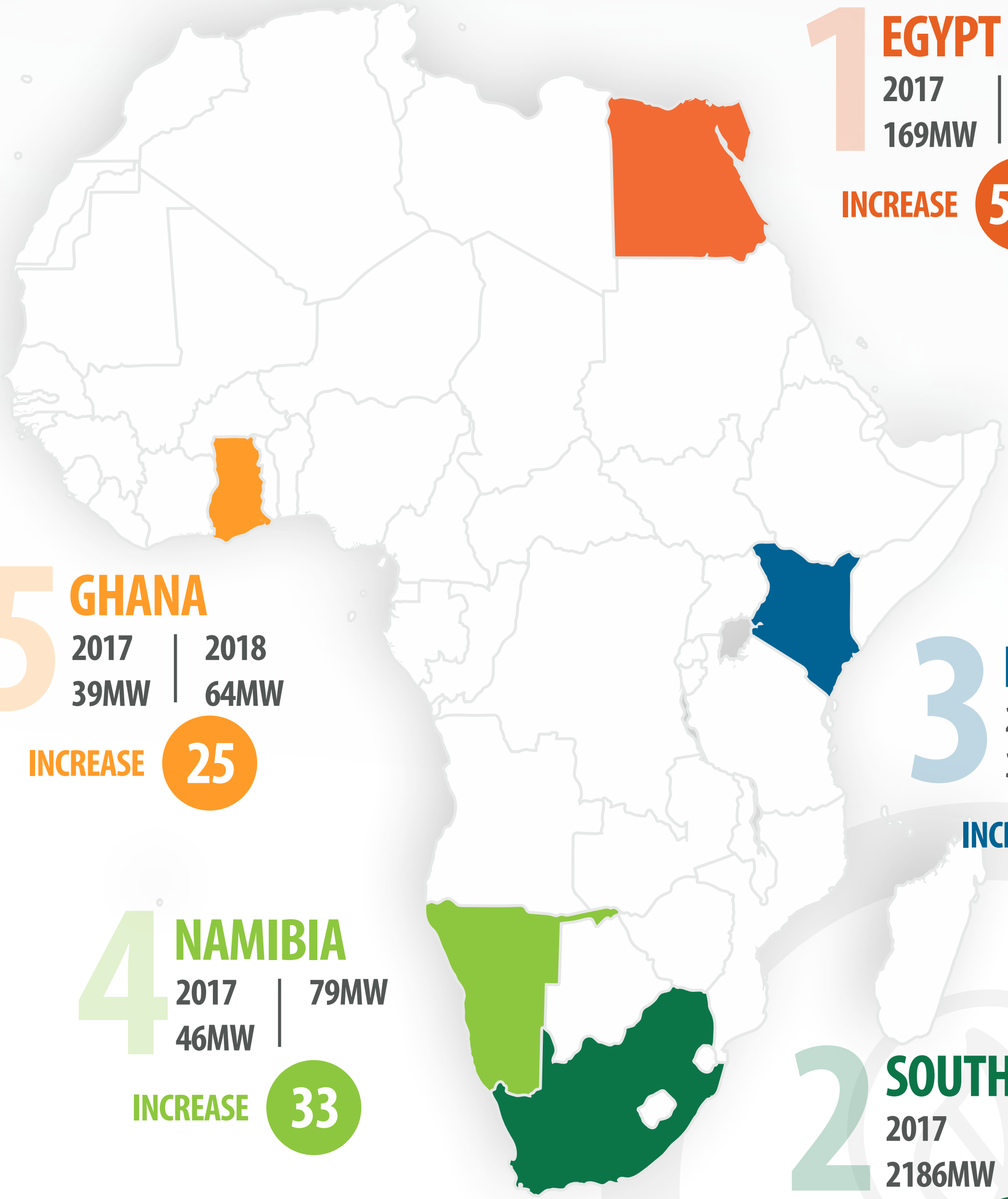
FUNDING

- **$200 Million** | The African Development Bank | REA | Expand Nigeria's Power Sector and Improve Access to Electricity | Investment Fund
- **$410 Million** | The African Development Bank | MOP | Transmission Infrastructure Development (Expansion of transmission lines and Construction of Substations) | Project Financing
- **$550 Million** | The World Bank | REA | Development of Mini-Grids and Solar Home Systems | Loan

Africa Opportunity:
Solar Development in Africa

THE BIG 5 AFRICA'S FASTEST GROWING SOLAR ENERGY MARKETS

CUMULATIVE INSTALLED SOLAR PV CAPACITY IN AFRICA (MW)



1 EGYPT
2017 | 2018
169MW | 750MW

INCREASE 581

5 GHANA
2017 | 2018
39MW | 64MW

INCREASE 25

3 KENYA
2017 | 2018
38MW | 93MW

INCREASE 55

4 NAMIBIA
2017 | 79MW
46MW |

INCREASE 33

2 SOUTH AFRICA
2017 | 2018
2186MW | 2559MW

INCREASE 373

Africa Opportunity: Solar Development in Africa

WHY AFRICA – GAPS, OPPORTUNITIES AND BENEFITS

Africa has some of the world's fastest growing economies, with emerging markets for a wide array of products and services including renewable energy technologies.

The IEA estimates that a 28billion dollars per year capital spend is required to achieve universal energy access in sub-Saharan Africa by 2030

Africa is a key market for solar for the following reasons

- High density of under-served population with about 40% of the African population without access to electricity
- Low connection rates due to lack of adequate generation, transmission and distribution infrastructure to meet the needs of a rapidly growing urbanizing population
- Centralized power generating facilities are unable to adequately cater to the needs of a dispersed population creating a gap and opportunity for rapidly deployable decentralized power infrastructure like solar or wind
- Financiers and Investors want an African footprint due to its strong economic market potential, CSR component and ESG affinity. Financiers and Investors want to eliminate sole country/geopolitical risk
- A large amount of Funds (Investment and Loans) and grants are targeted at developing African countries with a commitment to the sustainable development of the region

INSTITUTIONAL INVESTMENTS & LOAN PROVIDERS

- The World Bank
- The African Development Bank
- US Trade and Development Agency
- USAID Power Africa Fund
- International Finance Corporation
- Africa Finance Corporation
- European Investment Bank
- China Development Bank

GRANTS AND FUNDS

- The EEP Africa Trust Fund
- Africa Renewable Energy Fund
- Sustainable Energy Fund for Africa
- IRENA/Abu Dhabi Fund for Development
- Global Climate Partnership Fund
- Other Climate Investment Funds

OANDO CLEAN ENERGY FOR AFRICA

Oando Clean Energy believes that a business strategy that considers key African countries such as Egypt, Kenya, South Africa, Namibia, Ghana, Cape Verde and Mauritius presents a unique opportunity for an integrated network of technological expertise, manufacturing capacities, supply chain & logistical solutions, Raw materials and resources designed to commercialize renewables for Africa by Africans.

Africa Opportunity: Comparative Overview

Morocco: Home to Africa's largest solar power Project (500MW)

- **Total Energy Demand:**
- **Energy Mix:** Heavy Coal (43%), Heavy Oil (25%), Gas (23%) Biomass, Renewables (11%)
- **Energy Gap Description:** Morocco seeks to reduce its dependency on heavy oils which is imported
- **Policy and Plan Roadmap:** Morocco plans to have 52% of Energy supplied from renewables by 2030 (20% solar, s0% Wind and 12% Hydro)
- **Key Driver:** Financial incentives and aggressive climate policies and regulations
- **Key Resistor:** Regulatory hurdles, red-tape, transparency and high cost of labor
- **Opportunity Summary:** Located in one of the best locations for solar power, Morocco is a fine location for utility scale Solar power projects

Ethiopia: Ethiopia wants to increase electricity access rate from 50% to 100% in 10 years

- **Energy Mix:** Heavily reliant on hydropower (85%) Others (Wind, coal and Solar)
- **Energy Gap Description:** Electricity access rate is at 45%
- **Policy and plan Roadmap:** Increase power generation capacity by 25GW - Hydro (22GW), geothermal (1GW), Wind and Solar (2GW)
- **Key Driver:** Government and International body commitment to achieve SDGs
- **Key Resistor:** Economic development
- **Opportunity Summary:** Ethiopia is part of the World Bank's scaling program, which has a goal of making privately funded grid-connected solar projects operational at competitive rates. The goal is to add 500MW of solar power to support its renewable energy growth plan

Egypt: Most accelerated growth in additional power capacity ~30GW in 7 Years

- **Energy Demand and Supply:** Egypt currently has a surplus in energy supply
- **Energy Mix:** Gas, Hydroelectric, Coal, Crude Oil , RE(Wind & solar)
- **Energy Gap Description:** Egypt's main constraint lies in its transmission and distribution infrastructure Mini-grids and utility scale power are sound strategies for Egypt
- **Policy and Plan Roadmap:** Egypt plans to add an additional 500km of transmission lines to increase connectivity and reduce loses
- **Key Driver:** Well developed energizing strategies and policies in place
- **Key Resistor:** Primarily government owned power sector
- **Opportunity Summary:** Egypt provides an opportunity for manufacturing and supply partnerships

Cape Verde: Cluster of islands presenting a unique challenge for transmission and distribution

- **Total Energy Demand:** Cape Verde meets about 90% of its energy requirements
- **Energy Mix:** Heavy Oils (77%), Wind (15%), Solar (7%)
- **Energy Gap Description:** 77% of electricity is generated from heavy oils that is imported, in addition the distribution of the 10 Islands makes for a transmission and distribution nightmare
- **Policy and Plan Roadmap:** Cape Verde is looking to reduce its reliance on Heavy oils and make a shit towards wind and solar power with distributed generation and transmission
- **Key Driver:** Governments determination for economic growth with minimal increase in emission contributions has created policies and finance opportunities for solar energy development
- **Key Resistor:** Small insular market with limited spending power
- **Opportunity Summary:** Opportunity for micro grid applications and SHS

Ghana: Home to Africa's largest solar Total Energy Demand

- Energy Mix: Hydro (50%), Natural Gas (47%) Solar (3%)
- Energy Gap Description: major gap is in rural electrification and transmission network development
- Policy and Plan Roadmap: Ghana has a rural electrification master plan that seeks to install 55 mini-grids and other stand-alone solar systems for 33,000 households, 1350 schools, 500 health centers and 400 communities
- Key Driver: Strong support from government policies for Renewable development
- Key Resistor: Facilities are intended to be government run limiting private involvement to construction
- Opportunity Summary: Ghana provides an opportunity for EPC based solar projects where Oando Clean Energy and its technical partners can obtain construction contracts

Africa Opportunity: Comparative Overview

Kenya: One of the few countries to develop and utilize Geothermal energy

- **Total Energy Demand:**
- **Energy Mix:** Hydro (30%), Geothermal (28%), Solar & Wind (14%), Fossil Fuels (28%)
- **Energy Gap Description:** Electricity access rate is at ~70%
- **Policy and Plan Roadmap:** Kenya aims for 100% electrification before 2030 and intends to do so by expanding its grid infrastructure and supporting the deployment of off-grid solutions
- **Key Driver:** Concerted government policy supporting stand-alone power stations and a strong availability of private investment
- **Key Resistor:** Simultaneous development of its oil and gas resources competing for investment
- **Opportunity Summary:** Kenya presents an opportunity for development of utility scale solar power stations. It also has strong potential as a manufacturing hub

Namibia: Currently imports a large amount of power from South Africa

- **Demand and Supply:** Namibia imports 61% of its electricity supply
- **Energy Mix:** Hydro, Coal, heavy oils and Solar
- **Energy Gap Description:** Only 36% of Namibians have access to electricity
- **Policy and Plan Roadmap:** Namibia is focused on Mini-grid (43%) and SHS (57%) solutions to meet its electrification targets by 2030
- **Key Driver:** Massive gap in supply and demand
- **Key Resistor:** Monopolistic commercial structure, Lack of commercial incentives
- **Opportunity Summary:** There is an opportunity for mini-grid development and SHS for rural electrification

South Africa: Home to 8 of Africa's biggest solar power plants

- **Current Generating Capacity:** ~60GW
- **Energy Mix:** Coal (80%) Gas (9%) Solar (6%) Wind (4%), Others (1%)
- **Energy Gap Description:** Less Dependency on Coal and Increased rural electrification
- **Policy and Plan Roadmap:** ~10GW additional solar by 2030
- **Key Driver:** Grid Support for Utility Grade Solar, extensive infrastructural development and policies and strong commercial structures
- **Key Resistor:** Strong indigenous players already in existence
- **Opportunity Summary:** There is an opportunity for leveraging on existing supply chain, manufacturing capacity and Technical expertise

Mauritius: Mauritius utilizes Bagasse (sugar cane waste) as a major resource for its WTE programs

- **Energy Mix:** Coal and Oil (80%) Biofuels and Hydro (15%), Solar and Wind (5%)
- **Energy Gap Description:** Mauritius needs to reduce its reliance on fossil fuels. It plans to do so by investing in more Solar, biomass, WTE and Wind power stations
- **Policy and Plan Roadmap:** Mauritius has a net metering policy in force to support independent power generation and has a plans to increase electricity generation from rentable energy sources from 22% to 40% by 2030.
- **Key Driver:** The Government is seeking international competitive bidding for its power projects and favors JVs between local private sector and international firms
- **Key Resistor:** small island with limited scale potential
- **Opportunity Summary:** Mauritius is a high prospect for the development of utility scale solar power plants (10MW recommended) qualified to participate in its medium-scale distributed generation scheme with potential sales agreements with the central electricity board

Market Entry Strategy

PV Business Landscape

VALUE CHAIN FLOW

	Product	Process	Industry Characteristics	Technology	Generic Strategies
Upstream	Polysilicon	Quartz silica changed into silicon ingots	◦ Oligopolistic ◦ 5-10 companies ◦ High entry barriers** ◦ Ample supply of inputs	◦ Siemens trichlorosilane ◦ Fluidized bed reactor ◦ Upgraded metallurgical silicon ◦ Vapor-to-liquid deposition	◦ Build scale economies ◦ Establish quality control ◦ Set price ceilings
	Water	Silicon ingots cut into waters	◦ Limited competition ◦ About 50 Companies ◦ Medium entry barriers due to high investment ◦ High dependence on polysilicon suppliers	◦ Siemens trichlorosilane ◦ Fluidized bed reactor ◦ Upgraded metallurgical silicon ◦ Vapor-to-liquid deposition	◦ Build scale economies ◦ Establish quality control ◦ Set price ceilings
Midstream	Cell	Circuitry put on water	◦ Highly competitive ◦ About 100 companies ◦ Low entry barriers ◦ Essential component of silicon-based power ◦ Boom-bust exposure	◦ Crystalline ◦ Thin film (CIGS, CdTe, a-Si)	◦ Establish proprietary technology ◦ Integrate midstream operations
	Module	Cells placed on glass and made into panels	◦ Highly competitive ◦ About 400 companies ◦ Low entry barriers due to low investment ◦ Boom-bust exposure	◦ Low technology	◦ Differentiation
Downstream	Installation	Solar panels installed	◦ Fragmented ◦ Numerous companies ◦ Requires Financing and connections	◦ Low technology	◦ Price Non-market strategies

MID - LONG TERM GOAL (Upstream, Midstream: Polysilicon, Water, Cell)

QUICK START (Module, Installation)

Source: Interviews/Research Barclay's, Deutsche bank (AG), GCL Poly, Evergreen Solar, Ignite solar, Natcore: Independent Research

Solar Power and Energy Development Insights

SCENARIOS (INSTALLED CAPACITY IN MW)	2019	2020	2025	2030	2035	2040	2045	2050
BP - Business As Usual Scenario	28	32	39	48	56	68	79	91
BP - Rapid Growth Scenario	28	32	44	57	77	104	127	142
BP - Net Zero Carbon Scenario	28	32	44	64	102	141	165	181
AAC & Energy Mix Ratio Constant	28	32	54	82	109	140		
AAC Progressive Pessimistic, Energy Mix Ratio Constant	28	33	56	90	128	178		
AAC Progressive Optimistic, Energy Mix Ratio Constant	28	37	62	104	156	226		
IEA Stated Policies & GHG Target Scenario	28	48	228	342	456	570		
IEA Africa Growth Case Scenario	28	342	799	1484	2168	3196		

Stated Policy Assumptions Considering Today's Policy Frameworks and Plans (Regulatory, Institutional, Infrastructural and Financial Circumstances)

- 85% of Population have access to electricity by 2040 (Grid Upgraded and expanded)
- 20% Unconditional reduction in GHG emissions by 2030

The Africa Growth Case Assumptions (based on Agenda 2063, the continents inclusive and sustainable vision for accelerated economic and industrial development)

- 100% of Population have access to electricity from 2030 (Grid Upgraded, Mini-grids and standalone systems deployed)
- Renewables will account for 1/3 o all new generation capacity.

Resistors to Solar Power Development:

- Government Policies and Incentives: Nigeria is still in the process of developing a robust set of policies to encourage and incentives solar power development. Tax breaks, and subsidies are good examples.
- Initial Investment: The Initial investment required for solar power plants of equivalent capacity to conventional power plants is higher
- Social Acceptance: Policy makers and end users have not fully embraced the concept of renewable energy
- Research and Development in Nigeria
- Renewables will account for 1/3 o all new generation capacity.

Source: Interviews/Research Barclay's, Deutsche bank (AG), GCL Poly, Evergreen Solar, Ignite solar, Natcore: Independent Research

Solar Power and Energy Development Insights

With the Information Available:

- Nigeria's Adoption of Solar might be slow
- Max Installed capacity in the next 20 years 220MW recommended pessimistic view and 570 recommended optimistic view
- Majority of this developments will be Micro-Grids for rural electrification and Institutional distributed power generation
- Majority of developments will initially be in the northern parts and in regions with available land space adapting as technology and efficiencies improve
- There are number of schemes, funds and partnership opportunities in place to spur on the solar development curve

Exploitation of these opportunities requires preparedness and positioning in the following areas;

- Technical and commercial partnerships
- Technology and skill transference
- Technical competency development
- Project execution capability & history
- Brand and clout development
- External relations development
- Opportunity conceptualization
- Financial capacity or access
- Feasibility studies

The solar boom is coming but it is not now (~2030)

- Entry into the Renewable energy market requires long term direction and focus
- Down stream business set-up, Capability development & positioning should be the Short-term strategy, supported by influencing
- reform and project execution

PV Opportunities in Nigeria

RESIDENTIAL & PRIVATE APPLICATION

- Homes
- Small Businesses
- Lighting
- Solar Products

Small systems 1- 10KW systems are typical here.

RURAL ELECTRIFICATION APPLICATIONS

- Distributed Power Generation for Rural Locations with no Power infrastructure in place
- Rural Water projects
- Rural agricultural applications
- Solar Products

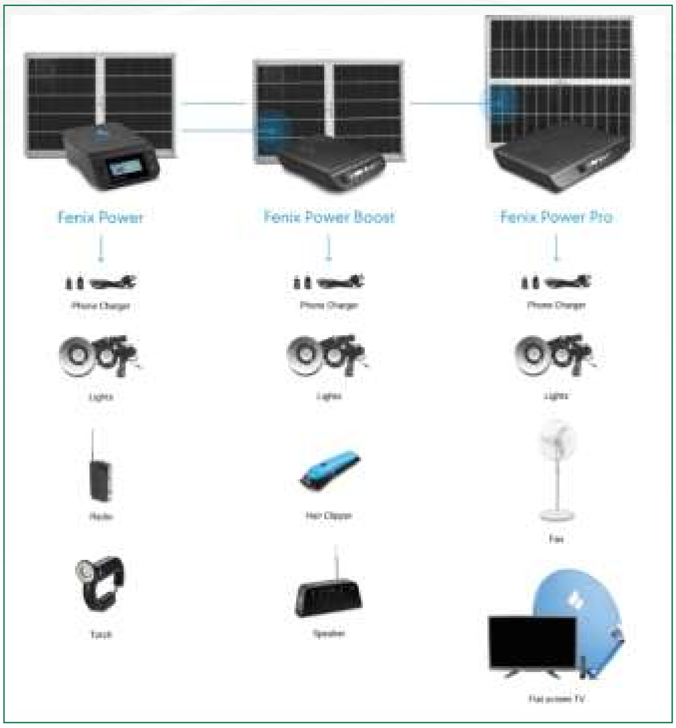
Solar systems vary from a few 100Kw to as much as 1MW.

MEDIUM SCALE UTILITY

- PV solar Farms for Estates
- PV Solar Farms for New Urban Areas
- PV power systems for Health care Facilities
- PV solar systems for universities
- PV solar systems for housing projects

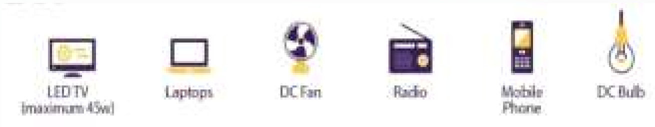
Solar systems can be as large as 3 -20MW.

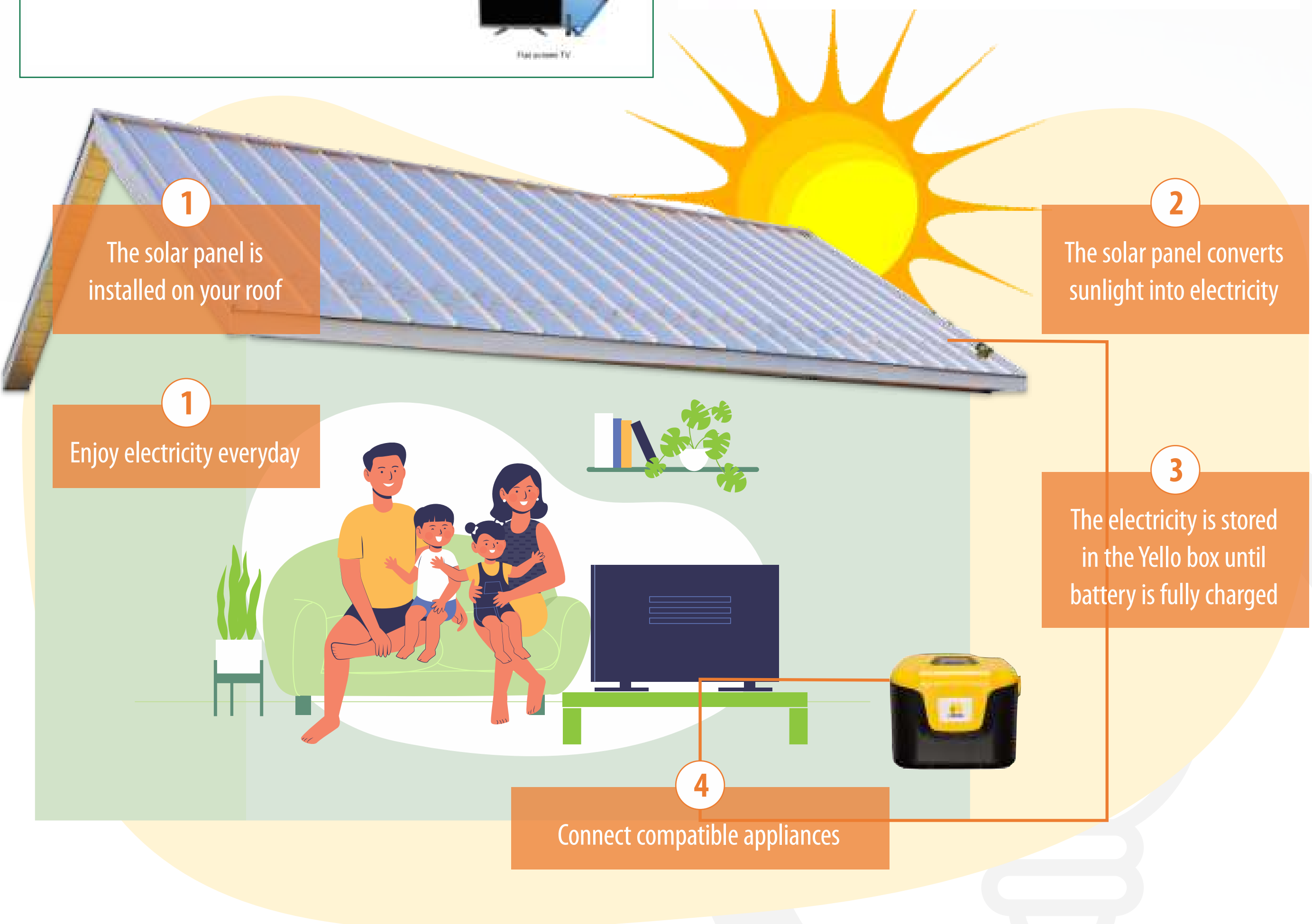
Downstream:
Solar Home Systems



Sample SHS by Fenix Power

Solar Home Systems are stand alone PV systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. Typically run on a PAYG or Subscription based commercial model





Downstream: Solar Home Systems

OPPORTUNITY: SOLAR HOME SYSTEMS: FGN BACKED

25m Nigerians are targeted to own these systems:

- Target users are underserved, off-grid communities across the country
- This is backed by the FGN's Economic Sustainability plan
- Beneficiaries are expected to pay N4,000 Monthly over a period of 3 years (Total: N 144,000) for outright ownership
- Deployment will be facilitated by a low cost CBN loan and implemented by Rural Electrification Agency (REA)
- World Bank through the REA has indicated interest in providing 20% of the retail cost of the systems to participating solar companies

KICK OFF- REQUIREMENTS

- Design Systems
- Manufacture Systems (Local Manufacturing to be incentivized)
- Manufacturing agreements must consider repair and replacements under a 3-year warranty
- Market systems to FGN
- Deploy systems (Must show Job creation pathway)

ON-GOING WORK / NEXT STEPS

To ensure readiness to exploit this opportunity we must ;

- Identify design and Manufacturing partners
- Determine strategy for Local Manufacturing
- Identify target communities
- Define installation and maintenance strategy

POWERDOME™ by Pulse Grids

Pulse Grids PowerDomes™ are pre-packaged systems that require little to no support infrastructure to set up. Pulse works with each customer on a project-by-project basis to provide subscription or project finance that get PowerDomes™ operating quickly.

About PowerDomes™

PowerDomes™ are not used like ground-mount or rooftop solar PV systems because they do more than simply produce power. PowerDomes™ are critical infrastructure hubs that can be expanded or moved as needed with minimal planning and cost. The Powerdome is not designed to sell power on a Kwh basis, but are designed to be critical infrastructure hubs that can be expanded or moved as needed with minimal planning and cost.

PowerDomes™ provide an end-to-end infrastructure solution to meet virtually any demand. The system's overall design and containerization pack renewable power into a radically small, but completely usable, footprint. All PowerDomes™ are built to provide underdome solutions powered solely by the sun, delivering sustainable experiences and results in real-time.

Kick-Off Requirements

- Partnership Agreements
- Solution design and development of bid and proposal decks

Some Technical Specifications

- PowerDomes are modular and easy to scape
- Installed footprint can be as little as 126sqm for a 20-22KWp system
- Includes battery storage
- Inverters include charge controllers
- Diesel tie-in possible for hybrid system

Timelines

- PowerDomes can be custom designed, built and ready to ship in **6 - 8 weeks**
- Installation timelines depend on scale.

On-going Work/Next Steps

- Technical engagements with Pulse Grids to fully define potential commercial use cases
- Further engagements with Pulse Grids to define possible commercial structures and supply chain structures

POWERDOME™ by Pulse Grids

MICROGRIDS
Perfect for distributed energy. easy to site and install. The domes provide power and control with grid reliability.

BASE / MAN CAMPS
The Domes solve challenges with sustained off-grid operations. Underdone equipment packages can be designed to provide comfortable amenities.

MEDICAL CARE
For primary care, medical labs and humanitarian aid, the PowerDomes™ can be outfitted to supplement existing medical facilities or provide dedicated medical support in remote locations.

TELECOMMS AND CONNECTIVITY
PowerDomes™ can be designed to enable 5G and Internet rollout in remote locations.

EVENT SUPPORT
PowerDomes™ create sustainability experiences, while providing power and reducing event-related carbon emissions.

DISASTER RESPONSE
With equipment packages that provide, cold and dry storage, and water treatment systems, PowerDomes™ can be deployed for support during disaster responses.

HOSPITALITY AND RETAIL
PowerDomes™ can be used by hospitality brands to expand their offerings and product accessibility in a truly sustainable, off-grid package.

COLD STORAGE
Temperature and humidity-controlled systems that provide cost-effective and fully automated perishable good storage.

Market Entry Strategy (Downstream)

SOLAR PRODUCT DISTRIBUTION AND INSTALLATION

System Designer and Aggregator

Leveraging on the availability of funding for the deployment of solar power infrastructure. The is an opportunity to develop a solar power business focused on;

- Mini Grid (Term Loans and Working Capital Available)
- Home Installations (Up to 500 Million Naira Funding available)
- Solar Power Farms (> 750Million Dollars available)

System Size Limit: 1MW (Less Regulatory requirements and Entry Barriers.

KICK OFF - REQUIREMENTS

- Material Supply Partnerships
- Technical Support Partnerships
- Local Installation Capacity development (Partnership or Acquisition)
- Opportunity development

START-UP COST REQUIREMENT

Minimal cost required for:

- Business Organization Establishment
- Business development
- Travels
- Trainings

SOLAR PRODUCT DISTRIBUTION AND INSTALLATION – KEY ACTIVITY TIMELINE TO FIRST MAJOR CONTRACT (15 MONTHS)

Activity	Timeline
Business Establishment& Setup	Setup / Recruit / Train — 9 months
Regulations, Permits & Licenses	6 months
Supply Partnerships	6 months
Technical Partnerships	8 months
Marketing and Business Development	12 months
Solution design and Proposals	8 months
Contracting and Financing	5 months

Operations and Maintenance **20 – 25 Years**

PV Solar for Rural and Institution Electrification (EPC/GENCO)

RURAL ELECTRIFICATION APPLICATIONS

- Distributed Power Generation for Rural Locations with no Power infrastructure in place
- Rural Water projects
- Rural agricultural applications
- Solar Products

Solar systems vary from a few 100Kw to as much as 1MW

COMMERCIAL STRUCTURES

- EPC Lump Sum – Turnkey Solution
- Power Purchase Agreement

SAMPLE CASE: 1MW PV PLANT

- Space Requirement: 20,000 Square Meter
- Cost Per Watt: $0.8 - $1.4 per Watt
- Investment cost: $ 800,000 – $1.4 Million
- OPEX assumptions: $0.002/Kwh
- Selling Price of Power: $0.12Kw/h
- Revenue Assumptions:
  - 6-8hrs per day, 80% Delivery Efficiency
  - 90% Uptime

MATERIALS REQUIRED

- 4326Nos of 250W Solar Panels
- 53Nos 20Kw Inverters
- Power Transformers
- Battery bank (Optional)

Other requirements include Cables, Protective devices, Connectors, Distribution panel etc.

KICK OFF - REQUIREMENTS

- Material Supply Partnerships
- Technical Support Partnerships
- Local Installation Capacity

SOLAR POWER DEPLOYMENT FOR RURAL ELECTRIFICATION – KEY ACTIVITY TIMELINE (15 MONths)

Business Setup: 12 - 15 months

EPC Bidding & Contracting	3 months
Audit, Design & Engineering	3 months
Material Procurement	6 months
Site Acquisition & Preparation	6 months
Site Construction Activities	3 months
Equipment Installation	3 months
Commissioning & handover	2 months

Operations and Maintenance **20 – 25 Years**

GENCO: Utility Applications (1-20MW)

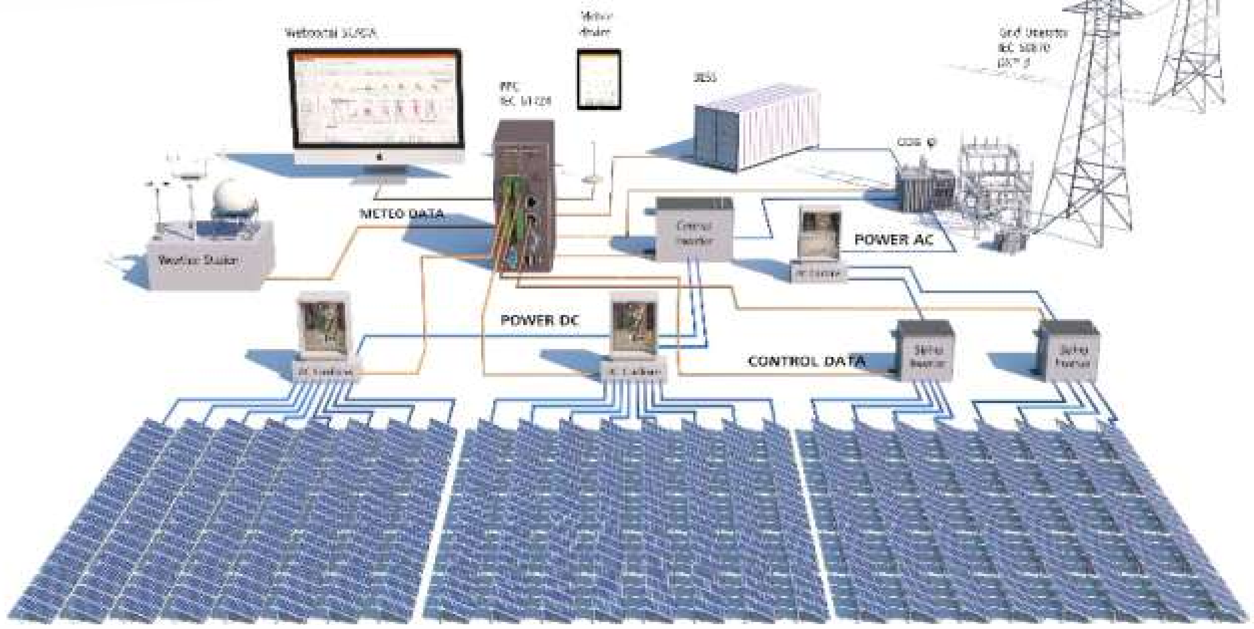
Utility scale applications are widely being considered and constructed for Rural electrification and Education Energizing Schemes. They are used for the following power provision scenarios:

- **Must-Take**
- **Peak-Load Support (Day time Only if without battery storage and All-day scenarios if inclusive of battery storage)**

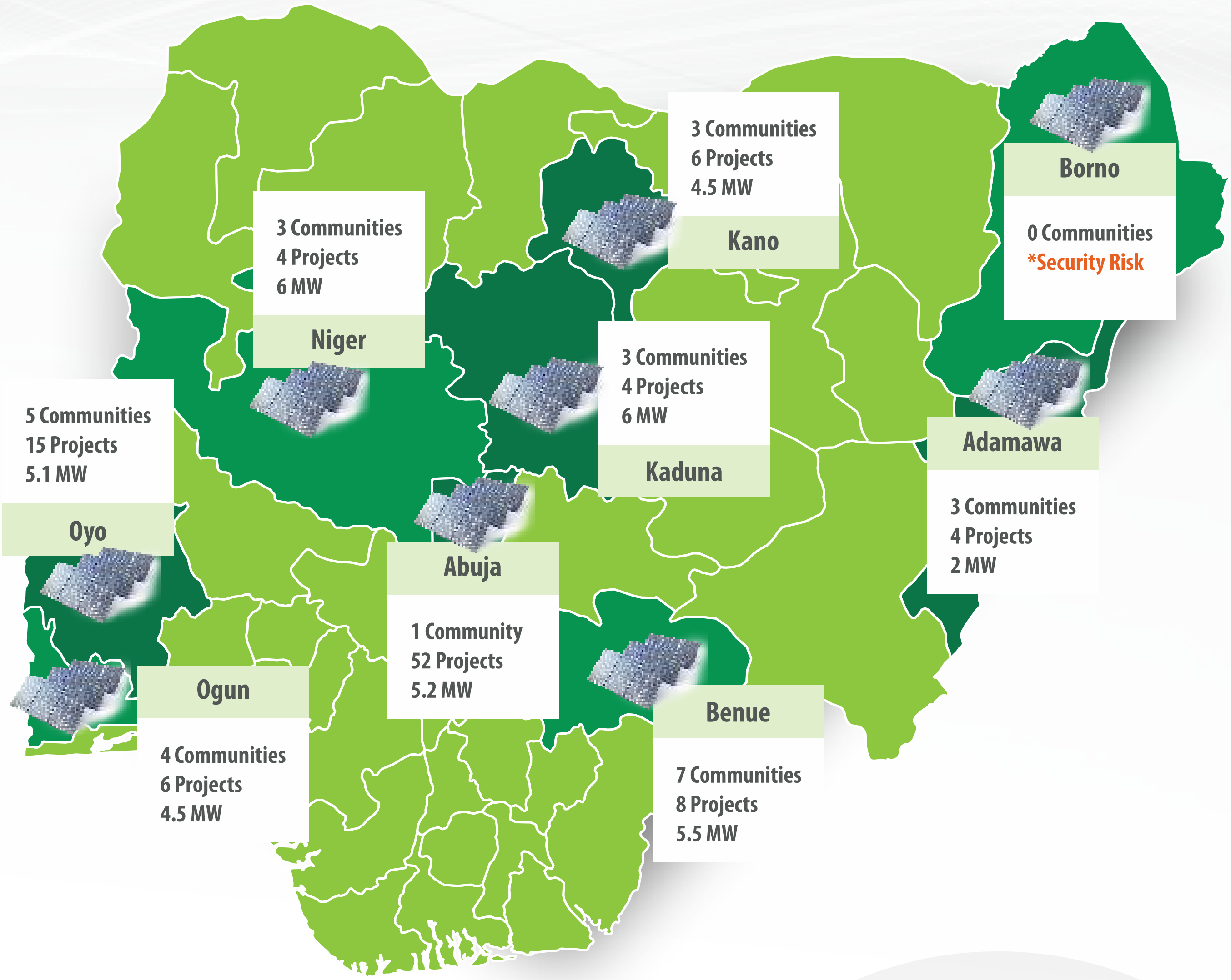
These Systems can be Configured as follows:

- **Stand alone off-grid (Micro-Grids) or Grid Connected with the following**
- **With or without battery storage / With or Without Diesel Power Support**

PV Solar Farm
DC Combiner to Central Inverter
String Inverters – AC Combiner
Control Station
Weather Station



Resource Map + Location Analysis



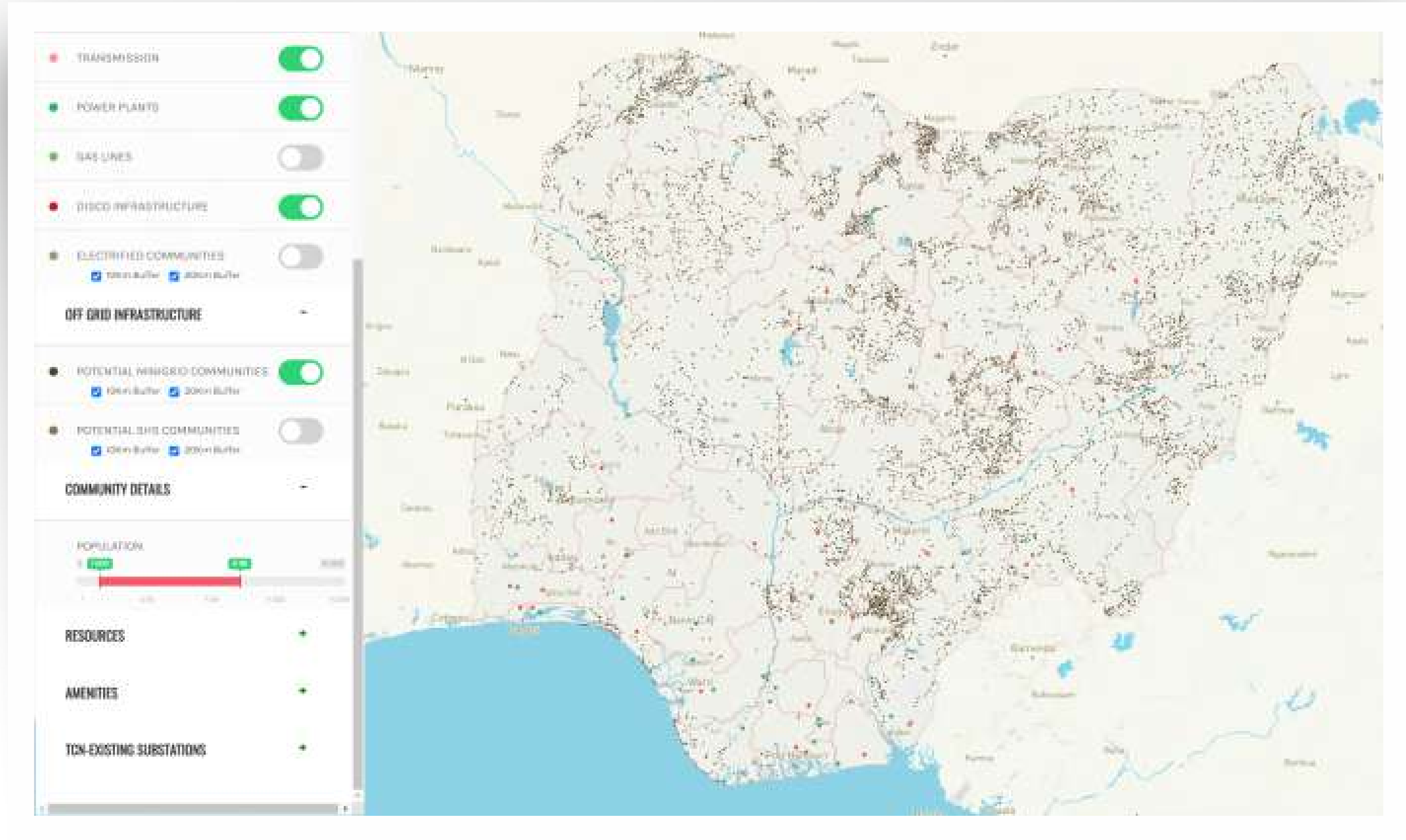
STATE SELECTION CRITERIA

1. Solar Irradiation
2. FGN Interest
3. Funding Scheme Preference
4. Request for Proposal specifications
5. Capacity to influence incumbent stakeholders
6. Nature of incumbent Stakeholders
7. Availability of land space
8. Market availability and potential
9. Potential for economic and sustainability impact
10. Energy Gap (Supply and infrastructure gaps)

Unelectrified Communities in Nigeria

Rural Electrification Agency Mapping for Communities without Access to Electricity:

Every Dot is a Community ~20km from the Nearest Grid Point



Community Project Strategy

Economic growth, urbanization and industrialization are all closely linked with electrification. Farmers reduce waste with proper storage (cold and dry) and processing, education is enhanced through improved telecommunications and internet availability, Institutions operate more efficiently, and micro industries thrive.

