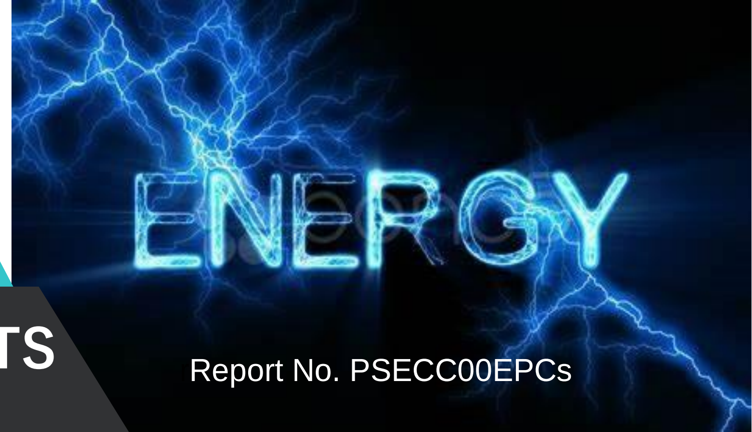
ENERGY

All PROPOSAL CONCEPTS



Report No. PSECC00EPCs

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Renewable Energy Technologies

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Date 1st March 2024


CONTRACT FACILITATION
AND
PROJECT CAPITALIZATION
THE ONE STOP FOR ENERGY
PROJECTS

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PSECC LTD

GEOTHERMAL PLANTS
PROPOSAL CONCEPT

November 2023

Prepared By: Alan Brewer MSc.

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Project No. PSECC001

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LAPSSET CORRIDOR

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Baseload Transitional Clean Energy

Net ZERO

March 2024

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National Electrification Strategy

COP28 indicated the importance of Adaption and to "Transition" into a Net Zero economy. Geothermal Plants - National Electrification Strategy: achieve universal electricity service to all households and businesses by 2022 at acceptable quality of service levels. Produce 100 000 barrels of oil per day from 2022 and develop 2,275 MW of geothermal capacity by 2030.

The use of geothermal energy, or heat contained in rocks and fluids beneath the Earth's surface, is expanding around the globe. Geothermal energy can generate a continuous supply of heat to power homes and office buildings. It can produce just one-sixth of the CO_2 emissions produced in a natural gas plant. Today, geothermal energy in Kenya has emerged as a sustainable power source and contributed to poverty-reduction throughout East Africa.

Kenya has set out ambitious targets for geothermal energy, aims to expand its geothermal power production capacity to 5,000 MW by 2030 and we support, with a medium- term target of installing 1,887 MW by 2017. Although there is significant political will and ambition, reaching these ambitious goals is a major challenge.

The Menengai Geothermal Project, in Nakuru County, has an estimated potential of 1,600 MW. The project will be developed in five (5) phases with the long-term goal of developing 465 MW of geothermal steam equivalent.

The Baringo-Silali Geothermal Project has an estimated geothermal potential of 3,000MW. The Company plans to develop 300MW in the first phase of the project, that is, Paka – 100MW, Korosi – 100MW, Silali – 100MW.

President Ruto's commitment

President William Ruto in November 9, 2022 had arrived back from Sharm El-Sheikh, Egypt where he attended the 2022 United Nations Climate Change Conference (COP27). The President called on developed nations to invest in Africa to unlock its clean energy production potential citing wind power, geothermal electricity, and solar energy.

The President signed a framework agreement for collaboration on the development of sustainable green industries in Kenya with an investor to produce 30 GW of green hydrogen in Kenya. There exists opportunities in Kenya to produce 20 GW of wind-power, 10 GW of geothermal electricity and being at the equator, considerable amounts of solar energy.

Fig 1. PSECC Targeted projects

PSECC Ltd - Phase One Railway & Economic Zones - Energy Installed & Cost Recommendations to meet Kenya Government, LCDA targets, NDC's and IPCC emission reduction.

		MW (2024 – 2028)		Cost	MW (2028 – 2035)		Cost
• expansion in geothermal	-	1,887	MW	US$ 2,830 m	3,113	MW	US$ 4,669 m
• solar PV	-	500	MW	US$ 500 m	500	MW	US$ 500 m
• solar farms	-	2,000	MW	US$ 1,770 m	1,000	MW	US$ 885 m
• solar PV Manufacturing plant	-	25	MW	US$ 10 m	50	MW	US$ 20 m
• waste plants	-	180	MW	US$ 900 m	180	MW	US$ 900 m
• wind farms	-	150	MW	US$ 328 m	350	MW	US$ 766 m
• green hydrogen	-	1,100	MW	US$ 1,432 m	1,100	MW	US$ 1,432 m
• dams – hydroelectricity	-	796	MW	US$ 796 m	500	MW	US$ 500 m
• climate smart agriculture Bio-Fuels	-	191	M Ltrs	US$ 190 m	150	M Ltrs	US$ 190 m
• Nuclear	-	-	-	- -	940	MW	US$ 4,800 m
• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

<u>PSECC Ltd propose 5000MW of Geothermal plants</u>

Leading the Way

Kenya is the leading producer of geothermal energy on the African continent and eighth in the world. The nation has helped set a valuable precedent for building green infrastructure and implementing sustainable poverty-reduction efforts. Additionally, Kenya will soon be in a position to offer other countries its geothermal equipment and expertise. KenGen intends to construct some of the first geothermal plants in neighboring countries such as Uganda and Ethiopia. Furthermore, the company has scheduled geoscientific investigations in Rwanda and the Comoros Islands. KenGen has partnered with the Kenyan government, Japan International Cooperation Agency (JICA), the World Bank and United Nations Development Programme to garner support for resource development.

Now more than ever, geothermal energy in Kenya is a promising alternative power source. Though not without its challenges, energy drawn from inside the earth promotes numerous financial and environmental advancements. In the end, geothermal energy can help Kenyans propel themselves and their neighbours down a sustainable path to economic stability.

The Prime Location

To access geothermal energy, production teams dig wells deep into reservoirs of steam and hot water. The method of access limits geothermal energy plants to locations along tectonic plates. For this reason, some have called geothermal energy “the most location-specific energy source” in the world. With an estimated geothermal potential of 10,000 megawatts, the Great Rift Valley in Kenya holds exceptional promise for clean-energy development. The Rift spans nearly 4,000 miles, extending north into Lebanon and south into Mozambique. Situated in the middle of the fault line, Kenya is in a position to harness vast stores of underground energy.

The first geothermal site opened here in 1984, in the region of Olkaria (about 150 miles from the nation’s capital, Nairobi). At the moment, Kenya is working to expand its 23 sites, only four of which contain deep wells. While geothermal power plants in Olkaria maintain a generation capacity of around 700 megawatts and can power nearby major cities, geologists hope to double their impact by 2025.

On Track to a Sustainable Future

Geothermal energy in Kenya remains vital to ensuring a sustainable future nationwide. Unlike natural gas or even solar power, geothermal energy is safe from climatic hazards. In addition, it is available year-round and is relatively low-cost after drilling. Accounting for half the power in Kenya on some days, it has alleviated the national energy shortage. Moreover, it helps provide 75% of Kenyans with access to electricity. This is a significant increase from 56% in 2016.

Kenya Electricity Generating Company (KenGen) recognizes the need to implement geothermal energy in sustainability efforts. According to Cyrus Karingithi, Head of Resource Development at KenGen, “We are too dependent on hydropower and this poses a real problem with the repetition of droughts.” Two-thirds of the power in Kenya came from dams in 2010. With the rise of geothermal energy, innovative companies like KenGen have reduced that number to less than 50% and are aiming for 28% by 2024. To achieve their goal, geologists will continue to identify new drilling areas along the fault line.

Economic Growth

Harvesting geothermal energy in Kenya provides environmental solutions, and it also stimulates economic growth. As geothermal plants create jobs and power Kenyan businesses, these operations can wield a direct influence on the fight against poverty. For instance, Oserian is one of the leading flower exporters in Kenya. Oserian relies on geothermal energy to heat greenhouses and sell 380 million flower stems each year. In addition, the company can grow new rose varieties with a 24-hour heating supply. The same geothermal plant generates power for 300,000 other small or medium-sized businesses in the area. With a fast-growing economy, Kenya is already moving toward industrialization and modernization. The nation hopes to be an upper-middle-income country within the next decade. Officials remain optimistic that geothermal energy can power burgeoning industries throughout the country.

BENEFITS GEOTHERMAL

Developing further geothermal plants in Kenya, especially in the context of the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor, can bring about various energy, environmental, and climate change mitigation benefits.
In summary, further developing geothermal plants in the LAPSSET Corridor offers a suite of benefits, aligning with goals related to sustainable development, environmental conservation, and climate change mitigation.

Here are some key advantages:

Global Climate Leadership:

As a part of global efforts to combat climate change, the expansion of geothermal energy in the LAPSSET Corridor positions Kenya as a leader in sustainable and low-carbon energy solutions, contributing to the country's international climate commitments.

Climate Resilience:

Geothermal energy is not dependent on weather conditions, making it a climate-resilient energy source. It provides a stable and continuous power supply, even during adverse weather events that may affect other renewable sources.

Clean and Renewable Energy:

Geothermal energy is a clean and renewable source of power. Developing additional geothermal plants in the LAPSSET Corridor contributes to a diversified energy mix, reducing reliance on fossil fuels and enhancing the sustainability of the energy supply.

Reduced Greenhouse Gas Emissions:

Geothermal power generation produces minimal greenhouse gas emissions compared to conventional fossil fuel-based power plants. By expanding geothermal capacity, the LAPSSET Corridor can significantly reduce carbon dioxide and other pollutant emissions, contributing to climate change mitigation.

Stable and Baseload Power Supply:

Geothermal energy provides a stable and consistent baseload power supply. Unlike some renewable sources, such as solar and wind, geothermal plants can operate continuously, providing a reliable source of electricity to meet the energy demands of the corridor.

Energy Security and Independence:

Geothermal resources are indigenous and not subject to international fuel price fluctuations. This enhances energy security and reduces dependence on imported fuels, contributing to greater energy independence for the LAPSSET Corridor.

Job Creation and Economic Development:

The development, construction, and operation of geothermal plants create employment opportunities. This can stimulate economic development in the regions along the corridor, fostering local skills and expertise in the geothermal energy sector.

Geothermal Heat Utilization:

In addition to electricity generation, geothermal resources can be used for direct applications such as district heating, industrial processes, and agricultural activities. This utilization of geothermal heat can further enhance energy efficiency and reduce reliance on other energy sources.

Reduction of Air Pollution:

Geothermal power plants produce minimal air pollutants compared to fossil fuel-based plants. The reduction in air pollution contributes to improved air quality, leading to health benefits for the communities in and around the LAPSSET Corridor.

Water Conservation:

Geothermal power plants generally have lower water consumption per unit of electricity generated compared to conventional thermal power plants. This is particularly important in regions where water scarcity is a concern.

GEOTHERMAL ENERGY IN KENYA

With an installed capacity of 863 MW, geothermal produced around 48% of all electricity supplied in Kenya in 2020/ 2021.

Within the Lapsset Corridor project we will enhance the capacity of Kenya with three more Geothermal Power plants utilising Kenyan companies. The cost of building a geothermal power plant depends on the size and location of the plant, as well as the type of technology used. The U.S. Department of Energy (DOE) estimates that a small geothermal power plant can cost between $0.5 million and $1 million per megawatt (MW), while larger plants can cost up to $2 million per MW.

CLIMATE CHANGE MITIGATION

Global Climate Leadership:

As a part of global efforts to combat climate change, the expansion of geothermal energy in the LAPSSET Corridor positions Kenya as a leader in sustainable and low-carbon energy solutions, contributing to the country's international climate commitments.

Climate Resilience:

Geothermal energy is not dependent on weather conditions, making it a climate-resilient energy source. It provides a stable and continuous power supply, even during adverse weather events that may affect other renewable sources.

The development of further geothermal plants within the LAPSSET Corridor can yield significant results in terms of climate change mitigation. Geothermal energy is considered a low-carbon and environmentally friendly energy source. The specific amount of carbon dioxide (CO_2) savings depends on several factors, including the capacity of the geothermal plants, their efficiency, and the carbon intensity of the energy sources being displaced.

Developing 5,000 MW of geothermal energy within the LAPSSET Corridor, with the assumptions mentioned, could potentially save approximately 15,768,000 tonnes of carbon dioxide annually. It's important to note that these calculations are estimates, and actual values may vary based on specific project details and local conditions.

ALIGNMENT WITH LAPSSET

The development of more geothermal plants in Kenya can align with the energy strategy of the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor in several ways. Here are key considerations for the alignment:

1. Diversification of Energy Sources: Integrating geothermal energy into the LAPSSET Corridor's energy strategy contributes to diversifying the energy mix. By relying on multiple sources, including geothermal power, the corridor can enhance energy security and resilience, reducing vulnerability to disruptions in any single energy supply.
2. Sustainability and Environmental Considerations: Geothermal energy is a clean and sustainable energy source with low greenhouse gas emissions. Its development aligns with environmental sustainability goals, contributing to the reduction of carbon footprint and air pollution. This is particularly relevant for a large-scale infrastructure project like LAPSSET, where sustainable practices are crucial.
3. Reliable Baseload Power: Geothermal power plants provide a stable and reliable baseload power supply. The continuous operation of geothermal facilities can complement intermittent renewable sources like solar and wind, ensuring a consistent and resilient energy supply for the LAPSSET Corridor.
4. Local Resource Utilization: Kenya has substantial geothermal resources, and the development of geothermal plants allows for the utilization of local resources. This contributes to regional economic development and reduces reliance on imported energy sources, aligning with the goal of maximizing the use of indigenous energy resources.

5. Economic Development and Job Creation: The development, construction, and operation of geothermal plants create job opportunities and stimulate economic growth. This aligns with broader development objectives, fostering local employment and supporting the socioeconomic development of communities along the LAPSSET Corridor.

6. Energy Independence: Geothermal energy, being a domestic resource, enhances energy independence. By incorporating geothermal power into the energy mix, the LAPSSET Corridor can reduce dependency on imported fuels and mitigate risks associated with fluctuations in global fuel prices.

7. Integration with Regional Power Grids: Geothermal power can be integrated into regional power grids, promoting connectivity and collaboration with neighbouring countries. This alignment supports the broader regional energy cooperation goals of the LAPSSET Corridor.

8. Climate Change Mitigation: Geothermal energy is a low-carbon technology, and its deployment contributes to climate change mitigation. Given the global emphasis on reducing greenhouse gas emissions, incorporating geothermal power aligns with international climate goals.

9. Long-Term Sustainability: Geothermal plants typically have long lifespans and low operating costs after initial investment. This aligns with the long-term sustainability objectives of the LAPSSET Corridor, providing a reliable and cost-effective energy source over the project's lifecycle.

10.

In summary, the development of more geothermal plants in Kenya aligns with the energy strategy of the LAPSSET Corridor by contributing to energy diversification, sustainability, economic development, and regional energy cooperation. It enhances the corridor's resilience, reduces environmental impact, and supports the achievement of long-term energy and development objectives.

TIMELINE

Following is the tentative timeline of the Geothermal programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	Five plants	1,887MW total	2024 to 2028
Phase 3:	Ten plants	3,113MW total	2028 to 2035

COST

The details of the indicative cost are provided below (dependent upon exact criteria):

Title	Cost (USD)	Installed Plant cost
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$300,000	
Phase 2. Five plants	$2 million to $4 million per MW	$3.77 Billion to $7.74 Billion
Phase 3. Ten plants	$2 million to $4 million per MW	$6.22 Billion to $12.44 Billion

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

The cost per megawatt (MW) to build geothermal plants can vary based on several factors, including project size, location, resource quality, technology advancements, and specific project requirements.

We can provide a general overview of costs per MW installed, based on historical data.

Historically the cost to build geothermal power plants has been in the range of \$2 million to \$4 million per MW for large-scale projects. It's important to note that costs can vary, and more recent data may reflect changes in technology, market conditions, and project-specific factors.

Here are some factors influencing the cost per MW for geothermal plants:

Resource Quality: The quality and temperature of the geothermal resource can impact the cost. Higher-temperature resources often require less drilling and can be more cost-effective.

Drilling Depth: The depth and complexity of drilling required to tap into the geothermal reservoir can significantly affect costs. Deeper and more complex drilling tends to increase project expenses.

Technology Advances: Advancements in geothermal technology can influence costs. Improved drilling techniques, more efficient turbines, and other technological innovations can impact project economics.

Economies of Scale: Larger projects may benefit from economies of scale, potentially reducing the cost per MW. However, large-scale projects may also face challenges related to grid integration and transmission.

Geographical Location: The location of the geothermal plant, including its proximity to existing infrastructure and the ease of transporting equipment, can impact costs.

Regulatory Environment: Regulatory requirements and permitting processes can affect project timelines and costs. Clear and streamlined regulatory frameworks may contribute to cost efficiency.

Financing Terms: The terms of project financing, including interest rates and access to international funding, can influence the overall cost of the project.

For the most accurate and up-to-date information on geothermal plant construction costs in Kenya, it is recommended to consult recent reports from relevant authorities, industry publications, or contact local energy authorities and project developers involved in geothermal projects in the region. Keep in mind that the cost landscape can change over time as technology evolves and market conditions shift.

REVENUE

PSECC Ltd calculations (to be confirmed once plant is operational and O&M considered) – indicative.

Items	Revenue (USD)
Yearly Energy Generation from 5,000MW plant (total) producing 39,420,000MWh – electricity sold at $0.05 KWh	$1.97 Billion
Government 35% share of revenue per year	$689 Million
Total Government revenue share over 20 years	$13.79 Billion

Loan repayments will then have to be made.

Full feasibility studies to determine exact amounts.

CARBON DIOXIDE SAVINGS

To estimate the potential CO_2 savings, we can use the following formula:

CO_2 Savings=Electricity Generated (in MWh)×Carbon Intensity (in kg CO_2/kWh)CO_2 Savings=Electricity

Generated (in MWh)×Carbon Intensity (in kg CO_2/kWh)

Now, let's make some assumptions for this calculation:

1. **Geothermal Capacity Factor**: Assume a conservative geothermal capacity factor of 90%. Geothermal plants typically have high-capacity factors due to their ability to operate continuously.

2. **Carbon Intensity**: Assume an average carbon intensity of 0.4 kg CO_2/kWh. This value is a general estimate and may vary based on the energy mix being displaced.

Using these assumptions, we can calculate the annual CO_2 savings for 5,000 MW of geothermal energy:

Electricity Generated=5,000 MW×0.90 capacity factor×8760 hours/year Electricity Generated=5,000MW×0.90capacity factor×8760hours/year

CO_2 Savings=Electricity Generated×0.4 kg CO_2/kWhCO_2 Savings=Electricity Generated×0.4kg CO_2/kWh

Now, let's perform the calculations:

Electricity Generated=5,000 MW×0.90×8760Electricity Generated=5,000MW×0.90×8760

Electricity Generated=39,420,000 MWh Electricity Generated=39,420,000MWh

CO_2 Savings=39,420,000 MWh×0.4 kg CO_2/kWhCO_2 Savings=39,420,000MWh×0.4kg CO_2/kWh

CO_2 Savings=15,768,000 tonnes of CO_2 Savings=15,768,000 tonnes of CO_2 a year.

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PSECC LTD

SOLAR PV FOR SEZ'S
PROPOSAL CONCEPT

November 2023

Prepared By: Alan Brewer MSc.

Project No. PSECC002

PSECC Ltd

PREPARED FOR:

Mr S. Ikua

Director General / CEO

LAPSSET CORRIDOR

Lapsset Corridor Development Authority - LCDA

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Transitional Clean Energy

Net ZERO

December 2023

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PSECC Ltd

Portsmouth Sustainable Energy &
Climate Change Centre

Solar PV installation

President Ruto’s commitment

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COP28 indicated the importance of Adaption and to “Transition” into a Net Zero economy.

Table 1. PSECC Targeted projects

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• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

<u>PSECC Ltd propose 5000MW of Geothermal plants</u>

Leading the Way

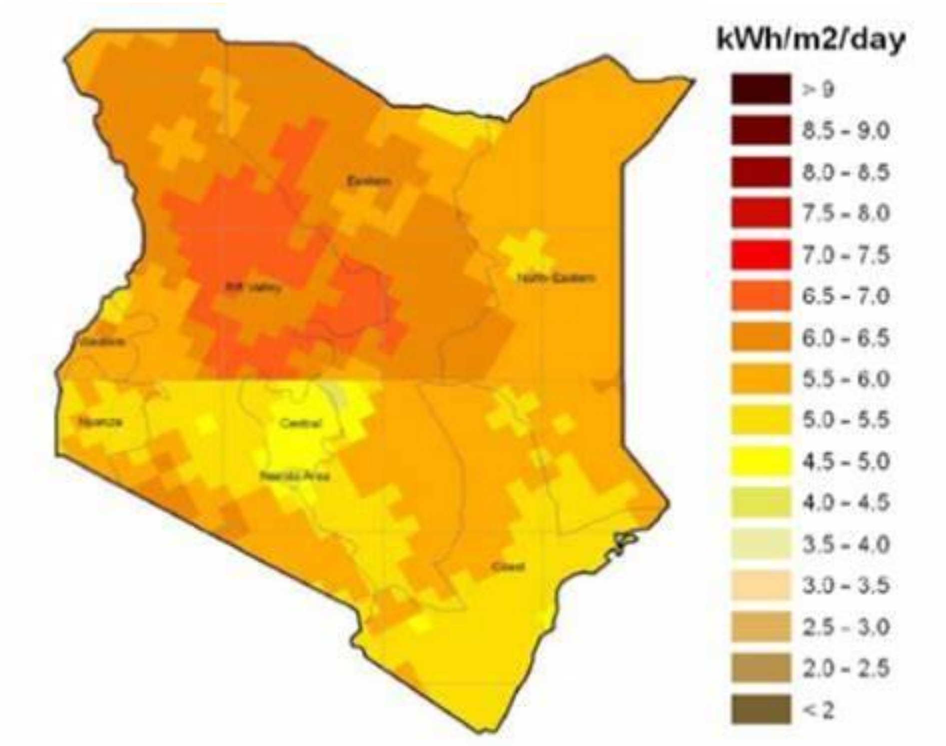
It is estimated more than 30,000 units of Solar PV panels are being sold locally every year, Kenya is ranked the biggest marketplace for home solar products in Africa.

The cost of switching to solar in Kenya has dropped significantly in the past several years. A decade ago, an average 1-kilowatt hour residential solar system could cost more than Ksh 1,000,000. Now, the outright cost of a typical home installation ranges from Ksh 300,000 to Ksh 360,000, which is a 64% average decrease.

Our PSECC Ltd / Headway USA offer will assist the National Climate Change Action Plan (NCCAP) followed in 2013 (ran to 2017), which is considered Kenya's first Action Plan on climate change. It has been developed with the aim of implementing the NCCRS. Its focus is on enabling Kenya to reduce vulnerability to climate change and to improve the country's ability to take advantage of the opportunities that climate change offers the cultivation of drought tolerant crops, water harvesting and integrated soil fertility management.

SOLAR RADIATION MAP

Fig 1. Kenya Solar Radiation Map



BENEFITS SOLAR PV

Developing further geothermal plants in Kenya, especially in the context of the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor, can bring about various energy, environmental, and climate change mitigation benefits.
In summary, further developing geothermal plants in the LAPSSET Corridor offers a suite of benefits, aligning with goals related to sustainable development, environmental conservation, and climate change mitigation.

Developing further solar PV installations within the Special Economic Zones (SEZs) in the LAPSSET Corridor in Kenya can bring about numerous benefits, encompassing economic, environmental, and social aspects. Here are key advantages:

1. **Clean and Renewable Energy:** Solar PV installations harness energy from the sun, providing a clean and renewable source of electricity. This contributes to a reduction in greenhouse gas emissions, mitigating the environmental impact of power generation.
2. **Climate Change Mitigation:** Solar PV is a low-carbon energy source, helping to mitigate climate change by reducing dependence on fossil fuels. Developing solar installations aligns with global efforts to transition to a more sustainable and climate-friendly energy system.
3. **Energy Independence:** Solar PV installations generate electricity locally, reducing dependence on imported fossil fuels. This enhances energy security and stability within the LAPSSET Corridor, promoting a more resilient energy infrastructure.
4. **Cost Savings:** Solar power can provide cost savings over the long term as sunlight is free. The initial investment in solar PV installations is often offset by lower operating and maintenance costs, leading to more predictable and stable energy expenses.
5. **Job Creation and Economic Growth:** The development, installation, and maintenance of solar PV projects create job opportunities. This can stimulate economic growth and enhance local skills and expertise in the renewable energy sector.
6. **Reduced Environmental Impact:** Solar PV has a lower environmental impact compared to conventional energy sources. It reduces air and water pollution and minimizes the ecological footprint associated with resource extraction and transportation of traditional fuels.

7. **Technological Innovation:** Investing in solar PV encourages technological innovation and research in the renewable energy sector. This can lead to advancements in solar technology, energy storage, and integration solutions.
8. **Scalability and Modularity:** Solar PV installations can be scaled up or down based on energy demand. Their modular design allows for flexibility in capacity expansion, enabling the LAPSSET Corridor to adapt to changing energy needs.
9. **Reliable Power Supply:** Solar PV can provide a reliable and stable power supply, especially in regions with abundant sunlight. It complements other energy sources and helps meet the growing energy demands of the SEZs in the corridor.
10. **Community Benefits:** Solar projects can have positive impacts on local communities by providing access to electricity and improving the overall quality of life. The LAPSSET Corridor's SEZs can benefit from enhanced energy access and reliability.
11. **Corporate Social Responsibility (CSR):** Solar PV projects demonstrate a commitment to environmental sustainability and social responsibility. They align with sustainable development goals and can enhance the overall corporate image of businesses within the SEZs.
12. **Grid Stability and Energy Resilience:** Distributed solar installations contribute to grid stability by reducing the load on centralized power generation during peak times. This enhances the overall resilience of the energy grid within the LAPSSET Corridor.

In summary, developing further solar PV installations within the LAPSSET Corridor's Special Economic Zones offers a range of economic, environmental, and social benefits. It supports the transition to cleaner energy, stimulates economic growth, and aligns with global sustainability goals.

Typical Solar PV Installation

ENERGY TRANSITION

Installing 1,000 MW of solar PV installations within the Special Economic Zones (SEZs) in the LAPSSET Corridor in Kenya contributes significantly to the energy transition by fostering a shift toward cleaner, more sustainable energy sources. Here are several ways in which this installation assists in the energy transition:

1. **Reduction of Greenhouse Gas Emissions:** Solar PV is a clean and renewable energy source that produces electricity without emitting greenhouse gases. By generating power from sunlight, the installation helps reduce the carbon footprint associated with traditional fossil fuel-based power generation, supporting the transition to a low-carbon economy.

2. **Diversification of the Energy Mix:** The introduction of a large-scale solar PV installation diversifies the energy mix within the LAPSSET Corridor. This reduces reliance on a single energy source, enhancing energy security and resilience. A diversified energy portfolio is a key aspect of a sustainable and adaptable energy system.
3. **Mitigation of Climate Change Impact:** The energy transition aims to mitigate the impact of climate change by decreasing dependence on fossil fuels. Solar PV installations contribute to this goal by providing a sustainable and climate-friendly alternative, aligning with global efforts to address environmental challenges.
4. **Promotion of Renewable Energy Integration:** Installing solar PV installations encourages the integration of renewable energy into the energy grid. As part of a broader strategy, this integration supports the transition toward a more sustainable and environmentally friendly energy system.
5. **Increased Energy Independence:** Solar power is a locally available and abundant resource. By harnessing sunlight within the LAPSSET Corridor, the solar PV installation promotes energy independence, reducing dependence on imported fossil fuels and increasing resilience to global energy market fluctuations.
6. **Job Creation and Economic Growth:** The installation and maintenance of solar PV projects create job opportunities, stimulating economic growth within the SEZs. The renewable energy sector can become a source of employment, fostering local skills and expertise.
7. **Technological Advancements:** Investment in solar PV projects encourages technological advancements and innovation in the renewable energy sector. This can lead to improvements in solar technology, energy storage, and grid integration, contributing to the overall development of the clean energy industry.
8. **Community and Social Benefits:** Access to reliable and clean electricity enhances the quality of life for communities within the SEZs. The energy transition focuses on ensuring equitable access to sustainable energy, positively impacting local populations and promoting social development.
9. **Alignment with Sustainable Development Goals (SDGs):** The installation of solar PV aligns with various Sustainable Development Goals, including those related to affordable and clean energy (SDG 7), climate action (SDG 13), and sustainable cities and communities (SDG 11).

10. **Grid Stability and Resilience:** Distributed solar installations contribute to grid stability and resilience by reducing dependence on centralized power generation during peak times. This enhances the overall reliability of the energy grid within the LAPSSET Corridor.
11.

In summary, installing 1,000 MW of solar PV within the Special Economic Zones in the LAPSSET Corridor is a pivotal step in the energy transition, promoting sustainability, reducing environmental impact, and contributing to broader socioeconomic development goals.

CLIMATE CHANGE MITIGATION

Climate change is not a distant threat, it is happening now and it is hitting vulnerable communities the hardest. In Kenya, we are already seeing the effects of rising temperatures and unpredictable weather patterns, with devastating consequences for farmers, herders, and those living in coastal areas. We must take urgent action to mitigate and adapt to the impacts of climate change, or risk leaving these communities even more vulnerable.

Therefore, a 1,000 MW solar PV installation in the Special Economic Zones of the LAPSSET Corridor in Kenya, assuming a radiation level of 6 kWh/m²/day, a capacity factor of 20%, and operating 8 hours per day, could produce approximately 35,040,000 megawatt-hours (MWh) of electricity annually.

Installing 1,000 MW of solar PV installations within the Special Economic Zones (SEZs) in the LAPSSET Corridor in Kenya contributes significantly to climate change mitigation through various mechanisms.

Here are the key ways in which this installation assists in mitigating climate change:

1. **Reduction of Greenhouse Gas Emissions:** Solar PV installations generate electricity without emitting greenhouse gases such as carbon dioxide (CO2) during operation. By displacing electricity generation from fossil fuel sources, solar PV helps reduce the overall carbon footprint associated with power production.
2. **Transition to Low-Carbon Energy:** The deployment of solar PV aligns with the transition to a low-carbon energy system. As a renewable energy source, solar power mitigates the reliance on fossil fuels, which are major contributors to greenhouse gas emissions and climate change.
3. **Avoided Fossil Fuel Combustion:** The 1,000 MW of solar PV installations would displace the need for electricity generated from conventional fossil fuel power plants. This avoids the release of large amounts of CO2 and other pollutants that result from burning coal, oil, or natural gas.

4. **Carbon Intensity Reduction:** Solar PV systems have a low carbon intensity compared to traditional fossil fuel-based power generation. The energy generated from solar panels contributes to a reduction in the overall carbon intensity of the electricity consumed within the SEZs.
5. **Environmental Sustainability:** Solar PV installations support environmental sustainability by providing a clean and renewable energy source. This aligns with global efforts to transition to sustainable energy systems that minimize environmental impact and support climate resilience.
6. **Positive Climate Action:** Implementing solar PV projects represents a concrete action toward addressing climate change. It supports the global commitment to limit temperature increases and mitigate the adverse effects of climate change, as outlined in international agreements such as the Paris Agreement.
7. **Renewable Energy Integration:** The solar PV installations contribute to the integration of renewable energy into the energy mix. This diversification helps build a more resilient energy infrastructure and reduces the dependency on fossil fuels, further supporting climate change mitigation goals.
8. **Adaptation to Climate Change:** A shift to renewable energy sources, such as solar power, contributes to climate change adaptation by reducing the vulnerability of energy systems to the impacts of climate change. It enhances the resilience of the energy infrastructure within the LAPSSET Corridor.
9. **Global Leadership and Commitment:** The installation of significant solar capacity demonstrates a commitment to global climate goals. It positions the LAPSSET Corridor and Kenya as leaders in sustainable development, contributing to the global effort to limit temperature increases and address climate challenges.
10. **Community and Ecosystem Benefits:** The reduced emissions from solar PV installations contribute to improved air and water quality, benefiting local communities and ecosystems. The avoidance of pollutants associated with fossil fuel combustion supports both human and environmental health.

In summary, the installation of 1,000 MW of solar PV within the Special Economic Zones in the LAPSSET Corridor actively contributes to climate change mitigation by reducing greenhouse gas emissions, promoting sustainable energy practices, and aligning with global climate action objectives.

ALIGNMENT WITH LAPSSET

The development of more solar PV installations on rooftops within the Special Economic Zones (SEZs) in Kenya can align with the energy strategy of the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor in several ways:

1. **Distributed Generation:** Rooftop solar PV installations contribute to distributed generation, where electricity is generated closer to the point of consumption. This can enhance energy resilience and reduce the need for extensive transmission infrastructure.
2. **Renewable Energy Integration:** Incorporating rooftop solar aligns with the integration of renewable energy into the energy mix. Solar power, being a clean and abundant resource, can complement other energy sources and contribute to a more sustainable and environmentally friendly energy strategy.
3. **Reduced Reliance on Grid Power:** Solar PV installations on rooftops can provide on-site power generation, reducing the reliance on grid-supplied electricity. This can be particularly beneficial in remote or off-grid areas within the LAPSSET Corridor, improving energy access and reliability.

4. **Energy Cost Savings:** Solar power generated on rooftops can lead to cost savings on electricity bills for businesses and industries within the SEZs. This can contribute to the economic viability of businesses and stimulate investment within the corridor.

5. **Local Economic Development:** The development of rooftop solar installations can stimulate local economic development. This includes job creation during the installation and maintenance phases and the development of local expertise in solar technology.

6. **Technological Innovation and Research**: Encouraging the deployment of solar PV on rooftops fosters technological innovation and research in the

renewable energy sector. This can lead to advancements in solar technology, energy storage solutions, and energy management systems.

7. **Carbon Emission Reduction:** Solar power is a low-carbon energy source. By increasing the deployment of rooftop solar, the LAPSSET Corridor can contribute to carbon emission reduction goals, aligning with global efforts to mitigate climate change.

8. **Grid Stability and Resilience:** Rooftop solar installations can enhance grid stability by reducing the demand for centralized electricity during peak times. This distributed generation approach contributes to a more resilient and adaptive energy infrastructure.

9. **Community Engagement:** Involving local communities in the development and ownership of rooftop solar installations can enhance community engagement. This participatory approach aligns with sustainable development practices and promotes social acceptance of renewable energy projects.

10. **Integration with Energy Efficiency Measures:** The development of rooftop solar can be coupled with energy efficiency measures within the SEZs. This holistic approach maximizes the overall energy efficiency of the facilities and supports sustainable practices.

It's important to note that the successful integration of rooftop solar within the SEZs will depend on various factors, including supportive policies, financing mechanisms, and the engagement of stakeholders. A well-designed and implemented strategy for rooftop solar deployment can contribute significantly to the overall success of the LAPSSET Corridor's energy goals.

TIMELINE

Following is the tentative timeline of the Solar PV programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	SEZ 1	333MW total	2024 to 2028
Phase 3:	SEZ 2	333MW total	2028 to 2030
Phase 4:	SEZ 3	333MW total	2030 to 2032

COST

The details of the indicative cost are provided below (dependent upon exact criteria):

Title	Solar PV Cost (USD)	Installed Plant cost
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$250,000	
Phase 2. SEZ 1	$1 million to $2.5 million per MW	$333 million to $666 Million
Phase 3. SEZ 2	$1 million to $2.5 million per MW	$333 Million to $666 Million
Phase 4. SEZ 3		$333 Million to $666 Million
Total	1,000MW	$1 Billion to $2.5 Billion

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

The cost per megawatt (MW) for installing solar photovoltaic (PV) panels can vary based on numerous factors, including project size, location, technology choice, site-specific conditions, labor costs, and other project-specific considerations.

We do not have the most current data on specific costs for solar PV installations in the LAPSSET Corridor.

However, as a general reference, the cost per MW for utility-scale solar PV projects has been decreasing in recent years and can range anywhere from $1 million to $2.5 million or more, depending on the factors mentioned above.

To estimate the total cost for installing 333 MW of solar PV panels, you can use the following formula:

Total Cost=Installed Capacity (MW)×Cost per MWTotal Cost=Installed Capacity (MW)×Cost per MW

Assuming a cost range of $1 million to $2.5 million per MW, let's calculate the total cost for both ends of the range:

1. **Lower Bound (Assuming $1 million per MW):** \text{Total Cost} = 333{MW} x $1,000,000/\text{MW}
2.
3. **Upper Bound (Assuming $2.5 million per MW):** \text{Total Cost} = 333 {MW} x $2,500,000/\text{MW}
4.

This would give you the cost estimate for installing 333 MW of solar PV panels in the LAPSSET Corridor within the specified cost range.

Please note that these figures are general estimates, and actual costs for specific projects may vary. For the most accurate and up-to-date information, it's recommended to consult recent project proposals, industry reports, or reach out to relevant authorities or project developers involved in solar PV projects in the LAPSSET Corridor.

REVENUE

PSECC Ltd calculations (to be confirmed once plant is operational and O&M considered) – indicative.

Items Solar PV Installations	Revenue (USD)
Yearly Energy Generation from 1,000MW solar PV installations (total) producing 35,040,000 MWh – electricity sold at $0.05 KWh	$1.752 Billion
Government 35% share of revenue per year	$613 Million
Total Government revenue share over 20 years	$12.26 Billion

Loan repayments will then have to be made.

Full feasibility studies to determine exact amounts.

To calculate the annual energy production from a solar photovoltaic (PV) installation with specific operating conditions, you can use the following formula:

Annual Energy Production (kWh)=Installed Capacity (MW)×Solar Radiation (kWh/m2/day)×Capacity Factor×Hours of Operation per Day×Days in a YearAnnual Energy Production (kWh)=Installed Capacity (MW)×Solar Radiation (kWh/m2/day)×Capacity Factor×Hours of Operation per Day×Days in a Year

Given the information provided:

- Installed Capacity = 1,000 MW
- Solar Radiation = 6 kWh/m²/day
- Capacity Factor (assumed) = 20%
- Hours of Operation per Day = 8 hours
- Days in a Year = 365 days

Now, let's plug in these values:

Annual Energy Production=1,000 MW×6 kWh/m2/day×0.20×8 hours/day×365 days/yearAnnual Energy Production=1,000MW×6kWh/m2/day×0.20×8hours/day×365days/year

Annual Energy Production=1,000 MW×6 kWh/m2/day×0.20×2,920 hours/yearAnnual Energy Production=1,000MW×6kWh/m2/day×0.20×2,920hours/year

Annual Energy Production=35,040,000 MWh

Therefore, a 1,000 MW solar PV installation in the Special Economic Zones of the LAPSSET Corridor in Kenya, assuming a radiation level of 6 $kWh/m^2/day$, a capacity factor of 20%, and operating 8 hours per day, could produce approximately 35,040,000 megawatt-hours (MWh) of electricity annually.

CARBON DIOXIDE SAVINGS

To calculate the carbon dioxide savings per year from a 1,000MW solar PV installation, you can use the following formula:

CO_2 Savings=Electricity Generated (MWh)×Carbon Intensity (kg CO_2/kWh)CO_2 Savings=Electricity Generated (MWh)×Carbon Intensity (kg CO_2/kWh)

Given the information:

- Electricity Generated = 35,040,000 MWh
- Carbon Intensity (assumed) = 0.4 kg CO_2/kWh

Plug in the values:

CO_2 Savings=35,040,000 MWh×0.4 kg CO_2/kWhCO2 Savings=35,040,000MWh×0.4kg CO_2/kWhCO2 Savings=14,016,000 tonnes of CO_2 Savings=14,016,000tonnes of CO_2.

Therefore, the estimated carbon dioxide savings per year from the 35,040,000 MWh of electricity generated by the solar PV installation in the Special Economic Zones within the LAPSSET Corridor in Kenya, assuming a carbon intensity of 0.4 kg CO_2/kWh, would be approximately 14,016,000 tonnes of CO_2. This represents the amount of carbon dioxide emissions that would have been released if the same amount of electricity were generated from a conventional fossil fuel-based power source.

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Solar Farms Project Concept REPORT

Project No. PSECC003
December 2023

PSECC Ltd
Portsmouth Sustainable Energy & Climate Change Centre

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Project Concept Report

The LAPSSET Corridor

Traversing nine counties, namely; Lamu, Garissa, Isiolo, Meru, Laikipia Baringo, Samburu, Marsabit and Turkana.

At the regional level, the core participating countries are the Republic of Kenya, Federal Democratic Republic of Ethiopia and Republic of South Sudan. The program will create a second strategic corridor to the land locked neighbouring countries of Ethiopia and South Sudan.

Project Objectives

Among others, the project will entail the following:

(vii) A port at Manda Bay, Lamu;
(viii) A standard gauge railway line to Juba in South Sudan and Addis Ababa in Ethiopia;
(ix) Road network; (iv) Oil pipelines (Southern Sudan and Ethiopia);
(x) An oil refinery at Bargoni, Kenya;
(xi) Three airports; and
(xii) Three resort cities.

COP28 indicated the importance of Adaption and to “Transition” into a Net Zero economy. The planned investment resources are equivalent to half of Kenya’s GDP (core investment). In fact, conservative feasibility statistics show that the project will inject between 2% to 3% of GDP into the economy.

The LAPSSET Corridor Project will make a tremendous contribution into Kenya's economic growth, with projections ranging between 8% and 10% of GDP. The project components are spread over a large part of Kenya and will open up the northern parts of the country, and relieve strain on the Mombasa Port.

Bring the entire land mass traversed by the LAPSSET Corridor into active economic activities will provide the country with ample and multiple revenue generating activities, create employment and contribute to economic growth. Solar Farms can assist that goal.

The program will also position the country strategically as a trade and logistics hub by serving the lower parts of Ethiopia and South Sudan and giving access an efficient transport network to over 100 million people. It will also link with the Northern Corridor via a link from Isiolo to Nairobi and therefore help to ease business for the regional countries of Uganda, Rwanda, Burundi and Democratic Republic of Congo.

President Ruto's commitment

President William Ruto in November 9, 2022, had arrived back from Sharm El-Sheikh, Egypt where he attended the 2022 United Nations Climate Change Conference (COP27). The President called on developed nations to invest in Africa to unlock its clean energy production potential citing wind power, geothermal electricity, and solar energy.

The President signed a framework agreement for collaboration on the development of sustainable green industries in Kenya with an investor to produce 30 GW of green hydrogen in Kenya. There exists opportunities in Kenya to produce 20 GW of wind-power, 10 GW of geothermal electricity and being at the equator, considerable amounts of solar energy.

Kenya is well known for its abundant geothermal and Hydroelectricity energy. However, it also has huge potential for solar and wind exploitation. That's why the government aims to have 600 MW of solar power generation capacity installed by 2030, up from less than 100 MW currently installed (South Africa's largest solar project alone is almost 100 MW). It is expected that this number will increase with to 5,000MW with many projects in the pipeline.

This is a Solar Farm Review – a Detailed Technical offer will follow on these Renewable Energy technology mitigation measures:

• Solar Farms provide power to the Green hydrogen plans and could be a critical enabler of the global transition to sustainable energy and net zero emissions economies.

• There is unprecedented momentum around the world to fulfil Solar and hydrogen's longstanding potential as a clean energy solution.

Solar Farms and especially Hydrogen is emerging as one of the leading options for storing energy from renewables with hydrogen-based fuels potentially transporting energy from renewables over long distances – from regions with abundant energy resources, to energy-hungry areas thousands of kilometers away.

The Solar Farm and Green Hydrogen Strategy and Roadmap for Kenya has been developed, Hydrogen strategy by the European Union Global Technical Assistance Facility (GTAF) for Sustainable Energy, in close cooperation with the Delegation of the European Union to Kenya (EU), the Ministry of Energy and Petroleum (MoEP) for Kenya.

PSECC Ltd - Phase One Railway & Economic Zones - Energy Installed & Cost Recommendations to meet Kenya Government, LCDA targets, NDC's and IPCC emission reduction.

		MW (2024 – 2028)		Cost	MW (2028 – 2035)		Cost
• expansion in geothermal	-	1,887	MW	US$ 2,830 m	3,113	MW	US$ 4,669 m
• solar PV	-	500	MW	US$ 500 m	500	MW	US$ 500 m
• solar farms	-	2,000	MW	US$ 1,770 m	1,000	MW	US$ 885 m
• solar PV Manufacturing plant	-	25	MW	US$ 10 m	50	MW	US$ 20 m
• waste plants	-	180	MW	US$ 900 m	180	MW	US$ 900 m
• wind farms	-	150	MW	US$ 328 m	350	MW	US$ 766 m
• green hydrogen	-	1,100	MW	US$ 1,432 m	1,100	MW	US$ 1,432 m
• dams – hydroelectricity	-	796	MW	US$ 796 m	500	MW	US$ 500 m
• climate smart agriculture Bio-Fuels	-	191	M Ltrs	US$ 190 m	150	M Ltrs	US$ 190 m
• Nuclear	-	-	-	- -	940	MW	US$ 4,800 m
• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

We can offer twenty 50MW solar farms totaling 1,000 MW, one for every 20 miles of the Lapsset Corridor or by having ten larger 300MW solar farms for SEZ's totaling 3,000MW. Solar PV panel Manufacturing plants can be provided for Solar PV panels for each solar farm at the same price or lower than those normally imported from China. This lower panel cost makes it possible to build a solar farm at a cost of USD 660 to 800,00 per MWh.

The Renewable Electricity Energy can provide power to SEZ's and for Green hydrogen production, which is defined as hydrogen produced by splitting water into hydrogen and oxygen using renewable electricity.

As we have seen Kenya presents itself as highly vulnerable to climate change effects – this is a major problem and this problem can be resolved, mitigated, lead to sustainable growth, 1,000's of jobs created and we aim to indicate just how that can be done and provide the funding to achieve an enhanced Solar Farm and Green Hydrogen Energy program for the Lapsset Corridor.

Fig 1. Kenya Solar Resource

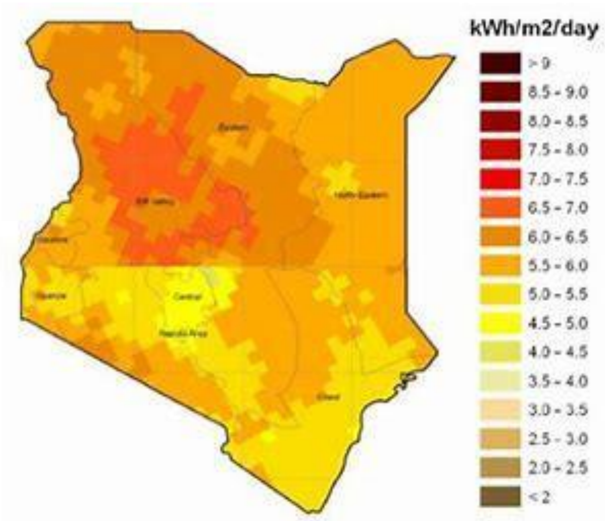
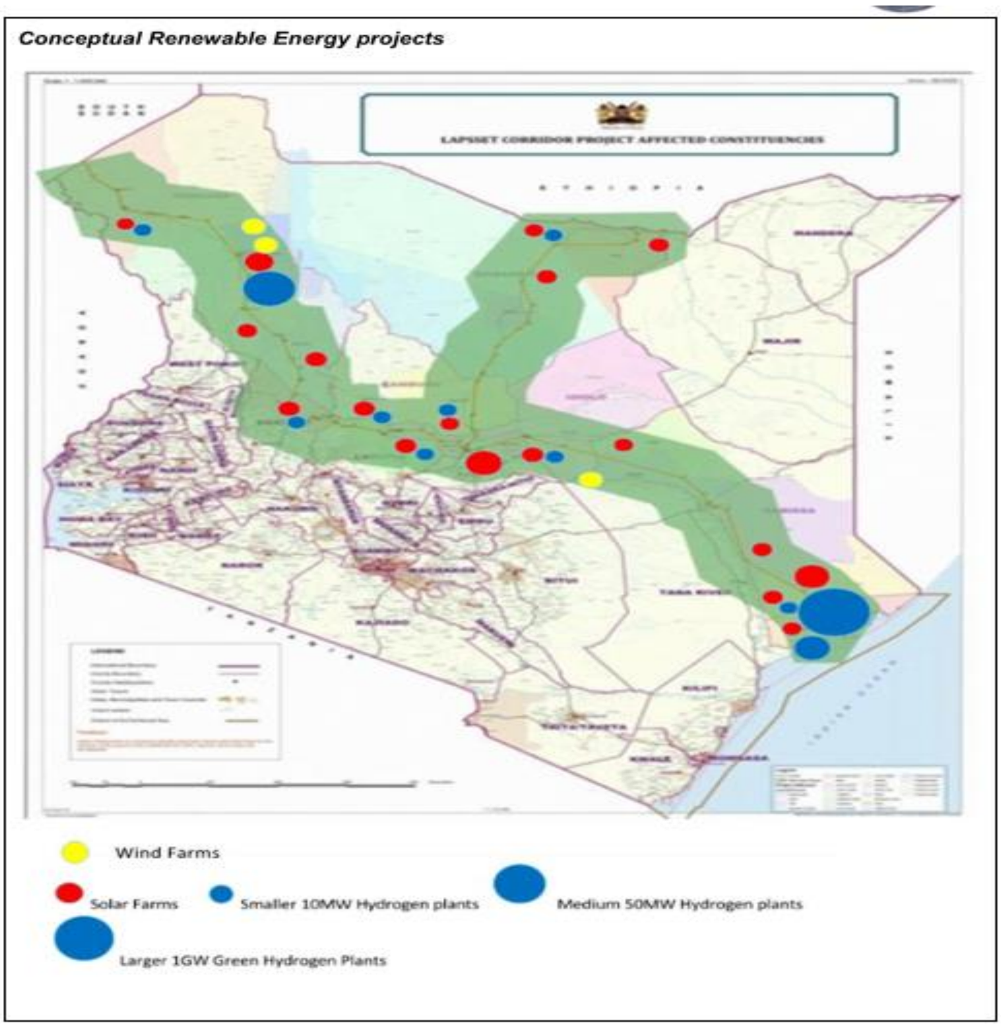


Fig 2. Renewable Energy technology deployment for Lapsset Corridor



Solar Farms already built in Kenya

Tables 1. 10 largest solar projects in Kenya

	Garissa	Malindi	Keesses 1	Kopere	Eldosol	Radiant	Rumuruti	Nakuru	WITU	Makindu
Size (Megawatts-peak)	54.7 MW	52 MW	52 MW	50 MW	48 MW	48 MW	40 MW	40 MW	40 MW	33 MW
Location	Garissa County	Kilifi County	Uasin Gishu County	Nandi County	Uasin Gishu County	Uasin Gishu County	Laikipia County	Nakuru County	Lamu County	Makueni County
Construction Start	May 2017	June 2019	December 2018	December 2019	Q1 2019	Q1 2019	Under development.	Under development	Under development	Under development
Operation Start	November 2018	Under Construction	Under Construction	Under Construction	Constructed – awaiting commissioning.	Constructed – awaiting commissioning.	Unknown	Unknown	Unknown	Unknown
Developer/ Sponsor (s)	Rural Electrification Authority (REA)	Globeleq	Alten Africa	Kopere Solar Park Ltd.	Selenkei Investment Ltd.	Selenkei Investment Ltd	Rumuruti Solar Generation Holding	Astonfield Sosian Solar Ltd.	Kenya Solar Energy Ltd.	responsAbility Renewable Energy Holding (rAREH)
Owner	REA	Malindi Solar Group Ltd.	Alten Africa	Voltalia	Selenkei Investment Ltd.	Selenkei Investment Ltd	Rumuruti Solar Generation Holding	Sosian Energy Ltd.	Kenya Solar Energy Ltd. (Kensen)	rAREH Icon Solar Ltd.
Offtaker	KPLC	KPLC	KPLC	KPLC	KPLC	KPLC	KPLC	KPLC	KPLC	KPLC
PPA	25 years	20 years	20 years	20 years	20 years	20 years	20 years	Advanced Negotiations	Negotiations	20 years
PPA Price per kWh	US$0.12	Unknown	US$0.12	US$0.08	US$0.12	US$0.12	US$0.08	Unknown	Unknown	Unknown

ENERGY TRANSITION

An energy transition for the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor project in Kenya would involve a shift from conventional, often fossil fuel-based energy sources to more sustainable and environmentally friendly alternatives. Here are key components that could be included in an energy transition strategy for the LAPSSET Corridor:

Renewable Energy Integration:
Prioritize the integration of renewable energy sources such as solar, wind, and hydroelectric power into the energy mix for the corridor. This can involve the installation of solar farms, wind turbines, and other renewable energy infrastructure to generate clean and sustainable power.