ENERGY USE CASE CONSIDERATION

Energization was considered for activities and scenarios that would improve economic activity and development in the regions. This includes rural electrification to eliminate burning of fossil fuels for lighting (use of Kerosene) and energizing markets, agricultural hubs and key development amenities.

GRID VS OFF-GRID STRATEGY

Grid Connections will not be considered as there are no Feed-in or Net Tariff policies in Nigeria

COMMERCIAL SUCCESS CONSIDERATIONS (DEMAND AND ECONOMIC FEASIBILITY)

Commercial success is possible with an energy cost swap. Swapping the cost of self-generation (kerosene for lanterns and Gasoline for generators) for the cost of solar power which is cleaner and consistent. Some Systems will also be beneficiaries of Grants

BESS CONSIDERATION

BESS will be considered for rural and institutional electrification. SMEs would not have BESS in place.

IMPLEMENTATION + O&M STRATEGY FOR MAXIMUM PROJECT SUCCESS AND SUSTAINABILITY

Project implementation will include local content participation which will involve engaging local expertise for project execution and also training and capacity development of indigenes towards building the required skill necessary for operations and maintenance.

Community Project Strategy

STATE	CONSIDERATIONS	RESULT
Ogun State	Main Economic Activities	Manufacturing Hub, Agriculture (including processing), Education
	Grid Infrastructure Status	Ibadan Disco, Grid Central to Abeokuta, Sagamu and Ijebu-Ode
	Populatin/Electrification Rate	31 unelectrified communities. Average of 30% of the population
	Government Plan/Interest	Strong interest & funding for SHS & mini-grid solutions for communities
Oyo State	Main Economic Activities	Agriculture (Crops + Animal Husbandry), Education
	Grid Infrastructure Status	Ibadan Disco, Grid Central to Ibadan Oyo, Ogbomoso and Iseyin
	Populatin/Electrification Rate	~85 unelectrified communities. Average of 30% of the population
	Government Plan/Interest	Strong interest & funding for mini-grid solutions for economy energizing
Niger State	Main Economic Activities	Hydro-Electric Power Generation, Agriculture
	Grid Infrastructure Status	Abuja Disco, Grid Central to Kainji, Shiroro, Jebba and Kontagora
	Populatin/Electrification Rate	>200 unelectrified communities. Average of 50% of the population
	Government Plan/Interest	Strong interest & funding for rural electrification and education energizing
Kaduna State	Main Economic Activities	Agriculture and Industry (Leather, Cotton, Food processing)
	Grid Infrastructure Status	Kaduna Disco, Grid Central to Gwagwada, Kaduna, Katabu and Zaria
	Populatin/Electrification Rate	>200 unelectrified communities. Average of 60% of the population
	Government Plan/Interest	Strong interest & funding for rural electrification
Benue State	Main Economic Activities	Agriculture
	Grid Infrastructure Status	Jos Dsico, Grid Central to Otukpo, Gboko, Makurdi and Zaki Biam
	Populatin/Electrification Rate	>200 unelectrified communities. Average of 60% of the population
	Government Plan/Interest	Strong interest & funding for rural, economy and education energizing
Kano State	Main Economic Activities	Agriculture (Grain), Industry (Textiles, Plastics, Pharmaceuticals), and Trade
	Grid Infrastructure Status	Kane Disco, Grid Central to Kano, Dabi, Bichi, Tsanyawa and Tadwea
	Populatin/Electrification Rate	>150 unelectrified communities. Average of 50% of the population
	Government Plan/Interest	Strong interest & funding for rural education and economy energizing
Borno State	Main Economic Activities	Agriculture
	Grid Infrastructure Status	Yola Disco, Grid Central to Maiduguri, Mainok, Borno, Kama, Biyu and Damboa
	Populatin/Electrification Rate	>400 unelectrified communities. Average of 60% of the population
	Government Plan/Interest	Strong interest & funding for rural electrification
Adamawa State	Main Economic Activities	Agriculture (including fishing and animal husbandry)
	Grid Infrastructure Status	Yola Dsico, Grid Central to Yola, Jimena, Nauman, Beti, and Mayo Belwa
	Populatin/Electrification Rate	>200 unelectrified communities. Average of 60% of the population
	Government Plan/Interest	Strong interest & funding for mini-grid solutions for economy energizing
Abuja	Main Economic Activities	Adminstrative and political capital. Host to major institutions
	Grid Infrastructure Status	Abuja Disco, Grid Central to Abuja, Gwagwalada, Juke, Madalla, and Bwari
	Populatin/Electrification Rate	>40 unelectrified communities. Average of 20% of the population
	Government Plan/Interest	Strong interest & funding for institution and rural electrification

Proposed Community Projects

State	Community	Opportunity Description	Project Type & Implementation Strategy	Scale	Justification
Ogun State	Obafemi	Rural Electrification	PV + BESS + Distribution	1MW (500KW x 2)	Rapid Urban Development
	Obafemi	Food Processing and Dry Storage	PV + BESS + Connections	2MW (1MW x 2)	Major Production of Food (Ofada Rice)
	Makoloki	Economy Energizing (Market)	PV + Connections	500KW	Major Market
	Lukogbe	Rural Electrification	PV + BESS + Distribution	1MW	Rapid Urban Development
Oyo State	Isemi-Ile	Rural Electrification	PV + BESS + Distribution	1MW	Rapid Urban Development
	Ado-Awaye	Economy Energizing (Tourism)	PV + Distribution	1MW	Tourist Destination and Urban Development
	Idi-Iya	Agriculture and Dry Storage	PV + Connections	1.5MW (300KW x 5)	Cocoa Production at Ido
	Aba Emo/Ilaju/Alako	Agriculture and Dry Storage	PV + Connections	600KW (200KW X 3)	Cocoa Production at Ido
	Saki	Agriculture and Dry Storage	PV + Connections	1.5MW (300KW x 5)	Developed Agricultural Communities
Niger State	Bida	Education Energizing	PV + BESS + Connections	3MW	Federal Polytechnic, Bida
	Zungeru	Education Energizing	PV + BESS + Connections	2MW	Niger State University, Zungeru
	Kampala	Rural Electrification	PV + BESS + Distribution	1MW (500KW x 2)	Rapid Urban Development (Proximity to Minna)
Kaduna State	Sabon Birnin Daji	Rural Electrification	PV + BESS + Distribution	2MW (500KW x 4)	Urban Development (Proximity to Tin Mine)
	Zaria	Health Centre Electrification	PV + BESS + Distribution	2.5MW (100KW x 25)	Government Sponsored Health Care Projects
Benue State	Ugbokolo	Education Energizing	PV + BESS + Distribution	3MW	Benue State Polytechnic, Ugbokolo
	Agate (5 Villages)	Agriculture processing	PV + Connections	500 KW (100KW x 5)	Farming Community
	Mbaanku	Rural Electrification	PV + Connections	2MW (500KW x 2)	Urban Development (proximity to Cement Mine)
Kano State	Dambatta	Education Energizing	PV + BESS + Distribution	1MW	Audu Bako School of Agricultture, Dambatta
	Dawanau	Economy Energizing (Market)	PV + Connections	1MW	Dawanau Grains Market (Incl. Dry Storage)
	Tsanyawa	Rural Electrification	PV + BESS + Distribution	1.5MW (500KW x 3)	Urbanization of Sabon Gari. Proximity to Market
Adamawa State	Yola	Health Centre Electrification	PV + BESS + Distribution	200KW	Adamawa State Polytechnic, Yola
	Ngugore	Food Processing and Dry Storage	PV + BESS + Connections	800KW (400 x 2)	Major Processing of Grains
	Girei	Economy Energizing (Market)	PV + Connections	1MW	Girei Grain Market (incl. Dry Storage)
Abuja	Gwagwalada	Health Centre Electrification	PV + BESS + Distribution	5.2MW (100KW x 52)	Government Sponsored Health Care Projects

Risk Assessment

Risks and Mitigation Measures

TECHNICAL

Key Risk Indicators	Mitigation Measures
• Market entry vehicle's (OCEL) experience in the sector • Limited local technical expertise (in the midstream PV module, wafer and solar cell manufacturing) and research and development culture in Nigeria • Proprietary nature of technology in the midstream sector of the Solar Power value chain (Wafer and PV Cells manufacturing)	• Oando Clean Energy (OCEL) would seek working partnerships and technical alliances with renowned international players in this sector. This is to augment local skill sets, gain new competitive skills and eventual technology and knowledge transfer that will have a lasting effect on the product-market positioning of OCEL.

FEEDSTOCK RESOURCE

Key Risk Indicators	Mitigation Measures
• Supply chain risks – With the near-term entry strategy into the solar downstream sector of PV assembly, material logistics coupled with an optimal sourcing strategy is key into gaining immediate competitive advantage.	• Leverage technical partners relationship with component manufacturers • Build strategic relationships and comprehensively assess solar components supply chain partnerships whilst expanding supply optionality and having alternative back up suppliers • Perform in-line and pre-shipment inspections on components for quality control assessments • Maintain module/component delivery timelines through a risk based logistics strategy

FEEDSTOCK RESOURCE/COMMUNITY

Key Risk Indicators	Mitigation Measures
• Location assessments for Solar farms – security, route to market (proximity).	• Detailed feasibility, market studies and security risk assessments are being performed on all location proposed and full route to market assessments performed to guarantee adoption and profitability.

OUTPUT AND END USE

Key Risk Indicators	Mitigation Measures
• End user sensitization - End users have not fully embraced the concept of renewable energy • Evaluate optimal profitability of output within different streams within the value chain in order to make final investment decision	• Sensitization efforts planned to significantly drive adoption. • OCEL's detailed economic and financial model evaluates the optimal profitability of the end-product within the different streams of the value chain from which a final investment decision would be made

Risks and Mitigation Measures

ECONOMICS AND FINANCING

Key Risk Indicators	Mitigation Measures
Significant Initial capital Investment and access to finance (funding and Grants) - Financial capabilities of project sponsor; OCEL	A number of solar intervention funds and grants (CBN intervention fund, World Bank Power sector loan) have been identified and OCEL is being positioned to access these funds As a subsidiary of Oando. Oando will provide financial support and guarantees if necessary
Eligibility of OCEL to access identified funds and Grants (CBN Intervention Fund, World Bank Power Loan)	OCEL to perform a thorough assessment of all identified funds/ grants' eligibility criteria and strategically position OCEL to access same If there are any time or experience-based barriers for fund/grant prequalification, consider partnership/technical alliances with companies that meet the set criteria
Alternative funding barriers - Parent company contagion risks with respect to debt financing options	The project economic model shows the viability of the project and should debt financing be required this would be ring-fenced to ensure banker's line of sight to re-payment OCEL's business model for the venture seeks to optimize the commercialization of the energy/power output with a focus on cost optimization and profitability
Perceived high cost of doing business in Nigeria and impact on the overall value creation potential of the project/ investment	OCEL has performed a detailed project evaluation and commercial optimization/ margin profit analysis which guarantees sustainability and profitability

GOVERNMENT AND REGULATORY

Key Risk Indicators	Mitigation Measures
Limited policy support/traction from a regulatory perspective creating a near uncertain environment for major investors and entrepreneurs within this space. In addition there are currently no tax credits for renewable energy as the Nigeria government is still in the process of developing a robust set of policies to encourage and incentivize solar power or general renewable energy development locally.	Investor confidence can be gained by a robust and stable policy framework and long-term national objectives and targets, backed-up by sound market forecasts. As a thought leader in the local energy industry Oando Plc is seeking to drive policy changes/support within this sector. It is envisaged that investor confidence would be gained by a robust and stable policy framework and long-term national objectives and targets backed up by sound market forecasts

ELECTRIC VEHICLES

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Executive Summary

Nigeria & Oando

Unstable global oil prices, an evolution of global and local polices in favor of "cleaner" energy sources, and a consequent shift in financiers' interest has accelerated the need for oil and gas companies, inclusive of Oando PLC to explore a portfolio diversification strategy towards renewable energy.

As the world transitions from fossil fuels into more renewable sources of energy (Solar, Wind, Geothermal, Tidal etc.), energy providers in the fossil fuel space must rapidly evolve to adapt to a new market reality or face disruption. One such disruption is the growth of electric vehicles to replace internal combustion engine vehicles a major swing consumer of fossil fuels.

Leveraging on the abundance of solar energy, growing financier interest in funding renewable energy projects in Africa as well as the FGN's interest in developing and executing solar power projects for rural and institutional electrification there are abundant opportunities for interested private actors to commit to an environmental sustainable Nigeria.

Introduction

The continued push for a world focused on Sustainable Development and the Energy Transition Act are increasingly tuning and shifting attention to transforming the global energy sector from fossil-based to zero-carbon by the second half of this century. The United Nations with its pledge to end poverty has provided an excellent roadmap aimed at protecting the planet and ensure prosperity for all by 2030.

The Oil and Gas industry is responding with operations models that seek to reduce carbon emissions, and with the Environmental, Social, and Corporate Governance-ESG framework, investors are putting increasing amounts of their funds in high sustainability and societal impact opportunities.

Renewables are essential in the drive towards universal access to affordable, sustainable, reliable and modern energy. Of the three end uses of renewables—electricity, heat, and transport—the use of renewables grew fastest with respect to electricity, driven by the rapid expansion of wind and solar technologies.

In Q1 2020, global use of renewable energy in all sectors increased by about 1.5% relative to Q1 2019, showing that renewable electricity has been largely unaffected while demand has fallen for other forms of energy.

The United Nations has set the pace with a plan that proposes an integrated approach to realize rapid results and progress, accelerating proven innovative solutions and partnerships. Over the next 10 years, the UN Climate Action targets:

- Carbon emissions: Absolute and per capita reductions of 25% by 2025 and 45% by 2030.
- Electricity consumption: Per capita reductions of 20% by 2025 and 35% by 2030.
- Renewable energy: 40% by 2025 and 80% by 2030 of consumed electricity.
- Commercial air travel: Per capita emissions reductions of 10% by 2025 and 15% by 2030.
- Climate neutrality: 100% of unavoidable carbon emissions are offset yearly from 2019 via certified carbon
- credits.
- Operational efficiencies: demonstrated long term economic benefits from the Plan implementation.
- Sustainable Development co-benefits: demonstrated increase in climate smart infrastructure and other sustainable development benefits to local communities from Plan implementation

This report provides an assessment of the solar power value chain, its technologies, opportunities and potential obstacles.

Developing the EV Business

The EV business / value chain development refers to the development and deployment of technologies to support the manufacturing of EV car components and the charging of the EVs. The main elements of these value chain are;

- Manufacturing of EV Power Train and other Sub-Systems
- Assembly of EV Cars, Distributorship and Sales
- Electricity Generation, Transmission and Distribution Infrastructure
- Manufacturing of EVSE and Other EV charging system components
- Charging Infrastructure (Private and Public)
- E-Mobility ServicesDevelopment of the EV charging business has been slow due to uncertainty around policy direction and timing; No one wants to invest in stranded assets.
- Investors must partner up with other stakeholders to define the development of EV

Development of the EV charging business has been slow due to uncertainty around policy direction and timing; No one wants to invest in stranded assets.
Investors must partner up with other stakeholders to define

THE EV CHARGING BUSINESS

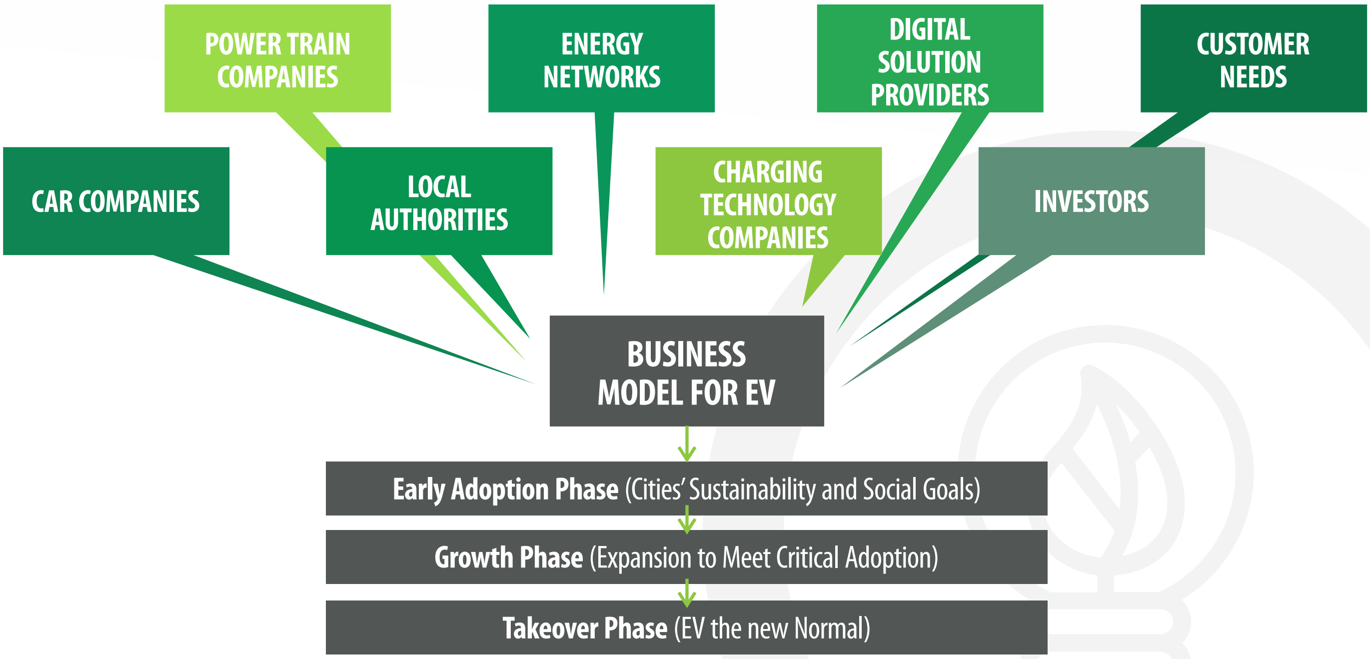
the development of EV

Most Importantly:
Investors must build infrastructure around existing demand

Developing an understanding of where the demand is coming from and how consumers will use EVs will be critical in sizing, scaling and shaping the right infrastructure. Outside the **"Home Charging Model",** two other models have been defined

Mode 1: The Destination User
Airports, Car parks, business parks and major office spaces. The target is areas where users will leave their cars for long periods of time.

Model 2: The Hub User
This targets fleets of cars, Taxis, buses, emergency vehicles, delivery trucks. This relies on the development of charging hubs around cities.



Opportunity Description

Global EV Market Size

NUMBER OF EVs ON THE ROAD IN 2010

0.002% of Global Car Stock **17,000**

NUMBER OF EVs ON THE ROAD AS OF 2019

7.2 million 1% of Global Car Stock

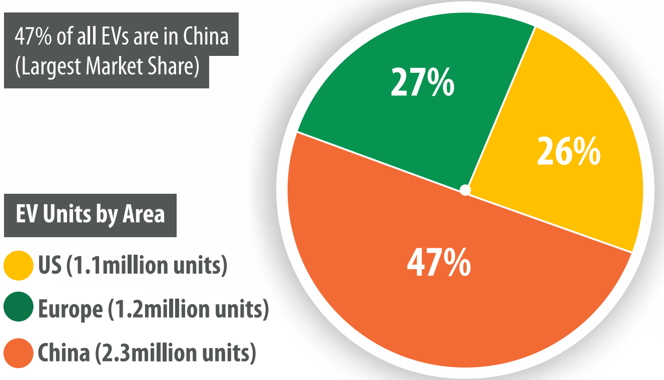
Number of EVs on the road as of 2019

GROWTH AND SALES TREND

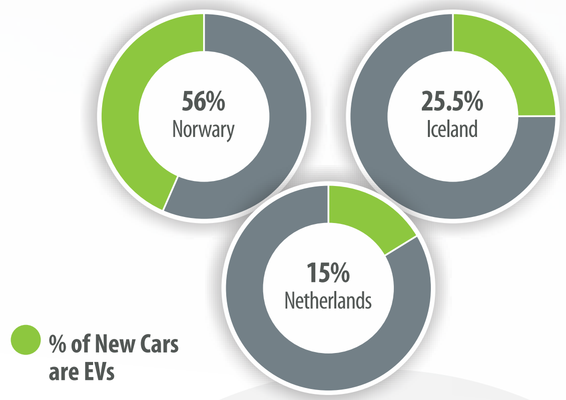
The global electric vehicle fleet expanded significantly over the last decade, underpinned by supportive policies and technology advances.

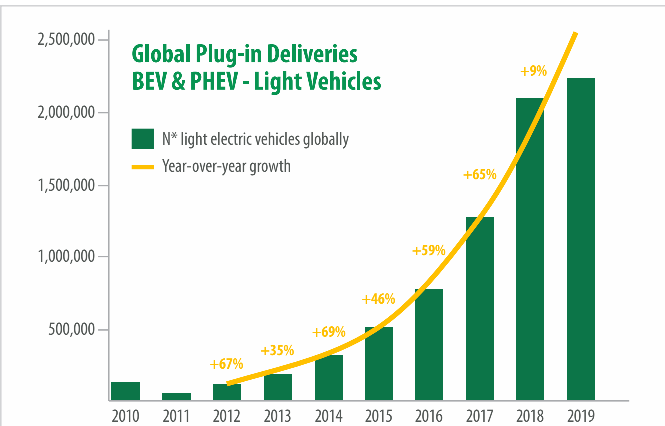
- In 2019, **2.1 Million** EVs were sold (2.6% of global car sales)
- Total EV as of 2019: **7.2 Million** (1% of global car stock)
- According to the SPC scenario, this will be 140 Million by 2030 (7% of global car stock)
- 9 countries have more than 100,000 EVs on the road today
- Although light passenger vehicles are the most popular EVs, 2-3 wheelers and light public and commercial vehicles are becoming popular

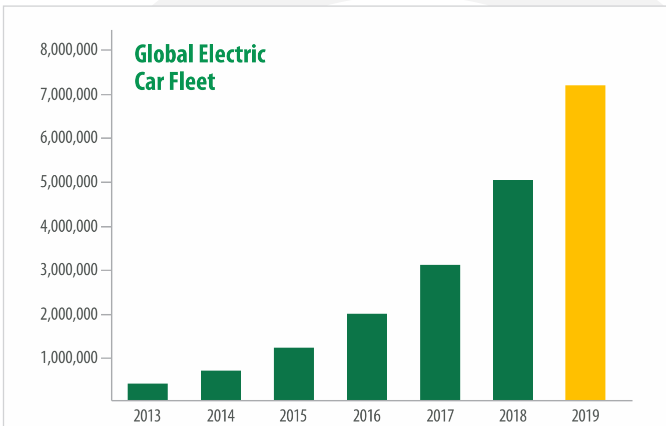
Europe has the Strongest Market Penetration



Leading Countries (Share of Sales of New Cars Running on Electricity)







Growth and Trends of EV

VEHICLE TYPE TRENDS

Transport modes other than passenger cars are also electrifying

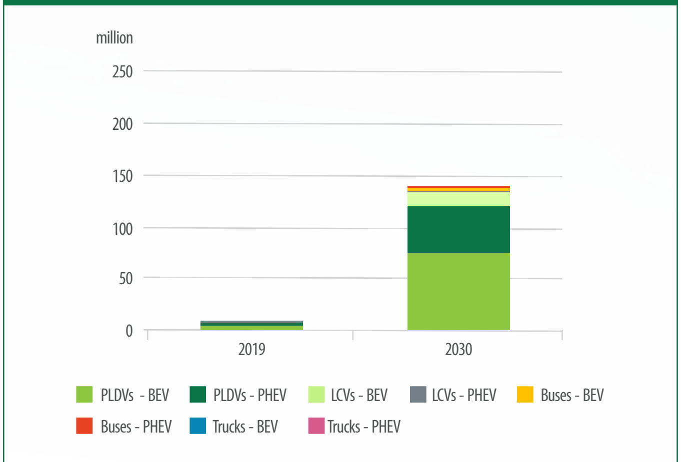
Two/Three Wheelers

- Electric mobility options have expanded to include E-scooters, E-bikes, Electric mopeds, and Electric Tricycles, which are now available in over 600 cities and across 50 countries globally
- The growth of two/three wheelers is driven by their popularity in China, India and other densely populated countries.
- The battery swap method of recharging is also efficiently suited for 2/3 wheelers making adoption easier

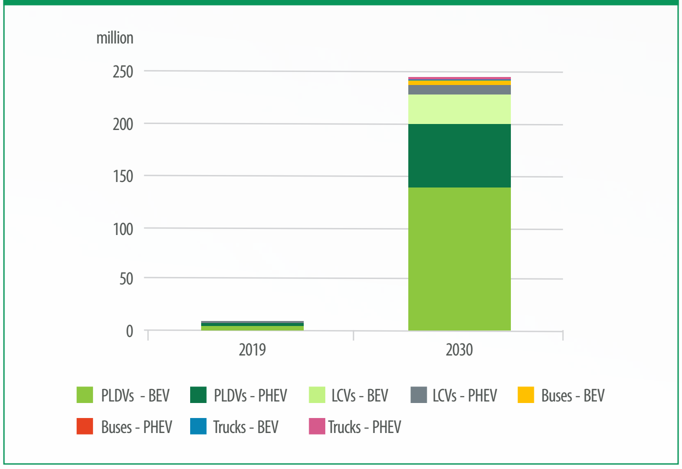
Light Commercial Vehicles

- Light commercial electric vehicles are also being deployed as part of a company or public authority fleet.
- Electric buses are also becoming popular with countries aiming to electrify most of their public transportation networks (Chile aims for 2040)

Global EV Stock in the Slated Policies Scenario, 2019 and 2030

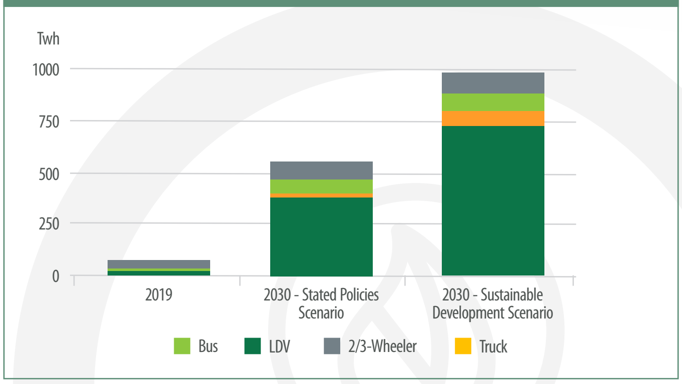


Global EV Stock in the Sustainable Development Scenario, 2019 and 2030



New Electric Bus Registrations by Country/Region, 2015 - 2019

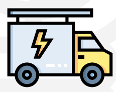
Electricity Demand from the Electric Vehicle Fleet by Mode, 2019 and 2030




Two/Three Wheelers
350 Million in circulation


Light Commercial Vehicles
380,000 in circulation


Electric Buses
500,000 in circulation


Electric Trucks
6000 in circulation

Global Market Outlook

The electrification of transportation is the new frontier of mobility and the trends exist to prove it. Other key changes/trends to note are:

Car companies have embraced EV and there are expected to be at least 21+ New EV brands in 2021 alone

- Nissan targets 1million EV & hybrid sales by FY 2023
- Renault expects 10% of its total sales to be EV in 2023 (Renault Zoe is one of the best-selling EV cars in Europe)
- Daimler plans to introduce 10 Pure electric and 40 hybrid models into its car manufacturing portfolio
- Volkswagen plans to have electrified all models of their cars by 2030 and have the entire company CO2-neutral by 2050

Utilities, Power and Other Energy companies have increased their investment in EV charging Infrastructure (~$1.7billion) and over $100 billion has been earmarked to be invested into battery and EV car manufacturing from 2018 till date.

Political and Government support is also on the rise

- In the USA, Biden has expressed support for EV adoption, targeting 500,000 new public charging outlets and restoring EV tax credits
- The UK government has made moves to bring forward its ban on fossil fuel vehicles to 2030

Private commercial companies are making changes to their fleet

- DHL has pledged to reach 70% clean operation of last-mile pick-ups and deliveries by 2025
- DB Schenker wants to make its transport activities in EUROPE emission free by 2030

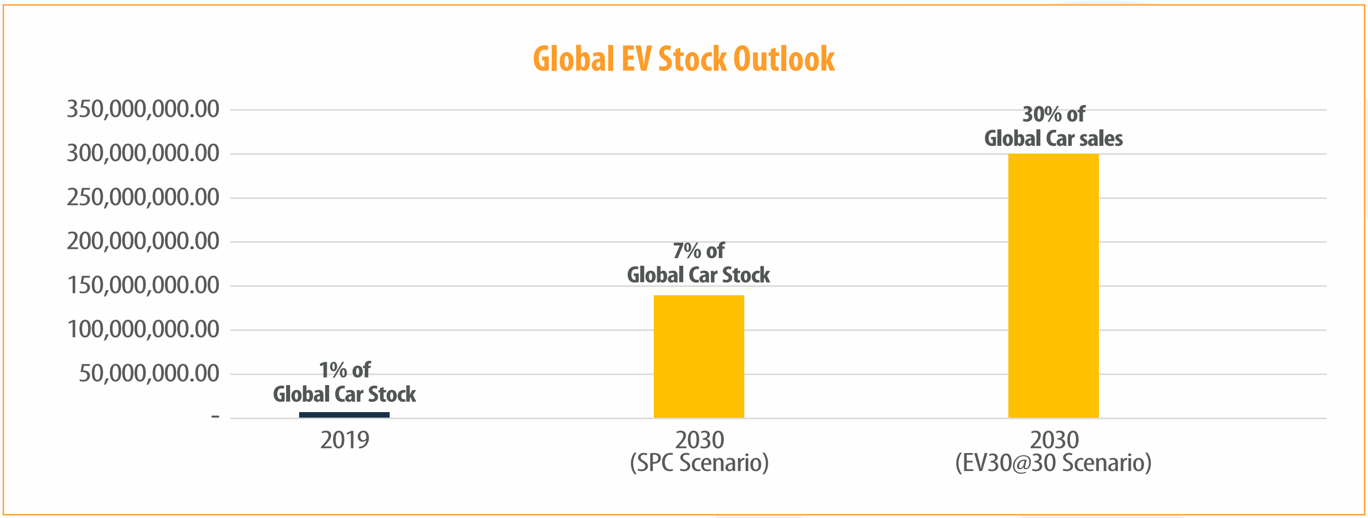
As the price parity between ICE and EVs gets even closer (~2-3years), these trends act as signaling devices for the rest of the market that EVs are here to stay. It thus puts pressure on competitors, stakeholders and investors to act faster or risk being left behind

The EV Market outlook presently has two widely recognized scenarios

1. **The State Policies Scenario:** This reflects the impact of existing policy frameworks and today's announced policy intentions on the EV market by the year 2030. It suggests that by 2030:
   - Global EV stock (excluding two / three wheelers) will be 140 million
   - Global EV stocks will account for 7% of global vehicle fleet

2. **EV30@30 Scenario:** This is a Clean Energy Ministerial Campaign which aspires to help governments achieve a reduction in GHG via the transportation sector by supporting the sales share of EVs. The campaign aspires that:
   - Global EV sales would be 30% of global car sales by 2030
   - Global EV sales would reach 43 million per annum

Time, new data and new policies will tell how these predictions will unfold.



EV in Africa and Nigeria

Africans want Electric cars, but they are still too expensive for most car owners says a survey carried out by auto-trader. The survey also collated drivers and resistors for EV adoption in Africa as shown in the table:

In Africa, South Africa first started the adoption of EVs with the introduction of the Nissan Leaf in 2014. **Currently there are estimated 1000 EVs in South Africa. EVs can also be found in Nairobi, Kenya, Uganda, Rwanda, Nigeria.**

EVs account for only 0.001 percent of car sales in Africa. Adoption techniques have been to use EVs for Ride – hailing services.

Charging Infrastructure: South Africa has the most developed charging infrastructure in Africa with investments of over 2MUSD going into the electric power way project.

Mindshift is necessary and vital for the adoption of EVs in Africa

However, The middle east and Africa are expected to register a CAGR of about 6.80% from 2020-2025 (Dubai aims to have 30% of road transport as Evs by 2030)

Drivers	Resistors
Anticipated fuel savings 40-70%	Higher upfront costs (Including high import tariffs and no form of subsidies)
Rapidly growing urbanization	Current lack of charging infrastructure
Opportunities provided by micro-mobility and gig economies	EV range limitations (Range Anxiety)
Lower lifetime running costs (EVs cheaper to maintain than ICE)	High electricity prices
Overcome fossil fuel scarcity (a problem in SSA)	Grid electricity supply instability (Impact of load shedding)
Environmental concerns; Desire for greener mobility	Charge time
Less Noise pollution	On-going lack of enabling policies - tax incentives and subsidies
Impending global regulations which would impact local automotive markets	No political will to support EV production / Imports and infrastructure development
Positive Image	Existing ICE "useable life"

Two and Three Wheelers expect faster growth in Africa. The UN is currently supporting projects in:
Ethiopia, Morocco, Kenya, Rwanda and Uganda.

Major Brands Introduced to Africa

- **BMW Mini-Cooper SE**
- **Jaguar I-Pace**
- **Nissan Leaf**
- **BMW i3**
- **Volkswagen E-Golf**
- **Hyundai Kona & Ioniq**

EV Assembly Plants unveiled in Africa (2018 – 2020)

- **Kampala** (Uganda)
- **Kigali** (Rwanda)
- **Lagos** (Nigeria)
- **Addis Ababa** (Ethiopia)

Main Partner Companies

- **Volkswagen**
- **Hyundai**

EV in Africa and Nigeria

In Nigeria, Hyundai and Stallion group have taken the first big step towards electric vehicle deployment and adoption in Nigeria by unveiling the first locally assembled EV electric car with a 64-kWh battery pack that allows a 300 miles (482 km) drive on single charge.

The Entrance of EV into the Nigerian space has come with many challenges, yet many opportunities. With the country's current power condition/realities comes many questions begging for answers:

- **Where is the power source going to come from?**
- **How will the generated power be distributed?**
- **How are the vehicles going to be charged?**
- **Would EV owners charge in their homes or at public stations?**
- **Who will own and operate public charging stations?**

It has however become imperative that these questions be met with solutions that would directly speak to the challenges presented with the peculiarity of our business terrain.

HYUNDAI KONA ELECTRIC: LAUNCHED IN LAGOS IN 2020

Can Nigeria Sustain an EV Industry?

With an electricity access rate of 60% and a national electricity grid that relies on load shedding (rolling blackouts) to manage demand and supply of electrical power, Nigeria as a country may not be positioned for the emergence of electric vehicles. Beyond the cost of EVs, this is and will be the major resistor to the adoption of EVs on a large scale to Nigeria. Without the right energy infrastructure in place to meet the new demand for electricity that EVs will bring, Owning EVs in Nigeria will start of as a luxury for the elite as they will either

- Provide their own "fuel" (electricity) for Level 1 or Level 2 charging at homes (Sources: PHCN + Diesel/Petrol Generators + Maybe solar).
- Pay a premium to charge at privately/Government owned public charging stations - Level 2 or DC Fast Charge if the existing power supply can indeed support it.

For EVs to become a means of transport on a large scale in Nigeria,

- Power generation, transmission and distribution capacity needs to be upgraded and expanded.
- EV pricing needs to be nearly as affordable as fossil fuel powered vehicles .
- Cost of power per distance traveled needs to be more affordable than liters of fuel per distance traveled.
- Gas powered and Solar EV charging stations will need to be part of the Energy source mix.

Market Entry Strategy

Market Entry Approach

Raw Materials | Vehicle Design & Development | Parts and Component Manufacturing | EV Vehicle Assembly | Distribution & Sales | Energy Infrastructure | Mobility Services

UPSTREAM

- High Technological advancement requirements
- Global & Established incumbents increasing capacity
- High Entry barriers (Including safety & manufacturing standards)
- Tough Quality expectations
- High Electrical Power requirement

MIDSTREAM

- Lower Entry Barrier
- Requires strong partnerships
- Lower capital reqauirement
- Multiple Supply Chains
- Medium Technological know-how

DOWNSTREAM

- Lowest Entry Barrier
- Multiple Supply Chains
- Low Tech Requirement
- I.T requirement
- Requires EV adoption

Risk Assessment

Risks and Mitigation Measures

TECHNICAL

Key Risk Indicators	Mitigation Measures
• Limited experience in the sector • Limited local technical expertise (Electric Vehicle Supply Equipment Supplier (EVSE-S) and Charge Point Operator (CPO) and as an E-mobility Service Provider) - lack of knowledge required to develop, produce, replicate and control the technological principles in the product/service	• Seek working partnerships and technical alliances with renowned international players in this sector. This is to augment local skill sets, gain new competitive skills and eventual technology and knowledge transfer that will have a lasting effect on the brand's product market positioning
• Slow development of the EV charging business due to uncertainty around policy direction, timing and inherent technology limitations of range (One-Time Travel Distance at Full Charge) which is envisaged to cause range anxiety for local long-distance travellers	• Seek to drive policy changes/support within this sector. It is envisaged that investor confidence would be gained by a robust and stable policy framework and long-term national objectives and targets backed up by sound market forecasts • Policy approaches to promote the deployment of EVs in relation to a variety of measures such incentives for zero- and low-emissions vehicles, economic instruments that help bridge the cost gap between electric and conventional vehicles and support for the phased deployment of charging infrastructure • The number of charging stations in the long-run can reduce the limited range problem and technological advancement has also seen the battery swap method of recharging growing which decreases charging time

FEEDSTOCK RESOURCE

Key Risk Indicators	Mitigation Measures
• Inadequate local electricity supply and infrastructure to sustain the Electronic Vehicle business/Industry. With low electricity access rates and a national electricity grid that relies on load shedding to manage demand and supply of electrical power, Nigeria as a country may not be positioned for the emergence of electric vehicles	• Build infrastructure around existing demand. An in-depth understanding of current and potential demand would be critical in strategically sizing, scaling and shaping the right infrastructure. A phased approach to adopting home, office and other public charging models would be defined • From the technical analysis, it is expected that initial adopters would provide their own fuel (electricity) for Level 1 or Level 2 charging at home (Sources: PHCN + Diesel/Petrol Generators + solar) or pay a premium to charge at private / Government owned public charging stations – Level 2 or DC Fast Charge if the existing power supply can support it

Risks and Mitigation Measures

FEEDSTOCK RESOURCE

Key Risk Indicators	Mitigation Measures
• Inadequate local electricity supply and infrastructure to sustain the Electronic Vehicle business/Industry. With low electricity access rates and a national electricity grid that relies on load shedding to manage demand and supply of electrical power, Nigeria as a country may not be positioned for the emergence of electric vehicles	**For EVs to become a means of transport on a large scale in Nigeria,** • Power generation, transmission and distribution capacity needs to be upgraded and expanded • EV pricing needs to be nearly as affordable as fossil fuel powered vehicles • Cost of power per distance travelled needs to be more affordable than liters of fuel per distance travelled • Gas powered and Solar EV charging stations will need to be part of the Energy source mix
• Limitations caused by non-existent nature of public charging stations - A sufficient number of charging stations is a prerequisite for EV adoption. The lower number of charging networks is recognized as a limiting factor for consumers to buy EVs. The public and private sectors are reluctant to invest in charging stations as the number of EV users is still insufficient and, conversely, potential EV users hesitate from purchasing EVs due to the insufficient number of charging stations	• Build infrastructure around existing demand. An in-depth understanding of current and potential demand (drive office policies to adopt EVs as official cars in line with ESG sustainability adoption by public companies) and how consumers will use EVs is critical in strategically sizing, scaling and shaping the right infrastructure. A phased approach to adopting home, office and other public charging models would be defined • Technological advancement has also seen the battery swap method of recharging growing which decreases charging time and is also efficiently suited for 2/3 wheelers making adoption easier • Seek to drive policy changes / support within this sector
• Supply chain risks – with the near-term entry strategy of exploring the downstream and mobility service component of the Electric Vehicle value chain as an Electric Vehicle Equipment Supplier, Charge Point Operator and an E-mobility Service Provider, material logistics coupled with an optimal sourcing strategy is key to gaining immediate competitive advantage	• Leverage technical partners relationship with component manufacturers • Build strategic relationships and comprehensively assess EV components supply chain partnerships whilst expanding supply optionality and having alternative back up suppliers • Perform in-line and pre-shipment inspections on components for quality control assessments • Maintain module/component delivery timelines through a risk based logistics strategy

Risks and Mitigation Measures

OUTPUT AND END USE

Key Risk Indicators	Mitigation Measures
• Slow adoption due to consumer perceptions about EVs e.g. infrastructure to support adoption, long range travel concerns - limits regarding driving distance with a single charge, higher pricing compared to CVs, charging times etc	• Social factors, particularly consumer understanding of the attributes of EVs, are being recognized as significant influencing variables for users choosing EVs over Cvs • As the popularity and adoption of EVs is significantly dependent on user acceptance, sensitization efforts and EV user education should be planned to significantly drive adoption from a quality, environmental awareness/benefits and long-term financial savings (maintenance costs) perspective
• Evaluate optimal profitability of e- mobility product or service of different streams within the value chain in order to make final investment decision	• Economic and financial models must evaluate the optimal profitability of the service within the different streams of the value chain from which a final investment decision can be made

ECONOMICS AND FINANCING

Key Risk Indicators	Mitigation Measures
• The relatively higher price of EVs compared to that of conventional vehicles (CV) serves as a critical local and regional barrier	• Transport modes other than passenger cars are also going electric guaranteeing cheaper options e.g Electric mobility options have expanded to include E-scooters, E-bikes, Electric mopeds, and Electric Tricycles, available in over 600 cities and across 50 countries globally • Help Government drive the Implementation of economic policies /incentives that help bridge the cost gap between electric and conventional vehicles & support for the early deployment of charging infrastructure coupled with other policy measures that increase the value proposition of EVs (such as parking waivers or lower toll or parking fees) • In-depth understanding of current and potential demand (help drive office and Government policies to adopt EVs as official cars in line with ESG sustainability adoption by public companies and government parastatals) whilst sensitizing the public on the environmental and medium to long term financial benefits of EV adoption (limited maintenance costs, lower carbon emissions etc)
• Limitations in market penetration rate, demand and profitability due to slow rate of adoption in Nigeria and Africa at large coupled with higher electricity price for charging battery as well as replacement cost • Low rate of market penetration compared to CVs to justify immediate commercial gains due to various cost and non-cost factors	• Development of detailed economic and financial models to evaluate optimal strategies to drive market penetration rate, demand and profitability of product /service within the different streams of the value chain from which a final investment decision can be made

Risks and Mitigation Measures

ECONOMICS AND FINANCING

Key Risk Indicators	Mitigation Measures
• Significant initial capital investment and access to finance - financial capabilities of project sponsor	• Identify local and international intervention funds and grants and be positioned accordingly to access these funds
• Eligibility to access identified funds and grants	• Perform a thorough assessment of all identified funds/grants' eligibility criteria and be strategically positioned to access same • If there are any time or experience-based barriers for fund/grant prequalification, consider partnership/technical alliances with companies that meet the set criteria
• Alternative funding barriers	• Development of a project economic model that shows the viability of the project
• Perceived high cost of doing business in Nigeria and impact on the overall value creation potential of the project/ investment	• Development of a business model that seeks to optimize the commercialization of the energy/power output with a focus on cost optimization and profitability • Development of a detailed project evaluation and commercial optimization/margin profit analysis which guarantees sustainability and profitability

GOVERNMENT AND REGULATORY

Key Risk Indicators	Mitigation Measures
• Limited policy support/traction from a regulatory perspective creating a near uncertain environment for major investors and entrepreneurs within this space In addition there are currently no tax credits for renewable energy as the Nigeria government is still in the process of developing a robust set of policies to encourage and incentivize solar power or general renewable energy development locally	• For Nigeria to expand in the electric mobility industry, Government would need to use a variety of measures such as, a revamp of the electricity supply infrastructure, institute procurement programmes to kick-start demand and stimulate automakers to increase the availability of EVs on the market, provide incentives for an initial roll out of publicly accessible charging infrastructure, fuel economy standards coupled with incentives for zero and low-emissions vehicles, economic incentives that help bridge the cost gap between electric and conventional vehicles & support for the early deployment of charging infrastructure coupled with other policy measures that increase the value proposition of EVs (such as parking waivers or lower toll or parking fees). Increasingly, policy support has to be extended to address the strategic importance of the electric vehicle technology value chain • Investor confidence can be gained by a robust and stable policy framework & long-term national objectives and targets, backed-up by sound market forecasts • Seek to drive policy changes/support within this sector. It is envisaged that investor confidence would be gained by a robust & stable policy framework and long-term national objectives and targets backed up by sound market forecasts

WASTE TO ENERGY

TABLE OF CONTENTS

Executive Summary

Nigeria & Oando

Unstable global oil prices, climate change and global warming have resulted in an evolution of global and local polices in favor of "cleaner" energy sources and a consequent shift in financiers' interest to renewable energy. This shift accelerated the need for oil and gas companies, inclusive of Oando PLC to explore a portfolio diversification strategy towards renewable energy.