Green Hydrogen Production:
Explore the potential for green hydrogen production along the corridor, using renewable energy sources for electrolysis. Green hydrogen can be used as a clean fuel for transportation and industrial activities, contributing to reduced carbon emissions.

Electrification of Transportation:
Promote the electrification of transportation within the corridor, especially the Railway. This can involve the use of electric vehicles (EVs), electric buses, and electric rail transport. Establish charging infrastructure and support the adoption of electric vehicles to reduce reliance on conventional fossil fuel-powered transport.

Energy Storage Solutions:
Implement energy storage solutions, such as battery storage systems, to store excess energy generated during peak times and release it during periods of high demand. This helps in stabilizing the energy supply and ensuring a reliable power grid.

Energy Efficiency Measures:
Implement energy efficiency measures across the corridor, including the use of energy-efficient technologies in buildings, transportation, and industrial processes. This can reduce overall energy consumption and enhance the sustainability of the project.

Community Engagement and Capacity Building:
Engage local communities in the energy transition process and provide capacity-building initiatives. This can include training programs for local residents on renewable energy technologies and creating opportunities for local employment in the renewable energy sector.

Regulatory and Policy Support:
Develop and implement supportive policies and regulations that encourage the transition to clean energy within the corridor. This may involve providing incentives for renewable energy projects, setting emissions reduction targets, and establishing regulatory frameworks that support sustainable practices.

International Collaboration:
Seek international collaboration and partnerships for technical expertise, funding, and knowledge exchange. Engage with international organizations, governments, and financial institutions to leverage support for the energy transition within the LAPSSET Corridor.

Research and Innovation:
Support research and innovation in clean energy technologies. Encourage the development and deployment of innovative solutions that can enhance the efficiency and sustainability of energy infrastructure along the corridor.

Monitoring and Evaluation:
Establish mechanisms for monitoring and evaluating the progress of the energy transition. Regularly assess the impact of the implemented measures on energy efficiency, emissions reduction, and overall sustainability, and make adjustments as needed. By incorporating these elements into an energy transition plan, the LAPSSET Corridor project can contribute to Kenya's sustainable development goals, reduce environmental impacts, and enhance the resilience and longevity of the infrastructure.

Solar farms play a significant role in climate change mitigation and are aligned with strategies like the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor in several ways. Here are some benefits of solar farms in the context of climate change mitigation:

Renewable Energy Generation:

Solar farms harness sunlight to generate electricity, providing a clean and renewable energy source. This reduces dependence on fossil fuels, which are major contributors to greenhouse gas emissions responsible for climate change.

Greenhouse Gas Emission Reduction:

Solar energy production is associated with minimal greenhouse gas emissions compared to conventional fossil fuel-based power generation. The use of solar power helps decrease the overall carbon footprint, mitigating the impacts of climate change.

Air and Water Quality Improvement:

Unlike traditional power plants, solar farms do not release pollutants into the air or water during operation. This improves air quality and reduces water pollution, positively impacting the environment and public health.

Mitigation of Climate Change Impacts:

By reducing reliance on fossil fuels, solar farms contribute to slowing down climate change. This, in turn, helps mitigate the adverse impacts of climate change, such as rising temperatures, sea level rise, extreme weather events, and disruptions to ecosystems.

Job Creation and Economic Development:

The development and maintenance of solar farms create jobs, contributing to economic development in the regions where these projects are implemented. This aligns with broader sustainable development goals, including poverty reduction and increased employment opportunities.

Diversification of Energy Sources:

Solar farms contribute to a more diversified energy mix, reducing vulnerability to energy supply disruptions and price fluctuations associated with fossil fuels. This enhances energy security and resilience, aligning with strategies focused on sustainable and reliable energy sources.

ALIGNMENT WITH LAPSSET

Regarding the LAPSSET Corridor strategy, it is important to note that the LAPSSET Corridor is a regional infrastructure project in East Africa, aiming to connect the landlocked countries of South Sudan and Ethiopia to the Kenyan coast. While the primary focus of LAPSSET is on transport infrastructure (such as roads, railways, and pipelines), integrating renewable energy sources like solar farms along the corridor aligns with broader sustainable development goals and can enhance the overall environmental sustainability of the project.

The use of clean energy in the corridor can contribute to reducing the environmental impact of transportation and other activities associated with the development of the corridor. Integrating sustainable practices, including renewable energy, can help ensure that infrastructure development is aligned with global efforts to address climate change and promote environmental sustainability.

The implementation of solar farms in the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor project in Kenya can bring about numerous benefits. Here are some key advantages of incorporating solar farms into the corridor:

1. **Clean and Renewable Energy:** Solar farms generate electricity using sunlight, a clean and renewable energy source. This helps reduce dependence on fossil fuels, contributing to a more sustainable and environmentally friendly energy mix.
2. **Reduced Greenhouse Gas Emissions:** Solar energy is a low-emission energy source. By utilizing solar power in the LAPSSET Corridor, the project can significantly reduce greenhouse gas emissions compared to traditional fossil fuel-based power generation, helping combat climate change.
3. **Energy Independence:** Solar energy provides a degree of energy independence by harnessing a local and abundant resource—sunlight. This reduces reliance on imported fuels and enhances the resilience of the energy infrastructure along the corridor.
4. **Cost Savings and Long-Term Stability:** While there may be initial investment costs, solar farms offer long-term cost savings as sunlight is free. The stable and predictable nature of solar power generation contributes to the stability of energy costs over the project's lifespan.
5. **Job Creation and Economic Development:** The development, construction, and maintenance of solar farms create job opportunities. This can stimulate economic development in the regions along the LAPSSET Corridor, providing employment and fostering local skills and expertise in the renewable energy sector.
6. **Diversification of Energy Sources:** Solar farms contribute to diversifying the energy sources within the corridor. A diversified energy mix enhances energy security and reduces vulnerability to supply disruptions or price fluctuations associated with a single energy source.
7. **Scalability and Modular Design:** Solar farms are scalable and can be designed in a modular fashion, allowing for flexibility in capacity expansion based on the energy demand of the corridor. This adaptability is beneficial for accommodating future growth and changes in energy needs.
8. **Reduced Transmission Losses:** Locally generated solar power can reduce the need for long-distance transmission of electricity, minimizing energy losses during transportation. This improves overall energy efficiency and grid reliability.

9. **Environmental Conservation:** Solar farms have a relatively low environmental impact compared to some other forms of energy generation. They do not involve fuel extraction, and their operation has minimal air and water pollution, preserving local ecosystems.
10. **Alignment with Sustainability Goals:** Integrating solar farms aligns with global and national sustainability goals. Kenya has set ambitious targets for increasing the share of renewable energy in its energy mix, and solar power can play a crucial role in achieving these goals.
11. **Technological Innovation and Research:** Implementing solar farms encourages technological innovation and research in the renewable energy sector. This can lead to advancements in solar technology and the development of more efficient and cost-effective solutions.

In summary, solar farms can provide a range of economic, environmental, and social benefits to the LAPSSET Corridor project in Kenya, contributing to its overall sustainability and resilience.

Green hydrogen (H2) is a versatile energy carrier that can be applied to decarbonize a wide range of sectors. It can be used directly or in the form of its derivatives like e-methanol, e-ammonia, or e-fuels to replace fossil fuels, coal or gas.

The following is the targeted strategic objectives for Green Hydrogen in Kenya.

<u>PSECC Ltd propose 2,200MW of Green Hydrogen – Eight plants in total</u>

Only around 40% of global carbon dioxide (CO2) emissions originate from power generation which can be decarbonized via electrification. The other 60% of CO2 emissions originate from industry, mobility, buildings and others. These can be decarbonized via sector coupling, using green hydrogen and its derivatives to make renewable energy available to those sectors. This is why the production of sustainable hydrogen is such a crucial issue and so too are Solar Farm developments.

Green hydrogen, produced through renewable energy sources like wind or solar power, can offer several benefits to the LAPSSET Corridor.

Clean Energy for Transportation:

Green hydrogen can be used as a clean fuel for various modes of transportation within the LAPSSET Corridor, such as trucks, trains, and ships. This can help reduce the carbon footprint of transportation activities associated with the corridor, contributing to sustainability goals.

Renewable Energy Integration:

Green hydrogen production can serve as a way to store excess energy generated from intermittent renewable sources like solar and wind. During periods of high renewable energy production, surplus electricity can be used for electrolysis to produce hydrogen, which can be stored and later used as a reliable energy source when renewable generation is low.

Energy Storage and Grid Balancing:

Hydrogen can be used as a form of energy storage, providing a means to store excess energy generated during peak times and release it when demand is high or renewable energy generation is low. This helps in balancing the electricity grid and ensuring a stable and reliable power supply along the corridor.

Decentralized Power Generation:

Green hydrogen production facilities can be distributed along the corridor, providing decentralized power generation. This can enhance energy resilience and reduce transmission losses associated with centralized power plants.

Job Creation and Economic Development:

The establishment of green hydrogen infrastructure, including production facilities and distribution networks, can create job opportunities and stimulate economic development in the regions along the LAPSSET Corridor.

Environmental Sustainability:

Green hydrogen production is a clean and sustainable process when powered by renewable energy sources. Using green hydrogen in transportation and industrial activities along the corridor can significantly reduce greenhouse gas emissions, contributing to environmental sustainability goals.

Technology Transfer and Innovation:

Implementing green hydrogen infrastructure within the LAPSSET Corridor can facilitate technology transfer and innovation. This can lead to the development of local expertise in renewable energy and hydrogen technologies, fostering a culture of innovation and sustainability.

International Cooperation and Funding Opportunities:

As the global community places increasing emphasis on reducing carbon emissions, projects incorporating green hydrogen can attract international cooperation and funding support. The LAPSSET Corridor, by adopting green hydrogen technologies, may become eligible for financial support and partnerships focused on sustainable development.

In summary, the adoption of green hydrogen within the LAPSSET Corridor can bring about environmental, economic, and technological benefits, contributing to the overall sustainability and resilience of the infrastructure project.

TIMELINE

Table 2.

Following is the tentative timeline of the Solar Farm program, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	Five Solar Farms	1,500MW	2024 to 2026
Phase 3:	Five Solar Farms	1,500MW	2026 to 2028

COST

Table 3. The details of the indicative cost are provided below (dependent upon exact criteria):

Title 3,000MW of Solar Farms	Cost (USD)	MWh per year
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$300,000	
Phase 2. Five 300MW Solar Farms	$265.5 Million	Approximately 2.628 Million
Phase 3. Five 300MW Solar Farms	$265.5 Million	Approximately 2.628 Million

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

REVENUE

Table 4. PSECC Ltd calculations (to be confirmed once plant is operational and O&M considered) – indicative.

Items	Revenue (USD)
Annual generation of electricity from 3,000MW of solar farms will generate 5,256,000MWh and electricity sold at $0.05KWh	$262.80 Million
Government 35% share of revenue per year	$91.98 Million
Total Government revenue share over 20 years	$11.839 Billion

Loan repayments will then have to be made.

The annual generation of electricity from a solar farm depends on various factors, including the solar farm's capacity factor, which represents the actual electricity output as a percentage of its maximum potential output. Additionally, solar irradiance, which is the amount of sunlight the area receives, plays a crucial role.

Assuming a conservative capacity factor of 20%, which is typical for utility-scale solar farms, we can estimate the annual electricity generation using the formula:

Annual Electricity Generation (in MWh)=Capacity (in MW)×Capacity Factor×Hours in a YearAnnual Electricity Generation (in MWh)=Capacity (in MW)×Capacity Factor×Hours in a Year

Let's calculate it for a 3000 MW solar farm:

Annual Electricity Generation=3000 MW×0.20×8760 hours/yearAnnual Electricity Generation=3000MW×0.20×8760hours/year

Annual Electricity Generation=5,256,000 MWhAnnual Electricity Generation=5,256,000MWh

So, a 3000 MW solar farm with a 20% capacity factor could generate approximately 5,256,000 megawatt-hours (MWh) of electricity annually. Keep in mind that this is a simplified estimate, and actual generation may vary based on specific local conditions, technology efficiency, and other factors.

swissjoule
smart energies

Financing Isiolo 300MW Lapsset Corridor Kenya, tracked, bi-facial, backtracking, Origin EU

Capex	265.500.000	885	$/kWp	300.000	EPC Cost	800	240.000.000		Carbon credits created		$ / Credit min	$ /Credit up	Selling assumption $
Insurance fee	0	0,0%	of debt		Commissions	10	3.000.000		1000	300.000	3	5	3
Financing fee	0	0,0%	of debt		Connection	55	16.500.000						
Total contract value	265.500.000				Reserves	20	6.000.000						
Equity of contract value	39.825.000	20%			Total	885	265.500.000						
Debt of contract value	225.675.000	80%											
Interest rate	5,0%												
Repayments per year	2												
Contract period in full years	15		Escalator / year	Inflation	Irradiation								
PPA incentive	0,050	$/kWh	0,00%	4,00%	2.259								

Year	1	2	3	4	5	6	7	8	9	10
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Turnover feed in	33.794.761	33.659.829	33.525.436	33.391.580	33.258.259	33.125.469	32.993.210	32.861.479	32.730.274	32.599.592
Turnover certificates	1.507.379	1.516.443	1.525.562	1.534.735	1.543.964	1.553.248	1.562.588	1.571.984	1.581.436	1.590.946
Insurance cost	2.655.000	2.761.200	2.871.648	2.986.514	3.105.974	3.230.213	3.359.422	3.493.799	3.633.551	3.778.893
Maintenance	2.763.000	2.873.520	2.988.461	3.107.999	3.232.319	3.361.612	3.496.076	3.635.920	3.781.356	3.932.611
Lease	0	0	0	0	0	0	0	0	0	0
Opex	2.763.000	2.873.520	2.988.461	3.107.999	3.232.319	3.361.612	3.496.076	3.635.920	3.781.356	3.932.611
EBITDA	37.994.882	37.619.911	37.236.994	36.845.781	36.445.911	36.037.004	35.618.670	35.190.499	34.752.069	34.302.937
- Amortization	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000
EBIT	20.294.882	19.919.911	19.536.994	19.145.781	18.745.911	18.337.004	17.918.670	17.490.499	17.052.069	16.602.937
- Interest amount	5.641.875	10.895.011	10.354.872	9.787.387	9.191.174	8.564.778	7.906.670	7.215.245	6.488.818	5.725.614
EBT	14.653.007	9.024.900	9.182.122	9.358.394	9.554.736	9.772.226	10.012.000	10.275.254	10.563.251	10.877.323
P/L before tax	14.653.007	9.024.900	9.182.122	9.358.394	9.554.736	9.772.226	10.012.000	10.275.254	10.563.251	10.877.323
Corporate tax	0	0	0	0	0	0	0	0	0	0
Other taxes	0	0	0	0	0	0	0	0	0	0
Profit / Loss	14.653.007	9.024.900	9.182.122	9.358.394	9.554.736	9.772.226	10.012.000	10.275.254	10.563.251	10.877.323
Accumulated P/L	14.653.007	23.677.907	32.860.029	42.218.423	51.773.159	61.545.385	71.557.385	81.832.639	92.395.890	103.273.212
Cash Flow										
Profit Loss	14.653.007	9.024.900	9.182.122	9.358.394	9.554.736	9.772.226	10.012.000	10.275.254	10.563.251	10.877.323
+ Amortization	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000
Available Cash Flow	32.353.007	26.724.900	26.882.122	27.058.394	27.254.736	27.472.226	27.712.000	27.975.254	28.263.251	28.577.323
- Repayment	5.140.344	10.669.427	11.209.566	11.777.051	12.373.264	12.999.660	13.657.768	14.349.193	15.075.621	15.838.824
Free Cash flow	27.212.663	16.055.473	15.672.556	15.281.343	14.881.472	14.472.566	14.054.231	13.626.061	13.187.630	12.738.499
Free Cash flow account	27.212.663	43.268.136	58.940.692	74.222.035	89.103.507	103.576.073	117.630.305	131.256.366	144.443.996	157.182.495
Debt Services										
Credit sum	225.675.000	220.534.656	209.865.229	198.655.663	186.878.612	174.505.348	161.505.688	147.847.920	133.498.727	118.423.107
-Repayment	5.140.344	10.669.427	11.209.566	11.777.051	12.373.264	12.999.660	13.657.768	14.349.193	15.075.621	15.838.824
Residual debt	220.534.656	209.865.229	198.655.663	186.878.612	174.505.348	161.505.688	147.847.920	133.498.727	118.423.107	102.584.283
IRR on total investment	11,97%		Above figures are a rough estimation and subject to a review. Errors and mistakes reserved.							
IRR on equity	48,10%		All terms and conditions are provided as mere indication without any obligation on our part.							

Year	11	12	13	14	15	16	17	18	19	20
	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Turnover feed in	32.469.433	32.339.793	32.210.670	32.082.064	31.953.971	31.826.389	31.699.316	31.572.751	31.446.691	31.321.135
Turnover certificates	1.600.513	1.610.137	1.619.819	1.629.559	1.639.358	1.649.216	1.659.133	1.669.109	1.679.146	1.689.243
Insurance cost	3.930.049	4.087.251	4.250.741	4.420.770	4.597.601	4.781.505	4.972.765	5.171.676	5.378.543	5.593.685
Maintenance	4.089.915	4.253.512	4.423.652	4.600.598	4.784.622	4.976.007	5.175.047	5.382.049	5.597.331	5.821.224
Lease	0	0	0	0	0	0	0	0	0	0
Opex	4.089.915	4.253.512	4.423.652	4.600.598	4.784.622	4.976.007	5.175.047	5.382.049	5.597.331	5.821.224
EBITDA	33.842.645	33.370.718	32.886.658	32.389.950	31.880.058	31.356.426	30.818.472	30.265.596	29.697.169	29.112.542
- Amortization	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	0	0	0	0	0
EBIT	16.142.645	15.670.718	15.186.658	14.689.950	14.180.058	31.356.426	30.818.472	30.265.596	29.697.169	29.112.542
- Interest amount	4.923.774	4.081.340	3.196.258	2.266.369	1.289.405	262.981	0	0	0	0
EBT	11.218.872	11.589.377	11.990.399	12.423.581	12.890.654	31.093.445	30.818.472	30.265.596	29.697.169	29.112.542
P/L before tax	11.218.872	11.589.377	11.990.399	12.423.581	12.890.654	31.093.445	30.818.472	30.265.596	29.697.169	29.112.542
Corporate tax	0	0	0	0	0	0	0	0	0	0
Other taxes	0	0	0	0	0	0	0	0	0	0
Profit / Loss	11.218.872	11.589.377	11.990.399	12.423.581	12.890.654	31.093.445	30.818.472	30.265.596	29.697.169	29.112.542
Accumulated P/L	114.492.084	126.081.461	138.071.860	150.495.441	163.386.095	194.479.539	225.298.012	255.563.608	285.260.777	314.373.318
Cash Flow										
Profit Loss	11.218.872	11.589.377	11.990.399	12.423.581	12.890.654	31.093.445	30.818.472	30.265.596	29.697.169	29.112.542
+ Amortization	17.700.000	17.700.000	17.700.000	17.700.000	17.700.000	0	0	0	0	0
Available Cash Flow	28.918.872	29.289.377	29.690.399	30.123.581	30.590.654	31.093.445	30.818.472	30.265.596	29.697.169	29.112.542
- Repayment	16.640.664	17.483.098	18.368.180	19.298.069	20.275.034	10.519.238	0	0	0	0
Free Cash flow	12.278.207	11.806.280	11.322.219	10.825.512	10.315.620	20.574.207	30.818.472	30.265.596	29.697.169	29.112.542
Free Cash flow account	169.460.702	181.266.982	192.589.201	203.414.713	213.730.333	234.304.539	265.123.012	295.388.608	325.085.777	354.198.318
Debt Services										
Credit sum	102.584.283	85.943.618	68.460.520	50.092.341	30.794.272	10.519.238	0	0	0	0
-Repayment	16.640.664	17.483.098	18.368.180	19.298.069	20.275.034	10.519.238	0	0	0	0
Residual debt	85.943.618	68.460.520	50.092.341	30.794.272	10.519.238	0	0	0	0	0

CARBON DIOXIDE SAVINGS

Estimate the carbon dioxide (CO_2) savings from a green hydrogen plant generating 221,440 MWh a year, we need to consider the emissions associated with conventional electricity generation and compare it to the emissions from the green hydrogen plant.

Emissions from Conventional Electricity:

The emissions depend on the energy mix of the region. If we assume a generic value, let's say 0.5 kg CO_2 per kWh, then the emissions from conventional electricity would be:

Emissions conventional=221,440MWh/year×0.5kg CO_2/kWh

Emissions from Green Hydrogen Plant:

Green hydrogen is considered a clean energy source during operation. However, emissions might occur during the manufacturing of the electrolyzer, construction, and other lifecycle stages. If we assume a conservative estimate for the emissions associated with green hydrogen production (including the manufacturing of the electrolyzer), let's say 2 kg CO2 per kg of hydrogen produced, then the emissions from the green hydrogen plant would be:

1. **Emissions Factor**

Emissionsgreen hydrogen=(Electricity Consumptionhydrogen production×Hydrogen Yi eld)×2 kg CO_2/kg hydrogenEmissionsgreen hydrogen =(Electricity Consumptionhydrogen production ×Hydrogen Yield)×2kg CO_2/kg hydrogen

Now, let's calculate the net CO_2 savings:

Net CO_2 Savings=Emissionsconventional−Emissionsgreen hydrogen Net CO_2 Savings=Emissionsconventional−Emissionsgreen hydrogen

Net CO_2 Savings=(221,440 MWh/year×0.5 kg CO_2/kWh)−(Electricity Consumptionhydr ogen production×Hydrogen Yield×2 kg CO_2/kg hydrogen)Net CO_2 Savings=(221,440M Wh/year×0.5kg CO_2/kWh)−(Electricity Consumptionhydrogen production ×Hydrogen Yield×2kg CO_2/kg hydrogen)

The actual electricity consumption for hydrogen production and hydrogen yield would depend on the efficiency of the electrolyzer and other factors specific to the green hydrogen plant.

Please note that these calculations involve some assumptions and estimations, and the actual emissions can vary based on the specific conditions and technologies used in the green hydrogen plant. It's recommended to obtain more precise data for the particular plant in question for a more accurate assessment of CO_2 savings.

Proposed Energy projects for Lapsset & Kenya

To estimate the carbon dioxide (CO_2) savings from different solar farm capacities in the LAPSSET Corridor in Kenya, we need to make some assumptions about the capacity factor of the solar farms and the carbon intensity of the electricity generation they displace. The capacity factor represents the actual output of the solar farm compared to its maximum potential output. Let's assume a capacity factor of 20%, which is a conservative estimate for solar farms.

Energy Source	Capacity (MW)	Estimated Emissions Reduction (tCO2/MWh)	Annual Carbon Reduction (tCO2)
Geothermal	5,000	0.01	50,000,000
Solar PV	1,000	0.02	2,000,000
Solar Farms	3,000	0.02	4,204,800
Wind Farms	500	0.02	1,000,000
Waste to Energy Plants	360	0.05	1,800,000
Green Hydrogen Plants	2,200	0.00 (assuming zero emissions)	0
Hydroelectricity Dams	1,296	0.00 (assuming zero emissions)	0
Bioethanol Plants	341	0.05 (assuming emissions similar to waste-to-energy)	1,705,000
Nuclear Plants	940	0.01	9,400,000
Clean Coal Plants	2,040	0.7 (assuming lower emissions for cleaner coal technology)	14,280,000

In General, Global Assumptions:

- Capacity factor: 20%
- Carbon intensity of displaced electricity: Assume a mix of fossil fuel-based sources with an average emissions factor of 0.4 kg CO_2/kWh (this is a general estimate and may vary).