As the world transitions from fossil fuels into more renewable sources of energy (Wind, Solar, Hydro and Biomass.), energy providers in the fossil fuel space must rapidly evolve to adapt to a new market reality or face disruption. A key part of that evolution is making deliberate efforts to gain an early understanding of the renewable energy value to determine opportunities and strategies for success.

Leveraging on the abundance of waste, growing financier interest in funding renewable energy projects in Africa as well as the FGN's interest in developing and executing solar power projects for rural and institutional electrification there are abundant opportunities for interested private actors to commit to an environmental sustainable Nigeria. Waste-derived energy raises unique interest because of the magnitude of benefits to environmental protection and socio-economic advancement.

Introduction

Nigeria is the largest country in Africa. With an estimated population of 200million as at 2019 and an annual growth of 2.6% based on world bank data, Nigeria's estimated waste per capita stands at 0.63-0.65Kg/capita/day leading to an average of up to 41,000 tonnes of waste generated daily and 42 Million tonnes of waste annually.

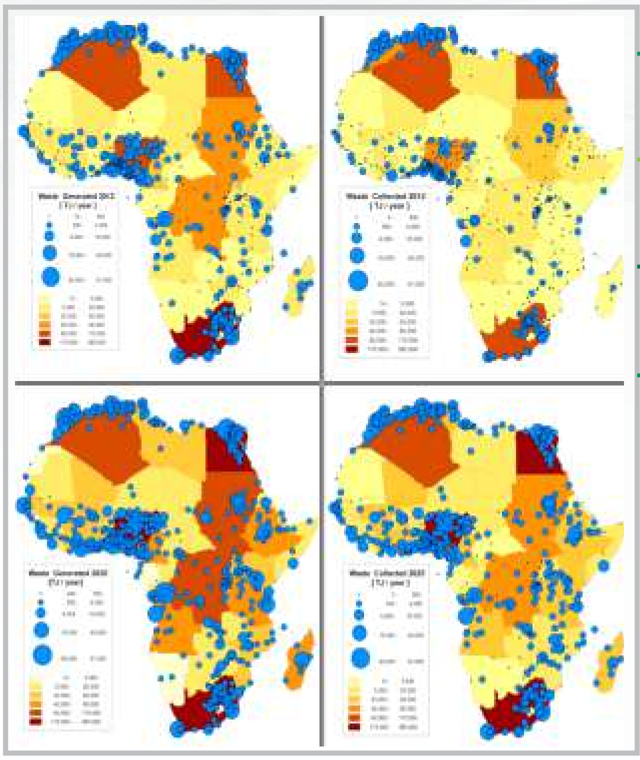
Lagos state which is located in Nigeria is the most populous and most commercial city in Africa. With a population of 14 million, it contributes approximately 25% of the total waste generation in country and suffers from a poor disposal system with many overflowing dumpsites which emit greenhouse gases.

Nigeria's power demand is 24MW, however the current generation is 12.522MW from mainly Hydro and Gas, of which only 40% is utilized, which leaves most of the population in Nigeria without power.

Given the amount of waste generated in Nigeria, the presence of overflowing dumpsites, the power supply gap in Nigeria and the absence of commercial waste to energy plants in the country, the company, Oando Clean Energy seeks to install a 250,000 ton/annum capacity Anaerobic Digestion (AD) plant on a dumpsite conversion site in the urban-rural municipality of Lagos.

Opportunity Description

Energy Potential from Waste



POWER SUPPLY GAP IN NIGERIA

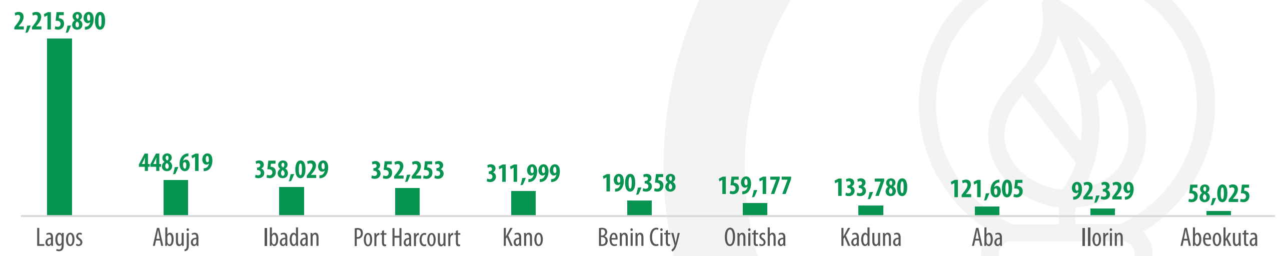
- **12,522MW** Installed power Generating Capacity (Mainly Hydro and Gas)
- **~5,000MW** Actual Generation Utilized
- **~24,000MW** Estimated Actual Demand Required for Consumption
- **~12,000 - 19,000MW** Opportunity for Electricity Generation

BIOMASS RESOURCE IN NIGERIA

Biomass Resource	Quantity (billion kg/year)
Crop Residues	153.76
Perennial Crop Residues	2.35
Forest Residues	19
Municipal Solid Wastes	4.51
Animal Wastes	17.69
Human Wastes	2.87
Overall Total	200.18

- The quest for reliable and adequate power supply in Nigeria has brought about a surge of interest in renewable energy generation, particularly from wind, solar, hydro and biomass resources including municipal solid waste (MsW).
- Waste-derived energy raises unique interest because of the magnitude of benefits to environmental protection and socio-economic advancement.
- The successful operation of Waste-to Energy (WtE) facilities in Nigeria requires continuous supply of solid waste.
- Estimated at 200 billion kg/year of biomass, such waste is in abundant supply however illegally dumped in open spaces and poorly managed with enormous environmental consequences.
- According to Somorin et al, Nigeria's annual electricity generation potential from Municipal Waste is estimated to be 26744 GWh/year if well collected.
- However, with current realities such as poor collection efficiencies, Nigeria's exploitable WtE capacity from MSW stands at 3800 GWh/year.
- Given the opportunity for on-site power generation such as dedicated power station for industrial estates and corporate users which WtE brings, protecocyst seeks to play in this space helping to transform waste to energy.

ANNUAL ORGANIC WASTE GENERATED ACROSS STATES IN NIGERIA (TONNES)



Source: Mwangomo EA (2018) Potential of Waste to Energy in African Urban Areas. Adv Recycling Waste Mgt.

Application Insights

The technology advancement and deployment globally provides an opportunity to explore WTE for commercial and socio-economic purposes. There are over 2000 WTE plants converting Municipal Solid waste to Energy and heat globally.

WTE IN AFRICA				
Name	Technology	**Location**	**Generation**	**Status**
Reppie Plant	Combustion	Ethiopia	20 MW	Active
Climate Neutral Group-Joburg	Combustion	South Africa	19 MW	Development
Gorge Farm	AD	Kenya	2.4 MW	Commissioning
Ikorodu WTE	Combustion	Nigeria	12 MW	Inactive
Ikosi Biogas Plant	AD	Nigeria	-	Inactive
Ebonyi	Gasification	Nigeria	12 MW	Active

Operations Overview

Waste-to-Energy includes processes such as incineration, gasification, pyrolysis that thermally treat solid waste and directly recover energy in the form of electricity and/or heat.

It also include bio-chemical processes such as landfill gas recovery and anaerobic digestion that converts the chemical energy in solid waste to yield products of high energy value e.g. methane.

In ranking the various technologies within the Waste To Energy space, various factors were considered:

- Electricity Generation: The technologies must provide for energy recovery in the form of electricity.
- Processing Capacity: A technology must be capable of processing adequate MSW
- Technology Maturity: The waste processing technologies should be proven on a commercial scale
- Operational Requirements: Handling of available type of waste and running of facility
- Environmental Issues and Human Factors: The technology should not adversely affect community and its environment

<table>
<tr><th>Guiding Principle</th><th>Combustion (Mass Burn Incineration)</th><th>Pyrolysis</th><th>Gasification</th><th>Anaerobic Digestion</th></tr>
<tr><td>Electricity Generation</td><td>1</td><td colspan="2">2</td><td>3</td></tr>
<tr><td>Technology Maturity</td><td>1</td><td colspan="2">2</td><td>1</td></tr>
<tr><td>Operational Reqt.</td><td>2</td><td colspan="2">3</td><td>1</td></tr>
<tr><td>Environmental issues</td><td>2</td><td colspan="2">2</td><td>1</td></tr>
<tr><td>Human Factor</td><td>2</td><td colspan="2">2</td><td>2</td></tr>
<tr><td>Overall Rank</td><td>2</td><td colspan="2">3</td><td>1</td></tr>
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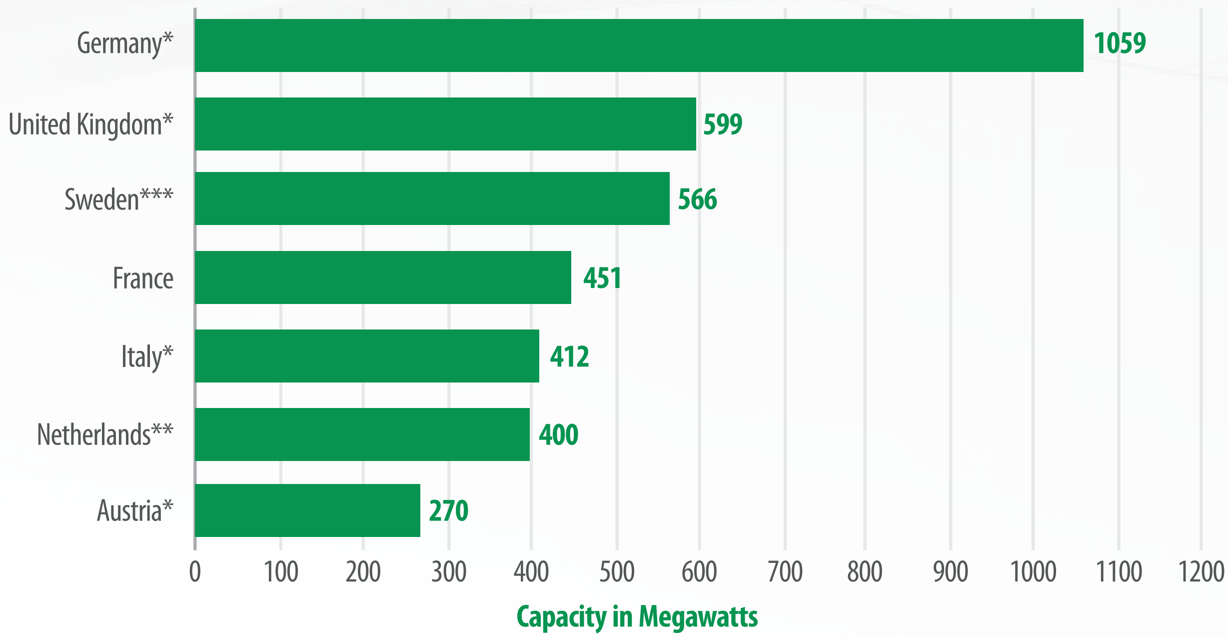
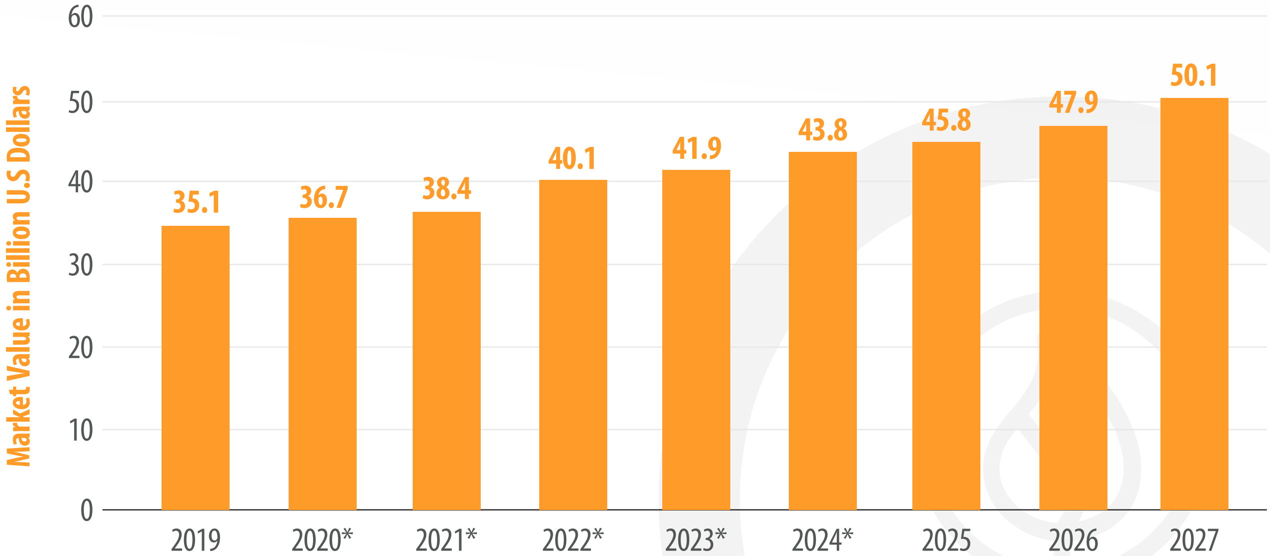
Global Market

CUM. INSTALLED CAPACITY OF MUNICIPAL WASTE TO ENERGY PLANT IN EUROPE (MW)



PROJECTED WASTE TO ENERGY MARKET VALUE WORLDWIDE (IN BILLION U.S. DOLLARS)



Market Assessment

WTE (AD Siting) & Revenue Assessment

There are a total of 7 dumpsites in Lagos state, Nigeria. 2 of the biggest sites are located in Ojota and Lasu Iba within 10km radius to a community.

The Lagos state government plans to carry out dumpsite conversions of some of the dumpsites one of which is the Solous 3 which will accommodate a Waste to Energy plant to power the General Hospital and the College of Nursing.

The conversion works include levelling of the refuse, slope stabilization, soil covering, grading as well as rolling and landscaping, rebuilding drainage and road network within and outside the site. The company will carry out facilitation of these works with the government.

DUMPSITE CONVERSION		
Location	Ojota, Lagos	Lasu-Iba rosd., Lagos
Capacity	2,100,000 T/yr	820,000 T/yr
Area	43 hectares	8 hectares
Residents	5million in 10km radius from the site Proximity to Various industries	200meters from the nearest dwellings, 4 4million people live within 10km radius Proximity to the General Hospital

Risk Assessment

Risks and Mitigation Measures

TECHNICAL

Key Risk Indicators	Mitigation Measures
• Limited local technical expertise – need to promote the development of domestic WtE technology capabilities (anaerobic digestion and/or thermal combustion technologies) • Non availability of components locally - need to source for high quality components/equipment from industrialized countries	• To promote development of domestic WTE anaerobic digestion technology capabilities, seek working partnerships and technical alliances with renowned international players and equipment suppliers in this sector. This is to augment local skill sets, gain new competitive skills and eventual technology and knowledge transfer that will have a lasting effect on the brand's product market positioning

FEEDSTOCK RESOURCE

Key Risk Indicators	Mitigation Measures
• Limited or non existent waste management/disposal practices in Nigeria and impact on sourcing, collection and aggregation of waste for a commercial venture. Researchers estimate that in Nigeria only 20-30% of waste disposed is collected, the rest are left to litter the environment or end up in arbitrary dumpsites constituting serious health, environmental and infrastructural hazards	• Where and if applicable drive policy changes in this sector especially as it relates to the collection, aggregation and segregation (recycling) of waste as this opportunity would not only provide electricity but also help to address the problem of solid waste management, especially in urban clusters around the country
• Limitations in WtE treatment alternatives as a result of Nigeria's poor waste management practices i.e. poor waste segregation at source/ recycling, inefficient transportation of waste	• Consider a highly efficient mass burn incineration/combustion process, based on the waste management landscape in Nigeria, as it requires minimal waste pre-treatment such as recycling and composting – this also comes with it's own risk factors such as low efficiency from wet waste and generation of toxic ash as a final product

COMMUNITY

Key Risk Indicators	Mitigation Measures
• Anaerobic Digestion Facility location assessments - For specific agricultural feedstock – the AD facility needs to be situated close to the feedstock/biomass source or a collection process implemented to optimize feedstock collection and ensure steady supplies.	• Perform location assessments for optimal location of these facilities

OUTPUT AND END USE

Key Risk Indicators	Mitigation Measures
• End user sensitization - End users have not fully embraced the concept of renewable energy	• Sensitization efforts to significantly drive adoption

Risks and Mitigation Measures

ECONOMICS AND FINANCING

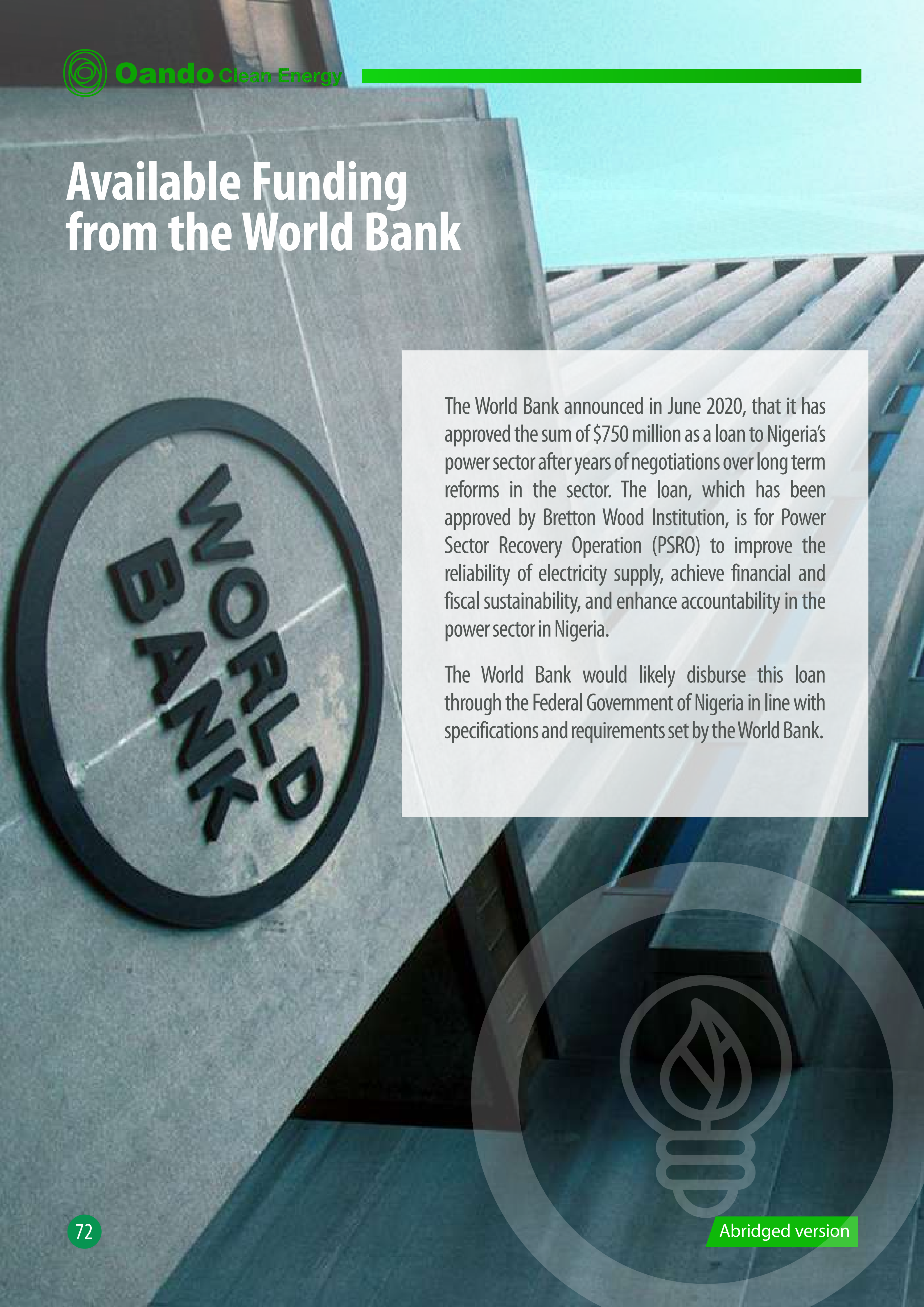
Key Risk Indicators	Mitigation Measures
• Financial capabilities of project sponsor	• Research to identify applicable intervention funds and grants
• Eligibility to access identified funds and grants	• Perform thorough assessment of all identified funds / grants eligibility criteria and strategically position company to access same • If there are any time or experience-based barriers for fund/grant prequalification, consider partnership/technical alliances with companies that meet the set criteria
• Alternative funding barriers	• Ensure project economics model shows the viability of the project
• Perceived high cost of doing business in Nigeria and impact on value creation potential of this investment.	• Development of a business model that seeks to optimize the commercialization of the energy/power output with a focus on cost optimization and profitability

GOVERNMENT AND REGULATORY

Key Risk Indicators	Mitigation Measures
• Absence of long term WtE policy programmes locally and the impact on this opportunity specifically limited policy support and private sector investment levels	• Investor confidence can be gained by a robust and stable policy framework and long-term national objectives and targets, backed-up by sound market forecasts • Seek to drive the implementation of appropriate legal, policy, regulatory, and institutional frameworks to promote newer and more sustainable energy recovery options from waste

Conclusive Information

Available Funding from the World Bank



The World Bank announced in June 2020, that it has approved the sum of $750 million as a loan to Nigeria's power sector after years of negotiations over long term reforms in the sector. The loan, which has been approved by Bretton Wood Institution, is for Power Sector Recovery Operation (PSRO) to improve the reliability of electricity supply, achieve financial and fiscal sustainability, and enhance accountability in the power sector in Nigeria.

The World Bank would likely disburse this loan through the Federal Government of Nigeria in line with specifications and requirements set by the World Bank.

Carbon Credits in Nigeria

Introduction

- Developed under the Kyoto Protocol;
- Establishes the Clean Development Mechanism ("CDM") applicable to developing countries
- The CDM allows Annex B Countries to execute/finance emissions reduction projects, including renewables (such as a solar power project, waste to power) in developing countries. Such projects can earn them saleable certified emission reduction ("CER") credits.

Eligibility

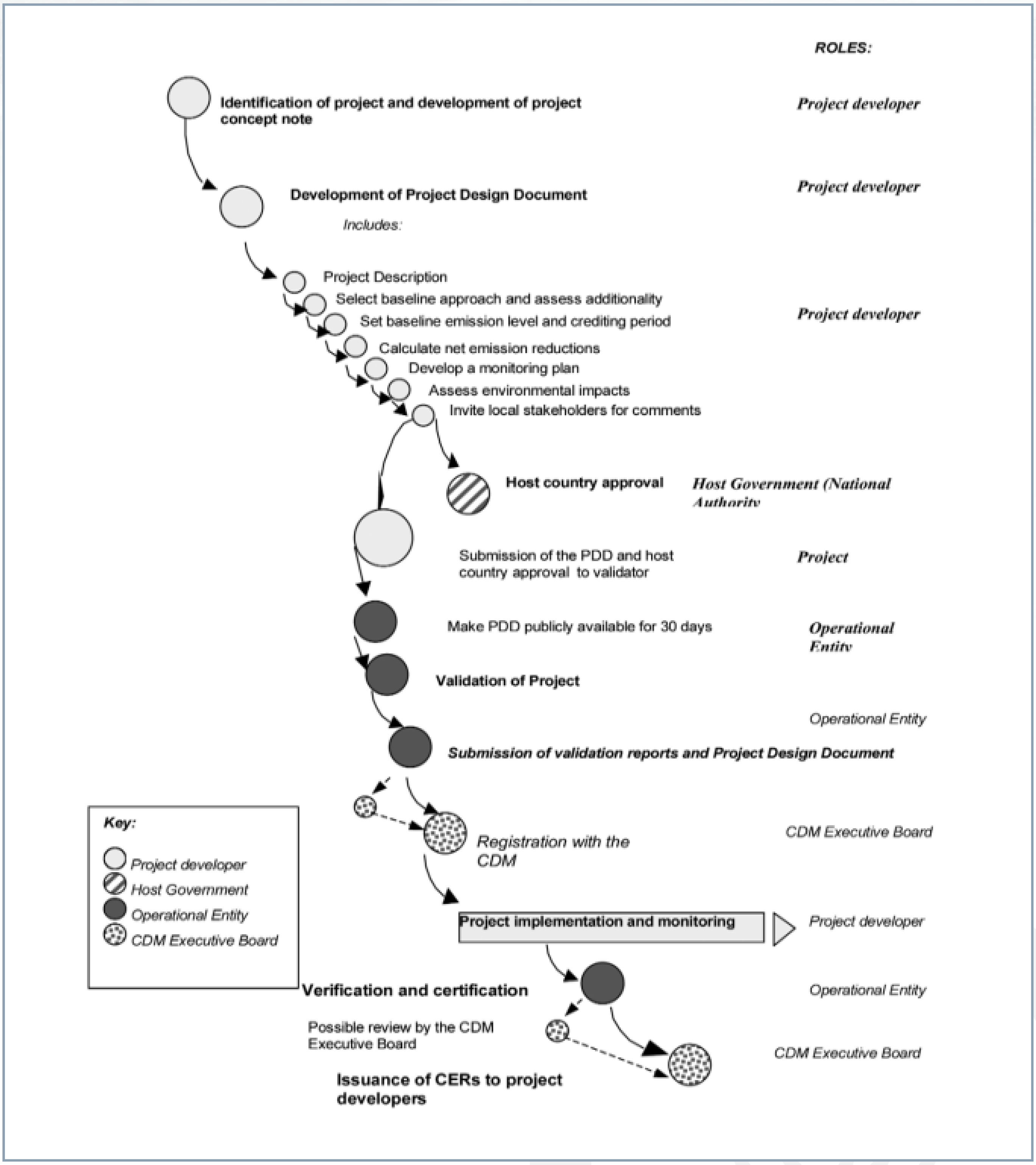
CDM project must:

- Have long term climate change benefits
- Achieve Reductions in emissions that are additional to any that would occur in the absence of the CDM project

Administration

- Presidential Implementation Committee for CDM, which was established under the auspices of the Federal Ministry of Environment;
- Companies creating projects, in developing countries, which actively reduce GHG emissions become eligible for carbon credits and then can raise funds, by selling them to a company exceeding its allowance on an exchange.
- Income from Carbon credit trading are tax exempt.
- Carbon credit prices are affected by forces of demand and supply, risks – project, sovereign, credit, etc

CDM Process flow



CBN Intervention Fund - Other Strategic Subsectors

Introduction

- Set up by the CBN in January 2016
- Funding for the agriculture, manufacturing, mining, solid minerals and other strategic subsectors
- For green and brown (expansion) projects - priority for local content, fx earnings and for job creation
- Trading activities shall not be accomodated

Other Key Points - Upstream

- Types – (i) Term Loan for acquisition of plants and machinery and (ii) Working Capital
- Tenor - Maximum of 10 years (1 year for Working Capital on a 1 year roll-over basis)
- Interest rate – 9%
- Moratorium – 1 year
- Eligibility – Borrower must be registered under CAMA

Real Sector Support Facility (initially for N300bn)

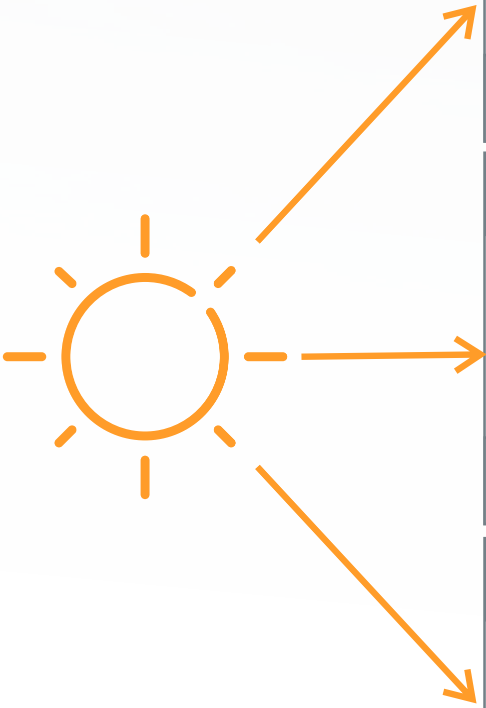
Appendix

SOLAR

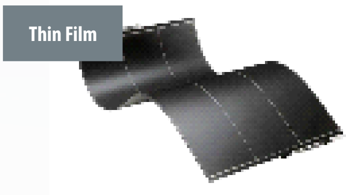
Technical

Solar Power

Solar Power is Energy from the sun: Solar power can be harnessed to produce electricity or heat using a variety of technologies:

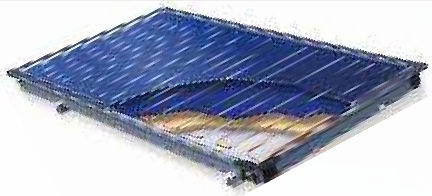


PHOTOVOLTAICS



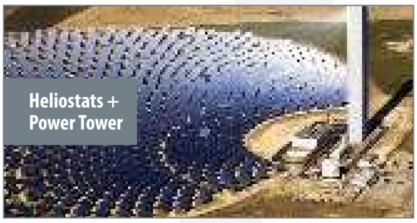
Solar cells Convert incident solar rays to Electricity – used for grid tied solar farms or distributed power generation

THERMAL COLLECTORS



Solar thermal collectors (flat plate or evacuated tube type) are used to heat up a working medium to convey heat to a use point

CONCENTRATED SOLAR POWER

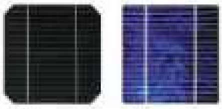


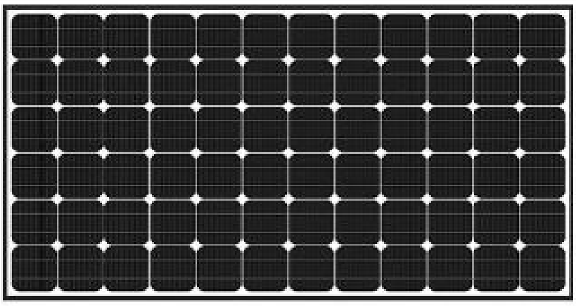
Special mirrors are used to concentrate the suns rays in order to generate heat which is used to heat up a working medium or heat engine for electricity generation

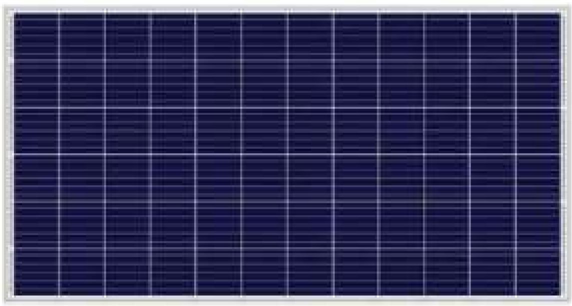
Monocrystalline vs Polycrystalline Solar Panels

There are two main categories of PV Panels. Monocrystalline (Mono) Solar Panels and Polycrystalline (Poly) Solar Panels. Below are some key differences between the two

Mono-Crystalline	Sample Cells	Poly-Crystalline
To make cells for mono panels, silicon is formed into bars and cut into wafers. Solar Cells are thus made from a single crystal of silicon		To make cells for poly panels, fragments of silicon are melted together to form the wafers. Solar cells are this made from many crystals of silicon



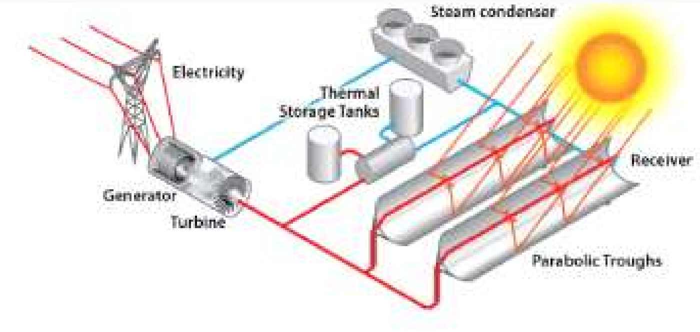




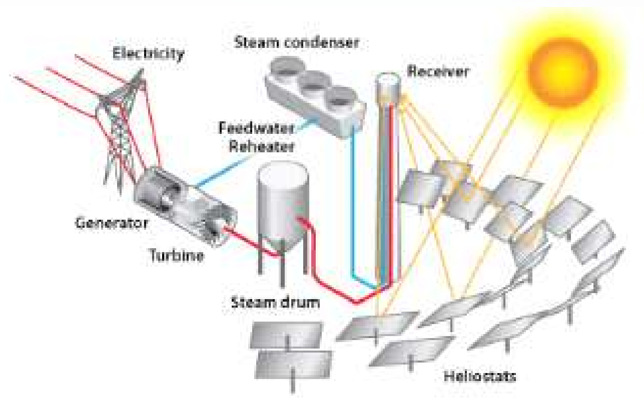
Mono-Crystalline		Poly-Crystalline
More Expensive (10 - 15% more)	**Cost**	Less Expensive (10 - 15% less)
Higher Efficiencies (23%)	**Efficiency**	Lower Efficiencies (17%)
Sleeker: Solar cells have a black hue	**Aesthetics**	Solar cells have a blueish hue
25+ years	**Longetivity**	25+ years
Best with space constraints	**Size (Space)**	Could be more economic with available space
Canadian Solar SunPower Hyundai SolarWorld	**Major Manufacturers**	Hanwha Trina Hyundai Solar World

Concentrated Solar Power (CSP)

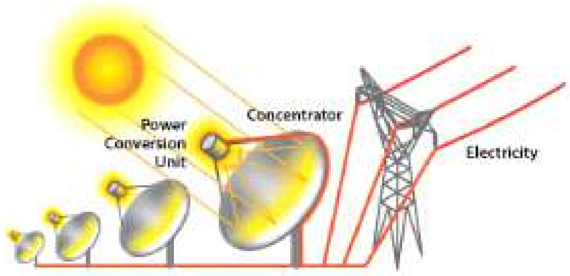
Concentrated Solar Power (CSP) – Is a thermal Energy Solution Strategy. CSP systems concentrate the radiation of the sun to heat up a working fluid (Oil, Water, Molten Salts, Games) which is then used to drive a heat engine (E.g. Steam turbines converting thermal energy to mechanical work) which drives an electric generator.



PARABOLIC TROUGH



POWER TOWER + HELIOSTATS



SOLAR DISH CONCENTRATORS

CSP vs Solar Farms

CSP is Very Different from PV. While PVs convert solar radiation directly to electricity by exciting electrons in the silicon cells using photons of light from the sun, CSP concentrates the thermal energy from the sun to heat up a working fluid which runs a heat engine for electricity generation.

Photovoltaic Panel Solar Farm		Concentrated Solar Power
Generates direct electric current (DC) which requires conversion to AC before transmission **Recommended for Grid-Tie in**	**Type of Electricity**	Generates alternating current (AC) which requires no conversion before transmission **Recommended for Off-grid solutions**
PV directly generates electricity which is more difficult to store especially at large energy levels and demand requirements. Battery electricity storage is considered more expensive and less efficient compared to thermal energy storage. **Recommended for small scale power generation: 1-100MW**	**Energy Storage, Power avilability & Efficiency**	Thermal Energy storage is used. Allows continuous generation even during times of low or no sunlight. This eliminates intermittence and allows CSP to be used as a primary power generation strategy for supplying base load requirements **Recommended for Large Scale power generation: > 100MW**
Cost of PV is lower for the same scale of power in the small to medium range of power generation capacity	**Cost**	Cost of CSP is competitive for the same scale of power in the large-scale range of power generation capacity
Although cost of energy, Ancillary services and power dispatch-ability on demand are top factors for determining investment in power, cost of energy has taken the lead in an uncertain economic climate thus supporting more investment in PV technologies	**Investors Perspective**	Cost of energy for CSP plants is much higher than PV plants from a CAPEX and OPEX perspective. However CSP provides greater power availability and potential energy storage which when included to a PV system by way of battery storage makes CSP almost competitive
Simpler to design, construct, operate and maintain	**Complexity**	More complex to design, construct, operate and maintain

The choice between CSP or PV is dependent on use case and Scale. Recommendation: Run economics for systems greater than 100MW capacity

Battery Storage & Hybrid Systems

Solar farms can only provide useable power when the sun light is available at good – high intensities or irradiation: 6 - 8 hours a day in most cases from 8:30am – 4:30Pm (Nigeria's Best Case). The presence of cloud cover also reduces the ability of PV to generate electricity. At night power generation is zero. To improve on power availability, intermittency and output quality the following strategies are employed:

- Battery Storage
- Back up power generation (Usually Diesel Generators)

1MW BATTERY STORAGE: $300,000 – $500,000 (4-8YEARS)

500KW Diesel Generator	**$50,000**	**20 years**	Will Include Maintenance and Operations Cost

Why Solar Is the Next Big RET?