Now, we can calculate the annual CO_2 savings for each solar farm capacity:

1. **50 MW Solar Farm:**
   Annual CO_2 savings=Capacity×Capacity factor×Hours in a year×Carbon intensity
   Annual CO_2 savings=Capacity×Capacity factor×Hours in a year×Carbon intensity

   Annual CO_2 savings=50 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=50MW×0.20×8760hours/year×0.4kg CO_2/kWh
2. **300 MW Solar Farm:**
   Annual CO_2 savings=300 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=300MW×0.20×8760hours/year×0.4kg CO_2/kWh
3. **3000 MW Solar Farm:**
   Annual CO_2 savings=3000 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=3000MW×0.20×8760hours/year×0.4kg CO_2/kWh

Now, let's calculate the values:

1. **50 MW Solar Farm:**
   Annual CO_2 savings=50 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=50MW×0.20×8760hours/year×0.4kg CO_2/kWh
   Annual CO_2 savings=70,080 tonnes of CO_2 Annual CO2 savings=70,080 tonnes of CO_2
2. **300 MW Solar Farm:**
   Annual CO_2 savings=300 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=300MW×0.20×8760hours/year×0.4kg CO_2/kWh
   Annual CO_2 savings=420,480 tonnes of CO_2 Annual CO_2 savings=420,480 tonnes of CO_2
3. **3000 MW Solar Farm:**
   Annual CO_2 savings=3000 MW×0.20×8760 hours/year×0.4 kg CO_2/kWh
   Annual CO_2 savings=3000MW×0.20×8760hours/year×0.4kg CO_2/kWh
   Annual CO_2 savings=4,204,800 tonnes of CO_2 Annual CO_2 savings=4,204,800 tonnes of CO_2

These are rough estimates, and the actual CO_2 savings will depend on specific factors like the actual capacity factor, solar irradiance in the region, and the carbon intensity of the displaced electricity. A further details Feasibility study will be undertaken, first in Isiolo.

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PSECC LTD

WIND FARMS
PROPOSAL CONCEPT

December 2023

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PSECC Ltd

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Project No. PSECC006

PREPARED FOR:

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LAPSSET CORRIDOR

Lapsset Corridor Development Authority - LCDA

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Transitional Clean Energy

Net ZERO

PSECC Ltd

Portsmouth Sustainable Energy & Climate Change Centre

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PSECC Ltd

Portsmouth Sustainable Energy &
Climate Change Centre

Kenya has launched what has been billed as the largest wind farm in Africa allowing the country to inject an additional 310 megawatts of renewable power to the national grid.

COP28 indicated the importance of Adaption and to "Transition" into a Net Zero economy. The mammoth project constructed at a cost of $680-million is located in Turkana the remote northern part of the country. The 365-turbine wind farm on the eastern shores of Lake Turkana, is the largest private investment in Kenya's since independence.

Speaking during the launch of the project Kenya's previous President Uhuru Kenyatta said that the East African nation was in course to becoming a force to reckon with when it comes to renewable energy.

"Today, we again raise the bar for the continent as we unveil the single largest wind farm," said President Uhuru Kenyatta, after touring the project.

"Kenya is without a doubt on course to become a world leader in renewable energy." Kenya hopes that the Turkana wind farm will help to satisfy it rising demand of energy as it seeks to become an industrial country by the year 2030.

A consortium of Chinese firms is racing against time to complete the construction of Lake Turkana Wind Power line. The firms have pledged to connect the Lake Turkana Wind Power project to the national grid by August 31 otherwise they will pay a fine of Sh1.3 billion per month.

NARI Group Corporation and Power China Guizhou Engineering Company, were awarded a Sh9.6 billion contract to complete the transmission line linking Lake Turkana Wind Power to the national grid following the termination of a Spanish firm’s contract last year. Isolux’s contract was terminated after it was placed under receivership, pushing back completion of the project.

Wind Energy from the Wind Farms can be used for Green Hydrogen production. The cost of green hydrogen production will continue to drop as countries ramp up their renewable energy ambitions.

About 3 billion people use conventional carbon- based fuels such as wood, charcoal, and animal dung for their daily cooking needs. Cooking with biomass causes deforestation and habitat loss, emissions of greenhouse.

The International Energy Agency estimates the cost of green hydrogen production to range from $3 to $7 per kilo. The cost of green hydrogen production is largely due to the use of renewable electricity, which is the main component.

KENYA STRATEGY

President Ruto's commitment

President William Ruto in November 9, 2022 had arrived back from Sharm El-Sheikh, Egypt where he attended the 2022 United Nations Climate Change Conference (COP27). The President called on developed nations to invest in Africa to unlock its clean energy production potential citing wind power, geothermal electricity, and solar energy.

The President signed a framework agreement for collaboration on the development of sustainable green industries in Kenya with an investor to produce 30 GW of green hydrogen in Kenya. There exist opportunities in Kenya to produce 20 GW of wind-power.

Fig 1.

PSECC Ltd - Phase One Railway & Economic Zones - Energy Installed & Cost Recommendations to meet Kenya Government, LCDA targets, NDC's and IPCC emission reduction.

		MW (2024 – 2028)		Cost	MW (2028 – 2035)		Cost
• expansion in geothermal	-	1,887	MW	US$ 2,830 m	3,113	MW	US$ 4,669 m
• solar PV	-	500	MW	US$ 500 m	500	MW	US$ 500 m
• solar farms	-	2,000	MW	US$ 1,770 m	1,000	MW	US$ 885 m
• solar PV Manufacturing plant	-	25	MW	US$ 10 m	50	MW	US$ 20 m
• waste plants	-	180	MW	US$ 900 m	180	MW	US$ 900 m
• wind farms	-	150	MW	US$ 328 m	350	MW	US$ 766 m
• green hydrogen	-	1,100	MW	US$ 1,432 m	1,100	MW	US$ 1,432 m
• dams – hydroelectricity	-	796	MW	US$ 796 m	500	MW	US$ 500 m
• climate smart agriculture Bio-Fuels	-	191	M Ltrs	US$ 190 m	150	M Ltrs	US$ 190 m
• Nuclear	-	-	-	- -	940	MW	US$ 4,800 m
• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

PSECC Ltd propose 500MW of Wind Farms for the Lapsset Corridor

BENEFITS OF WND FARMS

Wind farms can offer various benefits to the LAPSSET (Lamu Port-South Sudan-Ethiopia Transport) Corridor project in Kenya, particularly in the context of energy generation and sustainable development. Here are key benefits:

1. **Renewable Energy Generation:** Wind farms provide a source of renewable energy by harnessing the kinetic energy of the wind to generate electricity. This contributes to the diversification of the energy mix, reducing reliance on conventional and finite fossil fuel resources.
2. **Carbon Emission Reduction:** Wind energy is a clean and low-carbon power source. By generating electricity without burning fossil fuels, wind farms help mitigate climate change by reducing greenhouse gas emissions. This aligns with global efforts to transition to low-carbon energy systems.
3. **Energy Independence:** Wind farms contribute to energy independence by providing a locally available and abundant source of power. This reduces dependency on imported fossil fuels, enhancing energy security and stability within the LAPSSET Corridor.
4. **Job Creation and Economic Development:** The development, construction, and operation of wind farms create job opportunities and stimulate economic growth. This includes roles in manufacturing, installation, maintenance, and related support services, benefiting local communities and economies.
5. **Technological Innovation:** Investment in wind energy projects fosters technological innovation in the renewable energy sector. Advances in wind turbine technology, control systems, and grid integration contribute to the overall development of clean energy technologies.
6. **Diversification of Energy Sources:** Integrating wind power into the energy mix diversifies the sources of electricity generation. This diversity enhances the resilience of the energy infrastructure, as it reduces vulnerability to fluctuations in the availability or prices of specific energy resources.

7. **Grid Stability and Reliability:** Wind energy, when integrated into the power grid, can contribute to grid stability. Wind farms, especially when strategically located, can provide a reliable and continuous power supply, complementing other energy sources to meet the demands of the LAPSSET Corridor.
8. **Rural Electrification and Community Benefits:** Wind farms can bring electricity to remote or underserved areas along the corridor, contributing to rural electrification. This has positive impacts on local communities, providing access to modern energy services, improving quality of life, and supporting social development.
9. **Sustainable Infrastructure Development:** Wind farms align with the principles of sustainable infrastructure development. By investing in renewable energy, the LAPSSET Corridor promotes environmentally responsible practices and long-term sustainability.
10. **Reduced Air and Water Pollution:** Wind power generation produces electricity without emitting air pollutants or consuming water resources, which is common in traditional power plants. This leads to improved air and water quality in the region, benefitting both the environment and public health.
11. **Energy Access and Affordability:** Wind energy projects contribute to increased energy access and affordability. By generating electricity locally, wind farms can help address energy poverty and provide a cost-effective and sustainable power source for industries and communities along the corridor.
12. **Mitigation of Energy Price Volatility:** Wind energy has a stable and predictable cost structure once the infrastructure is in place. This can help mitigate the impact of energy price volatility, providing a more predictable and reliable energy supply for businesses and consumers in the LAPSSET Corridor.

In summary, the integration of wind farms into the LAPSSET Corridor project in Kenya brings multiple benefits, ranging from clean energy generation and carbon emission reduction to economic development and improved energy resilience. These advantages align with sustainable development goals and contribute to the overall success of the corridor project.

ENERGY TRANSITION

Green Energy investments within the corridor are on the rise.

The LAPSSET Corridor investments will increase energy demand up to 1,000 MW

Lake Turkana Wind Farm - 300 MW Completed

Meru Wind Farm – 100MW Planed

Isiolo Wind Farm – 150MW Planed

Marsabit Wind Farm- 50 MW Planed

This is a Wind Farm Energy Review – a Detailed Technical offer will follow on these Renewable Energy technology mitigation measure

Wind farms in the LAPSSET Corridor project in Kenya can contribute significantly to the energy transition of the country, by the following:

1. **Renewable Energy Integration:** Wind farms provide a clean and renewable source of energy, contributing to the integration of sustainable and environmentally friendly power sources into Kenya's energy mix.
2. **Diversification of Energy Sources:** Integrating wind power diversifies Kenya's energy portfolio, reducing dependence on conventional fossil fuels. This diversification enhances energy security and resilience by mitigating risks associated with fluctuations in fuel prices and availability.
3. **Reduction of Greenhouse Gas Emissions:** Wind energy generation produces electricity without emitting greenhouse gases during operation. By displacing electricity generation from fossil fuel sources, wind farms contribute to the reduction of carbon emissions, aligning with Kenya's climate change mitigation goals.
4. **Mitigation of Climate Change Impact:** The deployment of wind farms supports efforts to mitigate the impact of climate change by reducing the carbon footprint of the energy sector. This aligns with global commitments, including Kenya's commitment to the Paris Agreement.
5. **Energy Independence:** Wind farms contribute to Kenya's energy independence by harnessing a locally available and abundant resource. This reduces the country's reliance on imported fossil fuels, promoting energy security and stability.
6. **Job Creation and Economic Development:** The development, construction, and operation of wind farms create job opportunities and stimulate economic growth. This is particularly relevant for local communities in and around the LAPSSET Corridor.
7. **Technological Innovation:** Investment in wind energy projects fosters technological innovation in the renewable energy sector. Advances in wind turbine technology, grid integration, and energy storage can contribute to the overall development of clean energy technologies in Kenya.
8. **Rural Electrification:** Wind farms can be deployed in remote or underserved areas, contributing to rural electrification. This extends access to electricity to areas that may not be connected to the national grid, improving the quality of life in rural communities.

9. **Stable and Predictable Energy Supply:** Wind energy has a stable and predictable cost structure once the infrastructure is in place. This contributes to a reliable and consistent energy supply, reducing the impact of energy price volatility.
10. **Sustainable Infrastructure Development:** Wind farms align with sustainable infrastructure development goals, promoting environmentally responsible practices and long-term sustainability in Kenya's energy sector.
11. **Energy Access and Affordability:** Wind energy projects contribute to increased energy access and affordability. By generating electricity locally, wind farms can help address energy poverty and provide a cost-effective and sustainable power source.
12. **Government Renewable Energy Targets:** Kenya has set ambitious renewable energy targets, including a significant share of wind power in its energy mix. The deployment of wind farms in the LAPSSET Corridor can contribute to achieving these targets.

In summary, wind farms in the LAPSSET Corridor project play a crucial role in Kenya's energy transition by providing clean, renewable energy, reducing greenhouse gas emissions, promoting economic development, and contributing to the country's long-term sustainability goals.

Wind Speed Map of Kenya

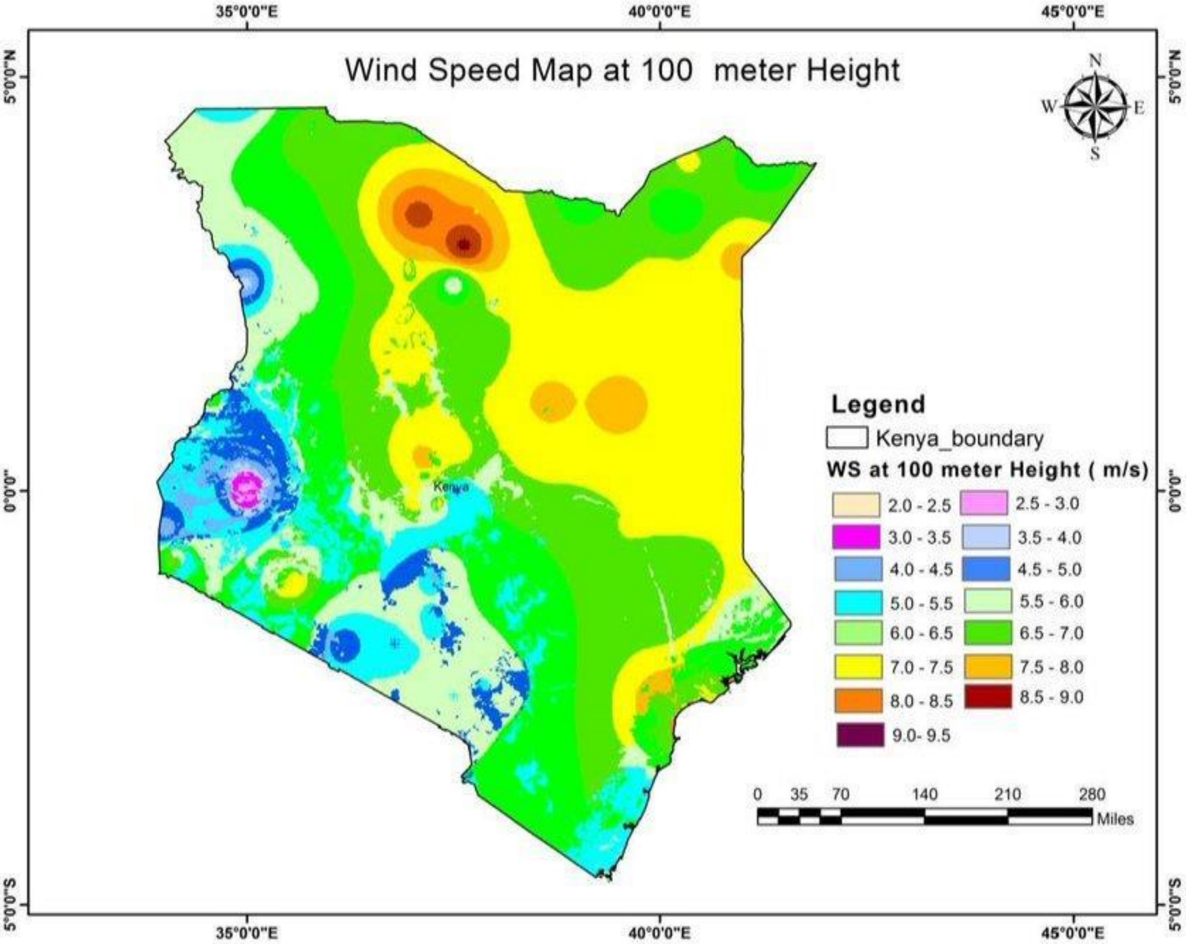

Figure 2: Wind Speed Map of Kenya at 100m height

Energy Generated from 500MW of Wind Farms

To calculate the annual energy production (AEP) from a 500 MW wind farm in Kenya with wind speeds of 7 m/s and running for 8 hours per day, you can use the following steps:

1. **Calculate Daily Energy Production (DEP):**
   DEP=Installed Capacity×Capacity Factor×Hours per DayDEP=Installed Capacity×Capacity Factor×Hours per Day
   In this case:
   - Installed Capacity = 500 MW
   - Capacity Factor (assumed) = It can vary, but let's assume 35%.
   - Hours per Day = 8 hours/day

   DEP=500 MW×0.35×8 hours/dayDEP=500MW×0.35×8hours/day

2. **Convert DEP to kWh:** DEP in kWh=DEP×1,000DEP in kWh=DEP×1,000
   Now, let's calculate it step by step:
   DEP=500 MW×0.35×8 hours/dayDEP=500MW×0.35×8hours/day
   DEP in kWh=DEP×1,000DEP in kWh=DEP×1,000

   Substitute the values and perform the calculations:

   DEP=500×0.35×8=1,400 MWh/dayDEP=500×0.35×8=1,400MWh/day
   DEP in kWh=1,400×1,000=1,400,000 kWh/dayDEP in kWh=1,400×1,000=1,400,000kWh/day

So, the wind farm would generate approximately 1,400,000 kWh of electricity per day. To get the annual production, you can multiply this value by the number of days in a year. Assuming 365 days:

Annual Energy Production=1,400,000 kWh/day×365 days/yearAnnual Energy Production=1,400,000kWh/day×365days/year = 511,000 MWh

CLIMATE CHANGE MITIGATION

The installation of 500 MW of additional wind farms within the LAPSSET Corridor project in Kenya can have significant climate change mitigation effects. Here are the key ways in which this contributes to mitigating climate change:

1. Reduction in Greenhouse Gas Emissions: Wind farms generate electricity without burning fossil fuels, which helps to reduce greenhouse gas emissions. By displacing electricity generated from conventional sources like coal or natural gas, the additional 500 MW of wind power can result in a substantial reduction in carbon dioxide (CO_2) emissions.
2. Avoided Fossil Fuel Combustion: The electricity generated by wind farms is considered "carbon-free" during operation. Installing more wind farms in the LAPSSET Corridor would avoid the combustion of fossil fuels, reducing the associated CO_2 emissions and air pollution.
3. Low Carbon Intensity: Wind energy has a low carbon intensity, meaning that the emissions produced per unit of electricity generated are significantly lower compared to many traditional power sources. This characteristic contributes to a more sustainable and environmentally friendly energy mix.
4. Alignment with National and Global Climate Goals: The installation of wind farms aligns with Kenya's commitment to addressing climate change. It supports the country's efforts to reduce its carbon footprint and achieve its targets outlined in international agreements, such as the Paris Agreement.
5. Contribution to Renewable Energy Targets: Kenya has set ambitious targets for increasing the share of renewable energy in its overall energy mix. The additional 500 MW of wind power contributes directly to meeting these targets, promoting a transition to a more sustainable and climate-friendly energy sector.
6. Enhanced Grid Stability and Reliability: Wind power, when integrated into the energy grid, can enhance stability and reliability. The variable nature of wind energy is often complemented by other renewable sources and energy storage solutions, creating a balanced and resilient power system.

7. Promotion of Sustainable Practices: Wind energy represents a sustainable and environmentally friendly power source. The expansion of wind farms in the LAPSSET Corridor project encourages sustainable practices in the energy sector, emphasizing the importance of reducing the environmental impact of electricity generation.
8. Air Quality Improvement: The reduction in the use of fossil fuels for electricity generation leads to improved air quality. Wind farms contribute to cleaner air by avoiding the release of pollutants associated with the combustion of coal, oil, or natural gas.
9. Economic and Social Co-Benefits: In addition to climate change mitigation, the development of wind farms brings economic and social co-benefits. It creates job opportunities, stimulates local economies, and improves living standards in the communities surrounding the wind farm sites.
10. Demonstration of Commitment to Sustainability: The installation of more wind farms within the LAPSSET Corridor demonstrates a commitment to sustainability and responsible environmental practices. It sets a positive example for other regions and contributes to a broader global effort to address climate change.

In summary, the additional 500 MW of wind farms within the LAPSSET Corridor project in Kenya would contribute significantly to climate change mitigation by reducing greenhouse gas emissions, promoting sustainable energy practices, and aligning with national and global climate goals.

ALIGNMENT WITH LAPSSET

How does further development of 500MW of wind farms fit into and have ALIGNMENT WITH LAPSSET in Kenya

The further development of 500 MW of wind farms aligns with the LAPSSET (Lamu Port-South Sudan-Ethiopia Transport) Corridor project in Kenya in several ways:

1. **Diversification of Energy Sources:** Integrating 500 MW of wind farms contributes to the diversification of energy sources within the LAPSSET Corridor. This aligns with the corridor's strategy of having a balanced and diversified energy mix to enhance energy security and reliability.
2. **Renewable Energy Integration:** Wind farms represent a renewable energy source, and their development supports the integration of clean and sustainable energy into the energy portfolio of the LAPSSET Corridor. This aligns with the global trend toward reducing reliance on fossil fuels and transitioning to renewable energy.
3. **Climate Change Mitigation:** The development of wind farms is a climate-friendly initiative that aligns with efforts to mitigate climate change. By generating electricity without greenhouse gas emissions during operation, wind farms contribute to the corridor's commitment to environmental sustainability and addressing climate challenges.
4. **National Energy Transition Goals:** Kenya has set ambitious goals for transitioning to a more sustainable and renewable energy future. The development of wind farms within the LAPSSET Corridor contributes directly to Kenya's national energy transition goals, promoting the use of clean energy sources.
5. **Energy Independence:** Wind energy, being a locally available resource, contributes to energy independence. The further development of wind farms within the corridor reduces dependence on imported fossil fuels, enhancing energy security and self-sufficiency.
6. **Job Creation and Economic Development:** The development, construction, and operation of wind farms create job opportunities and stimulate economic growth. This aligns with the broader socio-economic development goals of the LAPSSET Corridor, contributing to local employment and prosperity.
7. **Sustainable Infrastructure Development:** The expansion of wind farms aligns with the principles of sustainable infrastructure development within the LAPSSET Corridor. It promotes environmentally responsible

practices and contributes to the long-term sustainability of the corridor's energy infrastructure.

8. **Technology and Innovation:** Wind energy projects encourage technological innovation in the renewable energy sector. The development of advanced wind turbine technology, grid integration solutions, and energy storage methods contributes to the overall technological advancement within the corridor.
9. **Community Benefits and Stakeholder Engagement:** The further development of wind farms provides an opportunity for community engagement and benefits. Involving local communities in the planning and implementation of wind energy projects can enhance acceptance and support for sustainable development initiatives.
10. **Alignment with International Best Practices:** The integration of wind farms aligns with international best practices in the field of renewable energy and sustainable development. It positions the LAPSSET Corridor as a region committed to adopting environmentally friendly and socially responsible energy solutions.

In summary, the development of 500 MW of wind farms within the LAPSSET Corridor in Kenya is in alignment with the corridor's goals for a diversified, sustainable, and resilient energy infrastructure. It contributes to national and global efforts in combating climate change, promoting renewable energy, and fostering economic and social development within the corridor.

TIMELINE

Following is the tentative timeline of the Wind programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	Five Wind Farms	250MW	2024 to 2028
Phase 3:	Five Wind Farms	250MW	2028 to 2035

COST

The details of the indicative cost are provided below (dependent upon exact criteria):

Title	Cost (USD)	MWh per year
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$300,000	
Phase 2. Five Wind Farms	$250 Million	Approximately 255,500 MWh
Phase 3. Five Wind Farms	$250 Million	Approximately 1,110,720 MWh

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

REVENUE

PSECC Ltd calculations (to be confirmed once plant is operational and O&M considered) – indicative.

Items	Revenue (USD) year
Yearly Energy Generation from 500MW plant producing 511,000 MWh – electricity sold at $0.05 KWh	$25.55 Million
Government 35% share of revenue per year	$8.94 Million
Total Government revenue share over 20 years	$178.85 Million

Loan repayments will then have to be made.

CARBON DIOXIDE SAVINGS

To estimate the potential carbon dioxide (CO_2) savings per year from a 500 MW wind farm operating at an average wind speed of 7 meters per second over 8 hours per day, you can follow these steps:

1. **Calculate Annual Energy Production (AEP):**
AEP=Capacity Factor×Installed Capacity×Hours in a YearAEP=Capacity Factor×Installed Capacity×Hours in a Year

In this case:

- Installed Capacity = 500 MW
- Capacity Factor (assumed) = It can vary, but let's assume 35%.
- Hours in a Year = 8 hours/day * 365 days/year

AEP=0.35×500 MW×8 hours/day×365 days/yearAEP=0.35×500MW×8hours/day×365days/year

2. **Convert AEP to MWh:** Since we typically measure carbon intensity in kilograms of CO_2 per kilowatt-hour (kg CO2/kWh), you'll need to convert the AEP to MWh:
AEP in MWh=AEP in kWh×1,000AEP in MWh=AEP in kWh×1,000
3. **Calculate CO_2 Emissions:**
CO_2 Emissions=AEP in MWh×Carbon IntensityCO_2 Emissions=AEP in MWh×Carbon Intensity

Assuming a carbon intensity of
Carbon Intensity=0.4 kg CO_2/kWhCarbon Intensity=0.4kg CO_2/kWh:

CO_2 Emissions=AEP in MWh×0.4 kg CO2/kWhCO_2 Emissions=AEP in MWh×0.4kg CO_2/kWh

Now, let's calculate it step by step:

AEP=0.35×500 MW×8 hours/day×365 days/yearAEP=0.35×500MW×8hours/day ×365days/year

AEP in kWh=AEP×1,000AEP in kWh=AEP×1,000

CO_2 Emissions=AEP in kWh×0.4 kg CO_2/kWhCO_2 Emissions=AEP in kWh×0.4kg CO_2/kWh.

To calculate the annual energy production (AEP) from a 500 MW wind farm in Kenya with wind speeds of 7 m/s and running for 8 hours per day, you can use the following steps:

1. **Calculate Daily Energy Production (DEP):** DEP=Installed Capacity×Capacity Factor×Hours per DayDEP=Installed Capacity×Capacity Factor×Hours per Day

In this case:

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DEP=500 MW×0.35×8 hours/dayDEP=500MW×0.35×8hours/day

DEP in kWh=DEP×1,000DEP in kWh=DEP×1,000

Substitute the values and perform the calculations:

DEP=500×0.35×8=1,400 MWh/dayDEP=500×0.35×8=1,400MWh/day

DEP in kWh=1,400×1,000=1,400,000 kWh/dayDEP in kWh=1,400×1,000=1,400,000kWh/day

So, the wind farm would generate approximately 1,400,000 kWh of electricity per day. To get the annual production, you can multiply this value by the number of days in a year. Assuming 365 days:

Annual Energy Production=1,400,000 kWh/day×365 days/yearAnnual Energy Production=1,400,000kWh/day×365days/year = 511,000,000KWh per year.

Important to note that detailed Feasibility studies will be required to determine exact values from each Solar Farm proposed.

To estimate the annual carbon dioxide (CO_2) savings from a 500 MW wind farm operating 8 hours per day with a wind speed of 7 m/s, you can follow these steps:

1. **Calculate Daily Energy Production (DEP):** DEP=Installed Capacity×Capacity Factor×Hours per DayDEP=Installed Capacity×Capacity Factor×Hours per Day

In this case:

- Installed Capacity = 500 MW
- Capacity Factor (assumed) = It can vary, but let's assume 35%.
- Hours per Day = 8 hours/day

DEP=500 MW×0.35×8 hours/dayDEP=500MW×0.35×8hours/day

2. **Convert DEP to MWh:** DEP in MWh=DEP×1,000DEP in MWh=DEP×1,000
3. **Calculate CO_2 Emissions:** CO_2 Emissions=DEP in MWh×Carbon IntensityCO_2 Emissions=DEP in MWh×Carbon Intensity

Assuming a carbon intensity of
Carbon Intensity=0.4 kg CO_2/kWhCarbon Intensity=0.4kg CO_2/kWh:

CO_2 Emissions=DEP in MWh×0.4 kg CO2/kWhCO2 Emissions=DEP in MWh×0.4kg CO_2/kWh

Now, let's calculate it step by step:

DEP=500 MW×0.35×8 hours/dayDEP=500MW×0.35×8hours/day

DEP in MWh=DEP×1,000DEP in MWh=DEP×1,000

CO_2 Emissions=DEP in MWh×0.4 kg CO_2/kWhCO₂ Emissions=DEP in MWh×0.4k g CO_2/kWh

Substitute the values and perform the calculations:

DEP=500×0.35×8=1,400 MWh/dayDEP=500×0.35×8=1,400MWh/day

DEP in MWh=1,400×1,000=1,400,000 kWh/dayDEP in MWh=1,400×1,000=1,40 0,000kWh/day

CO_2 Emissions=1,400,000×0.4=560,000 kg CO_2/dayCO_2 Emissions=1,400,000×0. 4=560,000kg CO_2/day

Now, to get the annual CO_2 emissions:

Annual CO_2 Emissions=560,000 kg CO_2/day×365 days/yearAnnual CO_2 Emission s=560,000kg CO_2/day×365days/year

Total annual CO2 emissions = 21.9 million tonnes per year.

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PSECC LTD

GREEN HYDROGEN PLANTS
PROPOSAL CONCEPT

December 2023

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www.psecc.co.uk

Project No. PSECC007

PREPARED FOR:

Mr S. Ikua
Director General / CEO

LAPSSET CORRIDOR

Lapsset Corridor Development Authority - LCDA

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Baseload Transitional Clean Energy

Net ZERO

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GREEN HYDROGEN

Green hydrogen is defined as hydrogen produced by splitting water into hydrogen and oxygen using renewable electricity.

COP28 indicated the importance of Adaption and to “Transition” into a Net Zero economy. This is a very different pathway compared to both grey and blue. Grey hydrogen is traditionally produced from methane (CH4), split with steam into CO_2 – the main culprit for climate change – and H2, hydrogen.

As we have seen Kenya presents itself as highly vulnerable to climate change effects – this is a major problem and this problem can be resolved, mitigated, lead to sustainable growth, 1,000’s of jobs created and we aim to indicate just how that can be done and provide the funding to achieve a Green Hydrogen Energy program for the Lapsset Corridor to have eight plants. To serve as an example to Kenya - What’s claimed to be the world’s largest facility yet for green hydrogen production from renewables has been completed in Fukushima, Japan. The project was developed by Toshiba Energy Systems and Solutions and is currently owned by New Energy and Industrial Technology Development Organization.

Fukushima Hydrogen Energy Research Field Solar PV Park is a ground-mounted solar project which is spread over an area of 180,000 square meters. The project construction cost was

$38.4m. The International Energy Agency estimates the cost of green hydrogen production to range from $3 to $7 per kilo. The cost of green hydrogen production is largely due to the use of renewable electricity, which is the main component.

The cost of green hydrogen production will continue to drop as countries ramp up their renewable energy ambitions.

About 3 billion people use conventional carbon- based fuels such as wood, charcoal, and animal dung for their daily cooking needs. Cooking with biomass causes deforestation and habitat loss, emissions of greenhouse.

Fukushima Hydrogen Energy Research Field Solar PV Park is a ground-mounted solar project which is spread over an area of 180,000 square meters. The project construction cost was $38.4m.

President Ruto's commitment

President William Ruto in November 9, 2022 had arrived back from Sharm El-Sheikh, Egypt where he attended the 2022 United Nations Climate Change Conference (COP27). The President called on developed nations to invest in Africa to unlock its clean energy production potential citing wind power, geothermal electricity, and solar energy.

The President signed a framework agreement for collaboration on the development of sustainable green industries in Kenya with an investor to produce 30 GW of green hydrogen in Kenya. There exists opportunities in Kenya to produce 20 GW of wind-power, 10 GW of geothermal electricity and being at the equator, considerable amounts of solar energy.

This is a Green Hydrogen Energy Review – a Detailed Technical offer will follow on these Renewable Energy technology mitigation measures:

• Green hydrogen could be a critical enabler of the global transition to sustainable energy and net zero emissions economies.

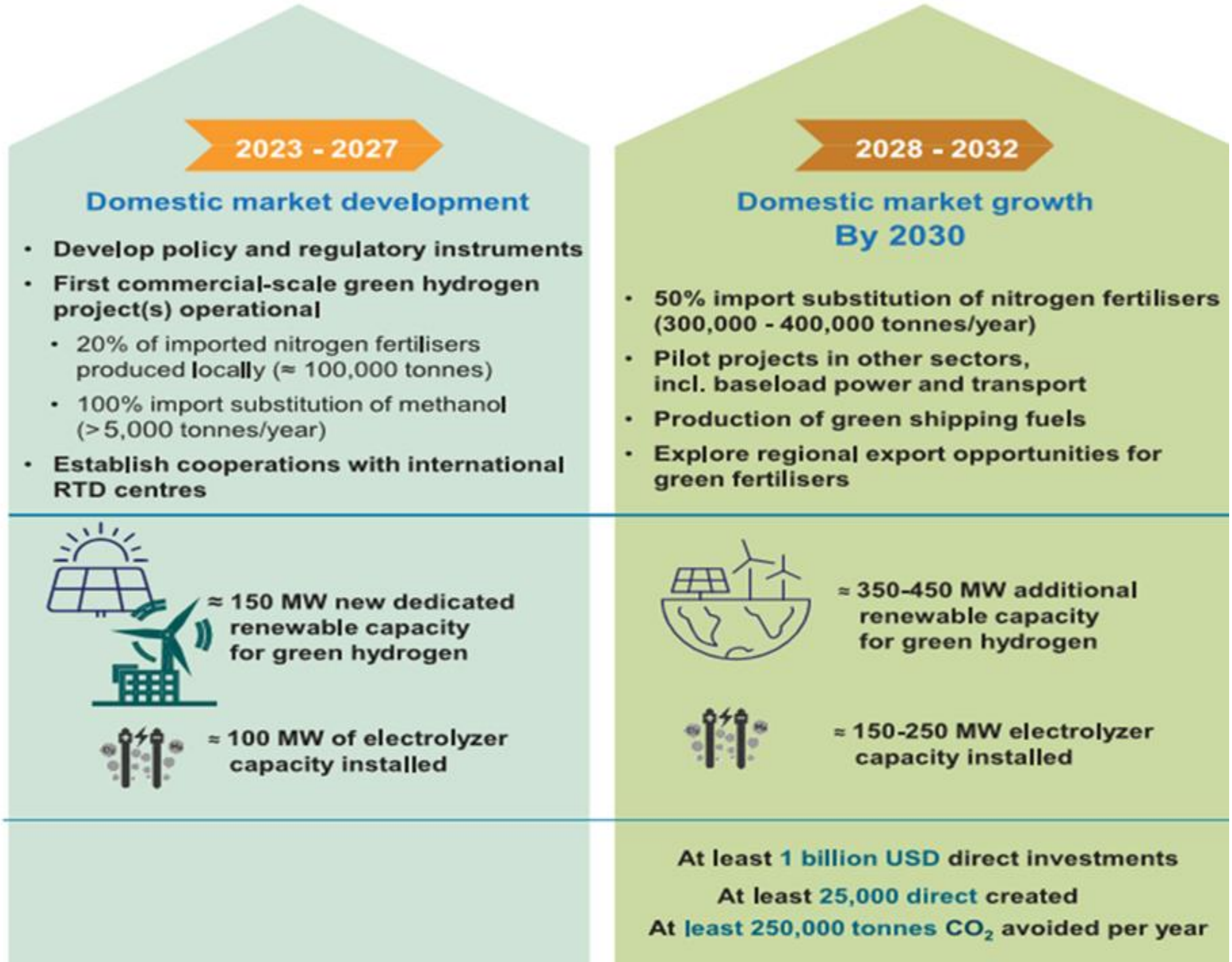
• There is unprecedented momentum around the world to

• fulfil hydrogen's longstanding potential as a clean energy solution.

Hydrogen is emerging as one of the leading options for storing energy from renewables with hydrogen-based fuels potentially transporting energy from renewables over long distances – from regions with abundant energy resources, to energy-hungry areas thousands of kilometers away. The Green Hydrogen Strategy and Roadmap for Kenya has been developed by the European Union Global Technical Assistance Facility (GTAF) for Sustainable Energy, in close cooperation with the Delegation of the European Union to Kenya (EU), the Ministry of Energy and Petroleum (MoEP) for Kenya.

President Ruto has signed agreements with the UK Government for a 30 GW Green Hydrogen programme for Kenya. We propose 2.2 GW of Green Hydrogen plants for the Lapsset Corridor

The following is the targeted strategic objectives for Green Hydrogen in Kenya.

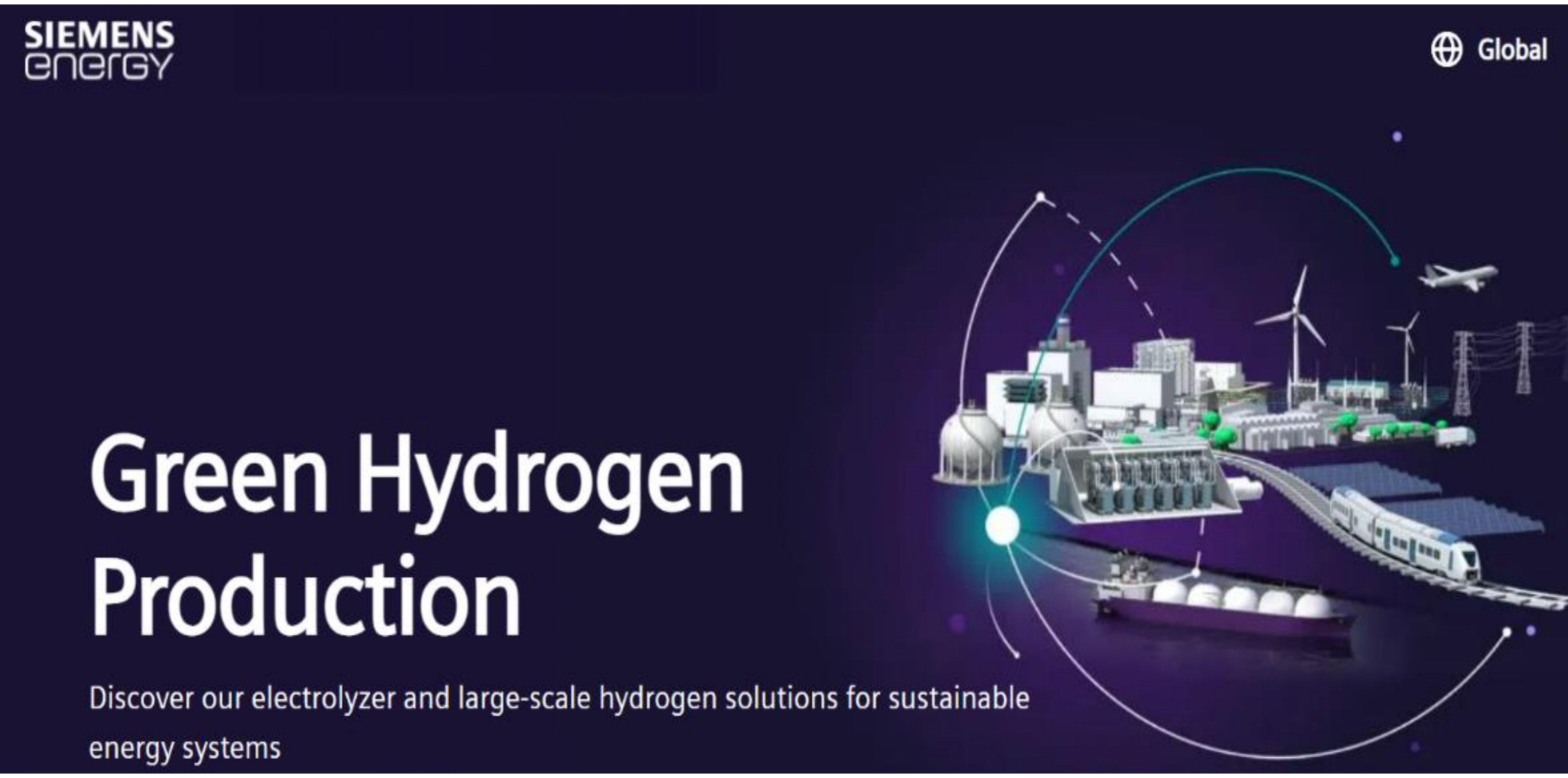


PSECC Ltd - Phase One Railway & Economic Zones - Energy Installed & Cost Recommendations to meet Kenya Government, LCDA targets, NDC's and IPCC emission reduction.

		MW (2024 – 2028)		Cost	MW (2028 – 2035)		Cost
• expansion in geothermal	-	1,887	MW	US$ 2,830 m	3,113	MW	US$ 4,669 m
• solar PV	-	500	MW	US$ 500 m	500	MW	US$ 500 m
• solar farms	-	2,000	MW	US$ 1,770 m	1,000	MW	US$ 885 m
• solar PV Manufacturing plant	-	25	MW	US$ 10 m	50	MW	US$ 20 m
• waste plants	-	180	MW	US$ 900 m	180	MW	US$ 900 m
• wind farms	-	150	MW	US$ 328 m	350	MW	US$ 766 m
• green hydrogen	-	1,100	MW	US$ 1,432 m	1,100	MW	US$ 1,432 m
• dams – hydroelectricity	-	796	MW	US$ 796 m	500	MW	US$ 500 m
• climate smart agriculture Bio-Fuels	-	191	M Ltrs	US$ 190 m	150	M Ltrs	US$ 190 m
• Nuclear	-	-	-	- -	940	MW	US$ 4,800 m
• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

<u>PSECC Ltd propose 2,200MW of Green Hydrogen – Eight plants in total</u>

BENEFITS OF HYDROGEN



Green hydrogen (H2) is a versatile energy carrier that can be applied to decarbonize a wide range of sectors. It can be used directly or in the form of its derivatives like e-methanol, e-ammonia, or e-fuels to replace fossil fuels, coal or gas.

Only around 40% of global carbon dioxide (CO_2) emissions originate from power generation which can be decarbonized via electrification. The other 60% of CO_2 emissions originate from industry, mobility, buildings and others. These can be decarbonized via sector coupling, using green hydrogen and its derivatives to make renewable energy available to those sectors. This is why the production of sustainable hydrogen is such a crucial issue.

Green hydrogen, produced through renewable energy sources like wind or solar power, can offer several benefits to the LAPSSET Corridor:

Clean Energy Source:

Green hydrogen is produced through the electrolysis of water using renewable energy sources. This means it does not emit greenhouse gases during its production, offering a clean and sustainable energy source.

Reduced Environmental Impact:

By using green hydrogen, the LAPSSET Corridor can reduce its overall environmental impact, contributing to the region's efforts to mitigate climate change and adhere to sustainability goals.

Energy Storage:

Hydrogen can serve as a means of energy storage, allowing excess renewable energy generated during peak times to be stored and later used when demand is high. This can help stabilize the electricity grid and improve overall energy reliability.

Versatility in Transportation:

Green hydrogen can be used as a fuel for various modes of transportation, including trucks, buses, and potentially even ships. This versatility aligns with the multi-modal transportation objectives of the LAPSSET Corridor.

Promotion of Renewable Energy Integration:

Incorporating green hydrogen production can provide a valuable way to integrate renewable energy sources into the energy mix along the LAPSSET Corridor, supporting a shift away from fossil fuels.

Economic Opportunities:

The production and use of green hydrogen can create economic opportunities, including job creation and the development of a new hydrogen-based industry. This can contribute to the economic growth and diversification of the countries along the LAPSSET Corridor.

Energy Security:

Green hydrogen can contribute to energy security by providing an alternative and reliable source of energy. It can be produced locally, reducing dependence on imported fossil fuels and enhancing energy resilience.

International Collaboration:

Embracing green hydrogen aligns with global efforts to transition towards sustainable energy sources. This can foster international collaboration, attract investments, and position the LAPSSET Corridor as a leader in adopting green and sustainable technologies.

Technology Transfer and Innovation:

The adoption of green hydrogen technology can lead to the transfer of knowledge and expertise in renewable energy and hydrogen production, fostering innovation and technological advancements within the region.

Strategic Positioning:

By incorporating green hydrogen in the LAPSSET Corridor, countries in the region can strategically position themselves as leaders in sustainable development, attracting positive attention and potential partnerships from the international community.

It's important to note that the success of integrating green hydrogen into the LAPSSET Corridor will depend on various factors, including the availability of renewable energy resources, infrastructure development, and supportive government policies.

Why hydrogen-fired power plants 'will play a major role in the energy transition'

Green-hydrogen power plants

Germany’s Siemens Energy — which was spun off from its parent company Siemens last year — is now offering hydrogen-fired power plant solutions to customers. We are linking into Siemens for the train aspects of Lapsset Corridor.

Siemens Energy and Air Liquide pave the way for the ramp-up of the hydrogen economy with a new gigawatt factory for electrolyzers. For hydrogen to become the game changer for a climate-neutral future, it must be available in large quantities and at competitive prices. This requires serial production of cost-effective and scalable electrolyzers. With the new factory, Siemens Energy is making electrolyzers a mass product. With an annual production capacity of one gigawatt, Siemens Energy and Air Liquide expect a ramp-up to at least three gigawatts by 2025 with potential for more.

Deep decarbonisation of the power system will not be possible without burning clean H2 for electricity generation, senior executives at Siemens Energy and Equinor tell Recharge.

At first glance, the concept of a clean-hydrogen power plant seems utterly absurd. Why would anyone use renewable power to make green hydrogen and then burn it to produce electricity? The round-trip efficiency would be less than 40%, so every 10kWh of wind or solar energy would provide less than 4kWh of electricity. And why would anybody create blue hydrogen from natural gas with carbon capture and storage (CCS) — with all the added expense of methane reforming and compressing/liquefying, transporting and storing the hard-to-handle H2 — when you could just add CCS to existing gas-fired power plants? And yet major energy companies such as Siemens Energy, Equinor and SSE believe there is a bright future for hydrogen-fired power plants. Why?

“If I have renewable power, convert it to hydrogen and re-electrify it, with a total cycle efficiency of less than 40%, it obviously only makes sense if you’re using hydrogen as long-term storage and compensation for variable renewables,” says Erik Zindel, Siemens Energy’s vice-president of hydrogen generation sales. “If you really want to [store power] for days, weeks, months, or for seasonal storage — which is using solar power from the summer in winter, or wind power from the autumn to the summer — you need to store electricity in a chemical way.

“You still need [clean] power for the dark doldrums periods in winter, when there’s no sun and no wind blowing for two or three weeks — you need to have a hydrogen supply.”
Our electrolyzer portfolio: The optimum solution for large-scale sustainable hydrogen production Generating green hydrogen efficiently from water and renewable energy requires high-end technology and innovative solutions — like the Silyzer product family from Siemens Energy. Using Proton Exchange Membrane (PEM) electrolysis, the Silyzer is ideally suited for harnessing volatile energy generated from wind and solar. Combining high efficiency and high-power density, our PEM electrolyzers ensure gas products of superior quality. It is easy to operate

and requires low maintenance. Using a modular design strategy that splits the electrolysis system into skids, we are able to optimize costs, reduce installation costs, and make the electrolysis system transportable.

CLIMATE CHANGE MITIGATION

Green hydrogen plays a crucial role in climate change mitigation due to its ability to provide a clean and sustainable energy source. Here are key aspects of how green hydrogen contributes to climate change mitigation:

Renewable Energy Integration:

Green hydrogen is produced through the electrolysis of water using electricity generated from renewable sources such as wind, solar, or hydropower. By using clean energy for hydrogen production, the process avoids the emissions associated with traditional hydrogen production methods that rely on fossil fuels.

Decarbonizing Industrial Processes:

Green hydrogen can be used as a feedstock for various industrial processes, such as chemical production and refining. By replacing conventional hydrogen produced from natural gas with green hydrogen, industries can significantly reduce their carbon footprint.

Clean Transportation:

Green hydrogen can be used as a fuel for fuel cell electric vehicles (FCEVs) and can contribute to decarbonizing the transportation sector. FCEVs emit only water vapor and heat as byproducts, making them a cleaner alternative to traditional internal combustion engine vehicles.

Energy Storage and Grid Balancing:

Hydrogen serves as a means of storing excess renewable energy generated during periods of high production. This stored hydrogen can be used during periods of high demand or when renewable energy generation is low, contributing to grid stability and reliability.

Long-Term Energy Storage:

Green hydrogen offers a solution for long-term energy storage, addressing the intermittent nature of renewable energy sources. It can be stored for extended periods and converted back to electricity when needed, providing a reliable and dispatchable source of energy.

Carbon-Neutral Synthetic Fuels:

Green hydrogen can be used to produce synthetic fuels like e-fuels or electrofuels. These fuels can replace conventional fossil fuels in sectors that are challenging to electrify, such as aviation and certain industrial processes, helping to achieve carbon neutrality.

Hydrogen in the Power Sector:

Green hydrogen can be used in power generation, either through direct combustion or by using hydrogen fuel cells. This provides an additional clean energy option, especially in situations where direct electrification is challenging.

Reduction of Methane Emissions:

Green hydrogen production can contribute to reducing methane emissions associated with traditional hydrogen production methods, such as steam methane reforming (SMR). This is important because methane is a potent greenhouse gas.

Global Collaboration and Diplomacy:

The production and use of green hydrogen encourage international collaboration in addressing climate change. Countries can work together to develop common standards, share technologies, and implement joint initiatives to promote the global adoption of green hydrogen.

Market Development and Innovation:

The growing demand for green hydrogen can stimulate innovation, cost reductions, and advancements in technology. As the technology matures and economies of scale are realized, the cost of green hydrogen is expected to decrease, making it more competitive with traditional, carbon-intensive alternatives.

In summary, green hydrogen contributes significantly to climate change mitigation by providing a clean and versatile energy carrier that can be integrated into various sectors, helping to reduce carbon emissions and transition toward a more sustainable and low-carbon energy system.

The heart of the PEM electrolyzer, stacks combined in groups. Prefabricated for modular and fast installation on site. The Wunsiedel electrolyzer with 8.5 MW on site.

Grid integration and safety first are in our DNA. Transformers and in-house developed rectifier configurations are part of our scope. The picture showcases the 17.5 MW electrolysis.

The compact design of the 17.5 MW electrolysis plant. With our longstanding experience in the energy industry, we ensure the smooth implementation of large-scale projects and provide comprehensive electrolysis plant services.