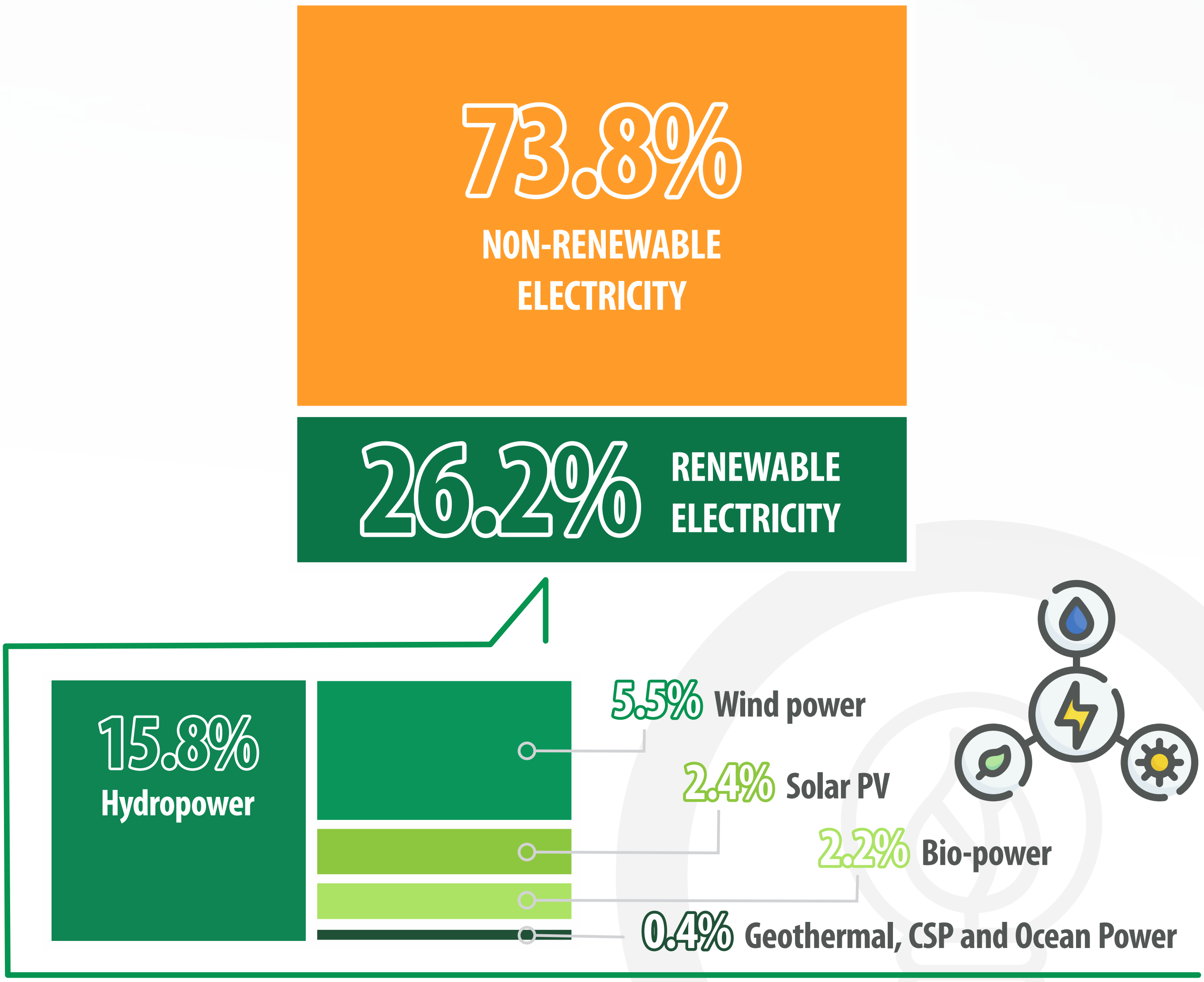
Solar Power is the considered to be the **3rd highest renewable energy source** contributor to the global energy mix, overtaking bio-power in 2017.

Solar is considered one of the fastest growing sources.

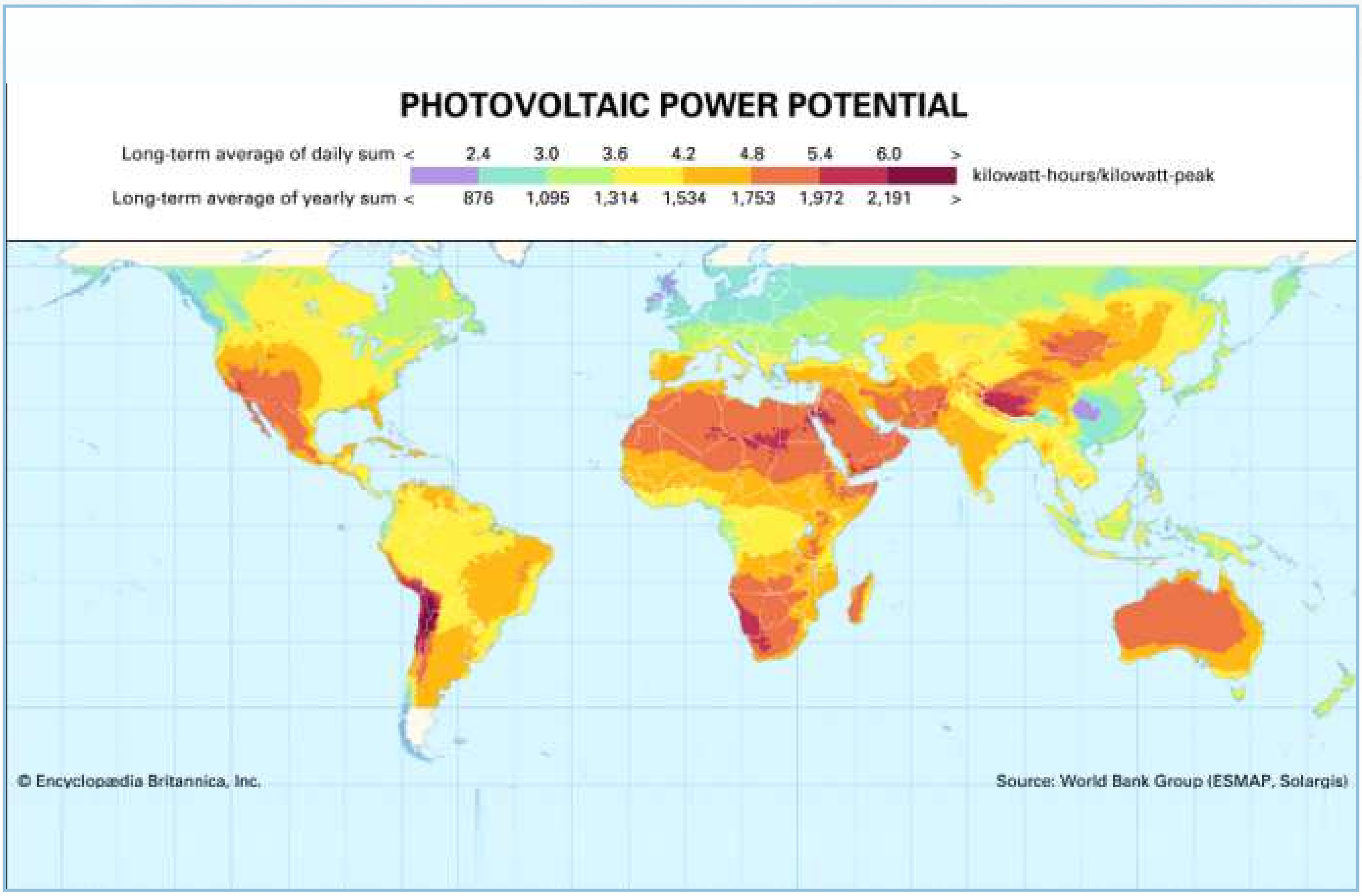
2015	1.2%
2016	1.5%
2017	1.9%

The increase in adoption has been due to improved efficiencies, lower cost, Government incentives / Policies and its suitability and scalability for distributed power generation

ESTIMATED RENEWABLE ENERGY SHARE OF GLOBAL ELECTRICITY PRODUCTION, END - 2018



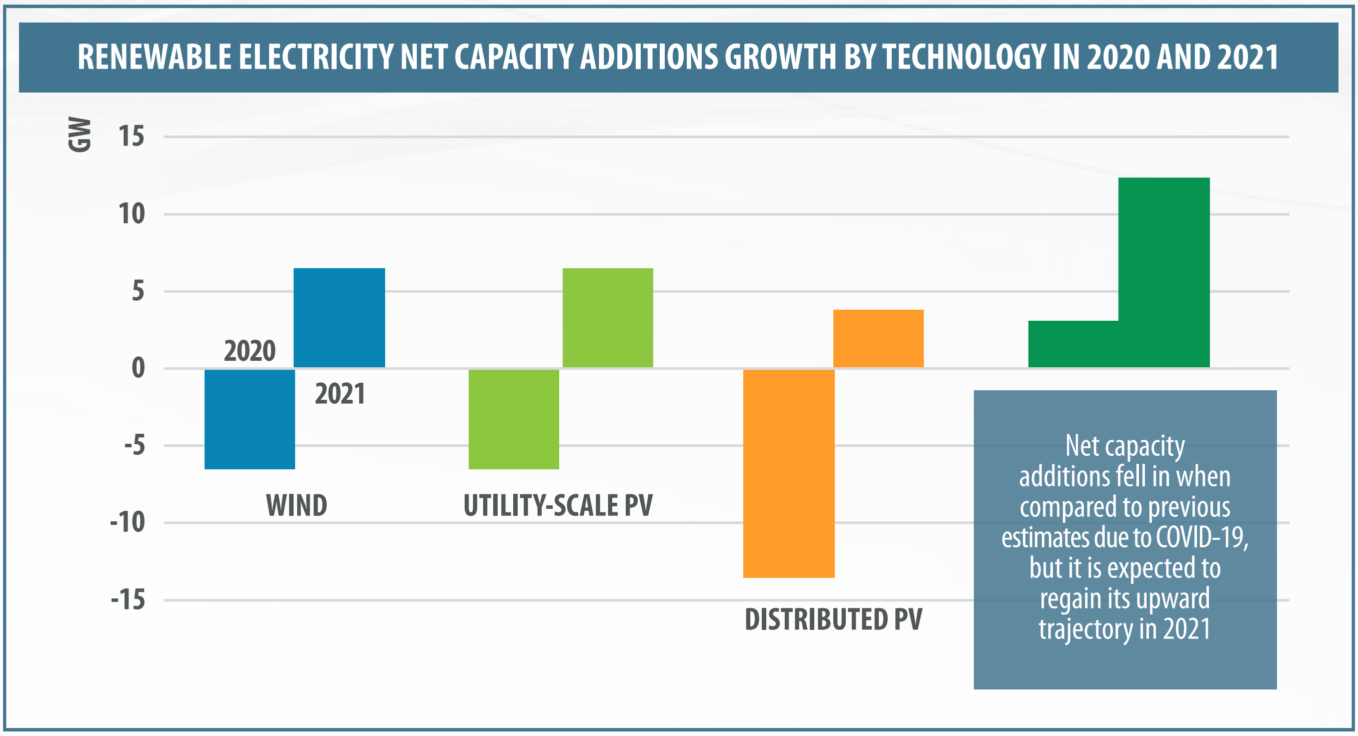
Solar Resource Distribution

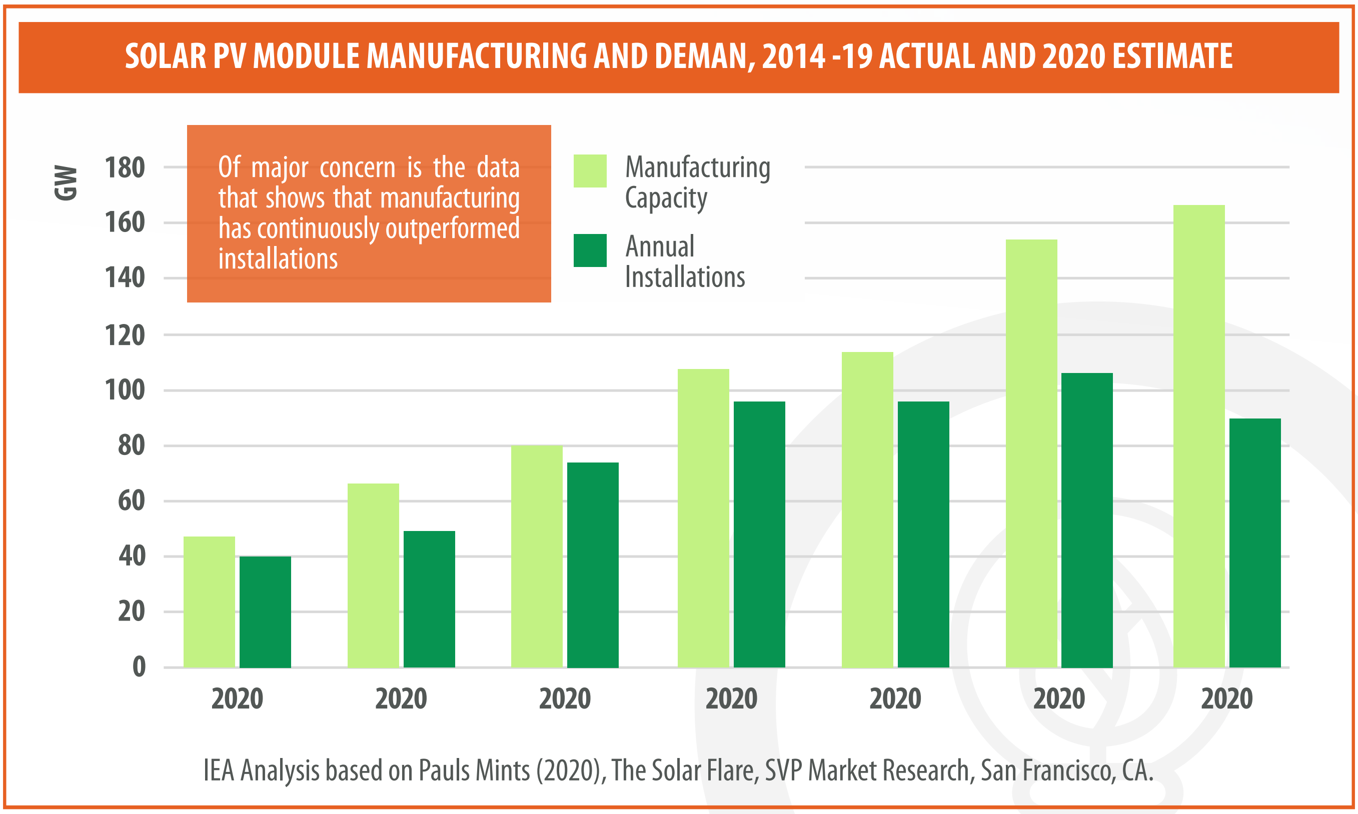


With an average daily Photovoltaic power potential of between **3.6 – 4.8 KWh/KW-P**

Nigeria has good solar irradiance for the adoption of solar technologies, with the best potential located in the northern states

PV Capacity Addition: Global Outlook





PV Value Chain

Poly-silicon Manufacturing	Poly-silicon Processing	Wafer Cutting	Solar Cell Production	PV Module Production
Quartzite rock is mined and processed into high purity MG-Si and then into Poly-Si	Polysilicon rock is melted at ~1,400 °C until it forms a white-hot liquid.	The Crystal Ingotis first saw -cut into equal cylindrical lengths before being wire-cut into the squared wafer	The polysilicon wafer is converted into solar cells through the addition of phosphorus and bus bar circuitry	Solar cells are strung together in a panel modeling and assembly line
The processes involved are:	The processes involved are:	The processes are:	The processes are:	The processes are:
Carbon Reduction Acid Treatment	**Charging Melting Growing Cooling**	**Cutting Squaring Slicing**	**Texturing Diffusing Coating Printing**	**Stringing Soldering Laminating Framing Inspecting Packing & Shipping**
The Processes are power intensive and require an Arc-Furnace	The Processes are power intensive and require a Quartz Crucible	The processes requireprecision cutters for proper shape configuration	The processes require specialized equipment set in a sterile environment	The process requires heavily automated robotics
Quartzite (Silica), Carbon (coke), Hydrochloric Acid, Hydrogen	Graphite, Silicon Crystal, Boron	Silicon Carbide	Silicon Film, Silicon nitride, Phosphorus	Titanium Dioxide, Ethylene Vinyl Acetate, Mylar or Tedlar sheets, Steel or Aluminum

END USE APPLICATION

Grid Power (Solar Farms)

Rooftop (Off-Grid Power)

Solar Products

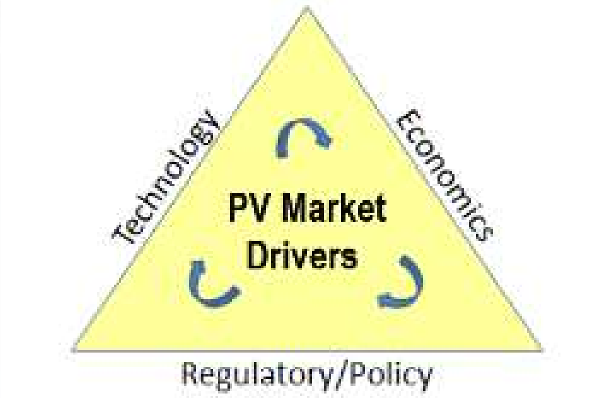
PV Value Chain

	Polysilicon & Precurcors	Waters to PV Modules	Installation to Energy
C-Si Approach	SIH4/TCS, Polysilicon	Wafers, PV Cells, PV Modules	Distribution, Installation, Energy
	Manufacturing Equipments		Ancillary Equipments, Financing
The Film Approach		PV Cells, PV Modules	Distribution, Installation, Energy
	Upstream(Manufacturing)		Downstream (Energy)
The Market	• Polysilicon manufacturing industry has moved to Asia • Global incumbents increasing capacity	• Wafer to PV module manufacturing is weak and getting weaker in the U.S. • Tax incentives/holidays, labour costs and supply chain benefits have driven ingot/wafer module manufacturing to Asia • All the indusry' s leaders and largest players are expanding capacity in Asia	• Installation to energy end market in the U.S is anemic compared to leading markets • Effective fee-in tariff (FIT) incentives drove primary markets largely in Europe • U.S market driven largely by tax incentives - a less efficient approach to drive market growth

Issues/Drivers	• Tax liability
	• Geography - safety
	• Supply chain cost
	• Consumables (electricity) cost
	• Skills-set: experience base
	• Labour cost
	• Landed cost
		• Tax liability
		• Supply Chain cost
		• Labour cost
		• Landed cost
		• Geography - end market
			• Project returns (ROI)
			  • Incentives
			  • Risk mitigation
			  • Geography
			• Cash flow mismatch - structured finance vehicles
			• Private capital scarcity
			• Limited supply of tax equity

Source: Deutsche Bank - Alternative Energy Solar Photovoltaics

PV Global Drivers and Resistors



- **Technology:** Available and deployed solar power technologies must be efficient in solar power conversion to reduce the cost and space requirement for conventional power need
- **Economics:** Economies of scale and the cost of raw materials play a vital role in the overall feasibility of solar power utilization – this is of course affected by location, nearness to raw materials, nearness to market, power cost and more
- **Regulatory/Policy:** Without the support of regulations, policies, subsidies and incentives put into law to support the adoption and development of solar power infrastructure, the PV market will fail to compete with other sources of energy

Incremental growth is expected in the following categories of the PV Market Segments

By Circuit Structure Type: **Crystal Silicon**
By End Use: **Commercial**
By Region: **Asia Pacific**

This is due to increased investments in PV, Declining cost of solar technology and the need for distributed energy generation

SOLAR MARKET INCENTIVES THAT HAVE BEEN DEPLOYED IN OTHER COUNTRIES

Incentives vary among nations, states and even cities, but they typically fall into these categories:

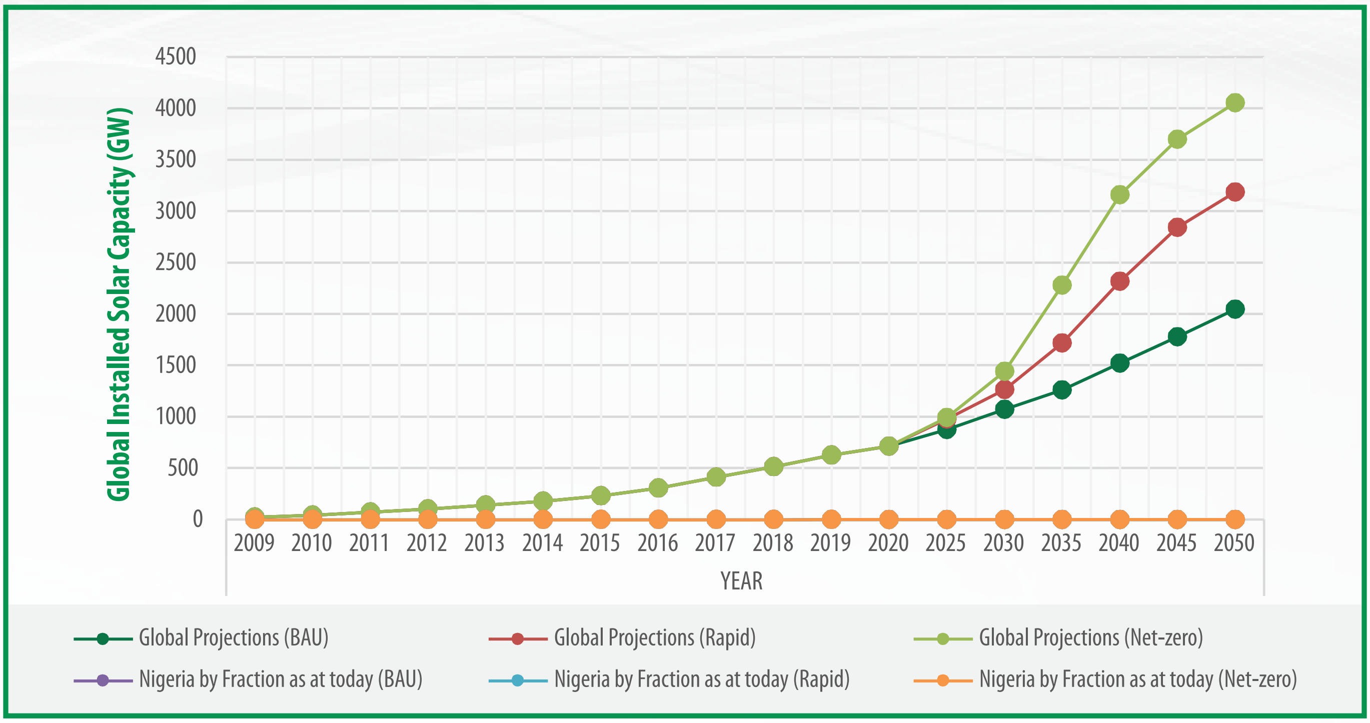
Rebates: Some organizations distribute outright reimbursements for a portion of system costs.

Tax incentives: The U.S. government and several states may offer investment tax credits or accounting provisions allowing extraordinary terms for asset depreciation. On Jan. 1, 2009, for instance, the federal government removed a $2,000 cap on a 30 percent credit for residential systems.

Net metering: This alternative to feed-in tariffs allows solar power producers to generate and use power with the same pricing and according to a single meter. When a home system, for instance, makes more power than it uses, its meter rolls backward.

Feed-in tariffs: Dozens of countries have implemented feed-in tariff systems – set premium rates that utilities are required to pay for power from solar systems. The rates remain fixed for a set number of years, perhaps 20. A power producer, such as a homeowner or business, separately pays normal market rates for power from the grid.

Solar Power and Energy Development Insights



ASSUMPTIONS

Assumed BP's Energy Outlook estimate for projected increase in solar installed capacity from 2020 to 2050 across three possible scenarios:

- Net Zero
- Rapid
- Business as Usual

Assumed that Nigeria will track global growth

Assumed that Nigeria's current fraction of global capacity, will remain the same

INSTALLED CAPACITY TODAY

Current Installed Global Capacity: **627GW**

Current Installed Nigeria Capacity: **28GW**

Current Fraction of Global Capacity: **0.0045%**

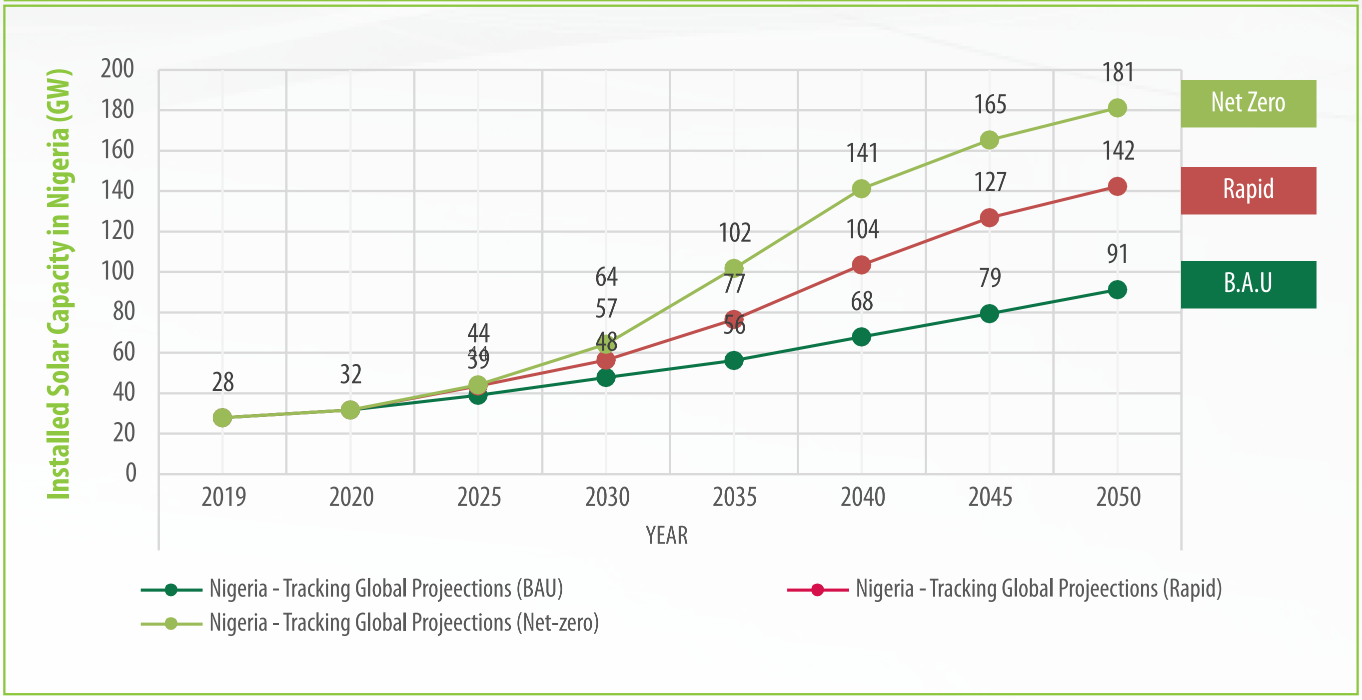
Nigeria's Installed capacity by 2050 is Pessimistically estimated to range between

91MW
Business as Usual

181MW
Net Zero

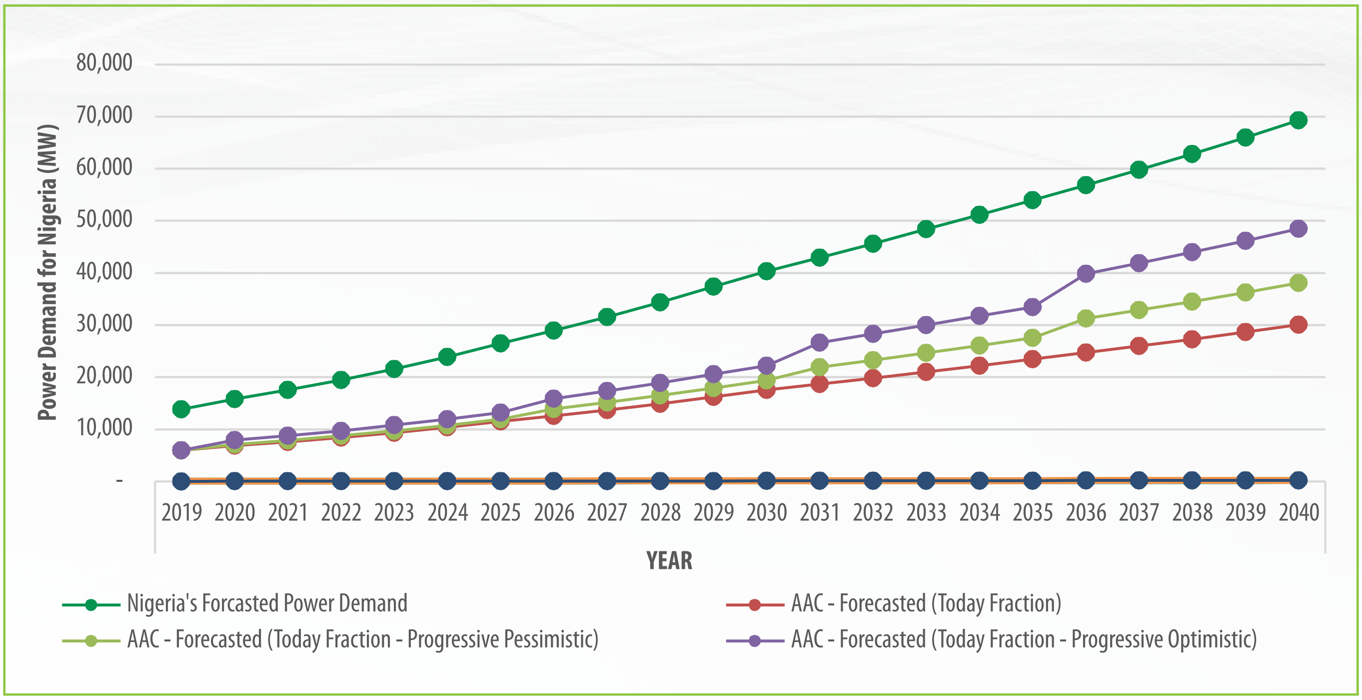
Solar Power and Energy Development Insights

SOLAR POWER INSTALLATION GROWTH TRACKING BP ENERGY OUTLOOK SCENARIOS



None of these projects have...

Solar Power and Energy Development Insights



Using Third – Party Research (Master Plan study on National Power System Development in Nigeria – 2019), Nigeria's Power Demand is expected to grow at an average growth rate of **7.8%** from 2015 – 2040. **Estimated to be 70,000MW by 2040**

ASSUMPTIONS

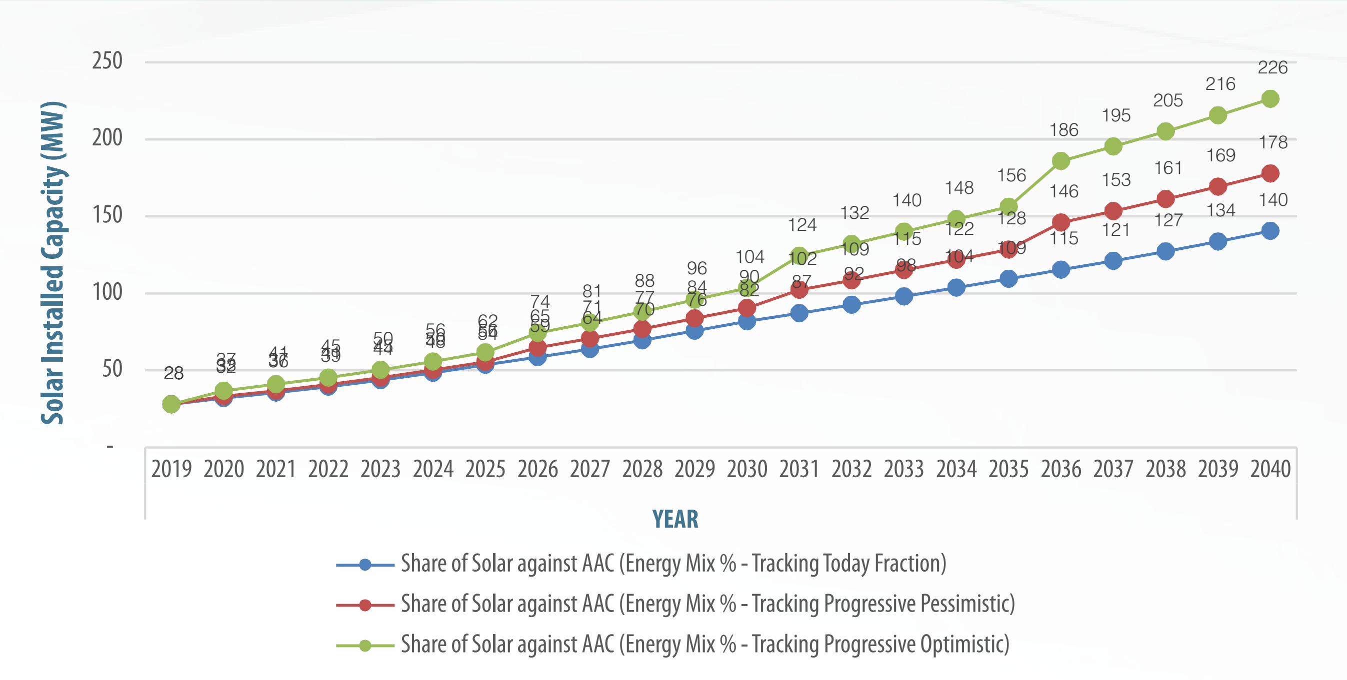
- Assuming Nigeria's Actual Available capacity (AAC) or Capacity Factor against actual Demand ranges from its current 43% up to 70%
- Assuming Nigeria's Solar contribution to the energy mix remains constant

Thus, assuming some growth in AAC but keeping solar fraction of the energy mix constant (0.47%)

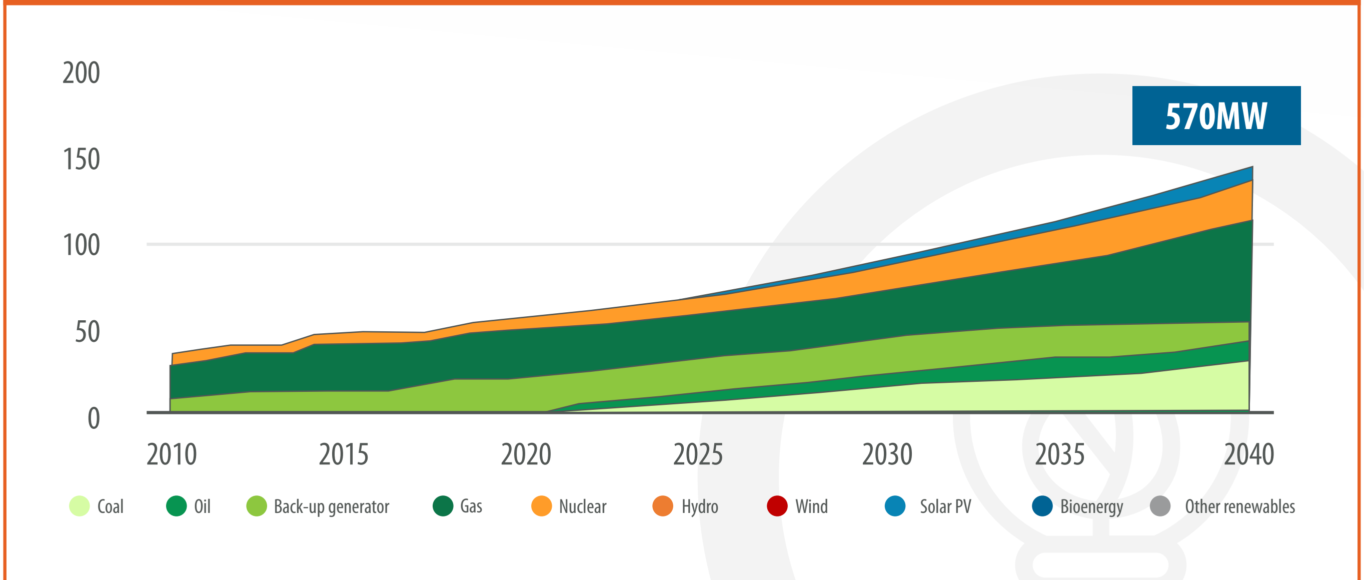
Solar Installed capacity is expected to be between **140 – 226 MW by 2040**

Solar Power and Energy Development Insights

INSTALLED SOLAR CAPACITY TRACKING FORECASTED POWER DEMAND GROWTH, ASSUMING 3 CAPACITY FACTOR SCENARIOS (MINISTRY OF POWER STUDY)



But….. IEA Estimates from Nigeria's stated policy scenarios and GHG emission Targets – PV Installed capacity will be >500MW by 2040



Quartzite Mining & Poly-Si Production

1. POLY-SILICON PRODUCTION

Stage 1

$Sio_2 + 2C \rightarrow Si + 2CO$

Silicon dioxide, Carbon → Silicon, Carbon monoxide

Stage 2

$Si + 3HCl \rightarrow HSiCl + 2H_2 \rightarrow 2Si + 6HCl$

Silicon, Hydrochloric Add → Trichlorosilane, Hydrogen → High Purity Silicon, Hydrochloric Acid

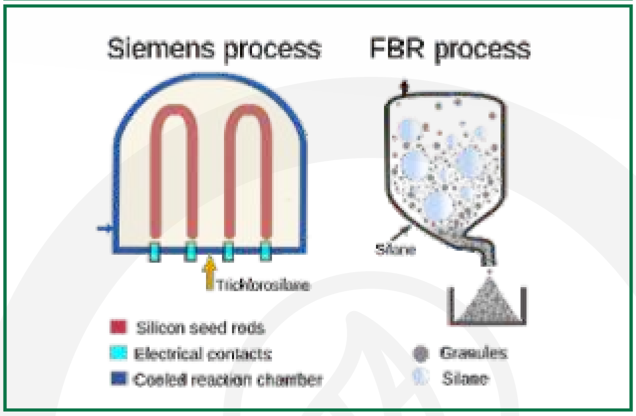
Silicon is the starting point of our solar production cycle.

It is extracted from sand (Quartzite Rock), which is made up primarily of silicon dioxide. As the second most common element of the earth's crust, there is an almost endless supply.

Silicon is treated and processed into poly-silicon

Mining Quartzite for Silicon

Silica Sand is then processed to obtain Poly-silicon



Of the 92 elements, silicon (Si) is Earth's most prevalent semiconductor – & second most common element of any kind, after oxygen. Appearing in silicon oxides such as sand (silica), quartz, rock crystal, amethyst, agate, flint, jasper and opal, silicon makes up about a quarter, by weight, of the Earth's crust. Photovoltaic manufacturing starts with polysilicon, a refinement of silicon materials.