Upscaling to a higher power level is demonstrated in the 50 MW reference plant. The modular design of the 17.5 MW electrolysis plant facilitates the design of larger plants up to gigawatt capacity.

ALIGNMENT WITH LAPSSET

The LAPSSET (Lamu Port-South Sudan-Ethiopia Transport) Corridor is a major infrastructure project in East Africa aimed at enhancing transportation and connectivity across the region. While my information is based on knowledge up to January 2022, the alignment of green hydrogen with the LAPSSET Corridor's energy strategy can bring several benefits:

Sustainable Energy Source:

Green hydrogen aligns with the LAPSSET Corridor's energy strategy by offering a sustainable and clean energy source. Produced through the electrolysis of water using renewable energy, green hydrogen avoids the environmental impacts associated with conventional hydrogen production methods that rely on fossil fuels.

Integration of Renewable Energy:

The production of green hydrogen relies on renewable energy sources such as solar or wind power. This aligns with the LAPSSET Corridor's potential to integrate renewable energy into its energy mix, contributing to a reduction in carbon emissions and promoting a more sustainable energy infrastructure.

Diversification of Energy Mix:

Integrating green hydrogen into the energy strategy of the LAPSSET Corridor can contribute to the diversification of the energy mix. This diversification enhances energy security by reducing dependence on a single energy source, fostering resilience in the face of potential supply disruptions.

Decentralized Energy Production:

Green hydrogen production can be decentralized, allowing for distributed energy generation along the LAPSSET Corridor. This can be particularly advantageous in areas where centralized power generation may be challenging or less efficient.

Clean Transportation:

Green hydrogen can be utilized as a clean fuel for transportation within the LAPSSET Corridor. This includes the potential use of hydrogen fuel cell vehicles for road and rail transport, reducing the carbon footprint of the transportation sector along the corridor.

Promotion of Economic Growth:

The adoption of green hydrogen technology can stimulate economic growth by creating job opportunities, attracting investments, and positioning the LAPSSET Corridor as a hub for sustainable and innovative energy solutions.

Technology Transfer and Innovation:

Incorporating green hydrogen into the LAPSSET energy strategy can facilitate the transfer of knowledge and technology related to renewable energy and hydrogen production. This can lead to innovation and advancements in the region's energy sector.

Global Collaboration:

Green hydrogen is part of the global effort to transition towards sustainable energy. Aligning the LAPSSET Corridor's energy strategy with green hydrogen can open avenues for international collaboration, partnerships, and shared initiatives focused on clean and renewable energy.

Resilience to Energy Price Volatility:

Green hydrogen production provides a level of insulation against energy price volatility, as it is based on renewable resources with relatively stable and predictable costs. This can contribute to the economic stability of the LAPSSET Corridor and its energy users. It's important to note that the successful integration of green hydrogen into the LAPSSET Corridor's energy strategy would depend on various factors, including the availability of renewable resources, infrastructure development, policy support, and economic feasibility. Therefore, ongoing collaboration between stakeholders, including governments, private sector entities, and international organizations, is crucial for the effective implementation of a green hydrogen strategy within the LAPSSET Corridor. Additionally, developments may have occurred since my last update, so it's advisable to check for the latest information on the LAPSSET Corridor project and related energy initiatives.

TIMELINE

Following is the tentative timeline of the Green Hydrogen programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	Four plants	1,100MW	2024
Phase 3:	Four plants	1,100MW	2028

COST

The details of the indicative cost are provided below (dependent upon exact criteria):

Title	Cost (USD)	MWh per year
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$300,000	
Phase 2. Four plants	$1,432 Million	Approximately 1,110,720 MWh
Phase 3. Four plants	$1,432 Million	Approximately 1,110,720 MWh

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

REVENUE

PSECC Ltd calculations (to be confirmed once plant is operational and O&M considered) – indicative.

Items	Revenue (USD)
Yearly Energy Generation from 2,200MW plant producing 2,221,440MWh – electricity sold at $0.05 KWh	$111.072 Million
Government 35% share of revenue per year	$38.87 Million
Total Government revenue share over 20 years	$777.50 Million

Loan repayments will then have to be made.

CARBON DIOXIDE SAVINGS

Estimate the carbon dioxide (CO_2) savings from a green hydrogen plant generating 221,440 MWh a year, we need to consider the emissions associated with conventional electricity generation and compare it to the emissions from the green hydrogen plant.

Emissions from Conventional Electricity:

The emissions depend on the energy mix of the region. If we assume a generic value, let's say 0.5 kg CO_2 per kWh, then the emissions from conventional electricity would be:

$$\text{Emissions}_{\text{conventional}}=221{,}440\text{MWh/year}\times 0.5\text{kg } CO_2\text{/kWh}$$

Emissions from Green Hydrogen Plant:

Green hydrogen is considered a clean energy source during operation. However, emissions might occur during the manufacturing of the electrolyzer, construction, and other lifecycle stages. If we assume a conservative estimate for the emissions associated with green hydrogen production (including the manufacturing of the electrolyzer), let's say 2 kg CO_2 per kg of hydrogen produced, then the emissions from the green hydrogen plant would be:

2. **Emissions Factor**

Emissionsgreen hydrogen=(Electricity Consumptionhydrogen production×Hydrogen Yield)×2 kg CO_2/kg hydrogenEmissionsgreen hydrogen =(Electricity Consumptionhydrogen production ×Hydrogen Yield)×2kg CO_2/kg hydrogen

Now, let's calculate the net CO_2 savings:

Net CO_2 Savings=Emissionsconventional−Emissionsgreen hydrogen Net CO_2 Savings=Emissionsconventional−Emissionsgreen hydrogen

Net CO2 Savings=(221,440 MWh/year×0.5 kg CO_2/kWh)−(Electricity Consumptionhydrogen production×Hydrogen Yield×2 kg CO_2/kg hydrogen)Net CO_2 Savings=(221,440MWh/year×0.5kg CO_2/kWh)−(Electricity Consumptionhydrogen production×Hydrogen Yield×2kg CO_2/kg hydrogen)

The actual electricity consumption for hydrogen production and hydrogen yield would depend on the efficiency of the electrolyzer and other factors specific to the green hydrogen plant.

Please note that these calculations involve some assumptions and estimations, and the actual emissions can vary based on the specific conditions and technologies used in the green hydrogen plant. It's recommended to obtain more precise data for the particular plant in question for a more accurate assessment of CO_2 savings.

Proposed Energy projects for Lapsset & Kenya

Energy Source	Capacity (MW)	Estimated Emissions Reduction (tCO2/MWh)	Annual Carbon Reduction (tCO2)
Geothermal	5,000	0.01	50,000,000
Solar PV	1,000	0.02	2,000,000
Solar Farms	3,000	0.02	6,000,000
Wind Farms	500	0.02	1,000,000
Waste to Energy Plants	360	0.05	1,800,000
Green Hydrogen Plants	2,200	0.00 (assuming zero emissions)	0
Hydroelectricity Dams	1,296	0.00 (assuming zero emissions)	0
Bioethanol Plants	341	0.05 (assuming emissions similar to waste-to-energy)	1,705,000
Nuclear Plants	940	0.01	9,400,000
Clean Coal Plants	2,040	0.7 (assuming lower emissions for cleaner coal technology)	14,280,000
Total Carbon Reduction			**85,185,000**

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Pumped Hydro

Project Concept REPORT

PREPARED FOR:

Mr S. Ikua
Director General / CEO

LAPSSET CORRIDOR

Lapsset Corridor Development Authority - LCDA

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Project No. PSECC008

December 2023

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EXECUTIVE SUMMARY

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GLOBAL POSITION

Hydropower generation globally decreased by 15 TWh (down 0.4%) in 2021, declining to 4,327 TWh despite a step increase in capacity growth. The decrease was caused by droughts in several parts of the world, including Kenya.

Nevertheless, hydro remains the largest renewable source of electricity, generating more than all other renewable technologies combined. In the Net Zero Emissions by 2050 Scenario, hydropower maintains an average annual generation growth rate of about 3% in 2022-2030 to provide approximately 5,700 TWh of electricity per year.

Kenya presents itself as highly vulnerable to climate change effects – this is a major problem and this problem can be resolved. Kenya's water and sanitation crisis With a population of 53 million, about 28 million Kenyans lack access to safe water and 41 million lack access to improved sanitation. Growing water demand and water scarcity have turned into a notable challenge in Kenya.

We are proposing five new Dams for hydroelectricity production with pumped hydro for security of supply. Solar and Wind will provide the power for the pumped hydro projects.

Hydropower registered an increment of 33% from 3,205.34 GWh in 2019 to 4240.42 GWh in 2020.

In general, the cost of a hydroelectric dam is around $1 million per megawatt (MW). That's a lot less than the cost of building a coal or nuclear plant. The Federal Energy Regulatory Commission estimates that the average annual operating and maintenance (O&M) cost for a hydroelectric dam is between $0.03 – $0.04/kWh and this must be taken into account when considering supplying electricity t Lapsset Corridor @ $0.05 KWh.

This is an Hydroelectricity Energy Review – Hydroelectric Dams and Pumped Hydro, a Detailed Technical offer will follow on these Renewable Energy technology mitigation measures.

CONCEPT

Project Concept Report

The Lapsset Corridor could be partly powered by a 796 MW Grand Falls Dam upgrade plus a further 500MW totaling of Hydroelectricity Dams together with pumped hydroelectricity backup

Table 1.

PSECC Ltd - Phase One Railway & Economic Zones - Energy Installed & Cost Recommendations to meet Kenya Government, LCDA targets, NDC's and IPCC emission reduction.

		MW (2024 – 2028)		Cost	MW (2028 – 2035)		Cost
• expansion in geothermal	-	1,887	MW	US$ 2,830 m	3,113	MW	US$ 4,669 m
• solar PV	-	500	MW	US$ 500 m	500	MW	US$ 500 m
• solar farms	-	2,000	MW	US$ 1,770 m	1,000	MW	US$ 885 m
• solar PV Manufacturing plant	-	25	MW	US$ 10 m	50	MW	US$ 20 m
• waste plants	-	180	MW	US$ 900 m	180	MW	US$ 900 m
• wind farms	-	150	MW	US$ 328 m	350	MW	US$ 766 m
• green hydrogen	-	1,100	MW	US$ 1,432 m	1,100	MW	US$ 1,432 m
• dams – hydroelectricity	-	796	MW	US$ 796 m	500	MW	US$ 500 m
• climate smart agriculture Bio-Fuels	-	191	M Ltrs	US$ 190 m	150	M Ltrs	US$ 190 m
• Nuclear	-	-	-	- -	940	MW	US$ 4,800 m
• Clean Coal Technology	-	2,040	MW	US$ 2,107 m	-	-	- -
	Total	8,869	MW	US$ 10,863m	7,883	MW	US$ 14,662 m

Kenya - Boosting the economy

Kenya is part of the African Great Lakes region and well-known for its safaris, diverse climate and geography, as well as expansive wildlife reserves.

The economy of Kenya is the largest in East and Central Africa and has grown over the last seven years. Only about 20% of the population has access to electricity. The country's technically feasible hydropower potential is about 3,500 MW, though not even a quarter of that has been developed.

There are no hydropower schemes currently under construction, but several in planning, such as The High Gand Falls scheme with 700MW or HPP Karura, both on the Tana River. An additional 120 MW could be achieved by modernization and upgrading of existing facilities. There is also the potential for several small-scale hydropower plants, some of which should be pumped hydro.

The government has a national energy strategy to boost the economy with the development of more hydropower.

ANDRITZ HYDRO

ANDRITZ HYDRO's activities in Kenya reach back to the 1960s, when the com-pany was involved in the initial installation of HPP Kin-da-ruma (72 MW). In 2010, ANDRITZ HYDRO received the order for the rehabilitation of this hydropower plant, which was successfully recommissioned in 2013. Other projects, such as HPP Masinga and the most recent order for HPP North Mathoyia, further strengthen the po-si-tion of ANDRITZ HYDRO in Kenya.

HPP Lower Nyamindi and HPP South Mara

The general EPC contractor JIANGXI Water and Hydropower Con-struc-tion Kenya Ltd. awarded ANDRITZ HYDRO with another two contracts to supply the complete electro-mechanical equip-ment, including two 930 kW Compact Francis turbines for HPP Lower Nya-mindi and one 2,200 kW six-jet vertical Compact Pelton turbine for HPP South Mara.

The two small hydropower plants were developed as pilot projects to generate power for the Kenya Tea Development Agency (KTDA). Com-mis-sioning of both hydropower projects, which further secure independent electrical energy supply from two more installations under the management of KTDA Power Company, took place in August 2016.

The Sir Adam Beck Pump Generating Station at Niagara Falls, which was built in 1957, is an Ontario Power Generation-owned and operated pumped-hydro storage system that uses off-peak electricity to pump water into its reservoir, which is then released during peak hours to turn turbines that produce up to 174 MW of power. This concept should be widely adopted in the e Lapsset Corridor project in Kenya to enhance the transition towards Net Zero.

Hydroelectricity is the oldest form of renewable energy. It is the most developed renewable energy and has been used all over the world for centuries.

Hydroelectricity harness energy in water flowing in rivers to produce electricity. In Kenya, hydro energy is a major source of electricity.

According to Energy and Petroleum Authority (EPRA), Kenya has installed hydroelectricity capacity of 826.23 MW, roughly a third of total installed capacity [1]. Most of the hydropower plants are large hydro with capacity greater than 10MW while only 15 MW are small hydro plants.

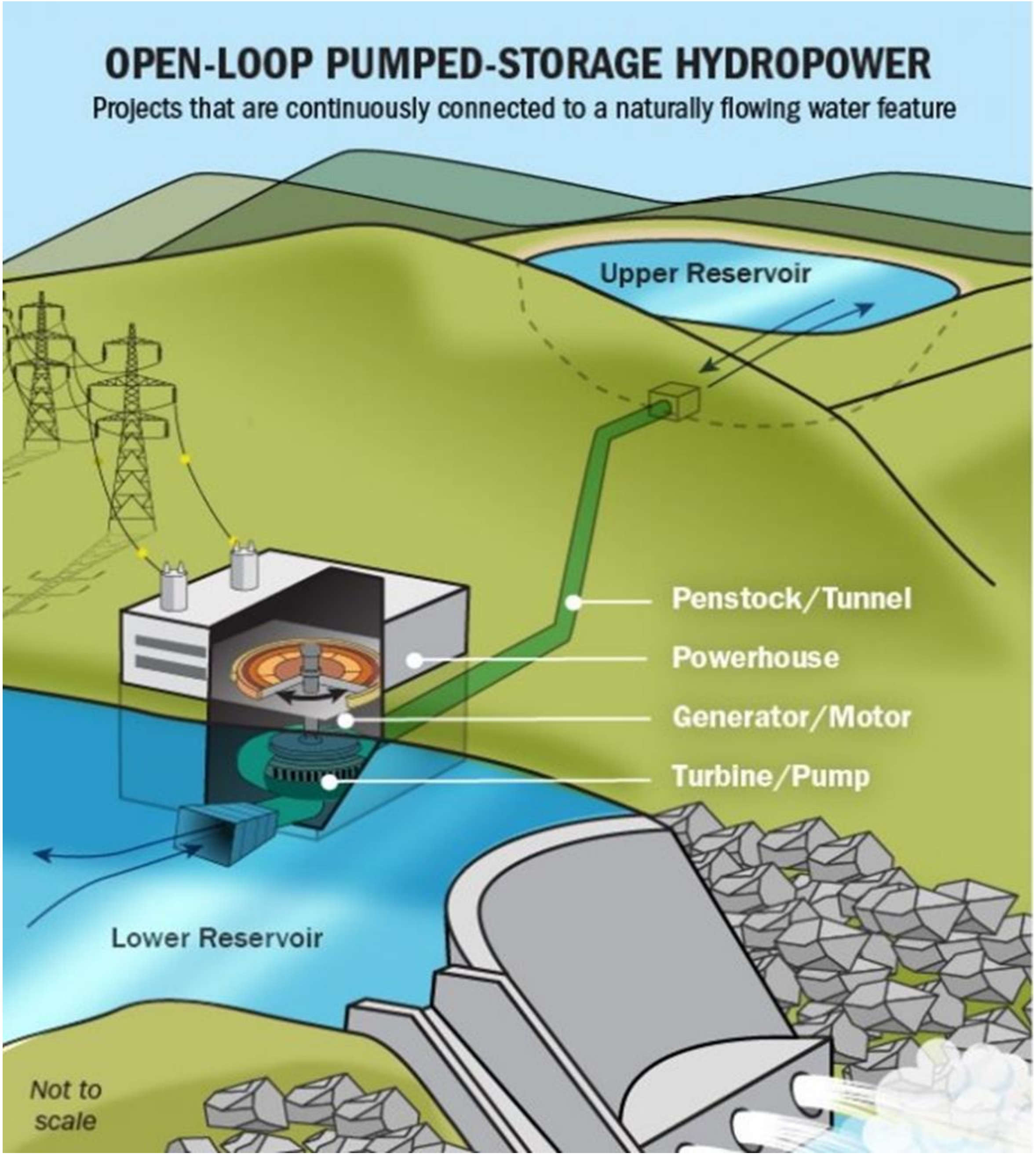
Kenya has significant hydropower potential which is estimated to be 6000MW. Of this potential, small hydro potential is projected to be slightly above 3000

MW. Hydropower potential is distributed across the country's five major drainage basins namely; Mt Kenya, Man Complex, Aberdare Ranges, Cherangani Hills and Mt Elgon [2]. Tana River boosts the highest hydropower potential among the five areas with a potential of 790 MW. Five major hydropower stations in Kenya are located along Tana River.

Energy storage in Kenya: energizing the transition

Fig. 1 An aerial view of the Goldisthal Pumped Storage Station, the largest hydroelectric power plant in Germany and one of the largest in Europe

Fig 2. Open Loop Pumped-Storage Hydropower



Open-loop pumped storage hydro (PSH) is a type of hydropower system that involves two water reservoirs at different elevations and a pumping/generating station. Unlike closed-loop (or conventional) pumped storage, open-loop systems do not have a natural water source at the upper reservoir. Instead, they rely on water from external sources, such as rivers or lakes, to fill the upper reservoir when needed. Here's a basic explanation of how open-loop pumped storage hydro works:

Upper Reservoir (High Elevation):

The upper reservoir is situated at a higher elevation and is typically filled with water from an external source, such as a river or lake. Unlike closed-loop systems, there is no natural inflow into the upper reservoir from a dedicated water source.

Lower Reservoir (Low Elevation):

The lower reservoir is located at a lower elevation. It is typically connected to the upper reservoir through a system of penstocks (large pipes).

Pumping Mode:

During periods of low electricity demand or when electricity generation is more cost-effective, surplus electricity from the grid is used to pump water from the lower reservoir to the upper reservoir. This process converts electrical energy into gravitational potential energy.

Generating Mode:

When electricity demand is high or during peak hours, water from the upper reservoir is released to flow back down through the penstocks to the lower reservoir. As the water descends, it passes through turbines connected to generators, converting the gravitational potential energy back into electrical energy. This generated electricity is then supplied to the grid.

External Water Source:

Open-loop systems rely on an external water source (such as a river or lake) to replenish the upper reservoir. This external water source does not necessarily have to be a dedicated watercourse associated with the power plant.

Open-loop pumped storage hydro offers a way to store and manage energy in response to varying electricity demand. It provides a means of storing excess energy during periods of low demand and releasing stored energy during peak demand, helping to balance the grid and improve overall system reliability.

While closed-loop pumped storage systems are more common, open-loop systems can be a viable option in locations where suitable natural water sources are available for filling the upper reservoir.

The height of a feed lake above a hydroelectric dam in a pumped hydro project can vary depending on a number of factors, including the specific requirements of the project and the available topography.

Ideally, the height of the feed lake should be sufficient to create a significant head or pressure that can be used to generate electricity when the water is released from the upper reservoir to the lower reservoir. This head is crucial for the efficient operation of the hydroelectric system.

In general, a higher elevation provides a greater potential energy, enabling a larger amount of electricity generation. However, there are practical considerations that might limit the height of the feed lake. These could include the availability of suitable topography, the distance from the prospective lake location to the dam site, and the cost and feasibility of constructing the necessary infrastructure.

Floating solar farms are becoming increasingly popular around the world because their unique design addresses multiple efficiency and city planning issues. These floating apparatuses free up land in more populated areas and also reduce water evaporation. The cooler air at the surface also helps to minimize the risk of solar cell performance atrophy, which is often related to long-term exposure to warmer temperatures.

The Floating Solar Farms can be put in any new lakes we build for Pumped Hydro, power coming from the lake solar PV arrays to pump the water back up to its own lake, which saves on taking any land for a solar farm.

The height of a feed lake above a hydroelectric dam in a pumped hydro project can vary depending on a number of factors, including the specific requirements of the project and the available topography.

Example - The Grand Falls Dam - Hydroelectricity enhancement - To determine the required head of water and the height of the feed lake above the hydroelectric dam, additional information is needed. Specifically, the technical specifications and design requirements of the pumped hydro project would be necessary.

However, it is possible to estimate the required head and height based on the power enhancement target of 796 MW. To generate this amount of power, a significant head would be typically required.

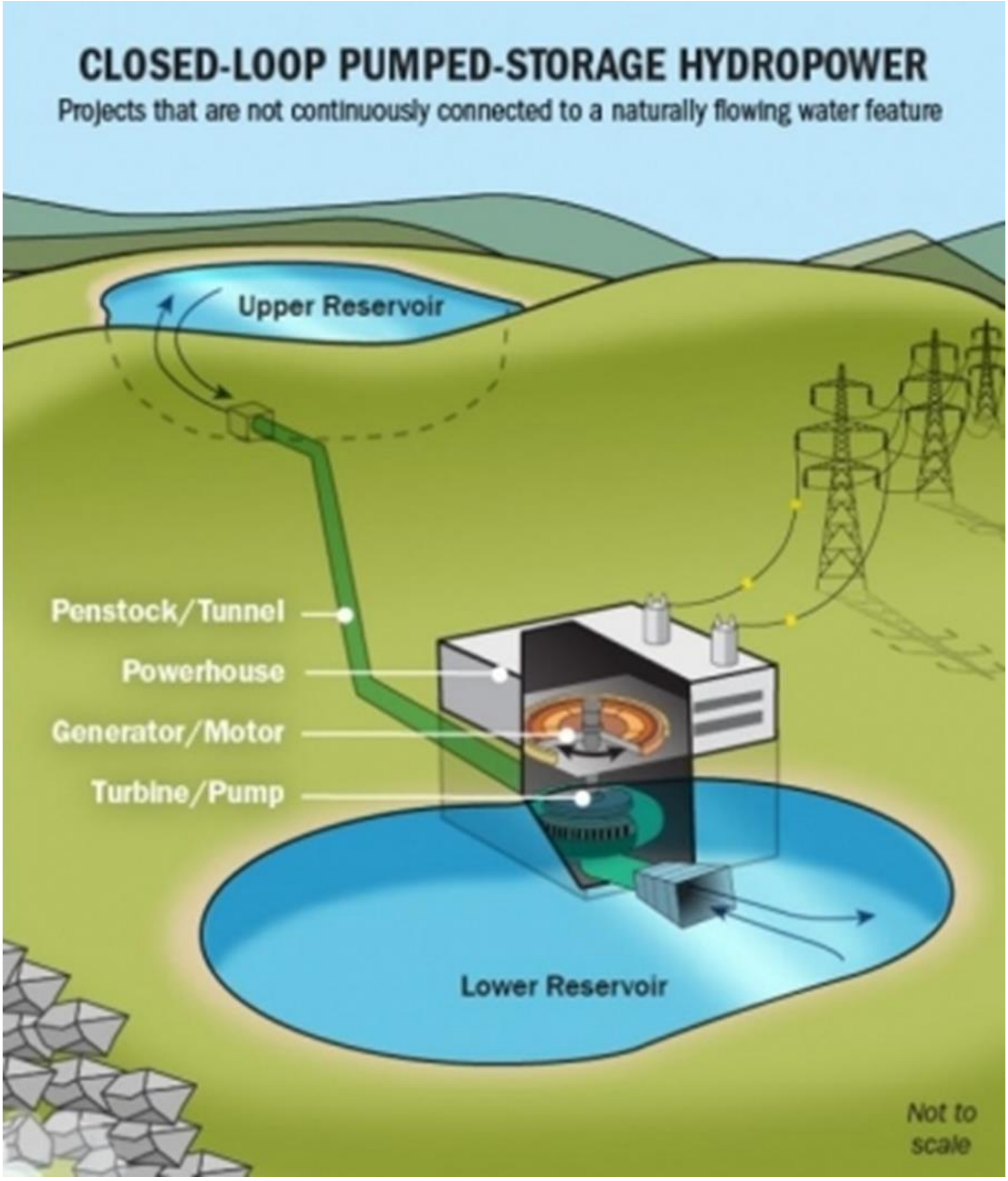
In a typical pumped hydro project, the head is determined by the height difference between the upper reservoir (feed lake) and the lower reservoir (hydroelectric dam). The potential energy of the water is harnessed as it flows downhill from the higher elevation to the lower elevation, turning the turbines and generating electricity.

A general guideline for pumped hydro projects suggests that a head of about 200-300 meters (656-984 feet) is commonly used. However, this can vary depending on the specific project requirements and constraints.

Given the desired power enhancement of 796 MW, it is reasonable to assume that a relatively high head will be required, potentially toward the upper end of the range mentioned above. This estimation can be used as a starting point, but it is essential to consult with experts and conduct a detailed engineering analysis to determine the precise head and height requirements for the specific pumped hydro project.