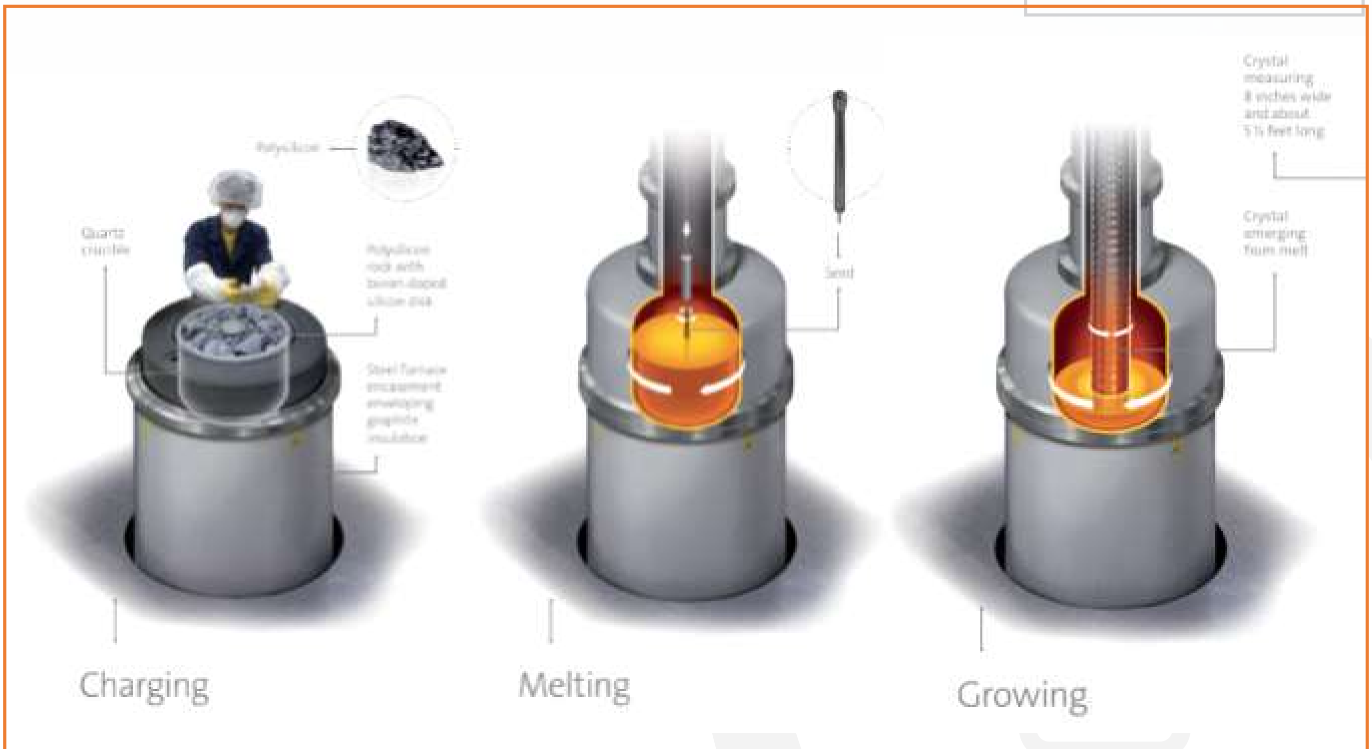
Poly-silicon Processing

2. POLY-SILICON PROCESSING

Poly-Silicon processed from quartzite rocks is melted and resolidified into cylindrical Ingots

This process involves the use of a Quartzite Crucible which melts and re-crystallizes the poly-silicon chunks into a cylindrical ingot in preparation for the next phase of PV Manufacturing – Solar Wafer Manufacturing

The Czochralski process is commonly used



Quartzite Mining & Poly-Si Production

COST ESTIMATES

CAPEX ($ Million)
500 - 980

Production (Metric Tonnes per Annum)
6,000 - 20,000

Polysilicon Spot prices ($/Metric Tonnes)
10,000 - 14,000

Projected Revenue ($ Million)
60 - 280

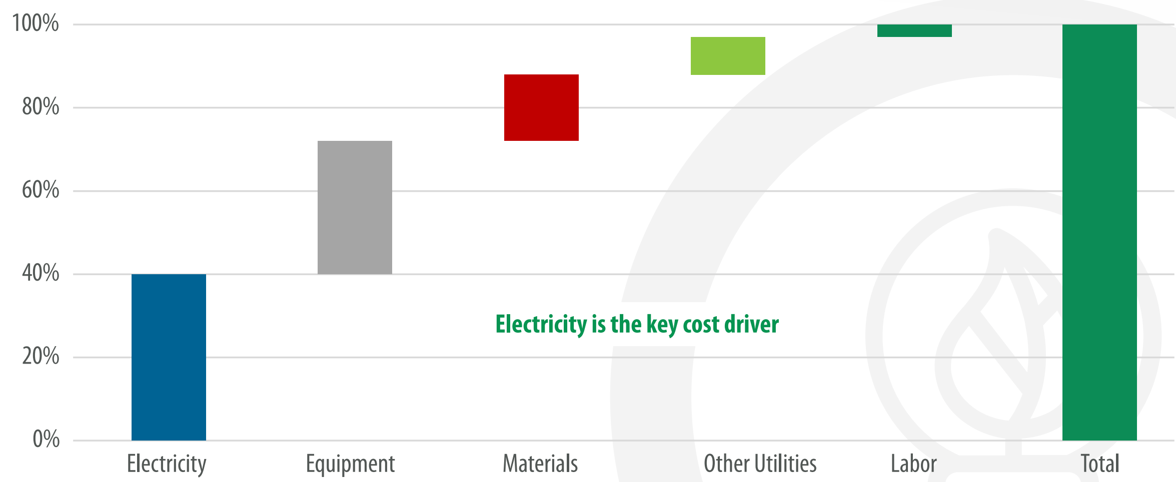
COST DRIVERS

1. Technology of Processing (Siemens / Fluidized Bed / CZ)
2. Scale of Operations
3. Materials for construction and raw materials for plant
4. Plant design and equipment selection
5. Construction Methodologies

Quartzite Mining & Poly-Si Production

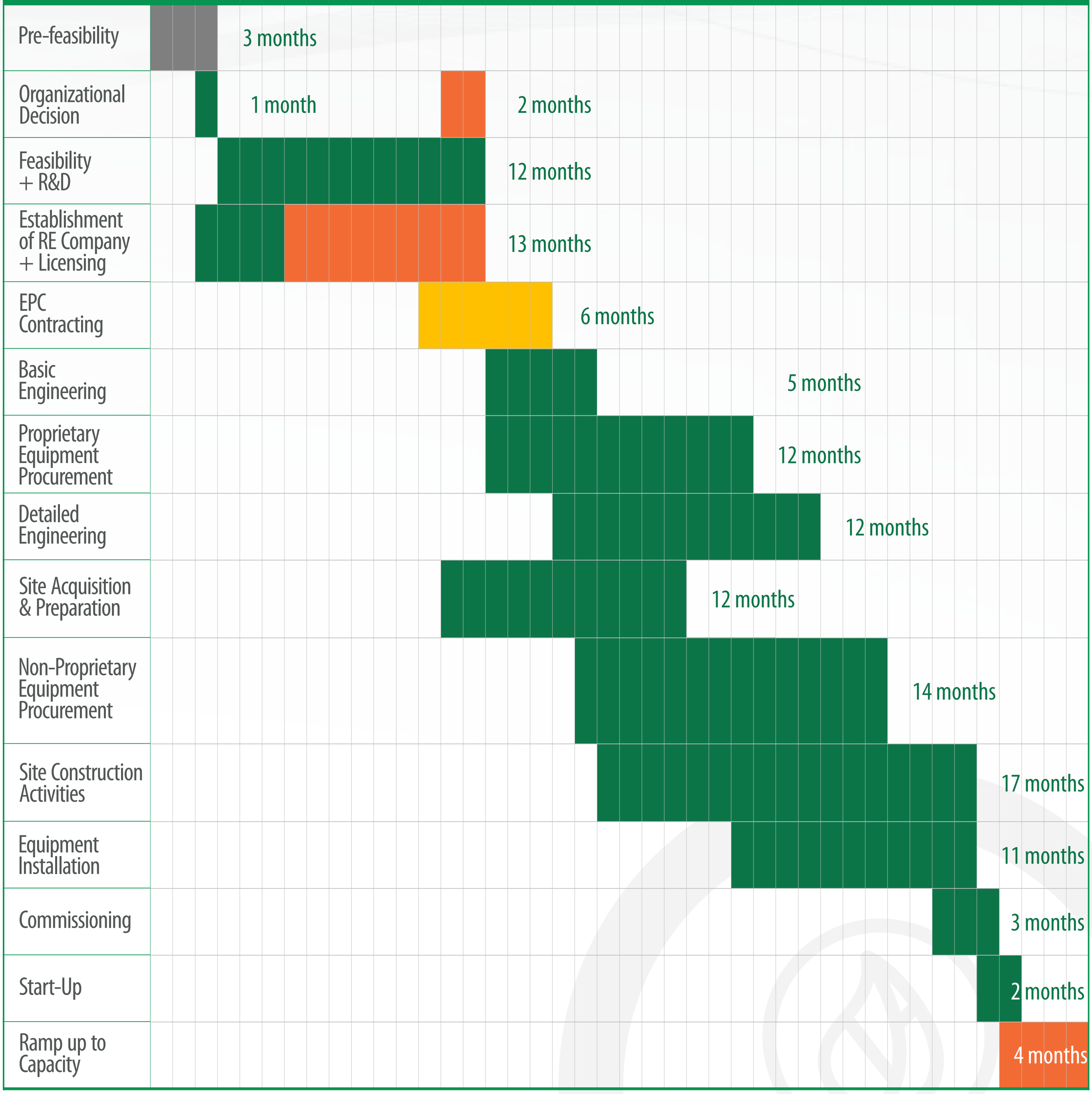
- Declining prices are due to oversupply of Polysilicon as more manufacturing capacity is added
- Increased demand in Sola panels may see the price average at $14/kg

OPEX COST STRUCTURE



Quartzite Mining & Poly-Si Production

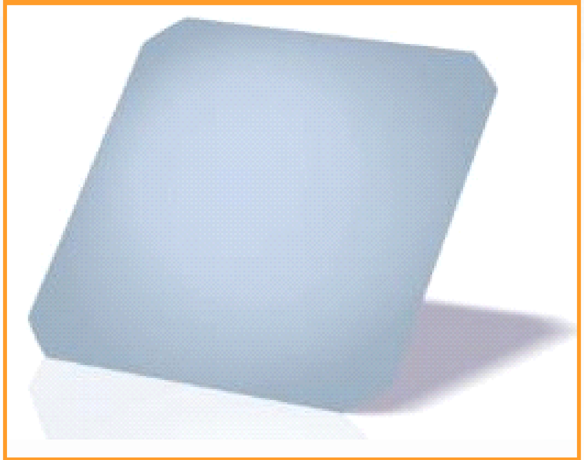
POLYSILICON MINING AND PRODUCTION FACILITY DEVELOPMENT – KEY ACTIVITY TIMELINE (42 MONTHS)



Operations and Maintenance **20 - 25 years**

Solar Wafer Production

3. WAFER CUTTING

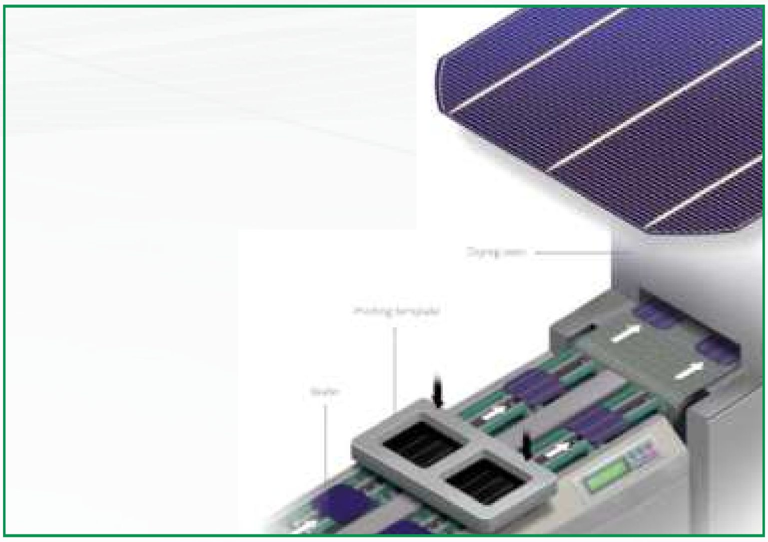


Crystallized Silicon Ingot columns are cut into extremely thin slices, or wafers, using state-of-the-art Saw-cutting and wire-cutting technology.

After cutting, squaring, slicing cleaning and thorough final testing, the monocrystalline and polycrystalline wafers form the base for the production of solar cells.

Solar Cell Production

4. SOLAR CELL PRODUCTION



The wafers are further processed into **solar cells** in the third production step. They form the basic element of the resulting solar panels.

The cells already possess all the technical attributes necessary to generate electricity from sunlight. Positive and negative charge carriers are released in the cells through light radiation, causing electrical current (direct current) to flow.

Quartzite Mining & Poly-Si Production

COST ESTIMATES

CAPEX ($ Million)
500 - 980

Production (Metric Tonnes per Annum)
6,000 - 20,000

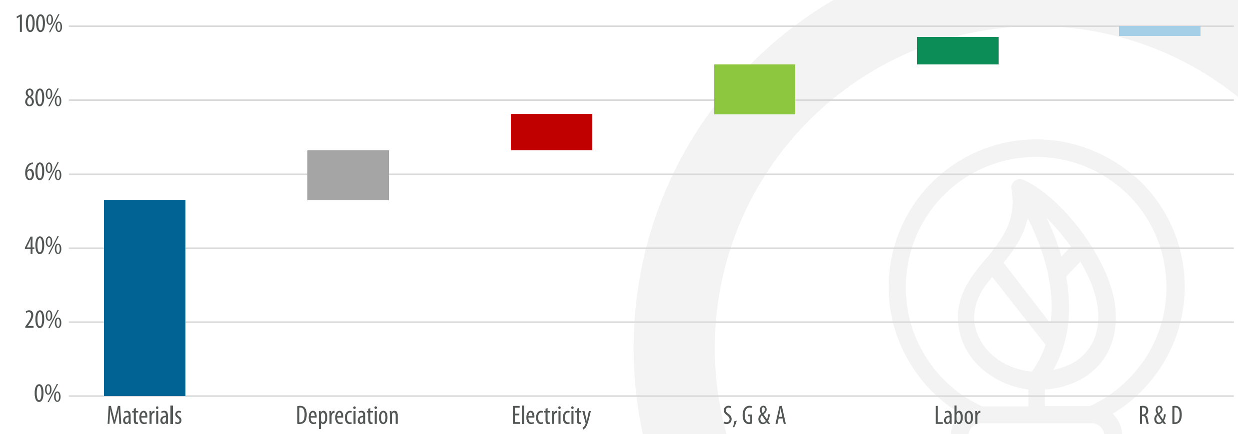
Polysilicon Spot prices ($/Metric Tonnes)
10,000 - 14,000

Projected Revenue ($ Million)
60 - 280

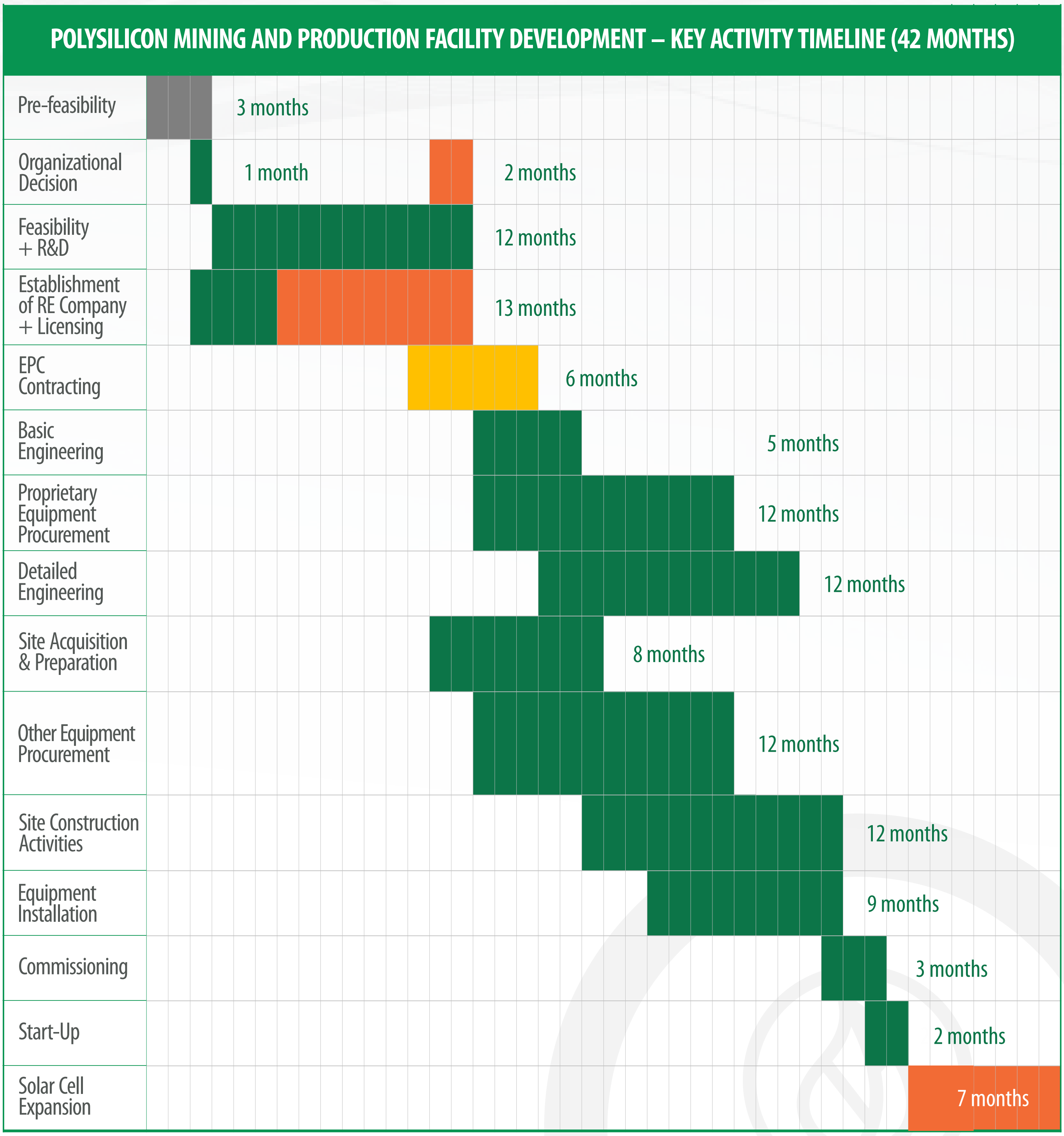
WAFER AND SOLAR CELL COST DRIVERS

1. Technology of Processing
2. Scale of Operations
3. Materials for construction and raw materials for plant
4. Plant design and equipment selection
5. Construction Methodologies
6. Electricity Cost

OPEX COST STRUCTURE



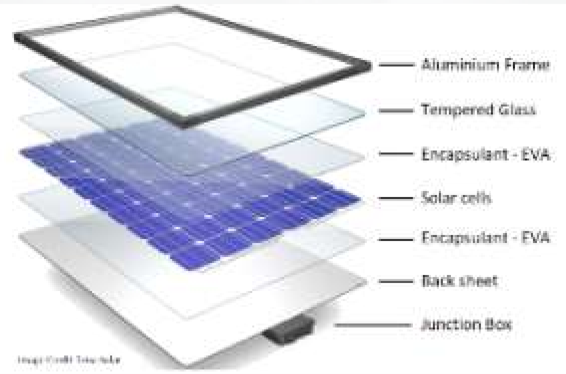
Quartzite Mining & Poly-Si Production



Operations and Maintenance **20 - 25 years**

PV Panel Assembly

5. PV PANEL ASSEMBLY



Solar cells are merged into larger units – the panels – in panel production. They are framed and weather-proofed.

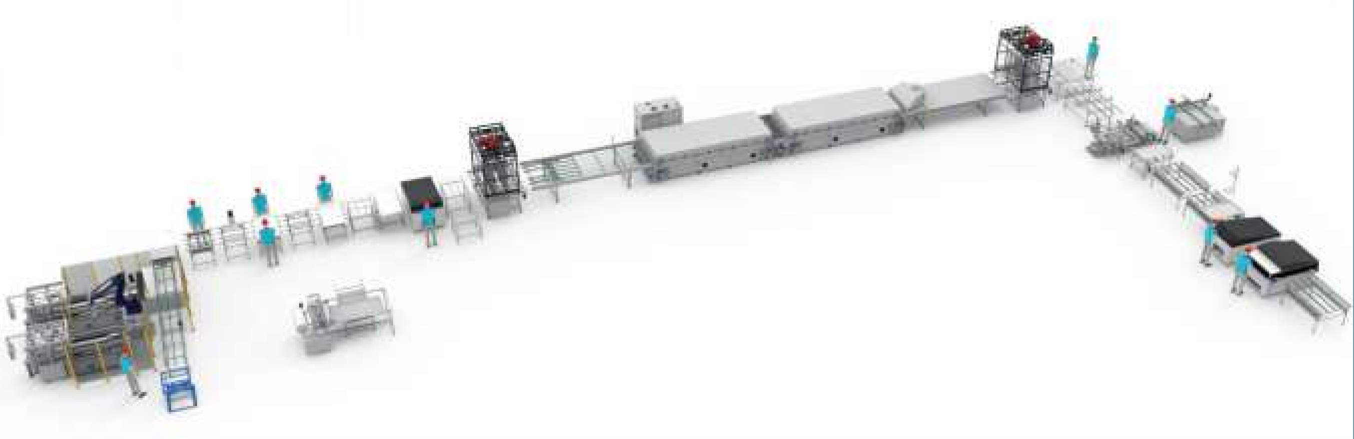
The solar energy panels are final products, ready to generate power. Sunlight is converted into electrical energy in the panels.

The direct current produced this way is converted to alternating current by a device called an inverter so that it can be fed into the utility grid or, if applicable, straight into the house.

PV Panel Assembly

100MW MODULE PRODUCTION SMART LINE

COMPLETE SOLUTION FOR PV MODULE MANUFACTURING



100 MW/year	58 modules/h	10 operators per shift	$850m^2$ production area required
4.7 W/cell	72 cells per module	160 kW/h	6bar 200nL/1
3shift of 8 hours	330 days/year		

Ecoprogetti "turnkey solutions". In this instance we will use the 100 MW Line, consisting of the following equipment and accessories:

- Stringer machine
- Layup station
- Automatic station with conveyor belts for manual bussing
- Electroluminescence Test
- Laminator with Buffers
- Automatic Framing Machine
- Automatic silicon dispenser
- Solar Simmulator

PV Panel Assembly

50 MW/year	28 panels/h	3shift
200 KW	14-16 operators per shift	1200m² area

PV Module Assembly

COST ESTIMATES

Production (Megawatts per Annum)
100 - 200

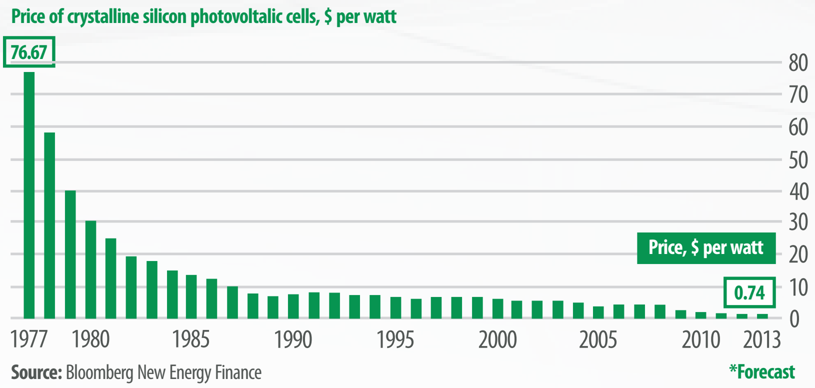
CAPEX ($ Million)
6 -12

OPEX per Annum ($ Million)
21 -54

Averge PV Panel Prices ($/Watt)
0.7 - 1.5

Projected Revenue ($ Million)
70 - 150

THE SWANSON EFFECT

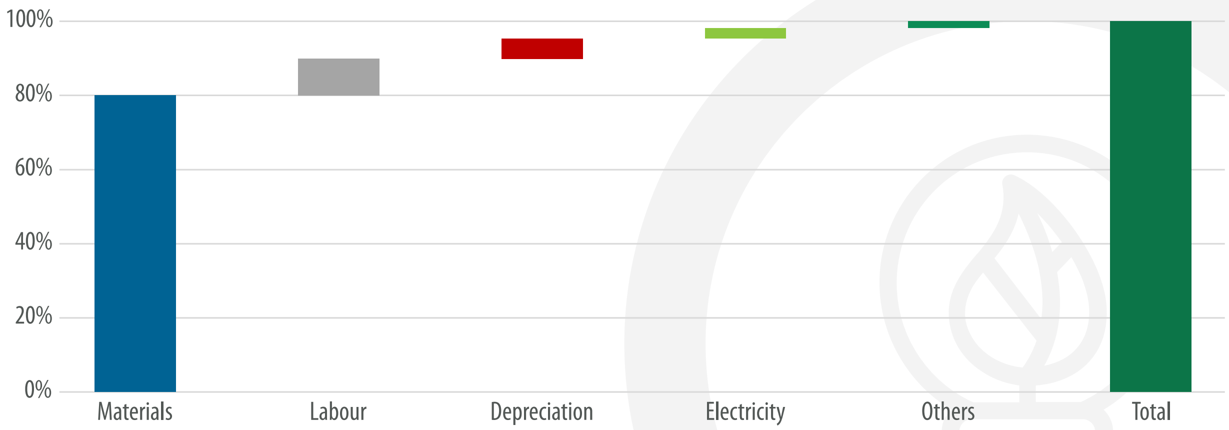


- Declining prices are due to increased efficiency PV Panels
- Prices have also declined due to more efficient methods of manufacturing

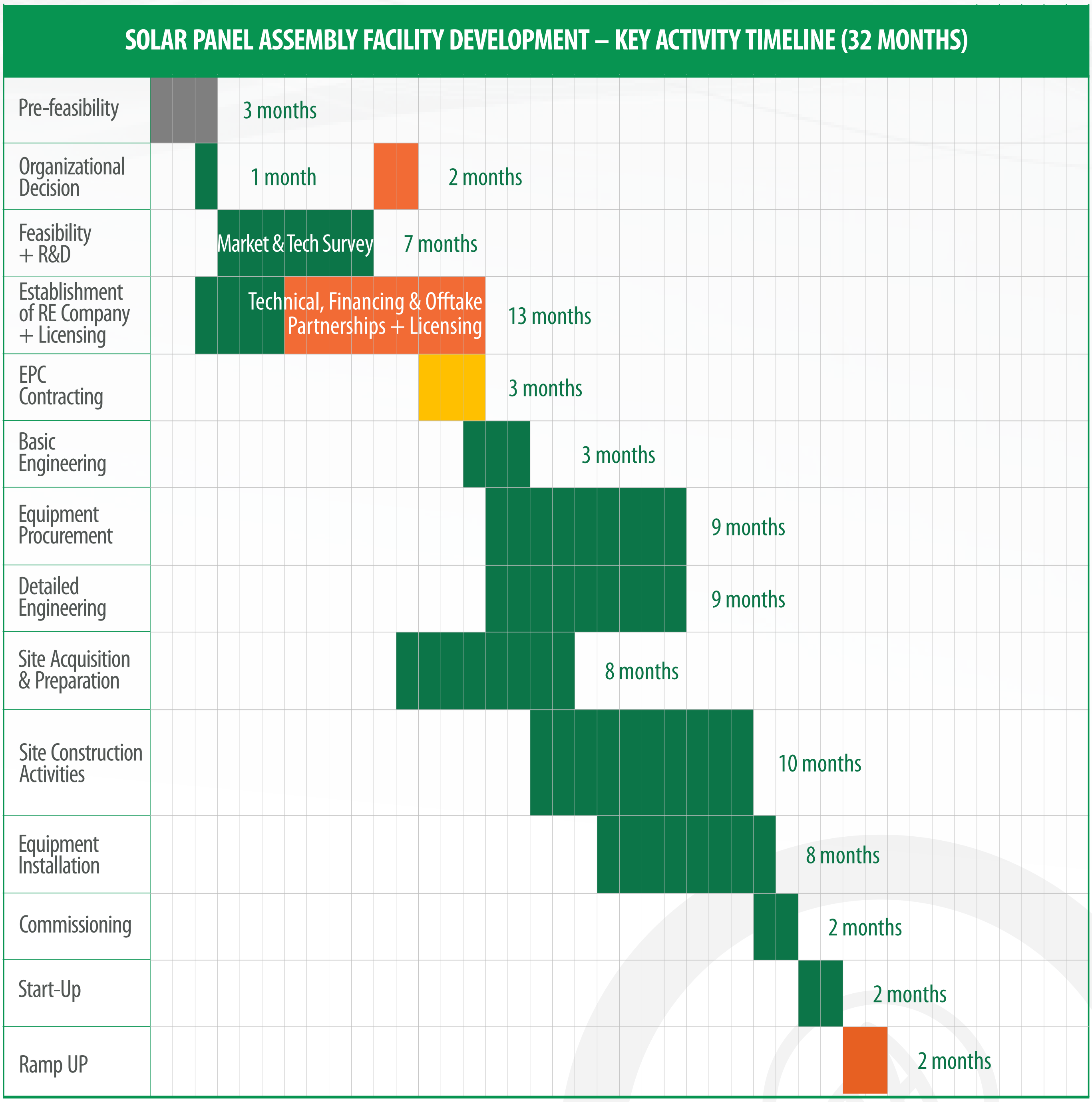
SOLAR PV MODULE ASSEMBLY PLANT COST DRIVERS

1. Number of Assembly Lines
2. Scale of Operations (Capacity)
3. Materials for construction and raw materials for plant
4. Plant design and equipment selection
5. Construction Methodologies
6. Electricity and Labour Cost

OPEX COST STRUCTURE



Quartzite Mining & Poly-Si Production



Operations and Maintenance **20 - 25 years**

Integrated Manufacturing Plant

SOLAR PV MODULE PRODUCTION (POLY-SI TO PANEL) COST ESTIMATES

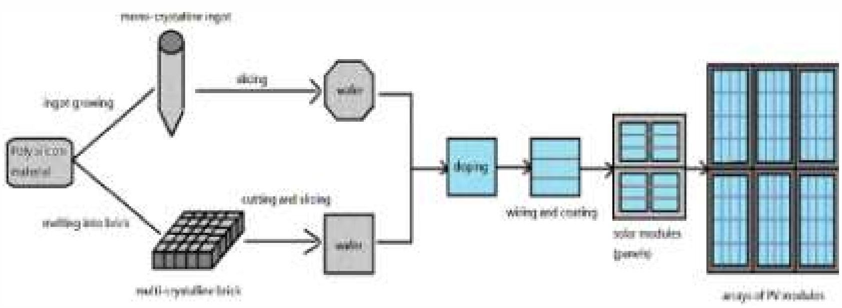
Production (Megawatts per Annum)
500 - 1000

CAPEX ($ Million)
200 - 400

OPEX per Annum ($ Million)
160 - 300

Averge PV Panel Prices ($/Watt)
0.7 - 1.5

Projected Revenue ($ Million)
350 - 1,000

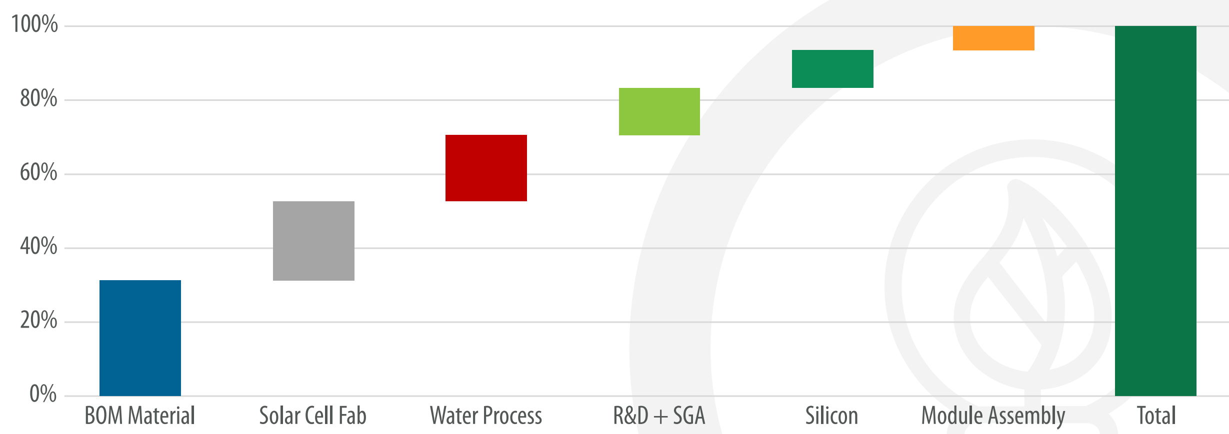


- A Large percentage of Solar Companies have integrated other value chain systems into their production portfolio to increase revenue margins
- The Most Common structure is from wafer – PV Module Production
- Integration is easier with scale

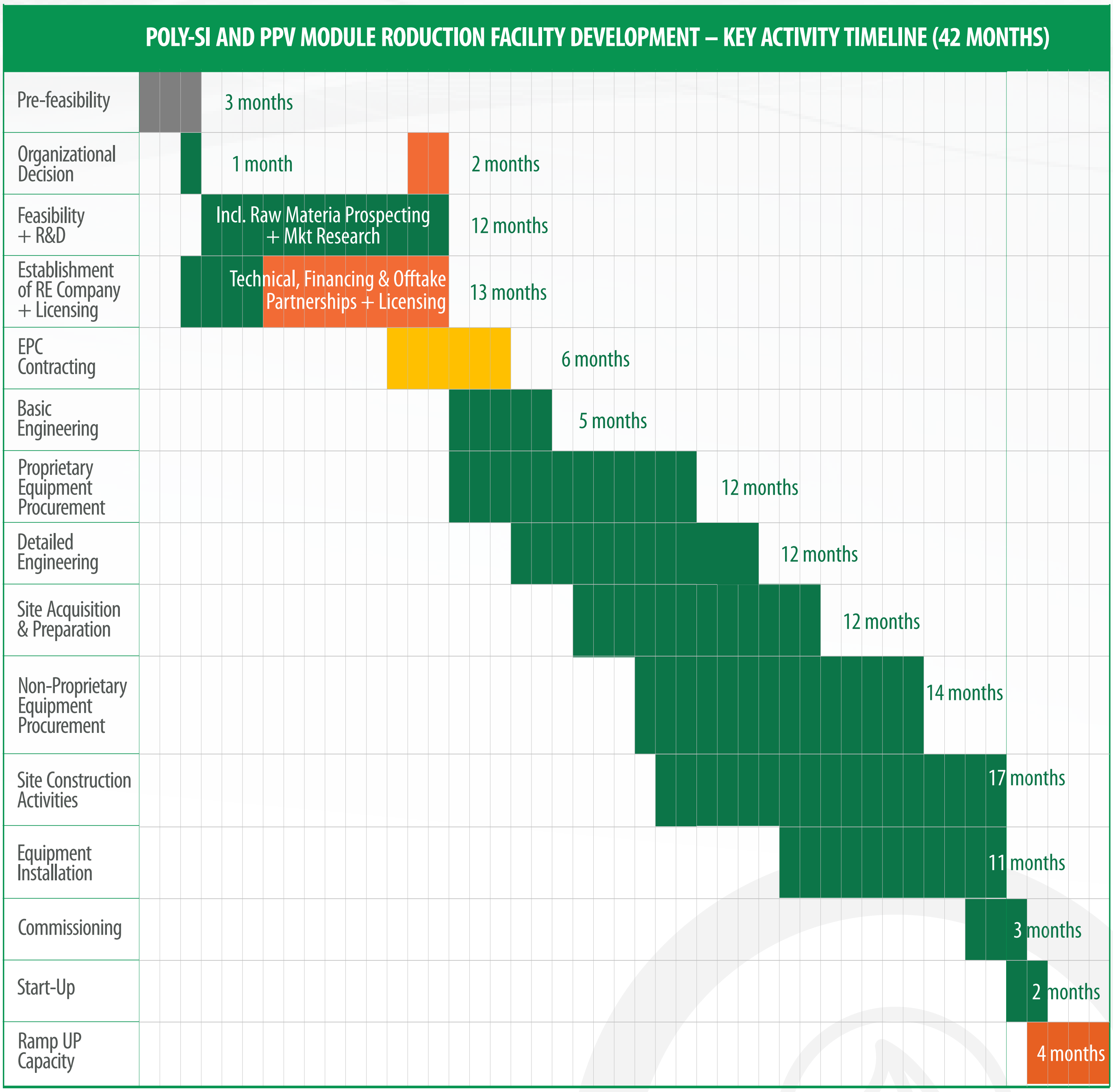
SOLAR PV MODULE PRODUCTION COST DRIVERS

1. Number of Assembly Lines
2. Scale of Operations (Capacity)
3. Materials for construction and raw materials for plant
4. Plant design and technology
5. Construction Methodologies
6. Electricity and Labour Cost
7. Location (Access to Raw Materials and Off-takers)

OPEX COST STRUCTURE

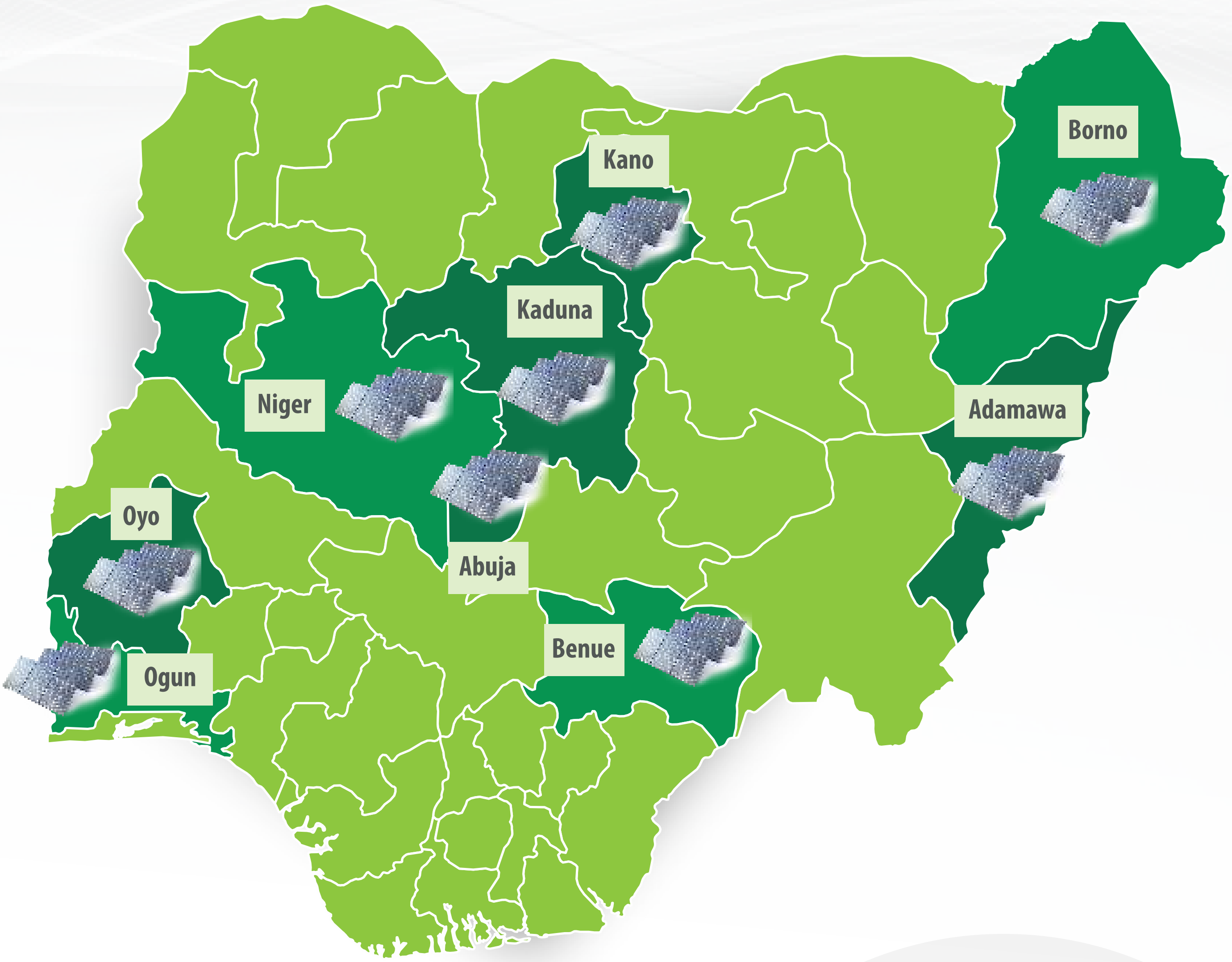


Poly-Si to PV Module Manufacturing



Operations and Maintenance **20 - 25 years**

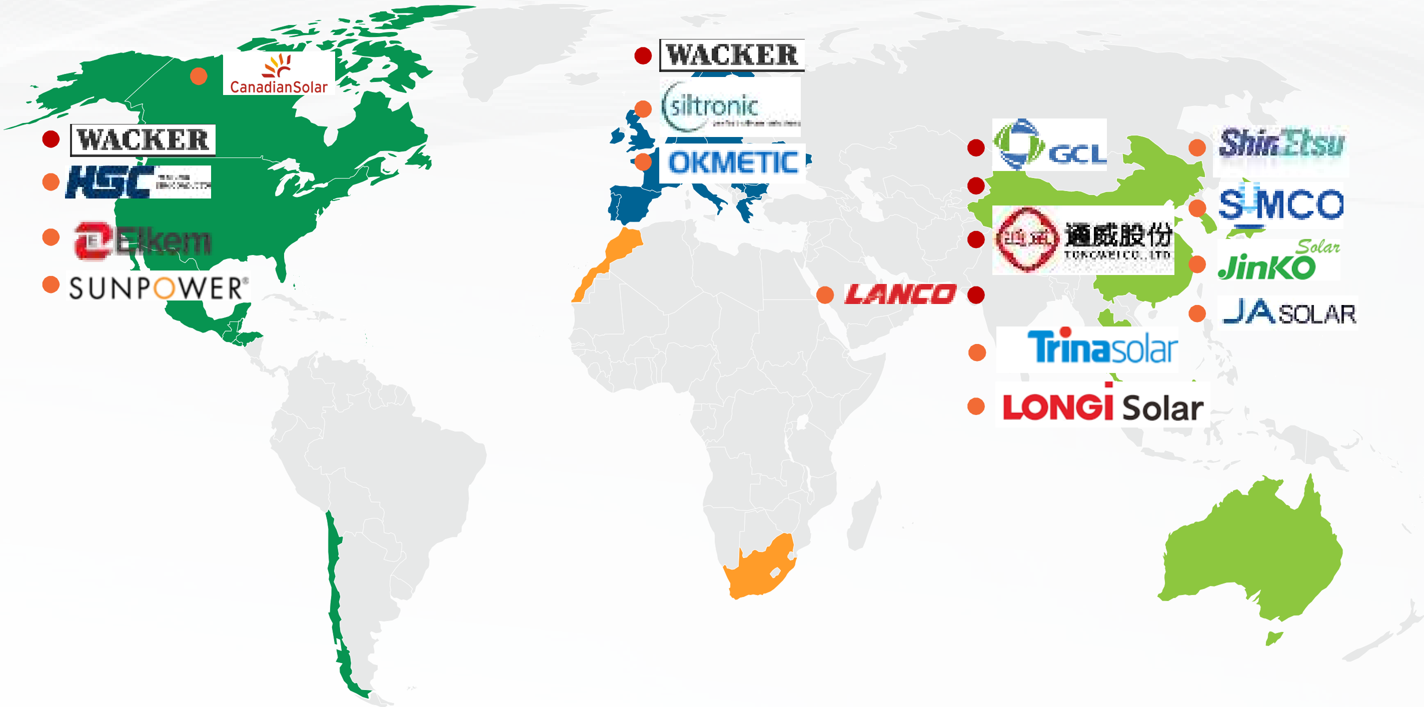
Investment Appraisal: Resource Map + Location Analysis



SELECTION CRITERIA

1. Solar Irradiation
2. FGN Interest
3. Funding Scheme Preference
4. Request for Proposal Specifications
5. Capacity to Influence Incumbent Stakeholders
6. Nature of incumbent Stakeholders
7. Availability of Land Space
8. Market Availability and Potential

Investment Appraisal: Key Players and Recommendations



RECOMMENDED PARTNERSHIPS

UPSTREAM

Quartzite Mining, Polysilicon Production

- Wacker Chemie AG (Germany)
- GCL Poly Energy Holdings (China)

Manufacturing expertise and Technology transfer

MIDSTREAM

PV Panel Manufacturing (Water, Solar Cell, PV Assembly)

- SunPower (USA)
- Trina Solar

Manufacturing expertise and Technology transfer

DOWNSTREAM

PV Panel Installation (Residential & Commercial)

- SolarWox
- Auxano Solar

Local Expertise can be utilized for these partnerships.