It is not possible to determine an exact height without knowing the specific requirements and constraints of the project. A detailed engineering analysis is usually conducted to determine the optimum height for a feed lake in a pumped hydro project, taking into account factors such as the available water supply, target energy capacity, and cost-effectiveness.

Fig 3. Closed-Loop Pumped-storage Hydropower



Closed-loop pumped storage hydro (PSH) is a type of hydropower system that involves two water reservoirs at different elevations and a pumping/generating station. Unlike open-loop pumped storage, closed-loop systems have a dedicated water source, typically in the form of an upper reservoir that is filled by a natural watercourse such as a river or stream. Here's a basic explanation of how closed-loop pumped storage hydro works:

Upper Reservoir (High Elevation):

The upper reservoir is located at a higher elevation and is typically filled with water from a natural water source, such as a river or stream. This water source provides a continuous inflow to the upper reservoir.

Lower Reservoir (Low Elevation):

The lower reservoir is situated at a lower elevation and is typically located downstream from the upper reservoir. It may also receive the natural flow of the river.

Pumping Mode:

During periods of low electricity demand or when electricity generation is more cost-effective, surplus electricity from the grid is used to pump water from the lower reservoir to the upper reservoir. This process converts electrical energy into gravitational potential energy.

Generating Mode:

When electricity demand is high or during peak hours, water from the upper reservoir is released to flow back down through a penstock (a large pipe) to the lower reservoir. As the water descends, it passes through turbines connected to generators, converting the gravitational potential energy back into electrical energy. This generated electricity is then supplied to the grid.

Continuous Water Source:

Closed-loop systems benefit from a continuous water source that refills the upper reservoir, ensuring a reliable and consistent water supply for the pumping and generating cycles.

Closed-loop pumped storage hydro provides a means of storing and managing energy in response to varying electricity demand. It serves as a form of grid energy storage, helping to balance the supply and demand of electricity and providing grid stability.

Closed-loop systems are more common than open-loop systems because they rely on a dedicated water source, making them suitable for a wider range of geographical locations. The availability of a natural watercourse for the upper reservoir is a key factor in determining the feasibility of closed-loop pumped storage hydro projects.

CALCULATION FOR THE SIZE OF A PUMPED HYDRO PROJECT

Calculating the size of a pumped hydroelectric power plant involves considering several factors related to the site and the desired capacity of the facility. The key parameters to be determined include the head (the difference in elevation between the upper and lower reservoirs), the flow rate of water, and the desired power capacity of the plant. Here's a simplified overview of the process:

Determine Head (H):

The head is the vertical distance between the water levels of the upper and lower reservoirs. It is a crucial factor in determining the potential energy available for power generation. The higher the head, the more gravitational potential energy can be converted into electricity. The head is usually measured in meters (m).

Determine Flow Rate (Q):

The flow rate represents the amount of water that can be circulated between the upper and lower reservoirs. It is typically measured in cubic meters per second (m^3/s) or cubic feet per second (cfs). The flow rate is influenced by factors such as the size of the watercourses and the natural flow of water.

Calculate Potential Energy (PE):

The potential energy (PE) available in the system is given by the equation:

$$PE = m \cdot g \cdot H$$

where:

m is the mass of water (in kg or other appropriate mass units),

g is the acceleration due to gravity (approximately 9.81 m/s^2), and

H is the head (in meters).

Determine Power Capacity (P):

The power capacity of the pumped hydro plant is the rate at which energy is converted. It is given by the equation:

$$\rho \cdot g \cdot Q \cdot H$$

where:

η is the efficiency of the system (a dimensionless value between 0 and 1),

ρ is the density of water (approximately 1000 kg/m^3),

g is the acceleration due to gravity (approximately 9.81 m/s^2),

Q is the flow rate (in m^3/s), and

H is the head (in meters).

Calculate Plant Size:

The size of the pumped hydro plant, often measured in megawatts (MW) or gigawatts (GW), is determined by the power capacity and the desired operational characteristics of the facility.

It's important to note that these calculations provide a basic overview, and a detailed feasibility study by engineers and experts is necessary for an accurate assessment of a specific site's potential and the required plant size. Additionally, environmental and regulatory considerations play a crucial role in the development of pumped hydro projects.

IMPORTANT FACTORS

1. Ensure foundations are sound, not on compacted soil but concrete.
2. Strong retaining wall that would not settle and crack or fail
3. Roller compacted foundations
4. Install High water level trips
5. Build away from communities

Building a Pumped Hydro Storage (PHS) dam involves several important factors to ensure its successful operation and long-term viability. Here are key considerations:

1. **Site Selection:**
    - **Topography:** Choose a site with significant elevation differences between an upper and lower reservoir. The greater the elevation change, the more energy can be stored.
    - **Geology:** Assess the geological stability of the site to ensure it can support the weight of the dam and reservoirs.
2. **Water Availability:**
    - **Water Source:** Ensure a reliable and sustainable water source for both the upper and lower reservoirs. This could be a river, lake, or other water bodies.
    - **Water Quality:** Assess the quality of the water to avoid sedimentation and erosion issues that could affect the efficiency of the system.
3. **Environmental Impact:**
    - **Environmental Assessment:** Conduct thorough environmental impact assessments to understand and mitigate potential ecological effects, including impacts on aquatic life, vegetation, and local ecosystems.
    - **Fish Migration:** Implement measures to address the impact on fish migration, if applicable.
4. **Permitting and Regulation:**
    - **Regulatory Compliance:** Ensure compliance with local, regional, and national regulations and obtain all necessary permits before construction begins.

5. **Construction Materials and Techniques:**
    - **Dam Design:** Develop a dam design that considers factors such as height, materials, and safety features. Consider both embankment and concrete dam options based on site characteristics.
    - **Tunnelling and Penstock Design:** Design tunnels and penstocks that connect the upper and lower reservoirs, considering factors such as length, diameter, and material.
6. **Energy Infrastructure:**
    - **Turbine and Generator Selection:** Choose appropriate turbines and generators based on the desired capacity and efficiency of the system.
    - **Transmission Lines:** Plan for the construction of transmission lines to connect the hydroelectric power station to the electrical grid.
7. **Safety Measures:**
    - **Emergency Preparedness:** Develop comprehensive emergency preparedness and response plans, including dam failure scenarios.
    - **Monitoring Systems:** Implement monitoring systems for dam stability, water levels, and other critical parameters.
8. **Lifecycle Costs and Financial Viability:**
    - **Cost-Benefit Analysis:** Conduct a thorough cost-benefit analysis to assess the economic viability of the project over its lifecycle.
    - **Maintenance and Repairs:** Plan for ongoing maintenance and periodic inspections to ensure the long-term reliability and safety of the dam.
9. **Community Engagement:**
    - **Stakeholder Consultation:** Engage with local communities and stakeholders to address concerns, gather input, and ensure the project aligns with community needs and expectations.
10. **Adaptability and Flexibility:**
    - **Technology Upgrades:** Design the system to be adaptable to future technological advancements in hydroelectric power generation.
11. **Reservoir Management:**
    - **Water Management:** Develop strategies for efficient water management, considering factors such as evaporation, sedimentation, and seasonal variations in water availability.
12. **Legal and Ownership Considerations:**
    - **Land Rights:** Ensure clear land rights and ownership agreements for the areas surrounding the dam.

By carefully addressing these factors, project developers can enhance the likelihood of a successful Pumped Hydro dam project that meets both technical and environmental requirements.

HYDROPOWER IN KENYA

Hydroelectricity is the oldest form of renewable energy. It is the most developed renewable energy and has been used all over the world for centuries. Hydroelectricity harness energy in water flowing in rivers to produce electricity. In Kenya, hydro energy is a major source of electricity. According to Energy and Petroleum Authority (EPRA), Kenya has installed hydroelectricity capacity of 826.23 MW, roughly a third of total installed capacity [1]. Most of the hydropower plants are large hydro with capacity greater than 10MW while only 15 MW are small hydro plants.

Kenya has significant hydropower potential which is estimated to be 6000MW. Of this potential, small hydro potential is projected to be slightly above 3000 MW. Hydropower potential is distributed across the country's five major drainage basins namely; Mt Kenya, Man Complex, Aberdare Ranges, Cherangani Hills and Mt Elgon [2]. Tana River boosts the highest hydropower potential among the five areas with a potential of 790 MW. Five major hydropower stations in Kenya are located along Tana River. The table 1 below shows hydropower plants in Kenya and their capacity.

Table 1: Hydropower Stations in Kenya. Source: [3],[4]

Plant	Installed Capacity (MW)	Operator
Gitaru Power Station	225	KenGen
Kiamburu Power Plant	90	KenGen
Kindaruma	72	KenGen
Kiambere	168	KenGen
Masinga	40	KenGen
Mesco	0.43	KenGen
Sagana Falls	1.5	KenGen
Sondu Miriu	60	KenGen
Tana	20	KenGen
Turkwel	106	KenGen
Wanjii	7.4	KenGen
Sosiani	0.4	KenGen
Gogo	2	KenGen
Ndula	2	KenGen
Sangoro	20	KenGen
James Finlay	2.4	James Finlay Tea Company
Brooke Bond	2.2	Unilever Tea Company
Diguna	0.4	
Ten Wek	0.32	Ten Wek missionary Hospital
Mujwa	0.01	
Thima	0.01	Community
Kathamba	0.001	Community
Imenti	0.9	KTDA
Tungu-Kabiru	0.014	Community
Savani	0.09	Eastern Produce

Source: Ian Njuguna Kenyatta University – Hydropower in Kenya September 2022

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Deforestation threatens Water supply

Poverty-fueled deforestation threatens - Mau Forest is East Africa’s largest native montane forest and Kenya’s largest water catchment.

• Olpusimoru Forest Reserve is one of Mau Forest’s protected areas, but its forest cover has been greatly reduced by logging, fuelwood collection and other poverty- driven human pressures.

• Beginning in 2018, thousands of families that had established themselves inside the forest reserve’s boundaries were evicted by the Ministry of Environment and Forestry, part of a wider push that saw more than 30,000 people evicted from the broader Mau Forest Complex.

• Despite government intervention and civil society initiatives to assuage poverty in the region, signs of fresh logging, charcoal burning and overgrazing are evident in Olpusimoru Forest Reserve.

OLENGURUONE, Kenya — Mau Forest covers some 2,700 square kilometres (1,042 square miles) in western Kenya, making it the largest native montane forest in East Africa. The forest is also Kenya’s largest water catchment area and feeds several lakes, including Lake Victoria.

But Mau Forest is shrinking as its trees fall to human pressures. Even Mau’s protected areas are not immune. One of these is Olpusimoru Forest Reserve, which has been facing high rates of deforestation as people cut down trees for timber and fuelwood collection.

Over the past 20 years, this forest has faced destruction from illegal loggers and encroachers who have extended their farming and grazing lands deep into the forest. By 2010, approximately 30 square kilometers (11.6 square miles) of Olpusimoru’s forest had already been impacted by logging, agriculture and illegal settlements, according to the Kenya Forest Service (KFS). Satellite data from the University of Maryland visualized on Global Forest Watch indicate the reserve lost a further 9% of its primary forest between 2011 and 2021, with preliminary data for 2022 showing deforestation continuing to eat away at remaining habitat.

Beginning in 2018, thousands of families that had established themselves inside the forest reserve’s boundaries were evicted by the Ministry of Environment and Forestry, part of a wider push that saw more than 30,000 people evicted from the broader Mau Forest Complex to which Olpusimoru belongs. But when walking around the forest today, fresh signs of continued encroachment and damage to the forest are evident. Recent, widespread deforestation can also be seen in satellite data and imagery on Global Forest Watch.

FIVE HYDROELECTRICITY PLANTS

Table 3. Dams suitable for Hydroelectricity in the Lapsset Corridor Five Dams generation will be 796 MW (Marked in Red) - 2023

MINISTRY OF WATER, SANITATION AND IRRIGATION

PROPOSED WATER HARVESTING AND STORAGE PROJECTS

S/No	Name of Dam	Scope				Capacity (million m3)	Domestic (people)	Irrigation (Acres)	Power Generation (MW)	Approx Cost (Billion KSh)	Type of Dam	Status
		Type	Height (m)	Produtio n (m³/d)	Land tenure							
1	Aberdare Water System - Malewa	Rock fill with central clay core	72		Private land	214	1,500,000	Nil	16	16	Large	Feasibility study completed
2	Arror Multipurpose Dam	Earth fill	93		Private farms RAP required	64	320,000	8,829	60	18	Large	Designs Completed
3	Kimwarer Dam	Rockfill dam	35m		Private farms RAP required	17.22	320,000	4,972	20	15	Large	Designs Completed
4	Radat Dam	Rockfill embankment with clay core	60		Private farms RAP required	124	20,000	21,000	15	15	Large	Feasibility study completed
5	Amaya Dam	Rock fill dam with central clay core	48		Private farms RAP required	10.45	116,566	1,200	16	16	Large	Designs Ready for funding
6	Lowaat Dam	Rock fill dam with impervious core	50	17,324	Community Land	348	20,000	60,000	15	16	46	Designs Ready
7	Thwake Dam	Concrete faced rock fill dam	80.5		Private land		1,300,000	100,000	20	38	Other	(Phase 2 -Water treatment Phase 3 -Hydropower. Phase 4 - irrigation). Metito has expressed interest as private party
8	High Grand Falls	Roller Compacted concrete dam	115		Private and Community land	5600	5,000,000	400,000	700	220	Large	Proposed for implementation under PPP as a PIP. GBM-ERG Consortium has expressed interest private party
9	Isiolo Dam	Rock Fill with impervious clay core	83	60,000	Private / Community land	214	1,500,000	30,000	16	16	Large	Designs Ready for funding
10	Galana dam	Rock fill dam with impervious core	41		Land Owned by ADC.	400		350,000	15	50	Large	Design Completed
11	Magwagwa	Dam construction and associated works.				45	580,000	150,000	100	21.0	Large	Feasibility and Preliminary Designs Done
12	Gogo dam	Concrete Faced Rockfill Dam (CFRD) and Roller Compacted	47		Private farms RAP required	348	30,000	60,000	25	28	Large	Designs Ready
	TANA RIVER											
58	Galana dam	Rock fill dam with impervious core	41		Land Owned by ADC.	400		207,564	15	50	Large	Design Completed
61	Matomba brook dam	Dam construction and associated works				1.00	50,000	313	50	0.18	Small.	Pre-Feasibility under preparaion
	TURKANA											
109	Lowaat Dam	Rock fill dam with impervious core	50	17,324	Community Land	348	20,000	37,065	15	16	46	Designs Ready

Table 4. Dams suitable for water supply in the Lapsset Corridor

Kenya's water and sanitation crisis With a population of 53 million, about 28 million Kenyans lack access to safe water and 41 million lack access to improved sanitation. Growing water demand and water scarcity have turned into a notable challenge in Kenya.

MINISTRY OF WATER, SANITATION AND IRRIGATION

PROPOSED WATER HARVESTING AND STORAGE PROJECTS

S/No	Name of Dam	Scope				Capacity (million m3)	Purpose			Approx Cost (Billion KSh)	Type of Dam	Status
							Domestic (people)	Irrigation (Acres)	Power Generation (MW)			
		Type	Height (m)	Prodution (m^3/d)	Land tenure							
	MARSABIT											
24	Badassa Dam	Rockfill	46.5	7350	Public Land	4	80,000	Nil	Nil	2.472	Large	Design Review undertaken and tender documents ready
25	Kambinye Mega Pan	Dam construction and associated works				0.5	12,000	156	-	0.09	Small	Feasibility Design Complete
26	Sagante Mega Pan	Dam construction and associated works				0.5	6,000	156	-	0.09	Small	Feasibility Design Complete
27	Huri Hills mega pan	Dam construction and associated works				0.5	6,000	156	-	0.09	Small	Feasibility Design Complete
28	Uran Dam	Dam construction and associated works	15	6,000		0.8	39,000	250	Nil	0.14	Small	Feasibility Design Complete
29	Goro Rukesa Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete

30	Golbo/Nana	Dam construction and associated works				0.5	15,000	156	Nil	0.09	Small	Feasibility Design Complete
31	Karatina Dam	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
32	Boruharo/Qachacha Dam	Dam construction and associated works				0.5	12,000	156	Nil	0.09	Small	Feasibility Design Complete
33	Songa/Kituruni Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete
34	Damballa Fachana Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete
35	Lagbalah River Basin Dam	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
36	Torbi Dam	Dam construction and associated works				0.5	13,000	156	Nil	0.09	Small	Feasibility Design Complete
37	Lake Larapasi Dam	Dam construction and associated works				0.5	11,000	156	Nil	0.09	Small	Feasibility Design Complete
38	Merille Dam	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
39	Kargi Dam	Dam construction and associated works		7,300		0.9	15,000	281	Nil	0.16	Small	Feasibility Design Complete
40	Ilaut Sand Dam	Dam construction and associated works				0.5	7,000	156	Nil	0.09	Small	Feasibility Design Complete
41	Sololo Dam	Dam construction and associated works				0.50	66,000	156	Nil	0.09	Small	Feasibility Design Complete
42	Milgis Laga Dam	Dam construction and associated works				1.00	15,000	313	Nil	0.18	Small	Feasibility Design Complete
43	Ngurrit Dam	Dam construction and associated works				0.50	12,000	156	Nil	0.09	Small	Feasibility Design Complete

S/No	Name of Dam	Scope				Capacity (million m3)	Purpose			Approx Cost (Billion KSh)	Type of Dam	Status
							Domestic (people)	Irrigation (Acres)	Power Generation (MW)			
		Type	Height (m)	Prodution (m^3/d)	Land tenure							
	ISIOLO											
101	Kobi Kalo Composite Rock fill Dam	Composite rock fill	22	30,740	Community land	1	143,000	1,291	Nil	6.4	Large	Feasibility Design Complete
102	Sericho water pan	Dam construction and associated works				0.5	6,000	156	-	0.09	Small	Feasibility Design Complete
103	Kipsing water pan	Dam construction and associated works				0.5	5,000	156	-	0.09	Small	Feasibility Design Complete
104	Ngare Mara water pan	Dam construction and associated works				0.5	5,000	156	-	0.09	Small	Feasibility Design Complete
105	Expansion of Haroresa water pan	Dam construction and associated works				0.1	7,000	31	-	0.02	Small	Pre-Feasibility under preparaion
106	Garbatula Dam	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
107	Merti Dam	Dam construction and associated works				0.5	7,000	156	Nil	0.09	Small	Feasibility Design Complete
108	Kipsing Dam	Dam construction and associated works				0.5	6,000	156	Nil	0.09	Small	Feasibility Design Complete
110	Kadokorinyang	Dam construction and associated works				0.50	10,000	156	-	0.09	Small	Concept done

MINISTRY OF WATER, SANITATION AND IRRIGATION

PROPOSED WATER HARVESTING AND STORAGE PROJECTS

S/No	Name of Dam	Scope				Capacity (million m3)	Purpose			Approx Cost (Billion KSh)	Type of Dam	Status
		Type	Height (m)	Prodution (m^3/d)	Land tenure		Domestic (people)	Irrigation (Acres)	Power Generation (MW)			
	GARISSA											
179	Modogashe Dam Project	Dam construction and associated works				5	50,000	1,236	Nil	5.0	Large	Site identified. Feasibility Design Ongoing
180	Hagarjarer	Dam construction and associated works				0.5	15,000	156	-	0.09	Small	Feasibility Design Complete
181	Fafi water pan	Dam construction and associated works				0.8	5,000	250	-	0.14	Small	Feasibility Design Complete
182	Maleyle water pan	Dam construction and associated works				0.9	15,000	281	-	0.16	Small	Feasibility Design Complete
183	Degbon Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete
184	Maalimin Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete
185	Doyi Water	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
186	Modogashe Dam	Dam construction and associated works				0.5	25,000	156	Nil	0.09	Small	Feasibility Design Complete
187	Fafi Dam	Dam construction and associated works				0.5	12,000	156	Nil	0.09	Small	Feasibility Design Complete
188	Hifow Dam	Dam construction and associated works				0.5	8,000	156	Nil	0.09	Small	Feasibility Design Complete
189	Galmagala Dam	Dam construction and associated works				0.5	15,000	156	Nil	0.09	Small	Feasibility Design Complete
190	Hulugho Dam	Dam construction and associated works				0.5	15,000	156	Nil	0.09	Small	Feasibility Design Complete
191	Kornel Dam	Dam construction and associated works				0.5	15,000	156	Nil	0.09	Small	Feasibility Design Complete
192	Haijabis Dam	Dam construction and associated works				0.5	9,000	156	Nil	0.09	Small	Feasibility Design Complete
193	Moraari Dam	Dam construction and associated works				0.5	5,000	156	Nil	0.09	Small	Feasibility Design Complete
194	Elin Dam	Dam construction and associated works				0.5	10,000	156	Nil	0.09	Small	Feasibility Design Complete
	LAMU											
249	Mangai Dam	Dam construction and associated works.		3000		0.5	8,000	156	-	0.09	Small	Pre-Feasibility under preparation

Website for full details and documentation on each project can be found at: www.ppp.water.go.ke/dashboard

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SOLAR PV – FOOD Project Concept REPORT

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Agricultural Corridor

Project No. PSECC009

PSECC LTD

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Project Concept Report

CLIMATE CHANGE

Clean, affordable energy for all.

COP28 indicated the importance of Adaption and to "Transition" into a Net Zero economy. We have observed that the drought in Kenya's ASAL regions had a detrimental effect on the most vulnerable communities, particularly pastoralists and small-scale farmers whose livelihoods are mostly dependent on the seasons of rainfall. This is due to the fact that Kenya had five consecutive rainy seasons that have been unsuccessful, beginning in October-November-December (OND) of 2020 to ending in OND 2022. It is anticipated that these vulnerable communities will require at least eight rainy seasons over the course of five years in order to properly recover from the consequences of the prolonged drought.

The main crops produced in Kenya are maize, beans, and pigeon peas (in terms of production area) or maize, tea, and potatoes (in terms of value)41. Maize is Kenya's primary staple crop, grown throughout the country (except in arid areas). It is sensitive to drought and temperature, which makes it vulnerable to climate change. Nationwide, a production decline of 90,000 metric tons has been predicted. Projections for maize cultivation under climate change suggest large regional differences. Before 2050, new maize production areas will be gained in central Kenya, particularly in highlands that were previously too cold for it43. Small yield gains are expected in areas along the Tanzanian border (Rift Valley). Total maize production in these areas may increase by 20%. This is not the case in the ASALs, where production decreases of 20% will harm the already vulnerable sector.

D R O U G H T

The vagaries of drought felt frequently in Kenya in the recent times

is as a result of cumulative rainfall deficits for many years. In the last 20 years, we've had more failed rainfall seasons than is the normal.

At the same time, there have been cases of rainfall seasons with intense rainfall episodes generating enormous rainfall amounts, however, the amounts do not seem to counteract the effects of the rainfall deficits. In 2022 alone, we saw signs of a serious hydrological and ecological drought in many places and that caused a lot of anxiety and concern to the people and the government.

President Ruto's commitment

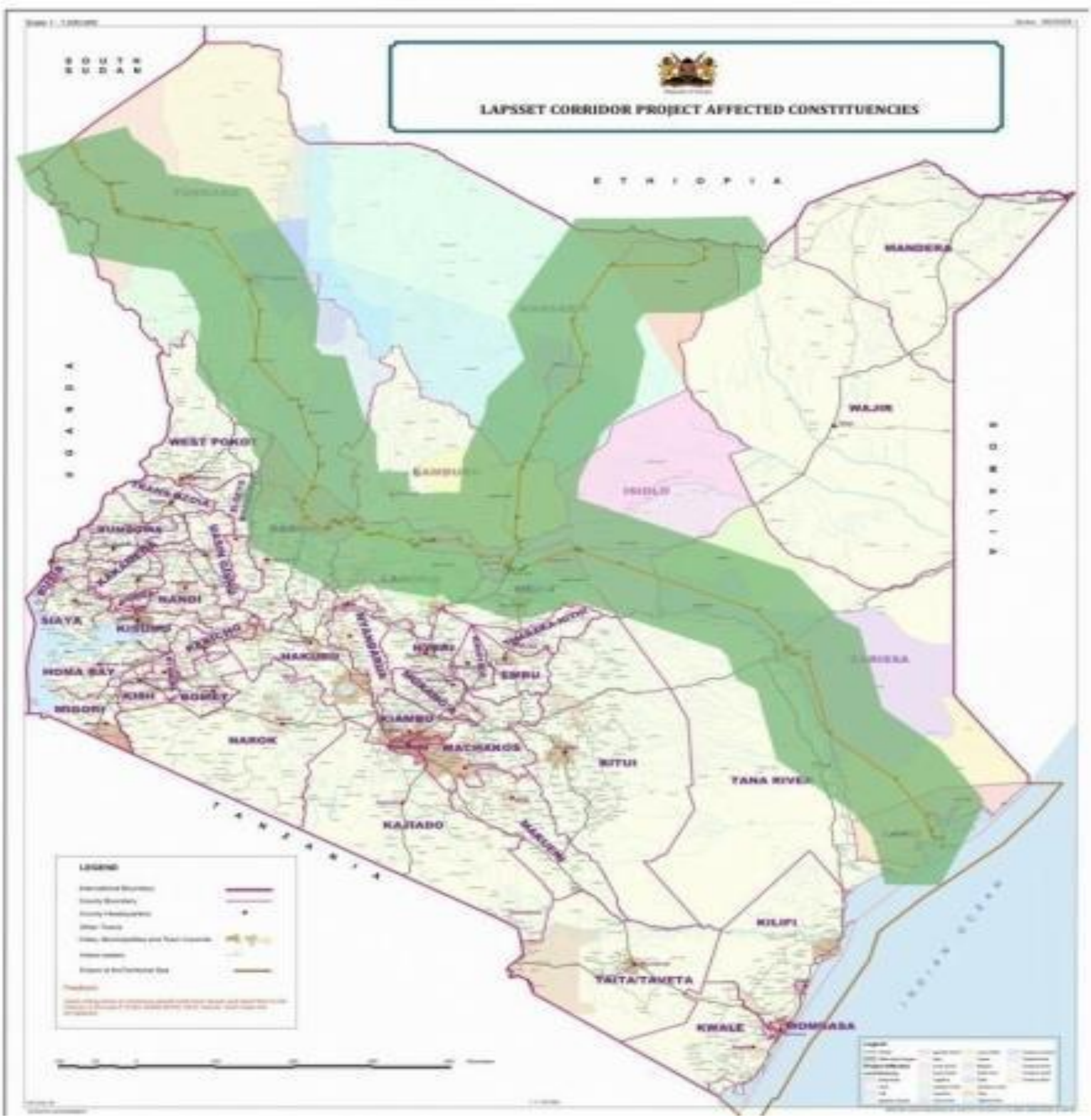
President William Ruto in November 9, 2022 had arrived back from Sharm El-Sheikh, Egypt where he attended the 2022 United Nations Climate Change Conference (COP27). The President called on developed nations to invest in Africa to unlock its clean energy production potential citing wind power, geothermal electricity, and solar energy.