PV Solar Farm Installation (Grid/Off Grid) - Incl. EPC + O&M

- Q-Cells
- First Solar (USA)

EPC Expertise for Large Scale Solar Farms

OTHER PARTNERSHIPS

Research and Development

- GCL (PV Silicon & Wafer)
- NREL
- SEIA
- Tesla

Feasibility Reports

- Research Gate
- NREL

Balance of Plant (Batteries, Inverters, Cables, Installation Accessories)

- Tesla, Powerplus, LG Chem
- Fronius, Sungrow, ABB, SMA
- Siemens, Victor, Morningstar

Financing

- CBN-Solar Connection Facility
- **World Bank**
- **Trina Solar (PPA/ Others)**
- **Bank Of Industry**

Legal and Regulatory Framework

Applicable Laws & Regulatory Institutions

Electric Power Sector Reform Act, No. 6 of 2005 (“EPSRA”)

Nigerian Electricity Management Services Agency Act

Nigerian Electricity Regulatory Commission (NERC)	The regulator of the electricity industry and generally responsible for enforcement of the EPSRA and such other related or incidental matters.
Nigerian Electricity Management Services Agency (NEMSA)	Carries out electrical inspectorate services in Nigeria’s electricity supply industry and ensures that all major electrical materials and equipment used in Nigeria are of the right quality and standards, among other powers
Standard Organisation of Nigeria (SON)	Issues the Mandatory Conformity Assessment Programme (“MANCAP”) Certificate for all locally manufactured products in Nigeria to ensure they conform to the relevant Nigerian Industrial Standards (NIS) before being presented for sale in Nigeria or exported. Also issues the Standards Organisation of Nigeria Conformity Assessment Programme (“SONCAP”) Certificate for all products imported into Nigeria. The SONCAP Certificate will be required for components or equipment imported for use in installing power systems in Nigeria.
National Office for Technology Acquisition and Promotion (NOTAP)	Registers contracts for the transfer of foreign technology to Nigerian parties as well as every agreement in connection with the use of trademarks, use of patented inventions, supply of technical expertise, the supply of basic or detailed engineering, and the supply of machinery and plant, among others

Technical & Commercial Options Assessment

Tech.	Available Tech. Opitons	Recommendations	Industrial Processes	End-Products	Potential Off-takers	Possible Licences
Solar	Sun Irridiation	Sun Irridiation	Changing quartz silica into silicon ingots	Polysilicon	• China High Sun • Dmsolar • Hareon Solar Tech	• NEMSA, • Factories Licence • MANCAP • EIA
			Cutting Silicon ingots into wafers	Wafer	• Tsinghua Unigroup, China	• NEMSA, • Factories Licence • MANCAP • EIA
			Putting circuitry on wafer	Solar Cell	• Ashanti Gold Group • LITE-UP NAIJA	• NEMSA, • Factories Licence • MANCAP • EIA
			Placing cells on glass & processing into panels	PV Module	• Tsinghua Unigroup, China	• NEMSA, • Factories Licence • MANCAP • EIA
			Changing quartz silica into silicon ingots	Polysilicon	• Ecozar technologies • Leks Environmental Ltd. • Solar Force Nig.	• NEMSA, • Factories Licence • MANCAP • EIA
			Installation	Solar Panels	• Bezalili House Solutions Ltd	• NEMSA, • Factories Licence • MANCAP • EIA

Licence Regime

S/N	Type of Licence	Description
1	Generation Licence	Required for electricity generation capacity (excluding captive power generation) exceeding 1 Megawatt (MW). Issued in respect of a specific site
2	Distribution Licence	Entitles the licensee to construct, own, operate and maintain a distribution system and facilities.
3	Mini-Grid Licence	Issued for integrated off-grid local generation and distribution systems with installed capacity below 1 MW. For projects below 100 Kilowatts (Kw), only a simple registration with NERC is mandatory.
4	Captive Generation Permit	Issued for generation of electricity exceeding 1 MW for the purpose of consumption by the generator, and which is not sold to a third-party. NERC's consent is required before supplying surplus power not exceeding 1MW to a third party.
5	Embeded Generation Licence	Enables the generation of electricity that is directly connected to and evacuated through a distribution system which is connected to a transmission network operated by the Transmission Company of Nigeria.
6	Independent Electricity Distribution Network Licence	Enables distribution of electricity through a network not directly connected to a transmission system and is issued where: (i) there is no existing distribution system within the geographical area to be served by the proposed IEDN; and (ii) where the infrastructure of an existing DISCO is unable to meet the demand of customers in the area.

Other Authorization or Institutions that May be Applicable

Authorization	Purpose	Issuing Authotiry
Environmental Impact Assessment (EIA) certificate	Confirms that an EIA of the mining activity have been adequately done and provisioned for. **Threshold for conduct of EIA for power projects is 10MW.**	Federal Ministry of Environment
NEMSA Certificate	Persons undertaking electrical installation work and contractors looking to engage in the business of electrical installations. The NEMSA certificate has therefore become one of the compulsory tender documents for contractors looking to bid for power projects in Nigeria.	Nigerian Electricity Management Services Agency
Building & Construction Permits	Required where construction would be carried out in relation to the Project.	Various land and physical planning agencies of various states.
Factories licence	Where any premises is occupied as a factory.	Director of Factories, Ministry of Labour
NESREA	Required for importing new electrical/electronic equipment and waste generation.	National Environmental Standards Regulation Enforcement Agency
NOTAP Registration	Required for agreements with foreign partners for technology transfer, such as, use of trademarks, patented inventions, technical/management, technological expertise, etc.	National Office for Technology Acquisition and Promotion
Import Related Permits	Where the company would import goods for use in the business.	Central Bank of Nigeria; Standards Organisation of Nigeria
Import Clearance Certificate	The importation (and clearing from the ports) of fully assembled generators, knocked-down parts imported for domestic assembling or spare parts	Nigerian Customs Service (NCS)

Electric Vehicles

Technical

Electric Vehicles (EVs)

PRODUCTION CAPACITY BASIS

Electric Vehicles (EVs) are vehicles that are driven by an electric motor instead of an internal combustion engine.
EVs are basically divided into 4 major categories:

- BEV (Battery Electric Vehicle)
- EREV(Extended Range Electric Vehicle)
- PHEV(Plug-In Hybrid Electric Vehicle)
- HEV (Hybrid Electric Vehicle)

The classification above is dependent on the Power Train Configuration

GENERAL OPERATING PRINCIPLE

Electric Vehicles (EVs) are driven primarily by a battery pack which stores the electrical energy that powers the electric motor. EV batteries are charged by plugging the vehicle to an electric power source. (Note: Although EV charging may contribute to air pollution, the U.S EPA categorizes BEVs as Zero-Emission vehicles because they produce no direct exhaust or tailpipe emissions).

KEY COMPONENTS AND SYSTEMS

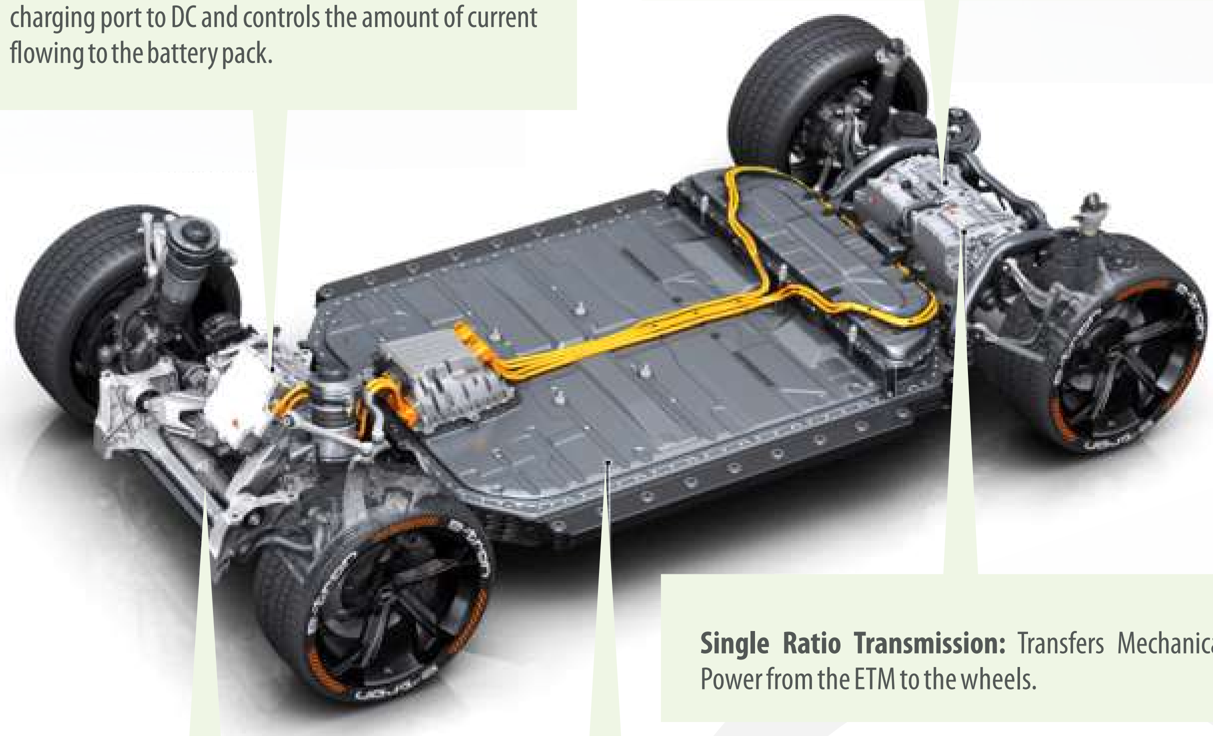
Auxillary Battery Pack	Charging Port	Onboard Battery Charger or AC - DC Converter	Transmission (Electric)	Power Electronics Controller
Traction Battery Pack	DC - DC Converter	Thermal System (Cooling)	Other Operational Systems	Electric Traction Motor (Engine)

EV Powertrain

The Powertrain is that part of the EV that provides power to the vehicles. Powertrain refers to the set of components that generate the power required to move the vehicle and deliver it to the wheels.

The Electric Traction Motor: This converts electrical energy to mechanical energy, that is delivered to the wheels via single ratio transmission.

The On-board Charger: Converts AC received from charging port to DC and controls the amount of current flowing to the battery pack.



Single Ratio Transmission: Transfers Mechanical Power from the ETM to the wheels.

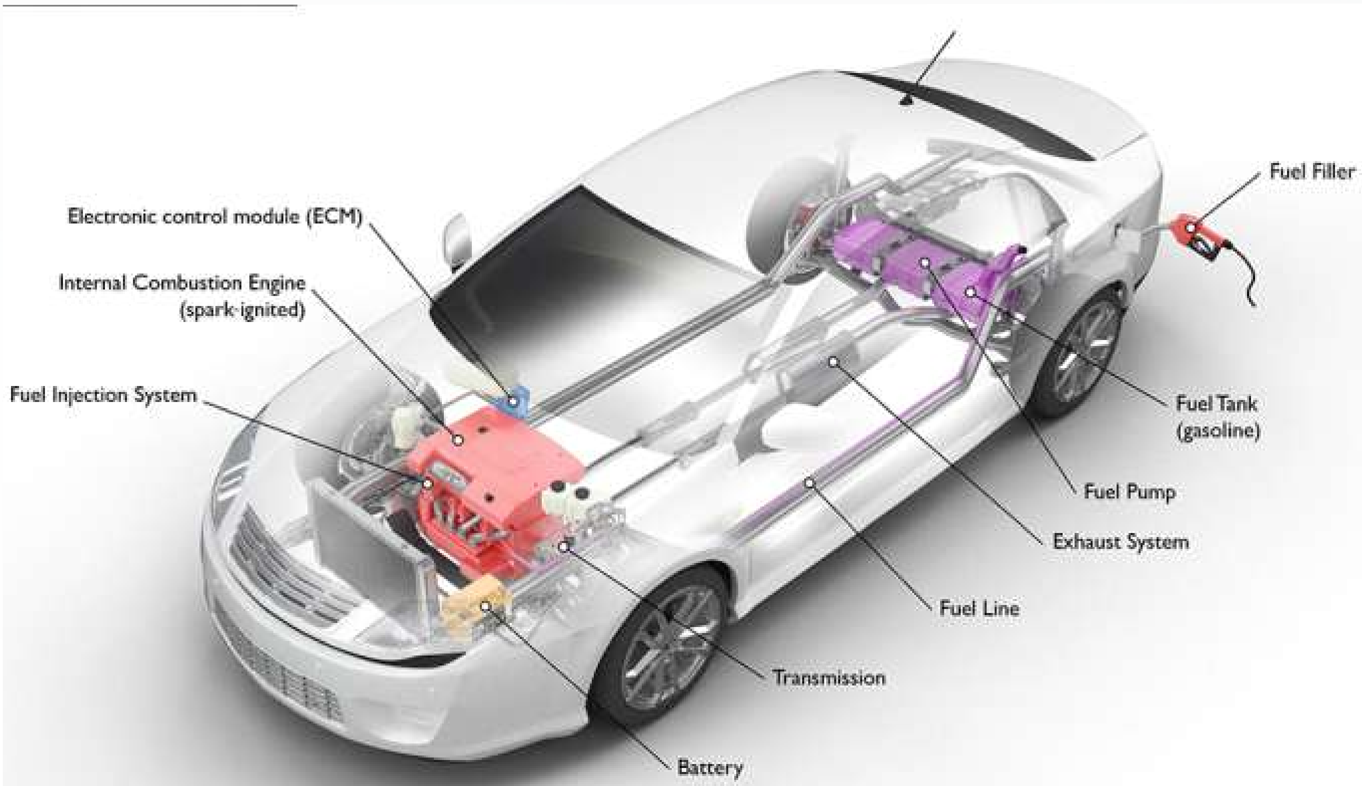
The Charging Port: connects the onboard charger to an external Power source.

The Battery Pack: made up of multiple lithium-ion cells and stores the energy needed to run the vehicle. Battery pack provides direct current (dc) output.

Powertrain Comparison

GASOLINE VEHICLE

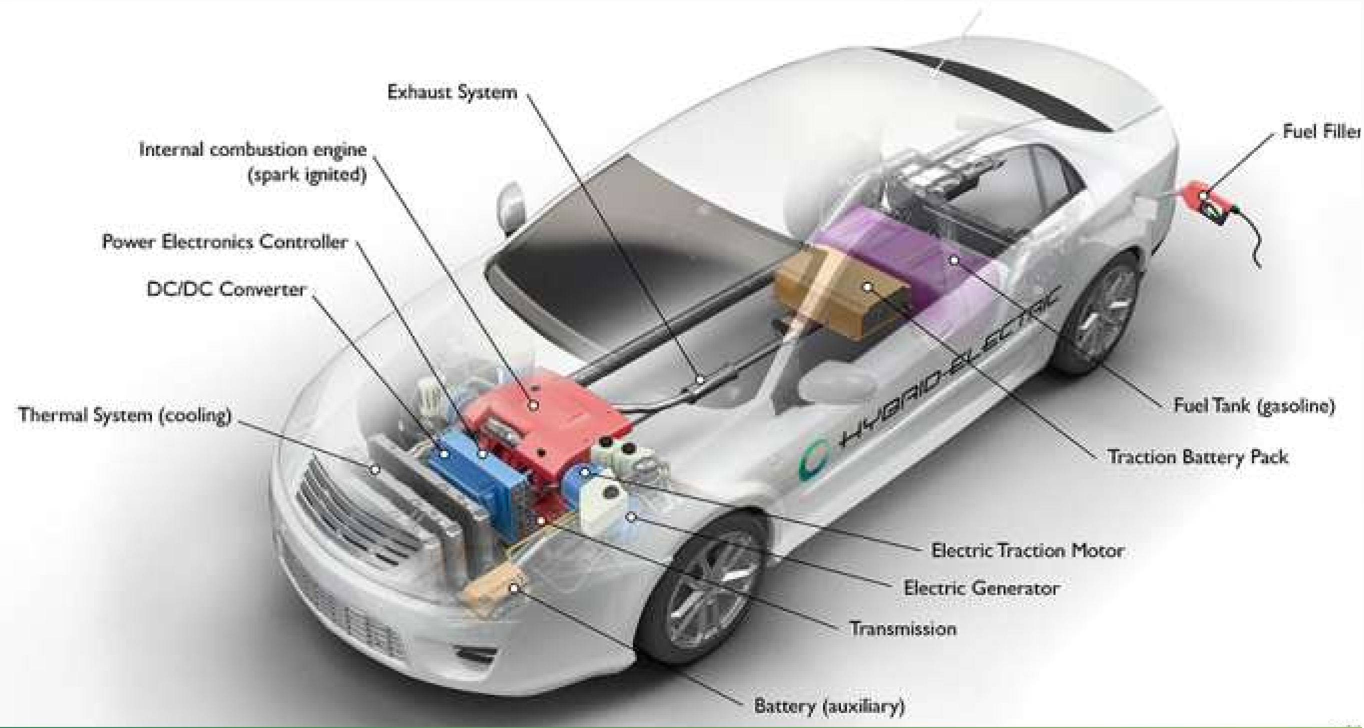
- Spark-Ignited Internal Combustion Engine
- Battery provides electricity for vehicle electronics/accessories
- Fuel System (Fuel injection System, Fuel line, Fuel pump, Fuel tank)
- Transmission transfers mechanical power from the engine to drive the wheels
- ECM – Fuel mixture, Ignition timing, emissions, operations, safeguards, troubleshooting



Powertrain Comparison

HYBRID ELECTRIC VEHICLE

- Spark-Ignited Internal Combustion Engine
- Electricity generator generates electricity from rotating wheels while braking to charge traction battery
- Electric Traction Motor uses power from the traction battery to drive / Power the car at low speed / Idle
- Fuel System (Fuel injection System, Fuel line, Fuel pump, Fuel tank)
- Transmission transfers mechanical power from the engine to drive the wheels
- Power electronics controller – manages flow electrical energy

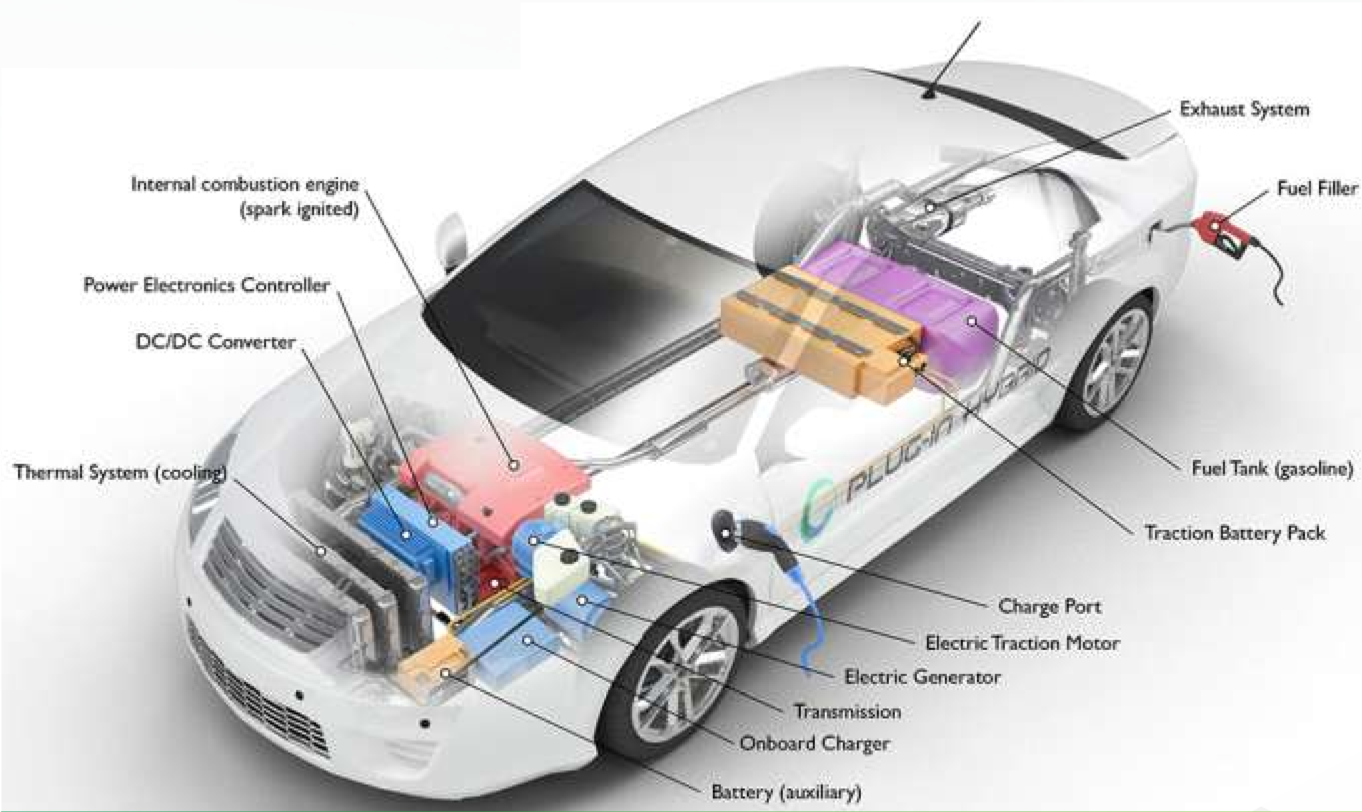


Powertrain Comparison

PLUG-IN HYBRID ELECTRIC VEHICLE

PHEVs have one major difference from the HEVs – Traction battery pack can be charged through regenerative braking, Wall outlets or charging equipment, and by the internal combustion engine

- Traction battery packs are slightly bigger
- An onboard charger and charging port have also been introduced

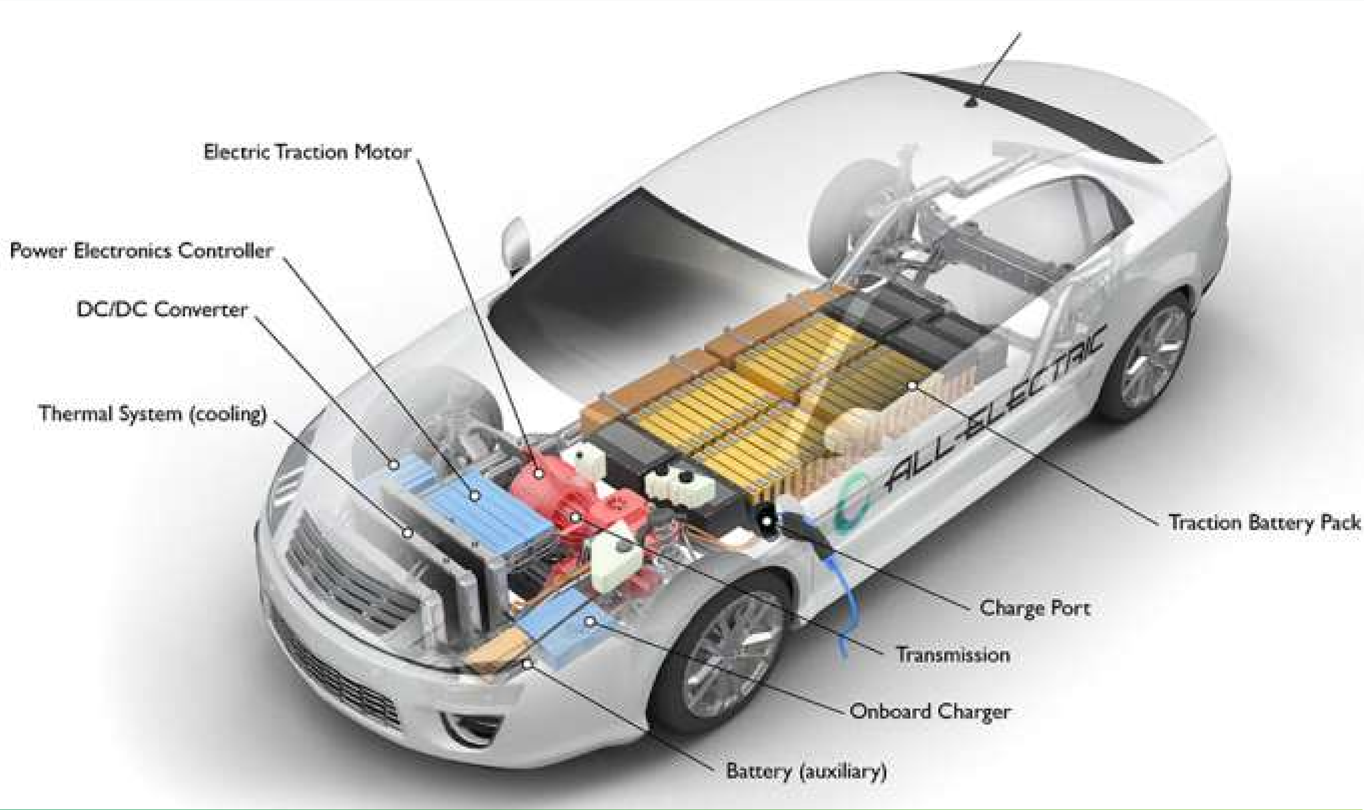


Powertrain Comparison

ALL-ELECTRIC VEHICLE

Also Known as BEVs – these vehicles operate entirely on electricity store in an on-board traction battery pack. They are charged from external electrical power sources. The major difference between BEVs and PHEVs or HEVs is the complete absence of an internal combustion Engine and fuel system

- The Electric Traction Motor is also scaled up

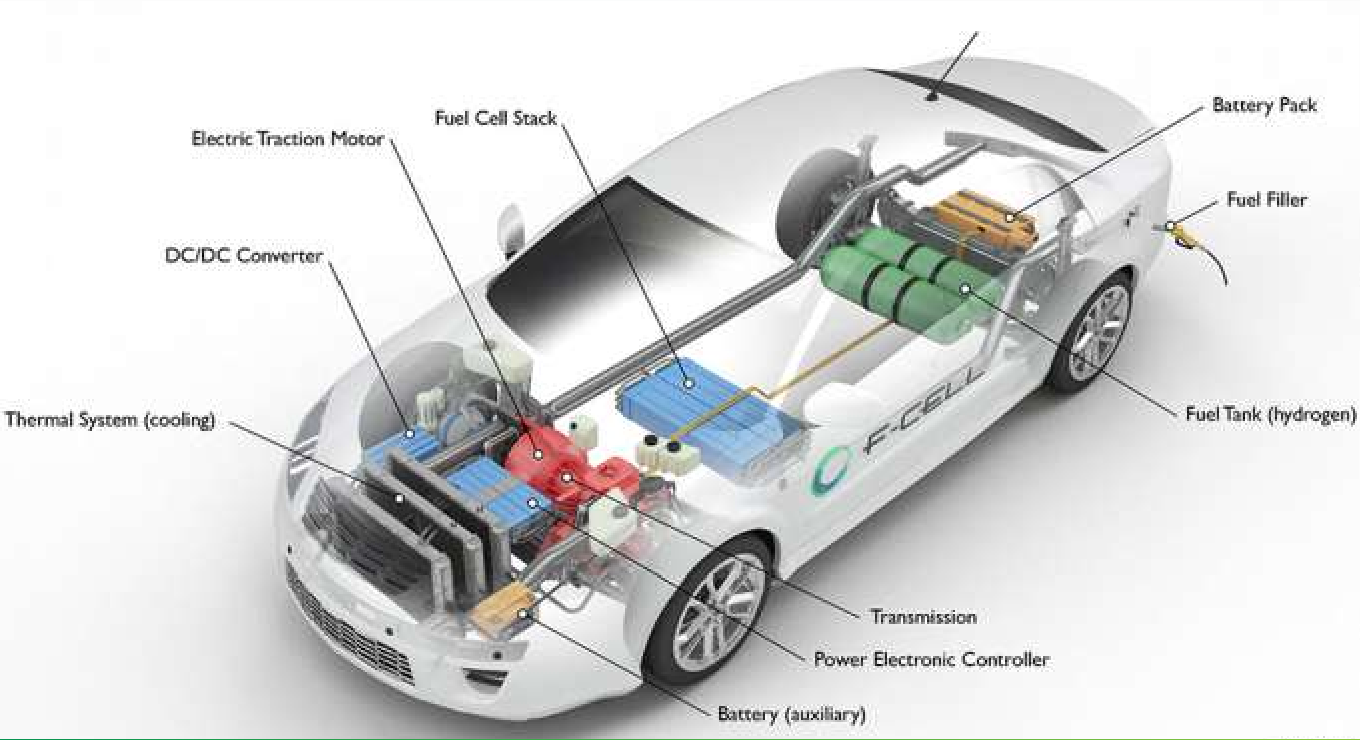


Powertrain Comparison

HYDROGEN FUEL CELL VEHICLE

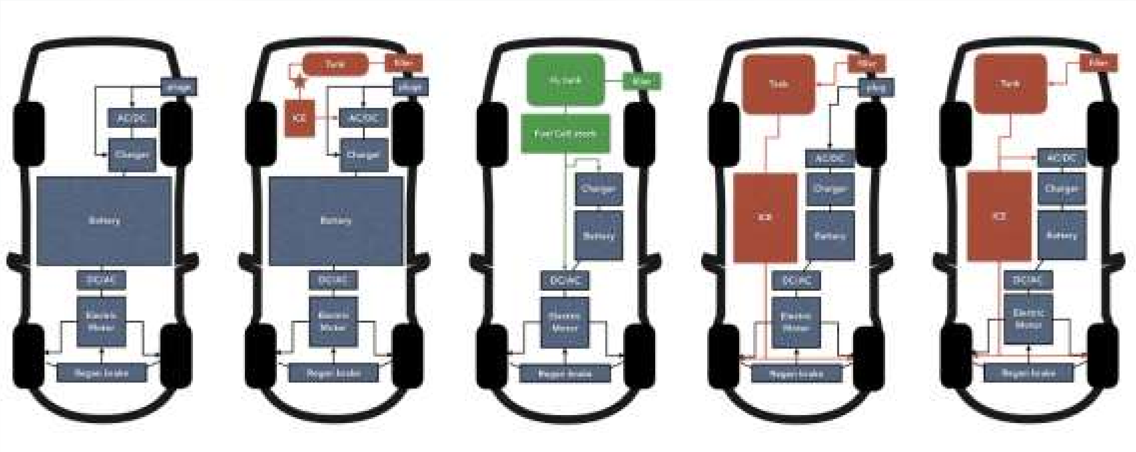
The hydrogen fuel cell electric vehicle uses electricity to power an electric motor, but this electricity is generated by a hydrogen fuel cell.

- The Fuel cell stack is an assembly of individual membrane electrodes that use hydrogen and oxygen to produce electricity (It is an electrochemical reaction – with water as a by product)



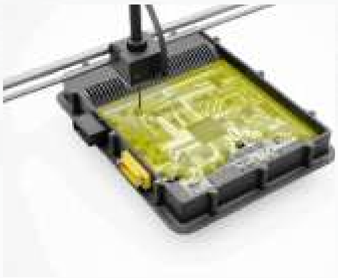
Powertrain Comparison

POWER TRAIN COMPARISON FOR EVs



	BEV	BEV + REx	FCEV	PHEV	HEV
EXAMPLE	Tessa Model S	BMWi3	Toyota Mirai	Mini Countryman Plug-in	Toyota Prius
ENERGY EFFICIENCY	73%	73%	22%	60%	54%
GEAR SHIFT	No	No	No	Yes	Yes
ENGINE	AC Induction/ Synchronous	AC Synchronous	AC Synchronous	AC Synchronous	AC Synchronous

EV Part Manufacturing



ELECTRIC MOTORS AND CONTROLLERS

BATTERY CELLS IN A MODULE

BATTERY PACK HOUSING

As with conventional Internal Combustion engines, Electric vehicles are made up of different parts and systems that are designed, Built and tested for assembly into the functional cars brought by customers.

Outside the standard parts of an automobile, Two main systems require manufacturing for a successfully built EV.

The Electric Motor and Controller: The controllers are responsible for managing the voltages and currents running from external electric supply, to the battery, to the electric motor and to other systems. The electric motors convert electrical energy into mechanical motion for propulsion. These systems are typically designed by car companies for manufacture in-house or by third-party manufacturers.

The Battery Storage System: This is made up of several connected battery cells enclosed in a specially designed housing which typically forms part of the chassis of the electric vehicle as shown in the images below. The Battery Cells are typically purchased from a battery manufacturer by the EV manufacturer in the required dimensioning that allows for easy configuration and scalability.

BATTERY MODULES ASSEMBLED IN THE CONSTRUCTED HOUSING

BATTERY AS PART OF THE CHASSIS

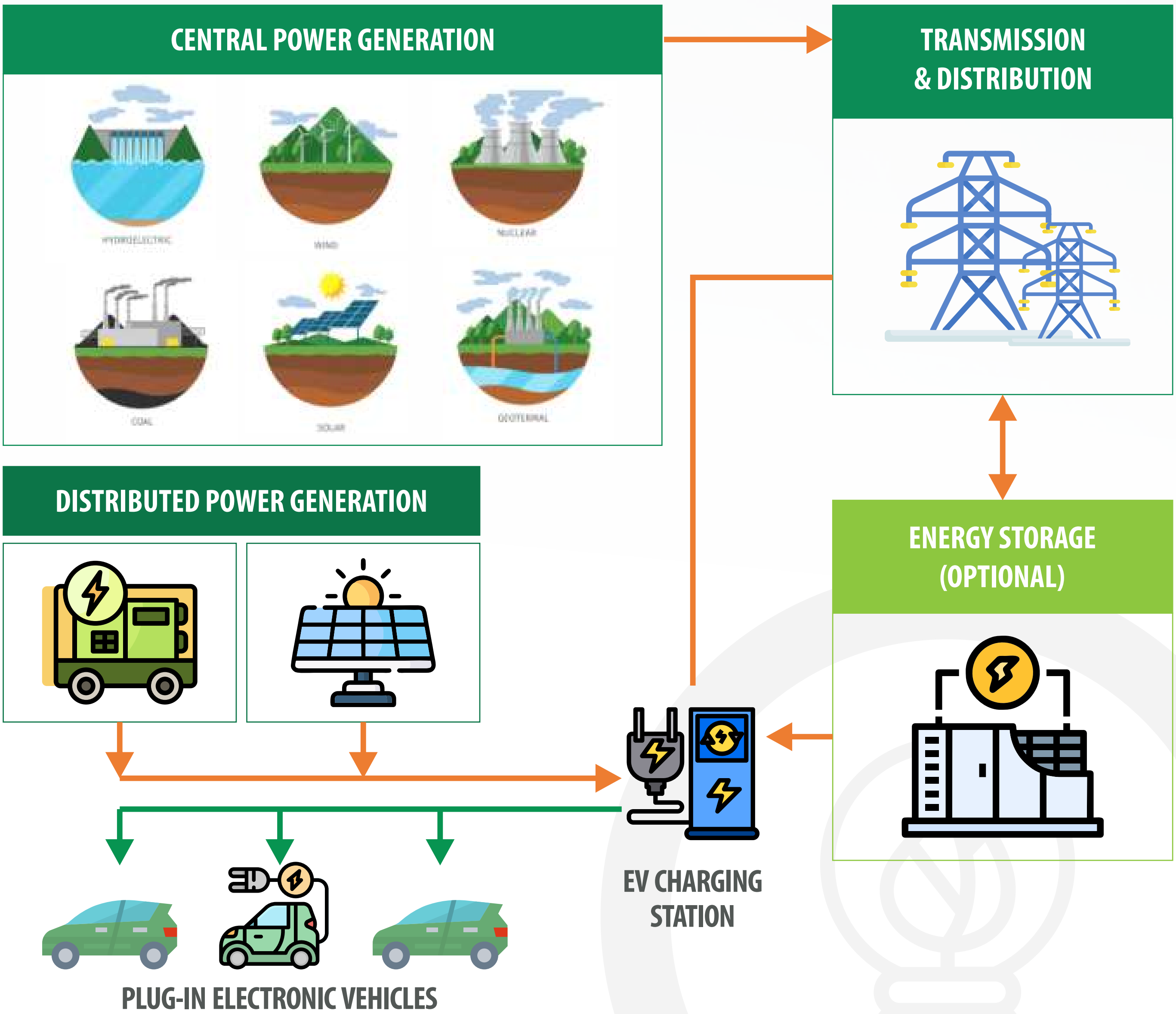
EV Energy Infrastructure

The EV Energy Infrastructure development refers to development and deployment of technologies to support the charging of electric vehicles across its increasing range of applications. The main elements of these infrastructural need include:

- Electricity Generation, Transmission and Distribution Infrastructure
- Charging Infrastructure (Private and Public)
- Smart Metering (Incl. Bundled Energy Solutions)

Key Stakeholders typically include:

- Energy supplier or GENCO
- DISCO
- Charge point Operator (CPO)
- Charge Location Owner
- Mobility Service Providers (MSP)
- Roaming Platform Provider
- EC Driver or Fleet Manager



EV Charging

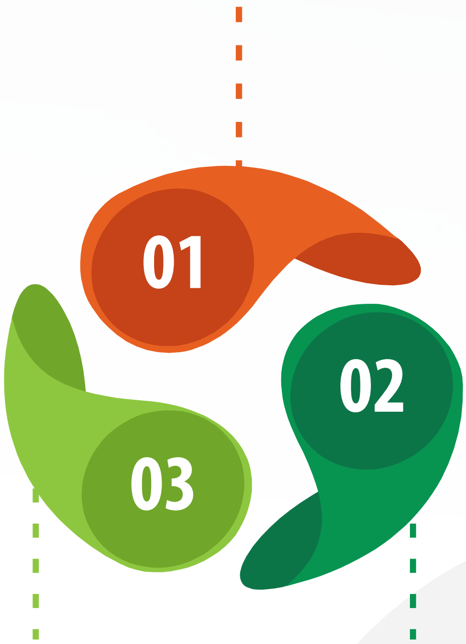
EV Cars require their batteries to be charged upon depletion after use. EV charging is done with an EVSE – Electric Vehicle Supply equipment required to condition and transfer energy from the constant frequency, constant voltage supply network to the direct current, variable voltage EV traction battery bus for the purpose of charging the battery: There are generally three ways of charging:

- Conductive Charging
- Inductive Charging
- Battery Swapping

Conductive Charging

Is a charging method where the battery is connected by a cable and plugged directly into an electricity source or charging unit. It is further classified into

- Level 1 Charging (Home / Public) – 120V
- Level 2 Charging (Home / Public) – 240V
- Level 3 Charging (Public) – 480V



Battery Swapping

Is a method where discharged batteries are swapped with fresh - fully charged batteries at a swapping station

Inductive Charging

This method of charging works through electromagnetic transmission without any contact between the EV and the charging infrastructure.

There are two further classifications

- Static
- Charging Lanes

EV Conductive Charging

CONDUCTIVE CHARGING

Conductive charging system use direct contact between the EV connector and charge inlet. The cable can be fed from a standard electrical outlet or a charging station. The main drawback of this solution is that the driver needs to plug in the cable, but of course this is only a connection issue

The Conductive Charging Method has different Charging levels. The Charging level describes the " power level" of a charging outlet and there are three levels in charging technology.

LEVEL 1 CHARGING

This is the first level of EV charging and it is simply charging from a standard 120V AC household outlet.

EV users who do not drive very far each day tend to find this sufficient.

LEVEL 2 CHARGING

This is the second level of EV charging and it supplies >200V AC. It provides a foster rate of charge, nearly 3-4 times the rate of a level 1 charger.

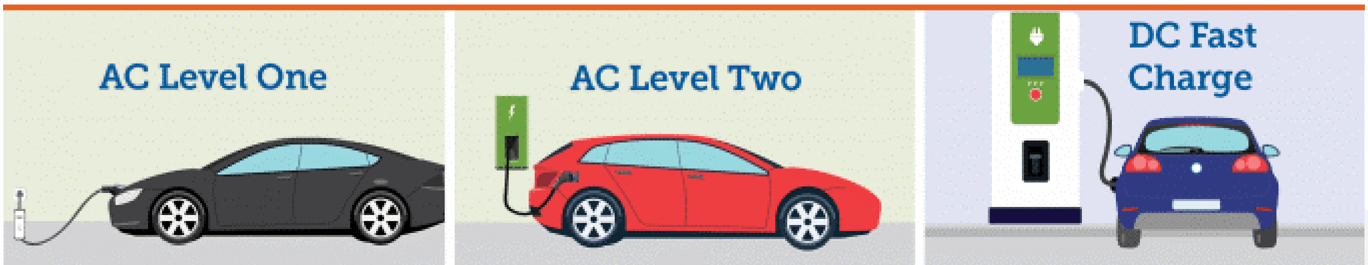
Level 2 chargers can be single or three phase power.

Level charging requires specialized electric vehicle supply equipment and cables. This could be home wall mount systems or public charges installed for commercial use.

DC FAST CHARGE (SOMETIMES REFERRED TO AS LEVEL 3 CHARGING)

DC fast charging uses direct current (DC) available in much higher voltages (as high as 800V). This allows for rapid charging. How ever, DC fast chargers are expensive, and the current needed to use them is not always readily available.

DC fast chargers have a charge rate that allows them to charge most cars fully in about 30 minutes.

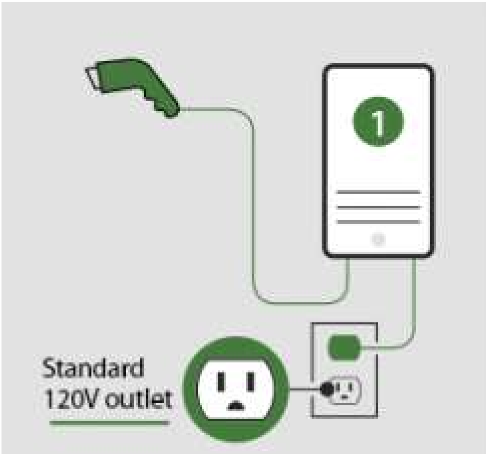


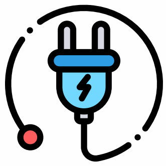
	AC Level One	AC Level Two	DC Fast Charge
VOLTAGE	120v 1-Phase AC	280v or 240v 1-Phase AC	280v or 480v 3-Phase AC
AMPS	12-16 Amps	12-30 Amps (Typ 32 Amps)	<125 Amps (Typ 60 Amps)
CHARGING LOADS	1.4 to 1.9KW	2.5 to 19.2KW (Typ 7kW)	<90KW (Typ 50kW)
CHARGE TIME FOR VEHICLE	3-5 Miles of Range Per Hour	10-20 Miles of Range Per Hour	80% Charge in 20-30 Mintues

EV Conductive Charging

CONDUCTIVE CHARGING

LEVEL 1
120V

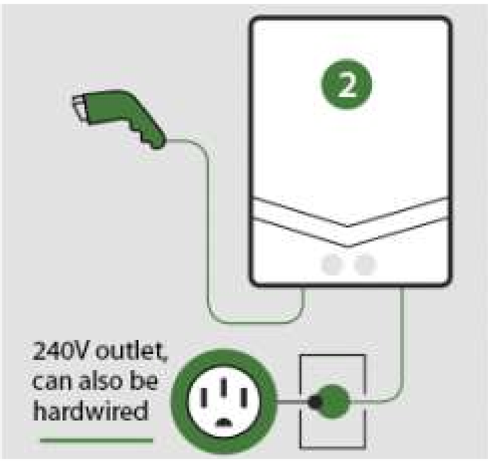


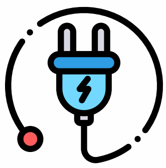


Adds 5 miles per hour of charge*

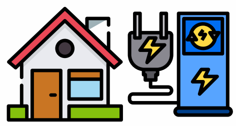
Residential Use

LEVEL 2
240V



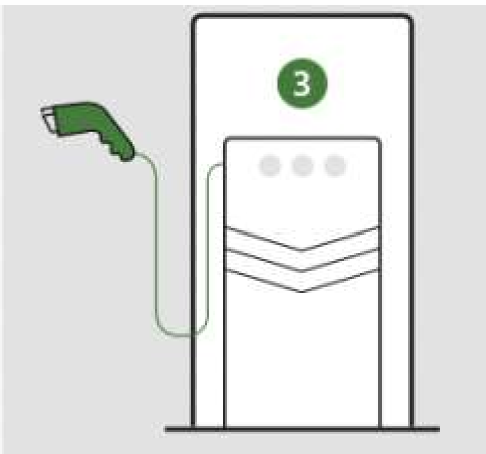


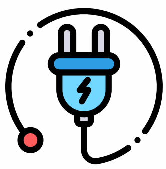
Adds 20-60 miles per hour of charge*



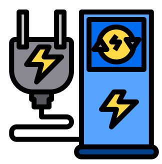
Residential & Commercial Use

LEVEL 3
480V
DC Fast Charger





Adds 60-100 miles per 20 minutes of charge*



Commercial Use

EV Conductive Charging

HOME CHARGING - LEVEL 1

As the popularity of EVs grow, EV batteries become more efficient at battery power utilization and Charging efficiency and speeds increase, it is predicted that EV car owners will prefer to charge their EVs at home with either a Level 1 or Level 2 Home charger. This is further driven by the cost of charge. It is cheaper to charge at home than at public stations.

SAMPLE TESLA LEVEL 1 CHARGERS

LEVEL 1 HOME CHARGERS

Level 1 home chargers plug directly to wall sockets and have a low rate of charge. This is measured in range per hour. Thy provide between 5-8 km per hour charge rate.

- They are typically supplied with the car ($0 Purchase & Installation Cost)
- Takes about 20hrs to fully charge a 200 km range EV

LEVEL 1 HOME CHARGER IN USE

EV Conductive Charging

THE BOSCH POWER MAX LEVEL 2 HOME CHARGER

HOME CHARGING - LEVEL 2

Level 2 Home chargers increase the rate of charge (they are 4 – 10times faster than Level 1 chargers. Level 2 chargers provide between 12-60 miles per hour charge rates

- They are sold separately from the car
- Requires specialize installation service (By OEM or certified Electricians)

Rating: 240 Volt Level 2 charger; 16Amps Charging current

- **$ 500 - $800** RRP depending on size
- Installation: **$1,000 – 3,000** incl. Permits
- Faster charge time (4-5 hours for full charge of 200km Range EV)

Also available in larger sizes with faster charging times

WALL MOUNTED LEVEL 2 HOME CHARGER IN USE

EV Conductive Charging

A DUAL PORT – PEDESTAL MOUNTED LEVEL 2 PUBLIC CHARGER

PUBLIC CHARGING - LEVEL 2

Public charging stations allows EV drivers to charge their cars on the road when they need to travel longer distances than allowed by the full range of the EVs. These public chargers are typically found near restaurants, shopping centers, general or office parking spots and other public locations. Their locations are usually available on digital mapping platforms

LEVEL 2 PUBLIC CHARGERS

Level 2 public chargers increase the rate of charge, they are 4 – 10 times faster than Level 1 chargers. Level 2 chargers provide between 12-60 miles per hour charge rates

Rated: 3-20 kw; 240V, 16Amps Charging Current

(Find Purchase Cost below: Installation cost average: **$1k - $4k**)

TYPICAL COSTS FOR LEVEL 2 PUBLIC CHARGERS

FLEET	WORKPLACE		COMMERCIAL
			
BASIC WALL MOUNT **$500 - $1000**	BASIC PEDESTAL **$1200 - $1700**	PEDESTAL WITH LOW LEVEL DATA COLLECTION **$1800 - $2700**	PEDESTAL WITH ADVANCE FEATURES **$3000 - $8000**

EV Conductive Charging

PUBLIC CHARGING – DC FAST CHARGERS

Level 3 public chargers increase the rate of charge (they are 20-40 times faster than Level 1 chargers, and 8-10 times foster than most Level 2 chargers.
They are sold separately from the car

- Requires specialize installation service (By OEM or certified Electricians)
- They are not available for residential use and are typically used for commercial applications

Typical Rating:
50 KW – 480V
Takes 30-45 mins for 200km range

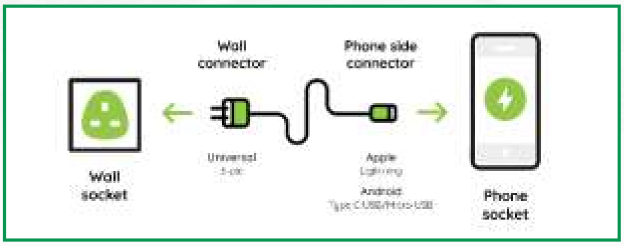
Price Range:
$10,000 - $50,000

Installation costs Ranges (Dual Port):
$4,000 - $20,000
Depending on presence of existing infrastructure

NOTE:

- Not all cars can charge with Level 3 chargers.
- They require unique charging connectors and power train architecture
- View following slides for more on the subject

EV Charging Connectors



If you can relate to this
<-----------------

You can understand this
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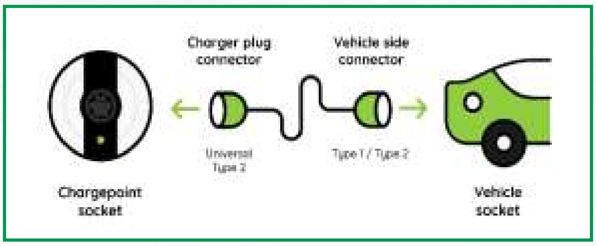


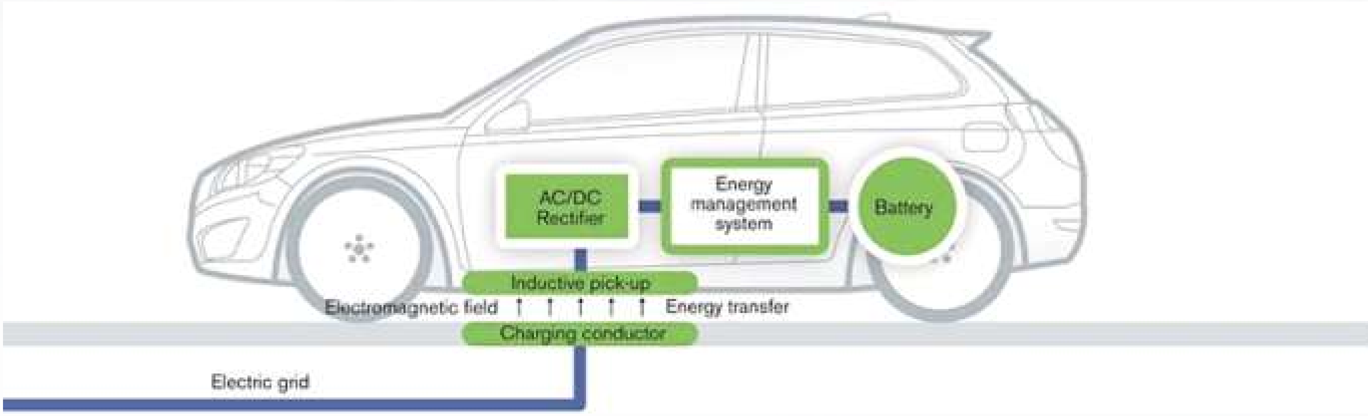
It is important to note that we cannot possibly talk of EV charging without the Charging cables. Similar to phone charging cables, EV charging cables tend to have two connectors, one that plugs into the vehicle socket and the other into the charge point. However, some charge points could have Charging connectors "Tethered".

The type of connector required varies by vehicle and the power rating ("speed") of the charge point.

- Electric vehicles either have a Type 1 or Type 2 socket for slow/fast charging and CHAdeMO or CCS for DC rapid charging.
- Most slow/fast charge points have a Type 2 socket. Occasionally they will have a cable attached instead.
- All DC rapid charging are tethered with mostly a CHAdeMO and a CCS connector.

EV Charging: Inductive

INDUCTIVE (WIRELESS) CHARGING



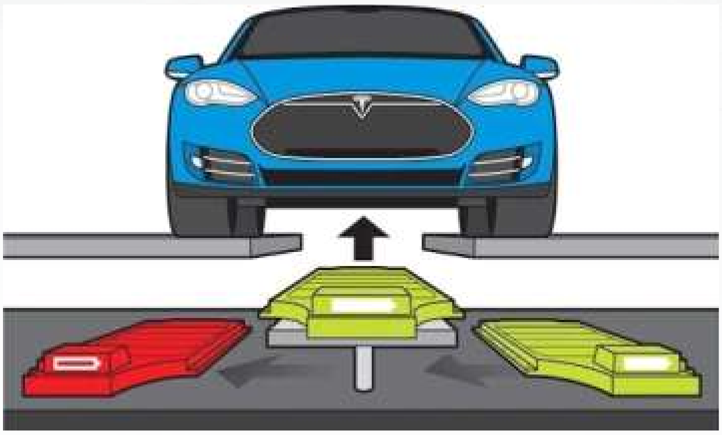
Inductive charging uses an electromagnetic field to transfer energy between two objects. Electricity is transferred through an air gap from a magnetic coil in the charger generating an alternating electromagnetic field (usually fixed on the ground or charging platform) to a second magnetic coil fitted to the car. All the driver needs to do is park in the right place to align both coils and charging will begin. These two induction coils in proximity combine to form an electrical transformer.

- Advanced Inductive Chargers like the Halo by Qualcomm and others by BMW and tesla can provide a Level charging experience
- Only about 10% of power is lost using inductive charging
- The Inductive pads can be purchased and fitted to most new Evs
- They cost between $1,500 - $3,000 and require professional installation

EV Charging

BATTERY SWAPPING

Battery swapping is simply the concept of swapping an already discharged battery pack with a fully charged battery eliminating the delay involved in waiting for the vehicles battery to charge. This is usually carried out in battery swapping stations (BSS).



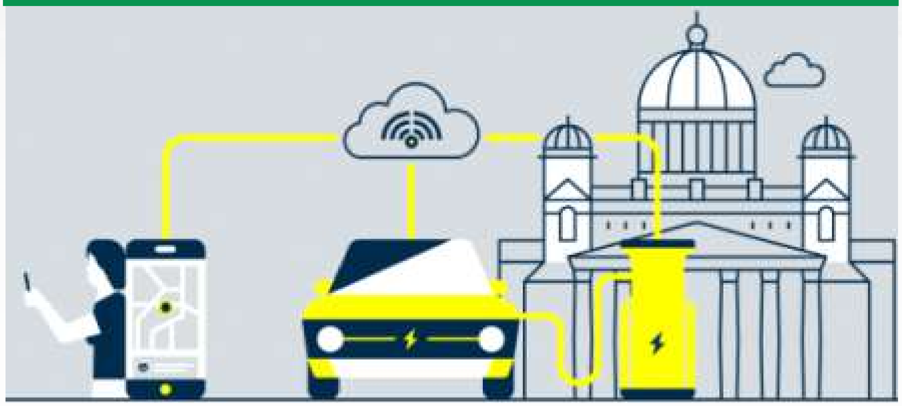
Battery swapping has had a couple of false starts. Better Places launched in 2005, pioneering BSS. They could only get Renault on board – couldn't get other car manufacturers or gas stations to buy into deploying them. Tesla also launched a battery swap service in 2013 and shut it down in 2016. BSS are expensive to build, maintain and the cost of battery replacements tend tot fall to manufacturers.

More recently a company in China NIO has set up 125 battery swapping stations for its E-vehicles. Offering battery swapping for free as a buy incentive to its potential customers. This tech is expected to be phased out as range and charge time continue to be improved.

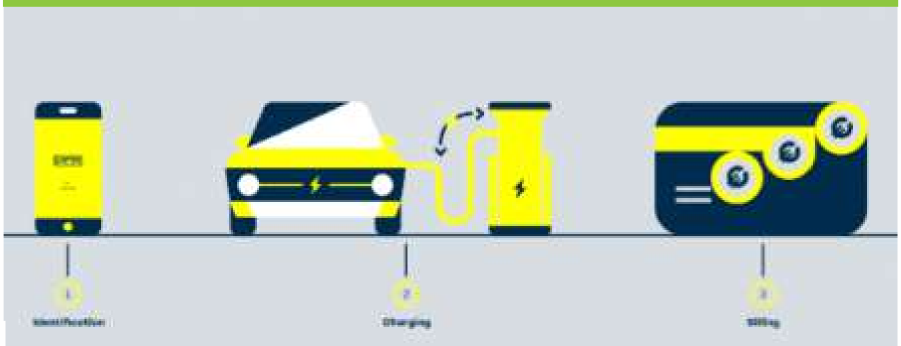
BATTERY SWAPPING HAVE FOUND HUGE APPLICATIONS IN OTHER MOBILITY SOLUTIONS SUCH AS THE YAMAHA + GOGORO SMART SCOOTER

Smart Charging

SMART CHARGING



IDENTIFY. CHARGE. PAY. (ALL WHILE USING DATA TO IMPROVE SERVICE)



SMART EV CHARGING FEATURES

- Find available charging stations for your EV
- Charge faster with BMS included
- Charge Safer
- Save money with network incentives, discounts and benefits

BENEFITS TO MUNICIPALITIES AND UTILITY OPERATORS

- Grid stability from the ability to control charging remotely and to match grid availability, energy production and consumption
- Energy management and consumption data

SMART CHARGING BENEFITS TO BUSINESSES AND CHARGING OPERATORS

- Monitor and control EV charging remotely
- View usage statistics and data
- Manage and monitor charging station issues
- Make changes to pricing packages and charging station information conveniently
- Seamless energy metering
- Seamless billing (on-site or offsite)
- Improved billing offerings (pay-as-you-use or subscriptions)
- Manage electricity consumption at stations (great for managing peak and off-peak pricing of power consumed)
- Better asset function and integrity management
- Asset life extension

EV R&D and Standards

The advancements in Electric vehicles Hass primarily been as a result of funded research in research in Power Electronics, Electric Motors and battery storage systems. These key research areas make it possible to develop electric drive technologies (Power Trains) that meet mobility performance on par with conventional car propulsion systems.

Research efforts are mainly trying to achieve the following

- Reduction in cost, weight and volume of key components including the energy storage
- Improvements in performance, efficiency and reliability
- Development of innovative modular and scalable designs
- Improvement in manufacturability
- Acceleration of commercialization

EV INFRASTRUCTURE STANDARDS

> EV companies are in a race to develop the most cost friendly and efficient power train in the market and thus they keep some of their developed technologies proprietary

As the electrification of the automotive industry continues to progress, car designers and manufacturers, charging service providers and the power industry have come together to standardize components and infrastructure surrounding the safe operations and maintenance of the vehicles.

The 3 major areas currently receiving these attentions are

EV Batteries

- Range, weight and size considerations
- Functional and electrical safety
- Environmental and performance testing

EV Charging

- Communication protocols
- Market specific requirements and
- Wireless and inductive charging development

EV Electronics and Components

- ISO and IEC Standards considerations
- Inverters, converters, and on-board chargers
- Connectors, plugs, charging cables, etc.

Drivers and Resistors

GROWTH FACTOR

The main growth factors for the development and deployment of EVs are as follows:

Technological Advancements

- Improvements in battery technology will reduce cost of EV production
- Improved energy density will also increase range and efficiency
- Improved chargers will lead to less time for battery charging and increase adoption in both first and third world countries

Price of Raw Materials (Battery and Charging Components)

- A reduction in price of raw materials such as Cobalt, lithium, silicon and other battery and charging related materials will lead to a further drop in EV manufacturing cost and sales price

Energy and Charging Infrastructure

- Improvements in power stability, availability, generation and transmission will aid the deployment of EV charging infrastructure across a wider network.
- The availability of power in conditions suitable for Fast charging will also influence the adoption of EVs especially in third world countries

Incentives and Policies

This includes but not limited to;

- Purchase Subsidies (including ICE trad-in incentives and Purchase financing)
- Infrastructural development financing
- Tax breaks and Credits
- Hardware and mobility service standards and mandates
- Import and export regulations
- Emission policy and sustainable development goals / Targets

Market Readiness (Investors, Manufacturers, End Users, EMSPs, Governments)

- As policies and incentives continue to be deployed, market readiness will be signaled, and investors interest will grow as the uncertainty in the market is mitigated
- The environmental and sustainability objectives of governments backed by policy and political will would make it halt growth in each market locality
- The Perception of people will also be a huge factor. Manufacturers and other key stakeholders must engage in end user education. The availability of varieties in car type, function and design will also encourage adoption.

EV Related Policies

Governmental International and local policies play a huge role in the adoption of Evs. Some of the most effective policies that have been implemented to date across some of the major EV markets are as seen in the table below. As the adoption of EVs increase, it is only a matter of time until the rest of the world catches up.

A SHIFT FROM DIRECT INCENTIVES TO POLICY

At the start of the EV technology growth path, due to the high cost of manufacturing it was essential that fiscal incentives and subsides be extended to both EV manufacturers and Users. Some these incentives included:

- Purchase subsidies
- Purchase financing
- Scrappage bonuses
- Infrastructural development financing
- Federal tax credits

With technology improvements in Battery Efficiency, Battery charging, and the Energy infrastructure which have led to an overall decrease in the cost of manufacturing, purchasing and maintaining an EV there are indications of a continuing shift from direct subsidies to policy approaches that rely more on regulatory and other structural measures – including zero-emission vehicles mandates and fuel economy standards –which will set clear, long-term signals to the auto industry and consumers that support the transition to EV in an economically sustainable manner.

Policies need to be tailored to support a market transition respective to the locality in question.

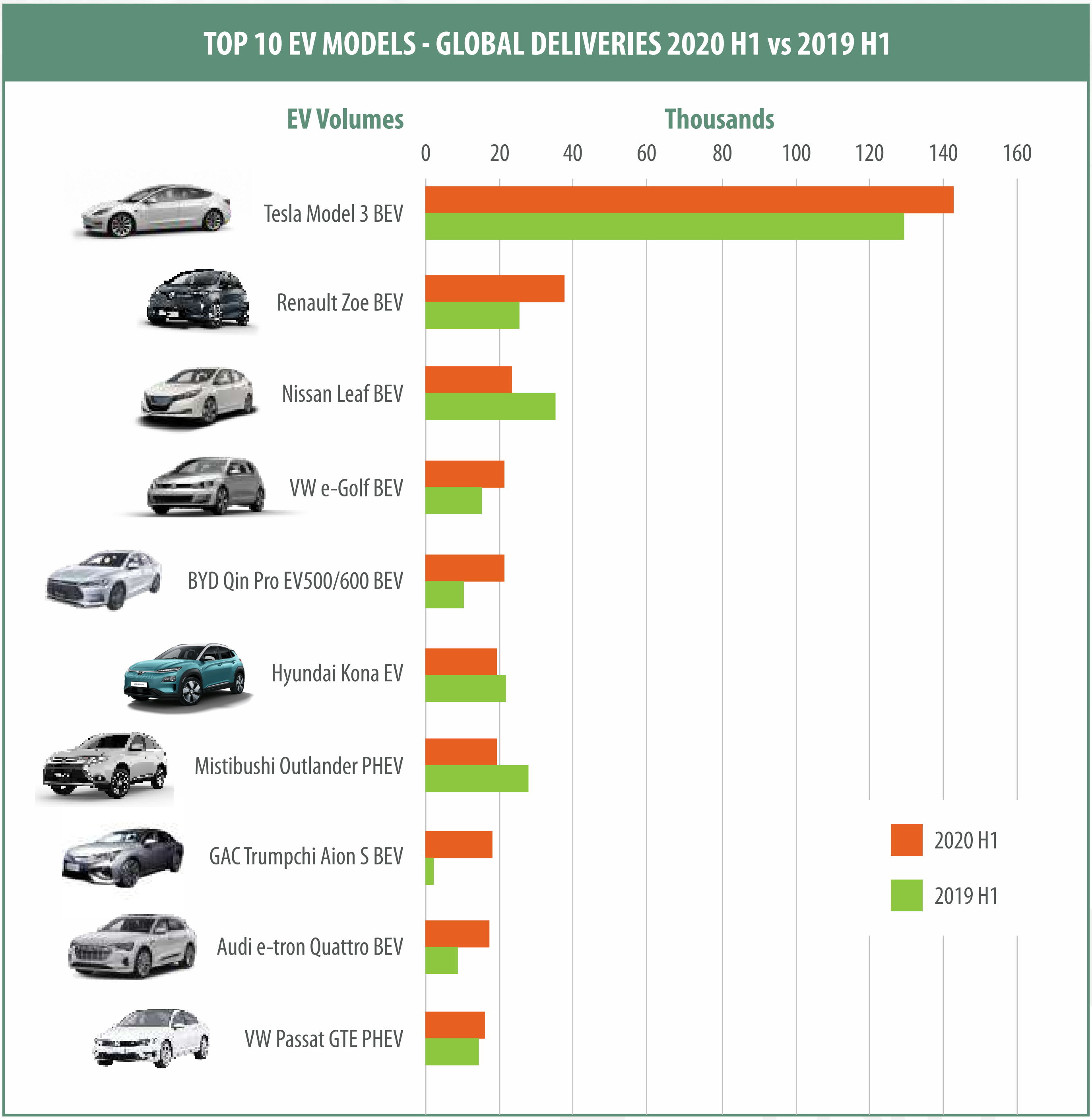
EV-Related Policies in Selected Regions

		Canada	China	EU	India	Japan	US
Regulations (Vehicles)	ZEV Mandate	✓*	✓				✓*
	Fuel Economy Standards	✓	✓	✓	✓	✓	✓
Incentives (Vehicles)	Fiscal Incentives	✓	✓	✓	✓		✓
Targets (Vehicles)	ZEV Mandate	✓	✓	✓	✓	✓	✓*
Industrial Policies	Subsidy	✓	✓			✓	
Regulations (Chargers)	Hardware Standards**	✓	✓	✓	✓	✓	✓
	Building Regulations	✓*	✓*	✓	✓		✓*
Incentives (Chargers)	Fiscal Incentives	✓	✓	✓	✓		✓*
Targets (Vehicles)		✓	✓	✓	✓	✓	✓*

*Indicate that the policy is only implemented as a state/province/local level

** Standards for chargers are a fundamental prerequisite for the development of EV supply equipment. All regions listed here have developed standards for chargers. Some (China, EU, India are monitoring specific standards as a minimum.

Top EV Cars & Makers



Top EV Cars & Makers

There are many car manufacturers now playing in the EV space. These Car makers are mainly from the USA, Germany, France, South Korea, Japan and China. Most are existing car makers while a few are new car companies strictly in the EV business.

CAR COMPANY & BRANDS

	TESLA Tesla Model 3 (BEV) Tesla Model S (BEV) Tesla Model X (BEV)	NISSAN Nissan Leaf (BEV)	BMW BMW i3 (BEV)
HYUNDAI Keona Electric (BEV)	CHEVROLET Bolt EV (BEV) Volt (PHEV)	RENAULT Zoe (BEV)	Volkswagen ID3 (BEV) E-Golf (BEV) Passat GTE (PHEV)
Audi e-tron (BEV)	HONDA Honda e (BEV)	KIA E-Niro (BEV) Soul EV (BEV)	

Top EV Cars & Makers

TESLA - MODEL S

NISSAN - LEAF

BMW -i3

HYUNDAI - KONA ELECTRIC

HONDA - E

AUDI - E TRON

CHEVROLET - BOLT

KIA - NIRO

PEUGEOT - E208

VOLKSWAGEN - E GOLF

NIO - ES8

RENAULT - ZOE

SOME OTHERS

- PORSCHE - TAYCAN
- JAGUAR - I PACE
- FORD - MUSTANG MARCH E

Legal and Regulatory Framework

Applicable Laws and Regulatory Institutions: Electric Vehicle

Nigerian Electricity Regulatory Commission (NERC)	The regulator of the electricity industry and generally responsible for enforcement of the EPSRA and such other related or incidental matters.
Standard Organisation of Nigeria (SON)	Issues the Mandatory Conformity Assessment Programme ("MANCAP") Certificate for all locally manufactured products in Nigeria to ensure they conform to the relevant Nigerian Industrial Standards (NIS) before being presented for sale in Nigeria or exported. Also issues the Standards Organisation of Nigeria Conformity Assessment Programme ("SONCAP") Certificate for all products imported into Nigeria. The SONCAP Certificate will be required for components or equipment imported for use in installing power systems in Nigeria.
National Office for Technology Acquisition and Promotion (NOTAP)	Registers contracts for the transfer of foreign technology to Nigerian parties as well as every agreement in connection with the use of trademarks, use of patented inventions, supply of technical expertise, the supply of basic or detailed engineering, and the supply of machinery and plant, among others
Nigerian Electricity Management Services Agency (NEMSA)	Carries out electrical inspectorate services in Nigeria's electricity supply industry and ensures that all major electrical materials and equipment used in Nigeria are of the right quality and standards, among other powers
National Agency for Food and Drug Administration and Control (NAFDAC)	responsible for regulation and control of the importation, export, manufacture, advertisement, distribution, sale and use of, among others, chemicals. To the extent that we would import, manufacture or utilize chemicals in the manufacturing process, NAFDAC's permit will be required.

Other Authorization or Institutions that May be Applicable - Electric Vehicle

Authorization	Purpose	Issuing Authotiry
Environmental Impact Assessment (EIA) certificate	Confirms that an EIA of the EV or battery manufacturing project or operation of the charging station has been adequately done and provisioned for	Federal Ministry of Environment
NEMSA Certificate	Required for the components to be deployed in the EV, batteries and charging stations	Nigerian Electricity Management Services Agency
Building & Construction Permits	Required for the construction at the Project site.	Various land and physical planning agencies of various states.
Factories licence	Required for occupation of any premises as a factory.	Director of Factories, Ministry of Labour
NAFDAC Certificate	Required for importation or use of industrial chemicals for the manufacturing of the EV, batteries or charging stations.	National Agency for Food and Drug Administration and Control
NESREA	Import new electrical/ electronic equipment; also required during the construction of the Project site for waste generation and management.	National Environmental Standards Regulation Enforcement Agency
NOTAP Registration	Required for agreements with foreign partners for technology transfer, such as, use of trademarks, patented inventions, technical/management, technological expertise, etc.	National Office for Technology Acquisition and Promotion
Import Related Permits	Required for the components of the EV, batteries charging stations that would be imported.	Central Bank of Nigeria; Standards Organisation of Nigeria
Import Clearance Certificate	The importation (and clearing from the ports) of fully assembled generators, knocked-down parts imported for domestic assembling or spare parts.	Nigerian Customs Service (NCS)

WASTE TO ENERGY

Technical

Waste to Energy Overview

Waste-to-Energy (WTE) or Energy-from-Waste (EFW)

Generating energy in the form of electricity and/or heat from the primary treatment of waste, or the processing of waste into a fuel source.

Bio-Energy

Bioenergy is renewable energy made available from materials derived from biological sources.

It the main source of renewable energy in the world today, **contributing to energy used in Heat, Electricity and Transport**

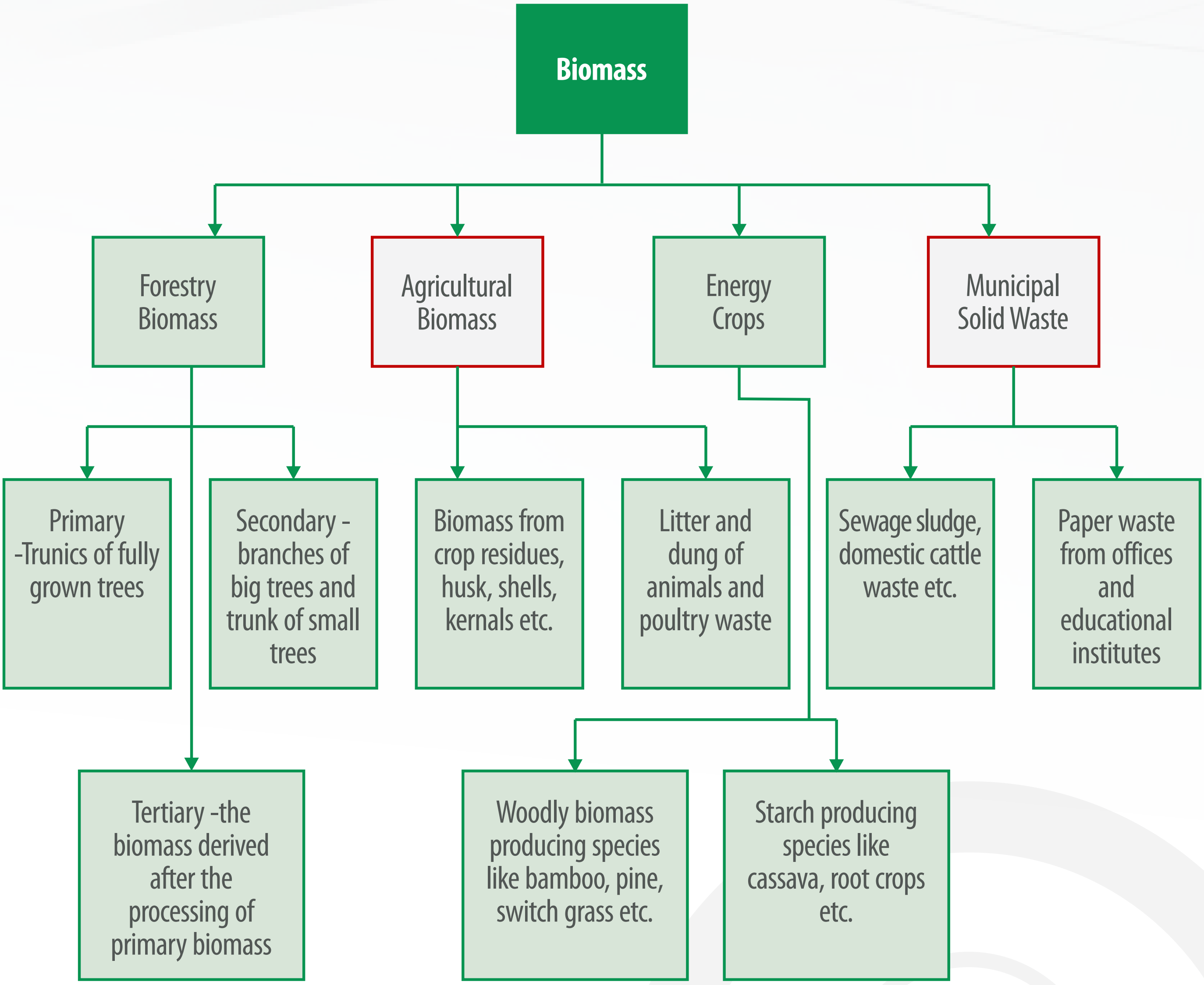
Biomass/Bio-Energy Feedstock

Biomass is the plant or animal material used for energy production. It is renewable organic material that comes from plants and animals. Biomass contains stored chemical energy from the sun.

It can be burned directly for heat or converted to renewable liquid and gaseous fuels through various processes.

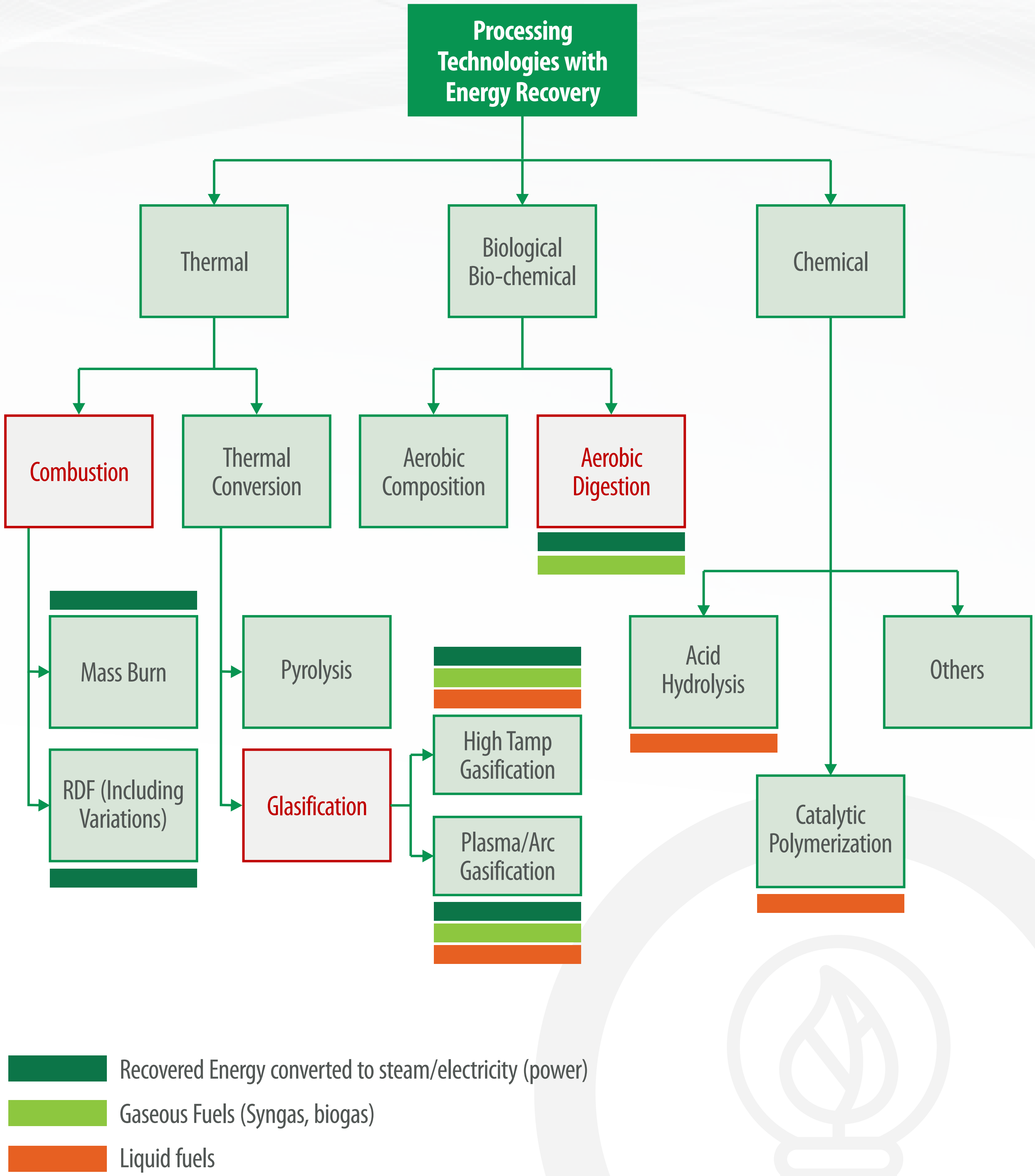
Waste to Energy /Bio-Energy Feedstock

- The type, characteristics, availability of feedstock will determine the type and amount of bioenergy that can be produced and the technology that can be used to produce it.



- Agricultural crop residue and Municipal Solid Waste (MSW) is our focus in this waste to energy analysis

Biomass Waste to Energy Recovery Pathway

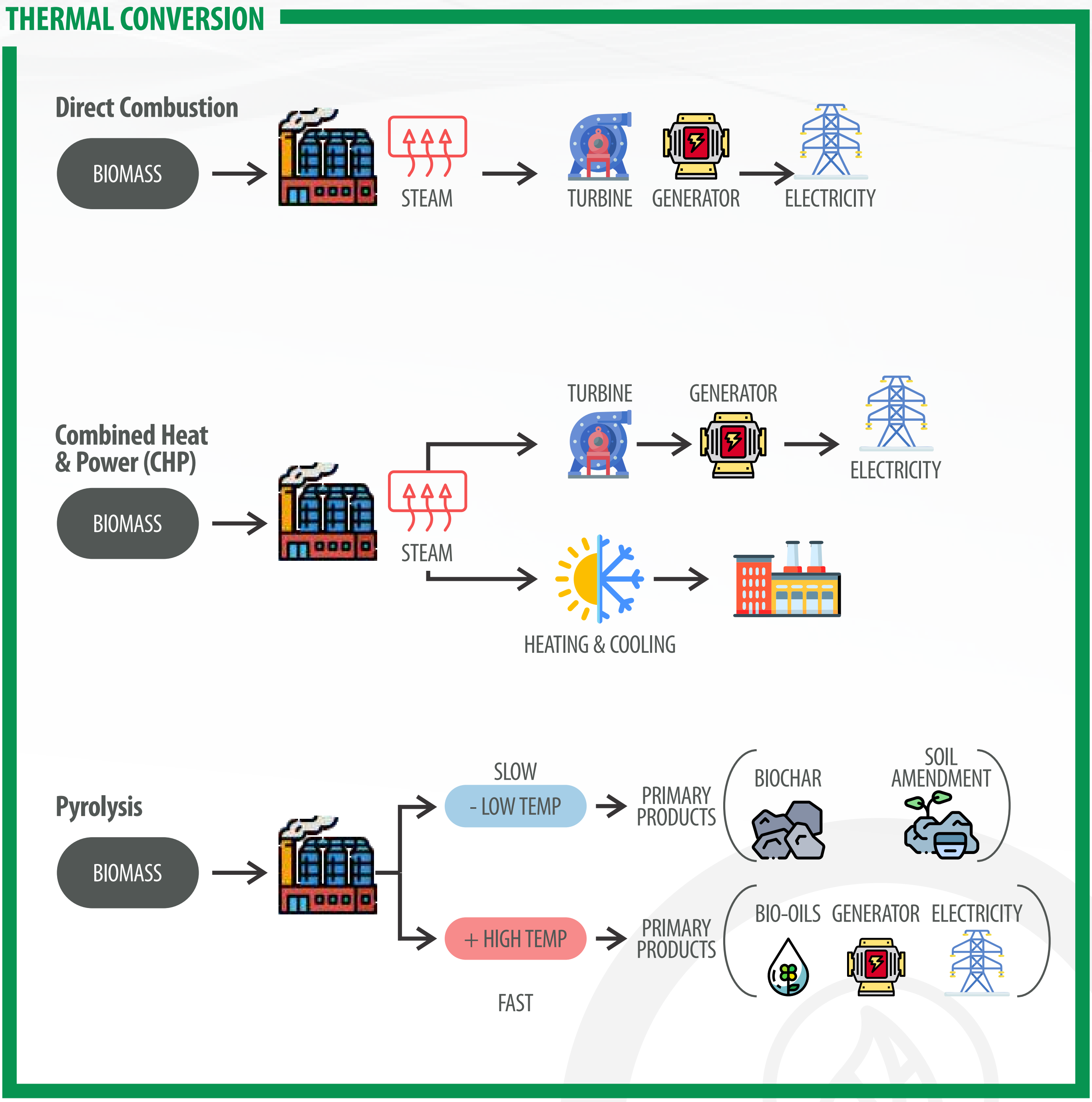


Waste to Energy Recovery Technologies

For the purpose of energy recovery, processing technologies, there are 3 main recovery technology classification.

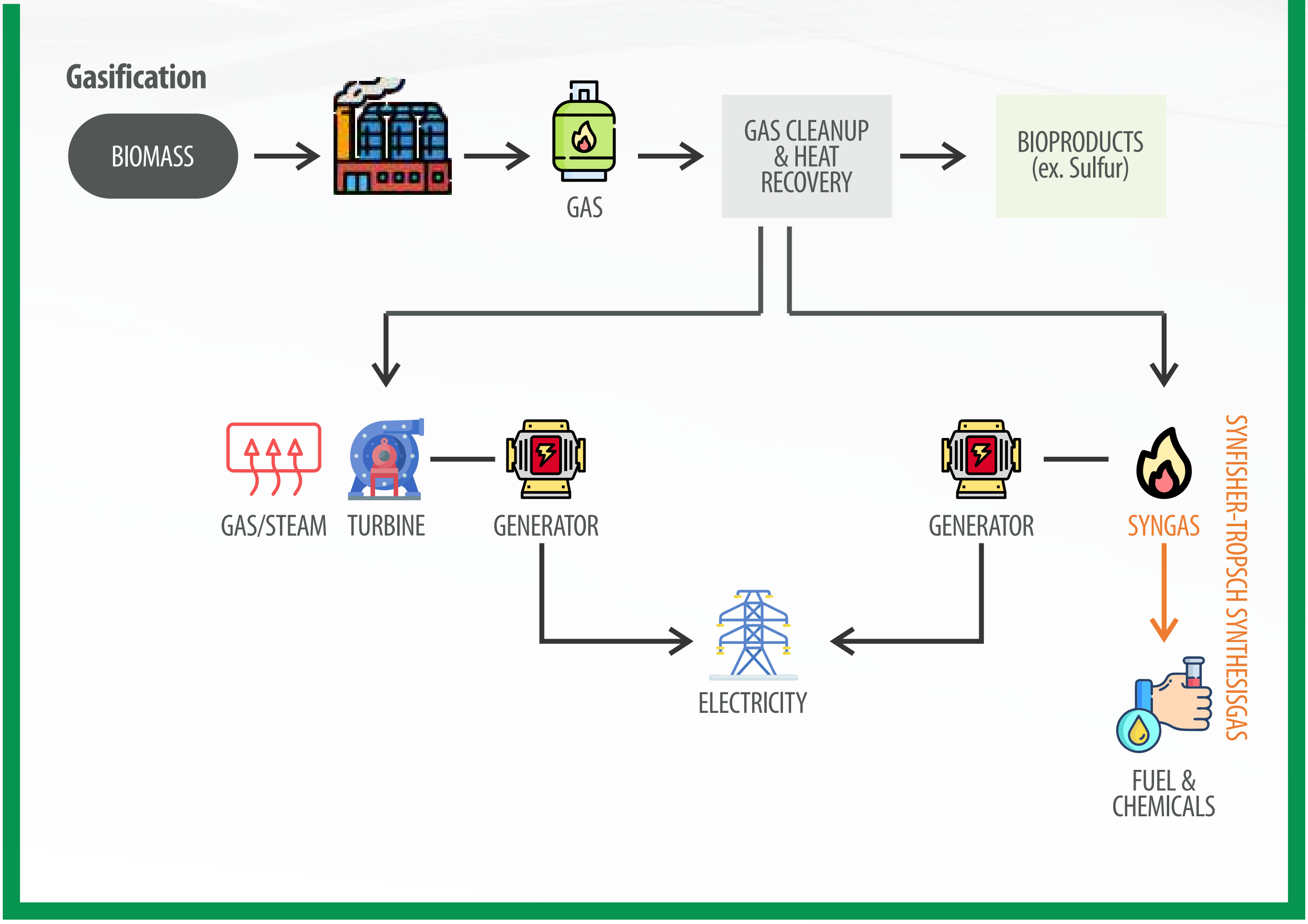
TECHNOLOGY	DESCRIPTION	MODE OF OPERATION
Combustion	Direct Combustion of feedstock utilizing excess air or oxygen as oxidant to generate heat	Grate Bubbling fluidized bed Circulating fluidized bed
Pryolysis	Thermal Conversion of feedstock in the absence of air or oxygen as oxidant to generate a synthetic gas or fuel and pyrolysis oil.	• Slow (low temp.) or Fast (High temp.) • HorizontalVertical (updraft/downdraft) • Plasma arch
Gasification	Thermal conversion of feedstock in a limited atmosphere of air or oxygen as oxidant to generate a synthesis gas or fuel	• Horizontal stationary • Horizontal rotating • Vertical (updraft/downdraft) • Stationary grate • Bubbling fluidized bed
Anaerobic Digestion	Biological conversion of a feedstock in the absence of oxygen to generate biogas	• Single or double stage • Wet or Dry Process • Mesophilic (77degF - 100degF) or Thermophilic (122degF - 135degF)

Combustion and Pyrolysis



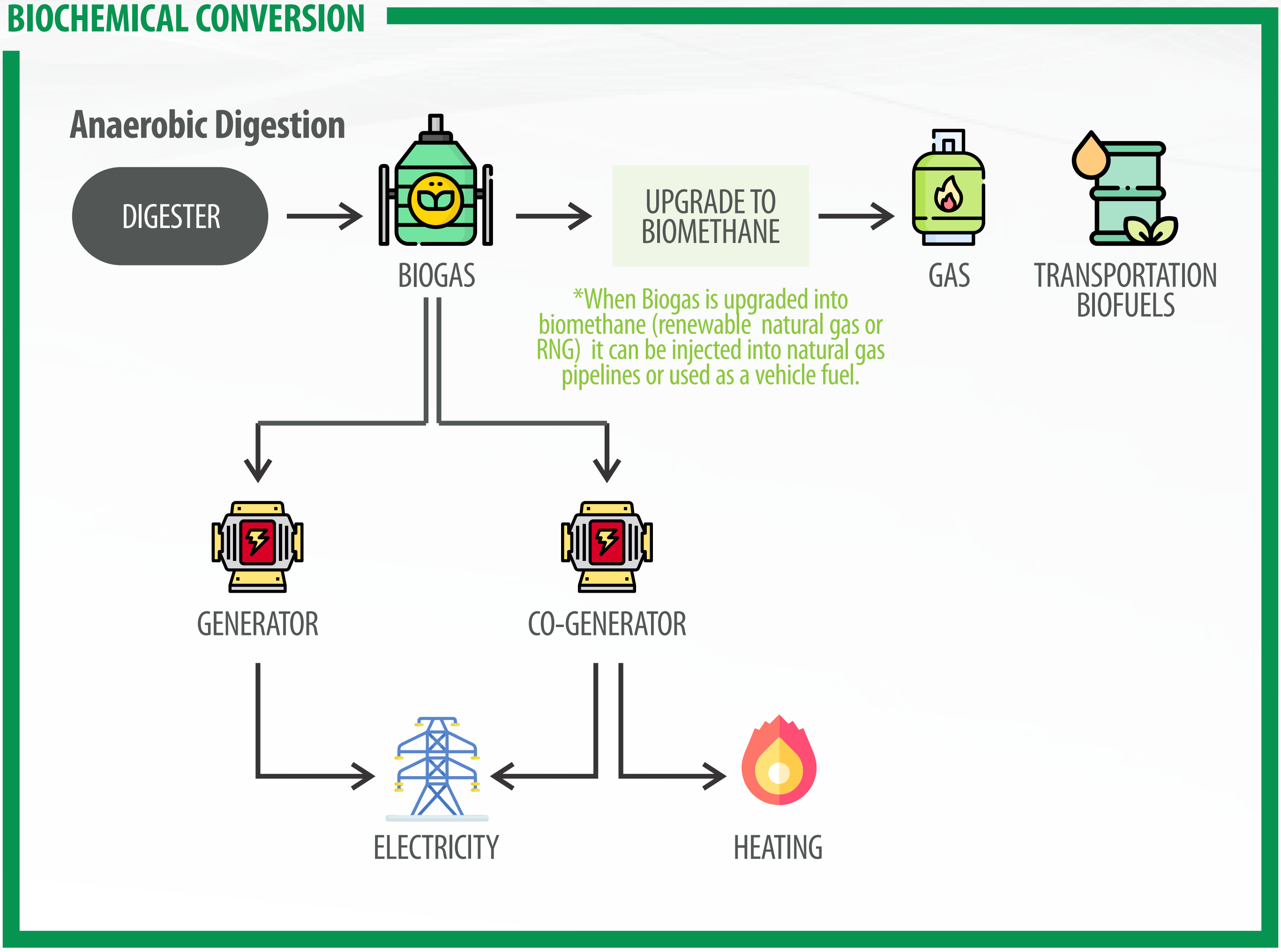
Gasification

THERMOCHEMICAL CONVERSION



Anaerobic Digestion

BIOCHEMICAL CONVERSION



Technology Comparison

CRITERIA	COMBUSTION (MASS BURN INCINERATION)	PYROLYSIS	GASIFICATION	ANAEROBIC DIGESTION
State of Techno-logy Maturity	Widely deployed	Early market deployment	Early market deployment	Widely deployed
Types of Solid Waste	Unsorted waste	Specific type of waste	Unsorted waste	Sorted organic waste, animal or human excreta, feedback
Final Products	Heat, Co2, H2O, Ash	Pyrolysis oil, Syngas, Ash char	Heat, Syngas, Ash Char	Digestate, Biogas
Adverse Impacts	Pollution from air emission toxic gases	High energy consumption during operation, Noise and air pollution	High energy consumption during operation, Noise and air pollution	Problem of leakage of methane gas
Air Pollution	High	High	Medium	Low
Solid Waste Generation due to Rejects	Low	Low	Low	Low
Volume Reduction of Waste	75 - 90%	75 - 90%	75 - 90%	45 - 50%
Contribution to Energy/ Efficiency	Power Generation 20 -30% Net electrical efficiency	Power Generation, Pyrolyis oil used as raw material 13 - 24% Net electrical efficiency	Natural gas replacement Power Generation 14 - 20% Net electrical efficiency	Natural gas (if upgraded), Power Generation from Biogas.
Contribution to Industry	Construction industry (Building Materials, roads)	None, high contamination	None	Agriculture industry (Digestate) as compost for cultivation

Organic Waste for Anaerobic Digestion

Various organic feedstock and can be used for Anaerobic Digestion, they can also be co-digested.

	LIVESTOCK MANURE	AGRIC. CROP RESIDUE	SEWAGE (HOUSEHOLD HUMAN WASTE)	ORGANIC MSW (OR FOOD WASTE)
Feedstock Quality	Lower biogas energy potential. Co-digestion may be required.	Good energy potential without co-digestion. Co-digestion may not be required.	Lower energy content. Co-digestion may be required. Steady and reliable stream. The flow of this feedstock is guaranteed.	High energy content and is a desirable feedstock. Co-digestion with other waste may not be required.
Advantage	In continuous supply. Potential to meet 100% energy needs of agriculture. Significant to the energy security of farms which are often off the grid.	Support to the energy security of farms.	Steady and reliable stream. The flow of this feedstock is guaranteed.	In continuous supply. In rural areas, large capacities possible for generation of electricity and heat or upgrade to biomethane. Stabilization allows for continued generation of energy.
Disadvantage	Proximity of recovery technology to rescue is recommended.	Crop residue is not in continuous supply (seasonal). Storage required for a steady supply throughout the year. Pre-treatment required to allow for faster digestion and higher biogas yields.	Decentralized system mostly applies especially in rural setting. Special Infrastructure needs to be set up to collect the waste. Quality of the sludge based digestate may not be safe (pollutants and pathogens).	Complicated digestion of food waste - one batch of food waste can vary significantly from the next so stabilization is required. In stabilizing (mixing with other substrates maybe required) and it reduces the energy generated. Separate food waste collection required or seararion from MSW

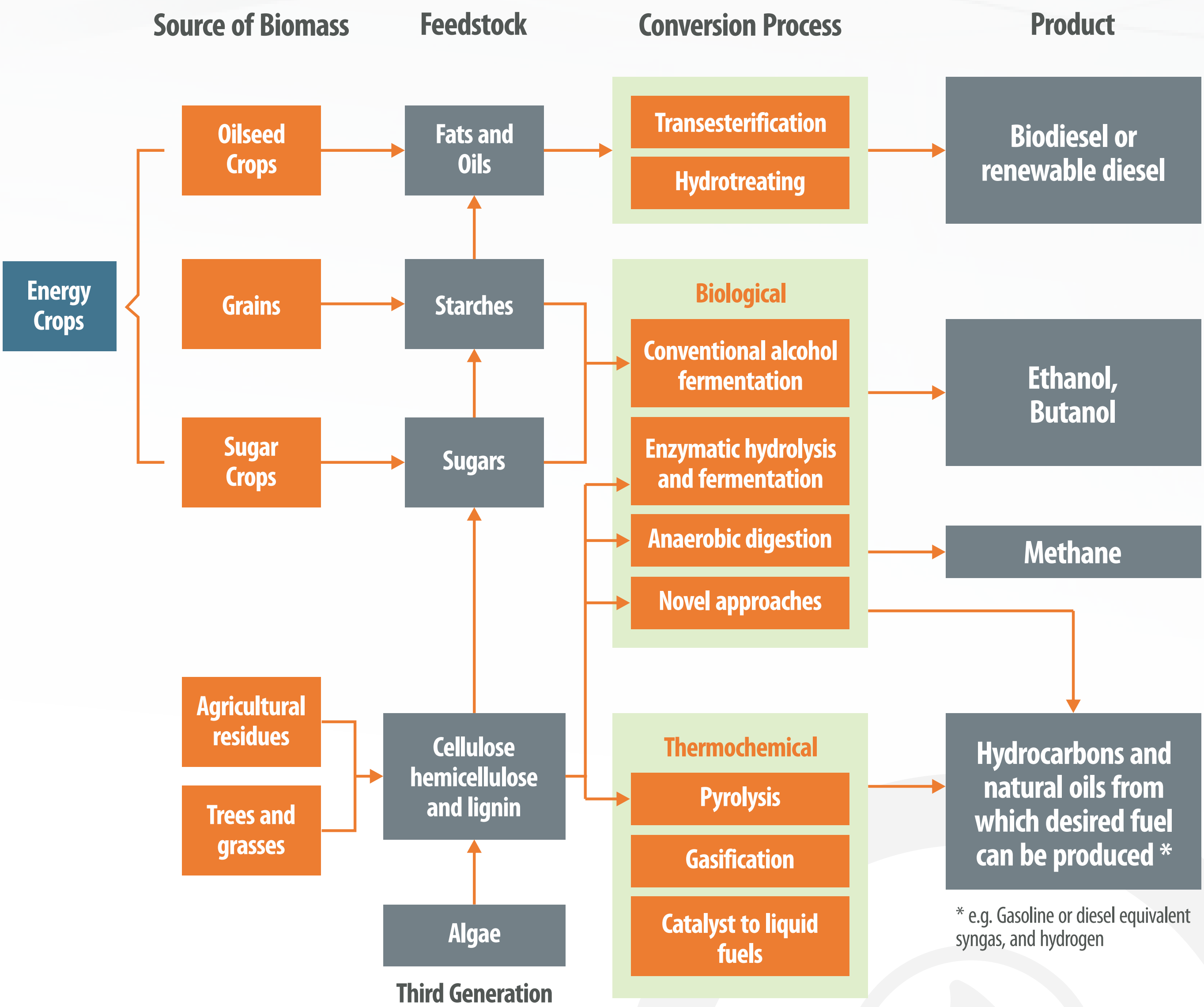
Biogas Yield from Organic Waste

Biogas Yield for Various Waste Material			
INPUT DIGESTION	Nm^3CH_4/raw ton	Biogas (m^3/t)	Biogas (ft^3/t)
Biowaste + Garden waste	50 - 60	80 - 90	2,800 - 3,200
Biowaste + Low level of Cardboard	65 - 75	104 112	3,700 - 4,000
Biowaste + Cardboard + Garden Waste	65 - 75	104 - 112	2,700 - 4,000
Biowaste + Cardboard	75 - 85	112 - 136	4,000 - 4,800
MSW	75 - 90	112 - 144	4,000 - 5,100

Typical Biogas Composition from the Anaerobic Digestion of Source Separated Food Waste				
BIOGAS COMPOSITION		AVERAGE	MINIMUM	MAXIMUM
Methane	Vol. %	65	52	70
Carbon dioxide	Vol. %	35	30	48
Hydrogen sulphide	ppm		50	1,800
Total Chlorine	mg/m^3	0.6	0.02	1.2
Total fluorine	mg/m^3	< 0.1	< 0.03	0.2

Biofuel Pathway (Transport Fuel)

The biomass/feedstock can be from purposely grown energy crops, forest residues or agricultural residue



Transport Fuel Production in Nigeria

- Biofuels used for transportation are blended into traditional petroleum fuel sources such as gasoline and diesel.
- **Bioethanol** is the most widely used biofuel and is a fuel additive for petroleum gasoline / petrol, the majority of which is produced using **fermentation.**
- **Biodiesel** can be produced in a process known as **transesterification.**
- **Biogas** can be converted to biomethane by **upgrading the biogas generated from AD**, through removal of the unwanted gases, particularly carbon dioxide, hydrogen sulphide and water. The purified or upgraded gas is called biomethane or renewable natural gas (RNG).
- By utilizing the syngas produced from **gasification** after impurities have been removed, hydrocarbons produced can be refined to produce a wide variety of fuels and chemicals.
- **In 2007 NNPC was mandated to create an environment for the take-off of a domestic fuel ethanol industry (Automotive Biomass Programme). In 2011 the Nigeria Export and Import Bank (NEXIM) granted loans to companies to commence commercial production of biofuel, most of their projects – both state**

Biofuel	Potential Raw Material	Inudustrial Feasibility in Nigeria	Proposed Use	Main Advantage	Land Use	Water Use
Bioethanol	Sugarcane, sweet sorghum, cassava	Developing	Transportation	Reduced pollution, diversification of fuel mix	Sizeable	Sizeable
Biodiesel	Jatropha, oil palm, soy beans	Under investigation	Transportation	Diversification of fuel mix	Depends on crop	Depends on crop
Biogas	MSW, Manure, Sewage	Good	Indoor Combustion	Reduce deforestation, improved indoor air quality	None	Limited

Waste Generation in Nigeria

- Proximity to the resource and end-user is key for siting a Waste to Energy Combustion plant or an Anaerobic Digestion plant.
- Based on a regional analysis of Nigeria, states identified. Lagos, Abuja, Ibadan, Port Harcourt, and Kano provide the best opportunity.
- Residual waste generated in other cities can be moved, the additional waste will ensure sufficient, reliable and increased amount of waste to fuel the plant or smaller capacity plant installed

Regions	Population	Cap/Person /Day (kg)	Daily MSW (t)	Avg. Monthly Waste (t)	Annual Waste (t)	Organic Waste (%)	Annual Organic (t)	Potential States Plant location
Northeast								
Northwest	3,999,000 1,130,000	0.56 0.58	2,239.44 655.40	60,465 17,696	725,579 212,350	43% 63%	311,998.78 133,780.25	Kano Kaduna
Northcentral	949,886 3,278,000	0.5 0.66	474.94 2,163.48	12,823 58,414	153,882 700,968	60% 64%	92,328.92 448,619.21	Ilorin Abuja
Southeast	1,081,000 1,415,000	0.56 0.56	605.36 792.40	16,345 21,395	196,137 256,738	62% 62%	0 121,604.72 159,177.31	Aba Onitsha
Southwest	14,368,000 3,552,000 533,000	0.7 0.51 0.56	10,057.60 1,811.52 298.48	271,555 48,911 8,059	3,258,662 586,932 96,708	68% 61% 60%	2,215,890.43 358,028.81 58,024.51	Lagos Ibadan Abeokuta
Southsouth	1,727,000 3,020,000	0.63 0.6	1,008.01 1,812.00	29,376 48,924	352,515 587,088	54% 60%	190,358.23 352,252.80	Benin City Port Harcourt

Dumpsites in Lagos

- There are various locations that can provide potential plant locations, proximity to Biomass, end user, land availability, required facility scale and capacity need to be considered.

DUMP CONVERSION

	Olusosun	Solous 2*3	Epe	Awotan (Apete)	Lapete	Eneka
Location	Ojota, Lagos	LASU-Iba rd, Lagos	Lagos	Ibadan	Ibadan	Port Harcourt
Year	1992	2006	2010	1998	1998	
Estimated Capacity	Largest dumpsite in Nigeria 2.1million t/yr	820,000 t/yr	12,000 t/yr	36,000 t/yr	9,000 t/yr	45,600 t/yr
Area	Area: 43hectars, 18m deep	8 hectares	80 hetares	14 hectares	20 hectares	5 hectares
Residents	5 million in 10km radius from the site	200 meters from the nearest dwellings, 4 million people live within 10km radius from the site. Proximity to the Alimosho General Hospital.	2km away from Osogbo River and 7km away from Lekki Lagoon.	200 meters away from nearest settlement. Close to Eleyele Lake (2.5km away) and IITA Forest Reserve (4.5km away).	2km away from nearest settlement 9km away from IITA Forest Reserve. Surrounded by vegetation.	1.2 million people living around 10km radius from the site (closest building is 200 meters away). Igwuruta/Eneka road and 9km from Okpoka River and Otamiri River.
Issues	Health problems - reported by residents living around 3km radius from the site.	Contamination of ground water	Waterway pollution	Groundwater contamination	Ground water and food crops contamination	Dumpsite flooded almost all year round (+/- 2,500mm per annum) ground water, surface water, and soil contamination.

	MARKET	ABATTOIR	SAW MILL	BREWERY	FARMS
Biomass	Keri, Mile 12, Oshodi, Itire, Ojuwoye (Mushin), Ajayi (Ikeja), Pako (Okokomaiko).	Lagos state government modern abattoir	Coconut saw mill (Ebute meta)	Guiness Nigeria PLC (Ikeja), Nigeria Breweries	Various

There are 3 other main dumpsites to consider in Lagos. For dumpsite conversion, rehabilitation works will be carried out:
Leveling of the refuse, slope stabilization, soil covering, grading as well as rolling and landscaping, rebuilding drainage and road network within and outside the site.

This can be done in partnership with the state government. The state is planning dumpsite conversion for *solous 3 to accommodate a Material Recovery Facility and WtE plants to power the General Hospital and the College of Nursing.

Typical Combustion and AD Facility

ANAEROBIC DIGESTER	DESCRIPTION
Combustion Plant	Waste is either stored on site or received weekly (The Waste bunker should be able to hold at least 1 week of MSW) The Plant layout typically is typically split into 4 main systems. • Furnace/boiler System Energy recovery • Flue gas treatment • Ash/residue handling According to WTERT, WTE overall availability is 330, 24-hr days per year.

ANAEROBIC DIGESTER	DESCRIPTION
Waste sorting site/central system	Waste Management company delivers to waste on plant location
Anaerobic Digestion	The AD system should operate 52 weeks per year, six (6) days a week, and two shifts (16 hours) per day. **The AD site should be accommodate :** • Material intake and digester facility • Separation and gas storage facility

Supply Chain of Recovered Energy Pathway

In the Supply chain process, there are 3 streams of Logistics involved in running a AD process:

LOGISTIC 1: DELIVERY OF FEEDSTOCK TO LOCATION

Partnership with one of the 364 LAWMA licensed waste collectors and environmental agency is required.

The material collection, processing facility should be located on site of the Waste to Energy facility if possible.

A Controlled and Well Managed Waste Management System is Required

Primary Collection	Transportation	Transfer Station and Processing Site	WTE Processing Plant/Site
Collection includes from markets, abattoir, sawmill brewery, farms	Waste collection bins transported to either transfer station or processing facility	Bio Degradable Waste (composting, vermicomposting) Non Bio Degradable Waste (recycle market, Waste to Energy Process)	

LOGISTIC 2: DISTRIBUTION SYSTEM FOR BY-PRODUCT

Composted Digestate (AD) or Bottom Ash	Buyers (Agric/Construction) offtake from WtE facility (to avoid any logistics f or company)

LOGISTIC 3: POST ENERGY GENERATION - ELECTRICITY DELVIERY TO END USER

Electricity Generated	Connect to Grid	Electricity Transmitted by TCN (not applicable for off-grid connection)	Electricity Delivered to Disco	Consumer

WTE Projects in Africa and Nigeria

To date, only one WTE developer of note has successfully constructed and started operating a major waste-fed power project in Africa

- The $120m Reppie plant in Ethiopia. Developed by Cambridge Industries and commissioned in 2018. The facility is designed to convert 1,400 tonnes of waste per day from the Koshe landfill site in south-east Addis Ababa into 185 GWHr of electricity per year.

Other African municipal solid waste (MSW)-fed plants are at various stages of development, including;

- Climate Neutral Group's Joburg Waste to Energy Offset Project, intended to produce 19MW of energy from landfill gas.
- Tropical Power's 2.4MW Gorge Farm Anaerobic Digestion Power Plant in Naivasha, Kenya, which runs on vegetable waste.

NREEP pilots projects

- The waste-to-energy plant that is proposed for Ikorodu Industrial Estate and surrounding areas in Lagos State and the 12 MW (no details)
- Biogas plant was installed for the ikosi fruit market in 2013 by government and Midori Environmental Solutions (MES). Project is no longer active.

The Ebonyi State Government took over this project from the United Nations Industrial Development Organization (UNIDO)

- Demonstration biomass **gasifier power plant** located at the UNIDO Mini -industrial cluster .The power plant is to generate 5.5 Megawatt energy using rice husk and other available waste materials available.

Potential WTE Technical Partnerships

USA companies for potential partnerships, these companies can enhance opportunity for US grants and funding.		
Company	**Contact**	**Service Offering**
1. EISENMANN USA	Eisenmann Corporation 150 E. Dartmoor Drive Crystal Lake, IL 60014. T (825) 455-4100	Technology, Consulting & Concept Design; Sale of Capital Equipment (AD Technology); Installations, Commissioning of Turnkey Systems.
2. BIOWORKS ENERGY LLC	4652 Beecher Rd, Flint, Michigan 48532, United States. T: 7409722499	Engineering & Process Evaluation, Feedstock /Waste Stream Screening, Evaluation, Process Laboratory Evaluations and Research.
3. ANAERGIA INC.	Pacific Ridge Corporate Center, 5870 Fleet Street, Suite 310, Carlsbad, California 92008 United States. T: +1 760-436-8870	Consulting and Concept Design, Sale of Capital Equipment, O&M Service.

European companies below can enhance opportunity for European grants and funding		
Company	**Contact**	**Service Offering**
1. STEINMULLER BABCOCK ENVIRONMENT GmbH	Fabrikstraße 1; 51643 Gummersbach info@steinmueller-babcock.com/en/energy; +49 (0) 2261 85-0 https://www.steinmueller-babcock.com/en/energy	Technology, Consulting & Concept Design; Sale of Capital Equipment (AD Technology); Installations, Commissioning of Turnkey Systems.
2. AEB	Australiehavënweg 21, 1045 BA Amsterdam, Postbus 58292, 1040 HG Amsterdam info@aebamsterdam.ni, (+37)-020-5876299	Technology, Sale of Capital Equipment (AD Technology), Installation & Commissioning of Turnkey Systems.

Partnership opportunity for European grant and funding focused on		
Company	**Contact**	**Service Offering**
1. PARTNERS FOR INNOVATION B.V.	Partners for Innovation B.V Withoedenveem 8, 1019 HE AMSTERDAM, the Netherlands +31 (0) 20 620 05 11. info@partnersforinnovation.com Partner for Innovation Niger Sarl Boulevard Bawa Djangorzo Avenue Niamey Nyala BP 577 NIAMEY, Niger +227 2035 1058 r.gazibo@partnersfor innovation.com	Technology, Consulting & Concept Design; Sale of Capital Equipment (AD Technology); Installations, Commissioning of Turnkey Systems.

Feasibility: Terms of Reference

TASK	TIME (WEEKS)	DESCRIPTION
Task 1: Project Kick off and Data Gathering	4	The firm shall have initial discussions with the project implementation lead to discuss the project and shall make a business visit to Nigeria. The firm shall develop and deliver a feasibility study plan to be discussed on the visit.
Task 2: Waste Stream Assessment	2	The assessment will include sources of waste, variation and waste characteristics. The assessment will determine waste supply and its characteristics and identified options available for energy recovery.
Task 3: Site assessment	1	Firm shall utilize all available information provided and gathered in Task 1 and 2 to conduct assessment of the proposed site location and determine if the proposed location is adequate for the project size.
Task 4: Digestate Management assessment	1	Firm shall assess the how the digestate will be management as the disposal of digestate is provides a large operational cost. Firm shall assess all possible avenues of digestate management including disposal, transformation, or treatment.
Task 5: Market Analysis, Electricity Connection requirements	2	The firm will carry out an analysis of the potential markets that will be provided by company based on collected data, and based on the information shall determine the potential demand and specific connection /metering requirement.
Task 6: AD Technology Assessment	2	The firm shall establish criteria and guideline in assessing the best AD technology specific to proposed site to cover electicity generation efficiency, processing capacity, operational requirment, Efficiency and Optimum retention time, Technology provider capabilities – financially, Status of the AD technology and commercial experience.
Task 7: Preliminary Engineering and Equipment Requirement	3.5	In line with Task 3,4&6, the firm shall define the technical design requirements to cover BOD, technlogy and equipment, power equipment sizing, technical designs.

Feasibility: Terms of Reference

TASK	TIME (WEEKS)	DESCRIPTION
Task 8: Determination of Scalability Analysis to determine future opportunities to scale up operation and output	1	Firm shall carry out an analysis on planned output and capability to scale up considering task 3 and 6.
Task 9: Planning and Regulations	1	
Task 10: Determination of incentives and Financial Analysis	2	Cost estimates for Capital expenditure, operating costs, full financial analysis and models, recommendations for possible financing options and tax incentives for the proposed project.
Task 11: Preliminary Environmental Impact Assessment	1	Firm will carry out analysis on the impact of the project to the environment including methane leak, ecology, soil erosion, water requirement and usage. Mitigating measures and management processes will be developed
Task 12: Development Impact Assessment	1	Firm will analyse the benefits of the project on all stakeholders including local content development, employment, technology transfer, infrastructure.
Task 13: Identification of U.S Supplier and Value of US exports	1	Firm shall identify the potential value of US export or equipment and services and will provide a detailed description of US sources for procurement of equipment and services.
Task 14: Develop Request for Proposal Specifications for the AD plant	2	The firm will prepare alongside the company RFP specifications for the project as well as criteria for evaluation of proposals.
Task 15: Final Report	1	Firm shall prepare a comprehensive final report of all work performed in task 1-14 above.
Additional Activites		Logistics, Project Management etc

Anaerobic Digestion Global Deployment

The biogas industry may be analyzed in 3 broad categories.

Micro-Digesters Using Biogas (Very small scale – >=100 KW)	• Family Scale or household biogas plants. • Important in rural communities (integral part of farming, waste management and energy security). Biogas is used in cooking stoves and lighting. • Feedstock is usually from household or family small farms. **+/-50 million micro-scale digesters operating around the globe** 42 million in China, 4.9 million in India, 700,000 biogas plants are estimated in rest of Asia, Africa and South America.
Scale Digesters Generating Electricity (Small, Medium, Large scale)	• Produces heat and/or electricity • Can utilize one or many suitable feedstock (Co-digestion – Large scale) • It is estimated that there is a total of around **132,000 small, medium or large-scale digesters operating in the world.** • China 110,448 plants • Europe 17,783 plants • (Germany has the most installation, others: Sweden, UK, France and Netherlands) • USA 2,200 plants with capacity of 977MW • 196 MW installed capacity in canada • India 180 plants with 300MW capacity
Scale Digesters Producing Biomethane (Medium -Large scale)	• Upgrading of biogas to biomethane is relatively new but now a proven technology. • While some plants upgrade biogas to be used as vehicle fuel, others inject it into the local or national grids. **Estimated that 700 plants upgrade biogas to biomethane globally.** • 540 upgrading plants in Europe • 50 in the USA • 25 in China • 20 in Canada • A few in Japan, South Korea, Brazil and India.

African Market Analysis

Country	Cape Verde	Egypt
Population	**550,000 residents (10 islands)**	**100.4 million**
Waste Generation	Cape Verde potentially have a waste collection coverage rate of 85% nationwide	**95 million tonnes waste produced/yr** 55.2% household's solid waste is collected by private companies 44.8% of the households dispose their waste by dumping it onto the street
Renewable Focus	257.6 MW and 314.5 MW for wind and solar photovoltaic sources.	Solar, Wind WTE (Incineration of MSW - 20 35 % target)
Current Electricity Capacity	Per capita electricity consumption is circa 828 kWh/yr per capita Sub-Saharan Africa average of 488 kWh per person per year.	It is Continent's Top Electricity Producer with about 55.21 MW per day in 2017/2018 to around 58,000MW Installed capacity as at end 2019
Electricity Prices	US$0.26 - 0.32	Renewable tarrif: The Egyptian Cabinet has approved the Waste-to-Energy tariff at EGP 1.4/Kwh. The approval was issued by virtue of Decree no. 41 of 2019 (the "Decree"). The tariff shall be applicable until reaching the maximum contractual capacity of 300 MW. Thereafter, the Cabinet will reconsider the tariff.
Current Electricity Capacity	No renewable energy pricing Small population with potentially small waste generation and organic waste is only 17%. Government focus is on waste management and recycling plan as more 10% of the waste make up is recyclable. Transportation of goods and services cost is very high Capable human resources is lacking	Potential Strict control by the Governorate via PPA (plant shall be located for a period of 25 years and control of the plant shall be by the Waste Management Regulatory Authority (WMRA), together with EgyptERA for regulatory rules and technical requirements for the connection of the plant to the electricity grids may be a challenge)

African Market Analysis

Country	Namibia	South Africa
Population	**2.5 million**	**59.62 million**
Waste Generation	Extrapolated from a domestic waste sample of Windhoek, Waste gen/year included 123,000tons of recyclable. But only a fraction of less than five percent was exported to South Africa for recycling each year.	**About 54,2 million tonnes of general (municipal, commercial, and industrial) waste per year,** a maximum of only 10% recycled or recovered for other uses, 90% is landfilled or dumped.
Renewable Focus	Non-electricity off-grid renewable energy projects- micro wind driven water pumps in farms (30,000) to be replaced by solar Solar, wind and biomass generation.Invade bush is widely spread in the country's northern parts, which allows a large scale bioenergy-based production capacity	Primary sources of renewable energy - solar, wind, hydroelectric, and biomass. The first large-scale WTE plant in Africa in cape town converts municipal solid waste into renewable, clean energy using technology from the Anaergia group of companies. Biomass is currently the largest renewable energy contributor in South Africa with 9-14% of the total energy mix.
Electricity Potential	Around 1 million Namibians lack access to electricity- almost half of the country is without access at all (~53% has access & ~47% has no access	Demand growth at about 1%
Current Electricity Capacity	Average consumption rate is around 1677kwh/yr per capita. Its generation capacity is about 1305 GWh/year.	Average consumption is 3,591 kwh/yr per capita 54GW installed generation capacity. Access at 86.1%, , peak demand of 34.5GW
Electricity Price	**Household 0.131 $/Kwh** **No renewable price**	**Household 0.140$/kWh and Business 0.068$/kWh** **Renewable Tarrif Biomass solid 0.12 €/kWh, Biogas 0.10 €/kWh**

African Market Analysis

Barriers/Resistors	No policies, population and households structures are sparse, lack of knowledge/ exposure by people – potential infrastructure vandalization. Potential unaffordability of renewable energy power by the people. There is a supply gap, covered by importing power from South-Africa, Zambia, and Mozambique" The government of Namibia and NamPower have committed to making Namibia energy self-sufficient.	Lack of political stability and capacity, marginalization, corruption, poverty, and environmental degradation. The high initial capital required to employ renewable energy is a large constraint the sector experiences National Grid connection challenges – all connections go through the grid for now and is controlled by ESKOM All renewable energy power generators under the REFIT will require a generation licence Power Purchase Agreement (PPA) The Independent Power Producers Procurement Programme (REI4P) exists to support renewables power projects hort-to-medium and long-term targets to help set the pace of renewable energy production in place by government with a focus to increase access to electricity in rural areas because of its suitability for off-grid and small-scale solutions.

Legal and Regulatory Framework

Applicable Laws and Regulatory Institutions: WTE

Electric Power Sector Reform Act, No. 6 of 2005 ("EPSRA")

Nigerian Electricity Management Services Agency Act

Nigerian Electricity Regulatory Commission (NERC)	The regulator of the electricity industry and generally responsible for enforcement of the EPSRA and such other related or incidental matters.
Nigerian Electricity Management Services Agency (NEMSA)	Carries out electrical inspectorate services in Nigeria's electricity supply industry and ensures that all major electrical materials and equipment used in Nigeria are of the right quality and standards, among other powers
Standard Organisation of Nigeria (SON)	Issues the Mandatory Conformity Assessment Programme ("MANCAP") Certificate for all locally manufactured products in Nigeria to ensure they conform to the relevant Nigerian Industrial Standards (NIS) before being presented for sale in Nigeria or exported. Also issues the Standards Organisation of Nigeria Conformity Assessment Programme ("SONCAP") Certificate for all products imported into Nigeria. The SONCAP Certificate will be required for components or equipment imported for use in installing power systems in Nigeria.
National Office for Technology Acquisition and Promotion (NOTAP)	Registers contracts for the transfer of foreign technology to Nigerian parties as well as every agreement in connection with the use of trademarks, use of patented inventions, supply of technical expertise, the supply of basic or detailed engineering, and the supply of machinery and plant, among others

Licenses Based on WTE Technology Deployment

Tech.	Available Tech. Opitons	Recommendations	Industrial Processes	End-Products	Potential Off-takers	Possible Licences
WTE	Combustion	Option recommended based on technical	Mixed Municipal to Steam to Electricity	Electricity only	Private Distribution Company (DISCOs), Private, EKDC Transmission Company of Nigeria (TCN)	Generation licence, IEDN licence; Embedded licence, EIA approval, Building permit, Factories licence, NESREA
	Anaerobic Digestion	Option recommended based on technical	Organic waste to Biogas	Electricity	Private Distribution Company (DISCOs), Private, EKDC Transmission Company of Nigeria (TCN)	Generation or IEDN licence; Embedded licence, EIA Building Permit, Factories licence, NESREA
			Organic waste to biogas to biomethane	Transportation fuel *(Only if biogas is upgraded to Bio-methane by removing impurities)*	Downstream companies (for Fuelling stations) NNPC	EIA, Building permit, Factories licence, NESREA
				Digestate (which is a by product - used as soil nutrient)	Business that sell fertilizer (Agriculture industry)	EIA, Factories licence, Nil.
	Pyrolysis	In early market development				
	Gasification	In early market development *(Opportunity to explore this is in future*				

Licence Regime: WTE

S/N	Type of Licence	Description
1	Generation Licence	Required for electricity generation capacity (excluding captive power generation) exceeding 1 Megawatt (MW). Issued in respect of a specific site
2	Distribution Licence	Entitles the licensee to construct, own, operate and maintain a distribution system and facilities.
3	Mini-Grid Licence	Issued for integrated off-grid local generation and distribution systems with installed capacity below 1 MW. For projects below 100 Kilowatts (Kw), only a simple registration with NERC is mandatory.
4	Captive Generation Permit	Issued for generation of electricity exceeding 1 MW for the purpose of consumption by the generator, and which is not sold to a third-party. NERC's consent is required before supplying surplus power not exceeding 1MW to a third party.
5	Embeded Generation Licence	Enables the generation of electricity that is directly connected to and evacuated through a distribution system which is connected to a transmission network operated by the Transmission Company of Nigeria.
6	Independent Electricity Distribution Network Licence	Enables distribution of electricity through a network not directly connected to a transmission system and is issued where: (i) there is no existing distribution system within the geographical area to be served by the proposed IEDN; and (ii) where the infrastructure of an existing DISCO is unable to meet the demand of customers in the area.

Other Authorization or Institutions that May be Applicable: WTE

Authorization	Purpose	Issuing Authotiry
Environmental Impact Assessment (EIA) certificate	Confirms that an EIA of the mining activity have been adequately done and provisioned for. **Threshold for conduct of EIA for power projects is 10MW.**	Federal Ministry of Environment
NEMSA Certificate	Persons undertaking electrical installation work and contractors looking to engage in the business of electrical installations. The NEMSA certificate has therefore become one of the compulsory tender documents for contractors looking to bid for power projects in Nigeria.	Nigerian Electricity Management Services Agency
Building & Construction Permits	Required where construction would be carried out in relation to the Project.	Various land and physical planning agencies of various states.
Factories licence	Where any premises is occupied as a factory.	Director of Factories, Ministry of Labour
NESREA	Required for importing new electrical/electronic equipment and waste generation.	National Environmental Standards Regulation Enforcement Agency
NOTAP Registration	Required for agreements with foreign partners for technology transfer, such as, use of trademarks, patented inventions, technical/management, technological expertise, etc.	National Office for Technology Acquisition and Promotion
Import Related Permits	Where the company would import goods for use in the business.	Central Bank of Nigeria; Standards Organisation of Nigeria
Import Clearance Certificate	The importation (and clearing from the ports) of fully assembled generators, knocked-down parts imported for domestic assembling or spare parts	Nigerian Customs Service (NCS)

CBN Intervention Fund

Mini Grid Developers

Types – (i) Term Loan and (ii) Working Capital

- **Term Loan**
  - Tenor – 7 years
  - Obligor limit – Max of 70%
  - Moratorium – 2 years

- **Working Capital**
  - Obligor limit – maximum of N500 million
  - Tenor – 3 years max;
  - Interest rate – 10%
  - Eligibility – pre-qualification under World Bank Nigeria Electrification Program; Nigerian companies (min of 70%)

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