National Electrification Strategy: achieve universal electricity service to all households and businesses by 2022 at acceptable quality of service levels. Produce 100 000 barrels of oil per day from 2022 and develop 2,275 MW of geothermal capacity by 2030. Kenya has set out ambitious targets for geothermal energy. It aims to expand its geothermal power production capacity to 5,000 MW by 2030, with a medium-term target of installing 1,887 MW by 2017. Although there is significant political will and ambition, reaching these ambitious goals is a major challenge.

Many current policies and programmes for agricultural development in Africa include components that have a distinctly spatial character: ideas of agri-clusters and business hubs, of long-distance supply chains and value chains, of rural–urban linkages and of physical infrastructure projects. One of the ways in which these ideas are being packaged and delivered is the agricultural growth corridor – a new spin on economic development corridors that has gained popularity in recent years. Combining physical infrastructure along transport and communication routes with place-based investment in agriculture and other sectors, corridor projects have received new life during the past decade. The emergence of agricultural growth corridors such as in Lapsset Corridor and other types of corridor with a prominent agricultural component will lead to an increase in GDP and wellbeing.

Three of the new Climate Smart Agricultural technologies

Fig 1. Lapsset Corridor



CURRENT WATER SITUATION

INTRODUCTION to the current water situation

Before we develop the Lapsset Corridor to have the 500 m wide corridor with Agriculture along the 1,000 KM length it is important to understand the rainfall details now and for the future. To understand how the Agricultural sector will transform into a more sustainable model for Kenya we first need to determine and understand the current and future water availability. We refer to the recent 2021 China report – "Water Scarcity in Kenya: Current Status, Challenges and Future Solutions". Water is an indispensable resource not only for sustaining all life but also for human socio-economic development. Global water demand is likely to surpass supply by more than 40% by 2030 and by more than 50% in the developing countries, especially in Sub-Saharan Africa. Consequently, over four billion people are facing severe water scarcity at least one month annually, while half a billion people experience severe water scarcity throughout the year.

Furthermore, estimates show that by 2050, 90% of the 3 billion people are expected to be added to the population of those who will be from developing countries and areas facing challenges of clean water and sanitation. Population increase will eventually result in reduced per capita availability of water.

Table 1. Status of the main water catchment areas in Kenya

Watershed name	Catchment area (ha)	Max. altitude (m)	Gazetted forest area (ha)	Main river
Mt. Kenya	1,253,959	5199	203,145 (4% cropland)	Tana, Athi
Aberdare	1,097,895	4001	104,078 (11% cropland)	Ewaso Ngiro, Athi
Mau Forest Complex	874,746	3098	404,706 (25% cropland)	Mara, Nyando, Yala
Cherangani Hills	212,267	3365	120,841 (19% cropland)	Nzoia, Turkwell
Mt. Elgon	2 49,996	4320	72,547 (15% cropland)	Nzoia, Turkwell

The water scarcity situation has worsened in most developing countries due to rapid population growth, economic development and urbanization which has made it so difficult to address the issue as well as providing adequate sanitation services. A country is defined as water-stressed if the per capita water availability is below 1700 m3 per year. Kenya is among the water-scarce countries across the world with per capita availability below 1000 m3 annually. The struggle for accessing clean and safe water is a problem experienced by more than 18 million people today. Previous studies indicate that only about 56% of the population has access to a clean water supply. Citizens mainly those in rural areas are forced to travel long distances of up to 8 miles to reach water that is highly polluted and even unsafe for human consumption.

The growth of Kenya's urban population and rapid urbanization of the rural areas is on the rise hence increasing domestic water demand, industrial and agricultural uses. However, challenges faced in the water sector, such as population pressure, water scarcity, climate change and water quality cannot be underestimated. To achieve the 2030 Agenda, water scarcity is a priority issue to be addressed. The increasing rate of wastewater production with inadequate wastewater treatment resources and systems that are insufficient has led to effluent discharge into river systems.

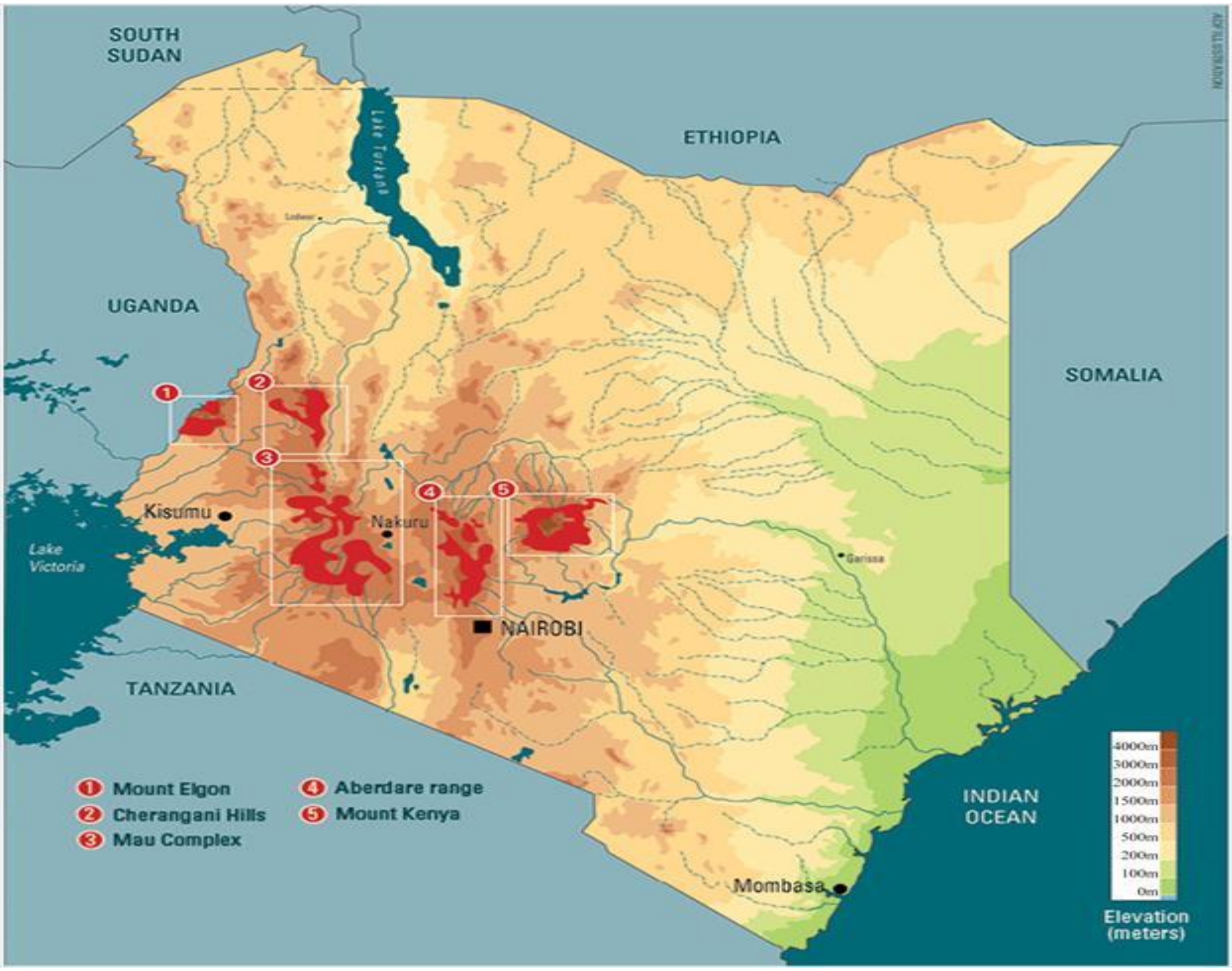
This not only leads to the degradation of downstream ecosystems but also causes health problems to humans. There is a dire need for developing countries to shift from current water management practices to sustainable ways such as water reuse as well as embarking on massive water development projects. Population growth has caused an imbalance between water demand and supply in the country. This has led to a state of water crisis to the people hence incapable of meeting their water needs. However, policy frameworks are enacted to enhance management of the resources.

The China report reviews the status of management of water resources, some of the challenges of water scarcity in Kenya. We hypothesize that a better understanding of water scarcity is important because it affects both the users and policymakers regarding the urgency to address the water crisis as well as their views on the most effective policies to address the crisis. Therefore, we further examine future solutions in water management that will help in the improvement of the water sector, the policies and regulations set to ensure that water laws are adhered to.

Water Resources in Kenya

Kenya's natural renewable water resources mainly rely on little and fragile catchments covered by the montane forests in the country's highland areas with a humid climate. The main five water towers in the country include Mt. Elgon, Cherangani Hills, Mau Forest Complex, Aberdare Ranges and Mt. Kenya. However, they are the main sources of many rivers in Kenya, feeding into major lakes, including Lake Victoria, Lake Nakuru, Lake Naivasha, Lake Baringo, Lake Natron, and Lake Turkana. Kenya's water resources are considered to be unevenly distributed, both across and within as shown in Figure 2 . The catchments contribute to over 75% of the nation's surface water resources. Table 1 shows the condition of the main catchments. Currently, the government has a challenge in agricultural development sector and growth of the country's economic status.

Fig 2. Kenya Water towers



Encroachment of Water Catchment

Kenya's forest cover is currently at 6.99% of its land area which is below the Kenyan constitutional requirement of 10%. Kenya's forests support five major catchment areas namely: Mount Kenya, Aberdare Range, Cherangani Hills, Mt. Elgon and Mau Forest Complex.

These water sources are "Kenya's water towers" as they form the upper catchment of all except one main river in Kenya. These water catchment areas with a coverage of only 2% of the total land area provide important services to the economy of Kenya as well as supporting transboundary water bodies, underlying their regional and international importance. Some activities like poor farming practices and deforestation lead to the degradation of these water catchment areas. The catchment degradation has led to increased surface runoff, flash floods, reduction in infiltration, erosion and siltation among others. Protection of the catchment environment is vital for the security and sustainability of urban water supply and the minimization of water scarcity.

These water towers have been damaged severely due to human encroachment, agricultural activities, rapid human population growth, illegal logging, charcoal burning, water pollution and other illegal abstractions by some industries and urban settlements. Land cover changes may cause negative impacts both within the forest and downstream in the form of water shortages, health problems, and desertification as well.

Fig 3. Distribution of unprotected dug wells and surface water points in various regions across Kenya

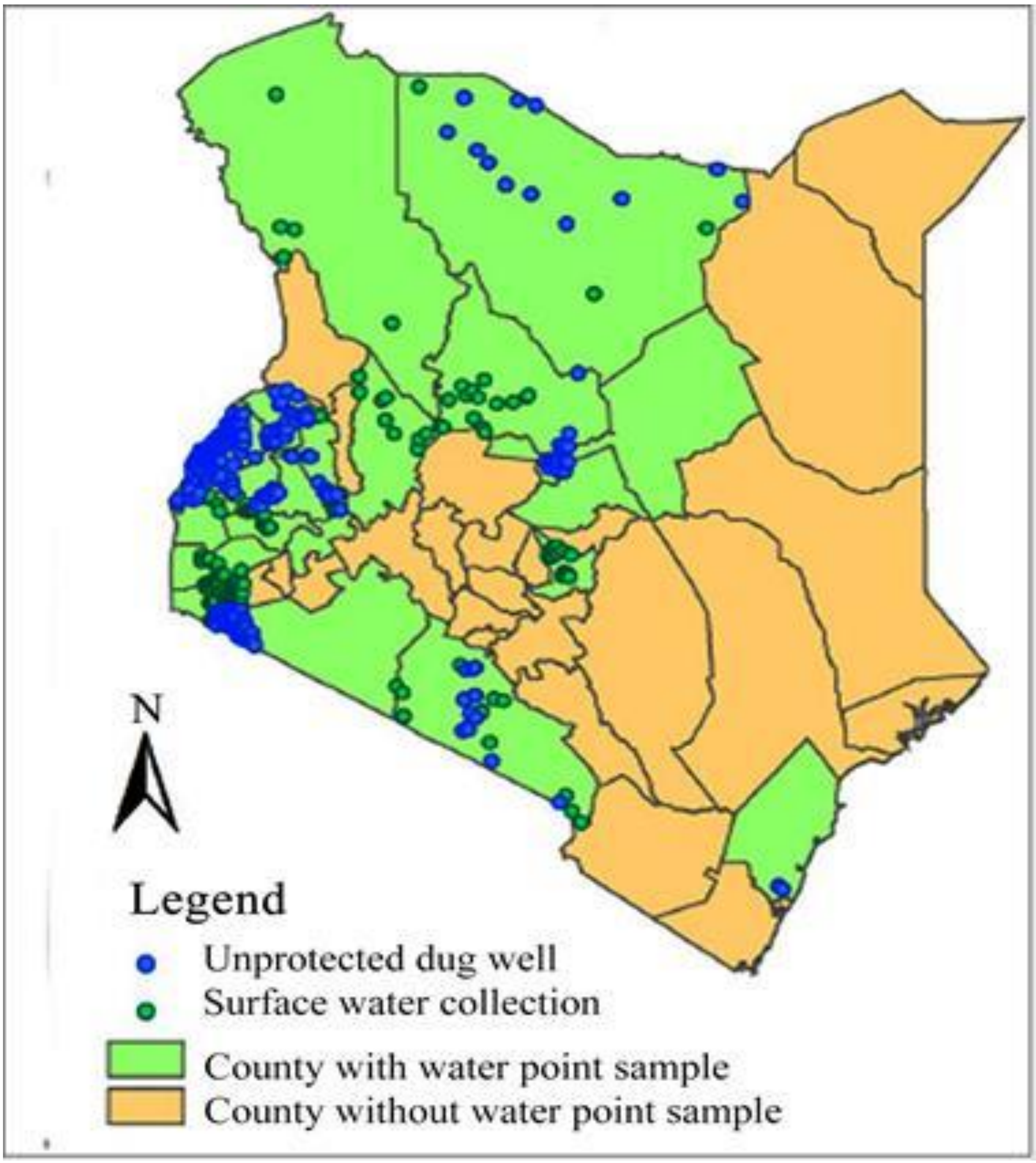


Fig 4. Overall Kenya's renewable water resources per capita

Kenyans are consuming about 33 billion m3, of which their total renewable water resources only amount to 30.7 billion m3, this results in a difference of 2.7 m3(16). Additionally, some studies show that Kenya has 15% of its available water resources developed. This water is not easily accessible due to the increase in costs of water access or even technical challenges.

RAINFALL FOR CROPS IN KENYA

Rainfall required for crops in Kenya

Nearly all of Kenya's crop production is rain-fed (98%), and the small portion of irrigated land is primarily used for export crops. It is estimated that only 15% of the country (in the southwest) receives sufficient rainfall to support the growth of maize and similar crops, while another 13% is suitable for special dry farming or irrigated agriculture. Rain-fed cultivation in the ASALs has a very high risk of crop failure (25-75% in semi-arid, and 75- 100% in arid areas)39 and is therefore extremely vulnerable to climate change. Most farmers in the ASALs therefore resort to mixed agriculture (crops and livestock) or only livestock production. The livestock sector, however, is also highly vulnerable to climate change due to limited water availability in the ASALs, where droughts have historically led to significant losses of animals.

The African continent will be hardest hit by climate change. There are four key reasons for this:

• First, African society is very closely coupled with the climate system; hundreds of millions of people depend on rainfall to grow their food

• Second, the African climate system is controlled by an extremely complex mix of large-scale weather systems, many from distant parts of the planet and, in comparison with almost all other inhabited regions, is vastly understudied. It is therefore capable of all sorts of surprises.

• Third, the degree of expected climate change is large. The two most extensive land- based end-of-century projected decreases in rainfall anywhere on the planet occur over Africa; one over North Africa and the other over southern Africa.

• Finally, the capacity for adaptation to climate change is low; poverty equates to reduced choice at the individual level while governance generally fails to prioritize and act on climate change African climate is replete with complexity and marvels. The Sahara is the world's largest desert with the deepest layer of intense heating anywhere on Earth. In June and July 2019 the most extensive and most intense dust storms found anywhere on the planet fill the air with fine particles that interfere with climate in ways we don't quite understand. The region is almost completely devoid of weather measurements yet it is a key driver of the West African monsoon system, which brings three months of rain that interrupts the nine-month long dry season across the Sahel region, south of the desert. For the decades following the 1960s and peaking in 1984, there was a downturn of rainfall of some 30% across the Sahel, which led to famine and the deaths of hundreds of thousands of people and the displacement of many millions.

No other region has documented such a long and spatially extensive drought. Evidence points to Western industrial aerosol pollution, which cooled parts of the global ocean, thereby altering the monsoon system, as a cause. The currently observed recovery of the rains is projected to continue through the 21st Century, particularly over the central and eastern Sahel. In southern Africa we are seeing a delay in the onset and a drying of early summer rains, which is predicted to worsen in forthcoming decades. Temperatures there are predicted to rise by five degrees or more, particularly in the parts of Namibia, Botswana and Zambia that are already intolerably hot. Meanwhile over Kenya and Tanzania, the long rains from March to May start later and end sooner - leading to an overall decrease in rainfall.

Solutions to Water Scarcity: Sustainable and Integrated Approaches

Future prospects are important for the type of solutions that would be appropriate in solving water scarcity issues in Kenya. Different techniques have been used to solve the issue of water scarcity. Water recycling and reuse are some of the reliable techniques which have been recognized as adaptive solutions to water scarcity, considering water reuse has the concept of a circular economy. However, the adoption of advanced technological solutions and practices that improve water use efficiency by users should be a primary goal for water management to reduce water loss, support the sustainability of water resources, and increase the economic profitability of water.

Water Pollution

Water pollution has affected water quality due to various pollutants such as chemical, microbiological, thermal pollutants among others. Chemical contamination may result from the presence of excess nutrients, heavy metal contents, salinity, acidification, and changes in sediment loads. However, microbiological contamination can result from the presence of either bacteria, viruses or protozoa present in water. Studies indicate that 32.5% of industries and 14% of agriculture are key contributors to the economic development of a population [38]. In contrast, 80% of water pollution and contamination come from these two sectors. Growth and development of agricultural sector in Kenya have led to an increase in the use of fertilizers. Agrochemicals eventually enter into water bodies causing pollution. Furthermore, some industrial and the country government's sewage plants may release partially treated or completely untreated effluents into the surface water sources containing high levels of toxic substances. As a result, this affects most people living in the urban informal settlements due to lack of access to clean water hence causing disease outbreaks affecting their health and livelihoods.

Encroachment of Water Catchment

Kenya's forest cover is currently at 6.99% of its land area which is below the Kenyan constitutional requirement of 10%. Kenya's forests support five major catchment areas namely: Mount Kenya, Aberdare Range, Cherangani Hills, Mt. Elgon and Mau Forest Complex. These water sources are "Kenya's water towers" as they form the upper catchment of all except one main river in Kenya. These water catchment areas with a coverage of only 2% of the total land area provide important services to the economy of Kenya as well as supporting transboundary water bodies, underlying their regional and international importance. Some activities like poor farming practices and deforestation lead to the degradation of these water catchment areas. The catchment degradation has led to increased surface runoff, flash floods, reduction in infiltration, erosion and siltation among others. Protection of the catchment environment is vital for the security and sustainability of urban water supply and the minimization of water scarcity.

These water towers have been damaged severely due to human encroachment, agricultural activities, rapid human population growth, illegal logging, charcoal burning, water pollution and other illegal abstractions by some industries and urban settlements. Land cover changes may cause negative impacts both within the forest and downstream in the form of water shortages, health problems, and desertification as well.

Solutions to Water Scarcity: Sustainable and Integrated Approaches

Future prospects are important for the type of solutions that would be appropriate in solving water scarcity issues in Kenya. Different techniques have been used to solve the issue of water scarcity. Water recycling and reuse are some of the reliable techniques which have been recognized as adaptive solutions to water scarcity, considering water reuse has the concept of a circular economy. However, the adoption of advanced technological solutions and practices that improve water use efficiency by users should be a primary goal for water management to reduce water loss, support the sustainability of water resources, and increase the economic profitability of water.

Water Scarcity and SDG 6: Clean Water and Sanitation

Clean water and sanitation remain vital for the 2030 Agenda for Sustainable Development, yet Kenya has achieved less when it comes to ensuring the availability and sustainable management of water and sanitation for all. The Sustainable Development Goal 6, target 6.4 relates to water use and scarcity, where it illustrates that: "By 2030, substantially increasing water-use efficiency across all sectors and ensuring the sustainable withdrawals and supply of fresh water in order to address water scarcity and substantially reduce the number of people affected by water scarcity."

The SDG guidance notes that a "high level of water stress can have negative impact on the economic development, increased competition and have potential conflict among different users, which calls for the effective supply and demand management policies as well as an increase in water-use efficiency. The key point for water managers and policymakers is that the portion of overall water that can effectively be used to meet demand at the right place can be enhanced by implementing appropriate policies or interventions, such as reducing the direct surface runoff through catchment restoration, water transport, and water storage technologies.

Water Policy and Implications

Water Act was enacted in Kenya to mainly provide the management, conservation, use and the control of water resources and for the regulation of rights to water usage; provision of regulations and management of water supply and sewerage services; to repeal the Water Act (Cap. 372) and provisions of Local Government Act; and other related purposes. The Act aims at improving the living standards among different people by ensuring proper access to water services. However, it provides management and development of water resources supply and sewerage development, intending to conserve, protect available water resources and allocate suitably and economically as well as supplying water in sufficient quantities to meet the various water needs while ensuring safe disposal of water. This Act therefore clearly outlines methods and ways of ensuring that water is used to all and its provision is ensured and managed adequately and sustainably.

Kenya has enacted policies at the national and regional levels to guide the conservation and management of its water resources. Crucial reforms have been set up in the water sector that culminates in the enactment of the Water

Act of 2002 and the consequent formation of various Water Resource Users Associations (WRUAs) by the Water Resource Management Authority. The National Policy on Water Resources Management and Development through the Water Act 2002 guides the water resources management and the provision of water services in the country. The Water Sector Trust Fund (WSTF) was established under the Water Act and

restructured from the Water Services Trust Fund to Water Sector Trust Fund (WSTF). The mandate of WSTF is financing water and sanitation services in the country. The establishment of these institutions aims to organize the water sector in the country and by ensuring that the anticipated universal access to water is achieved.

The Water Act 2016 establishes a Water Resources Authority which is a regulatory authority mandated to perform the following functions:

1) Formulation and the enforcement standards, procedures and regulations for the management and use of water resources and flood mitigation;

2) Regulation of water resources use and management;

3) Receiving water permit applications for water abstraction, water use and recharge and decision making, issue, vary water permits; and enforce the conditions of those permits.

Integrated Approaches to Water Scarcity

Based on the present water demand and the future national development plans, Kenya would face a huge gap between water demand and the available water supply in the years to come. Sustainable development and management of water resources is therefore critical and should effectively be addressed by respective government institutions, various development partners, civil society groups and the private sectors.

Kenya can boost its water productivity in a short-term period by harmonizing and strengthening the existing and established multi-level water management bodies such as the Catchment Area Advisory Committees, Water Users Associations and Water Resource Management Authority. In order to improve the availability of a sustainable water supply, conservation and the restoration of national water catchment areas, as well as a strategic investment in the additional dams, is key. In addition, the construction of efficient water treatment plants should be a priority for urban water and sewerage companies in order to facilitate water treatment and re-use.

Green or nature-based solutions can help in the improvement of water supply and shortage, thus increasing water availability. This is important particularly in the current world considering expectations that water shortage would worsen in Sub-Saharan Africa as a result of climate change drought risk causing the decline of water levels of dams and freshwater supply sources . Water scarcity and security issues will be exacerbated by recent trends of climate variability and the consequent rise in droughts.

Thus, climate-resilient water resource management will require an integrated strategy to ensure resilience for water-related policy making to address both short- and long-term impacts of climate change by balancing robustness with flexibility. With future uncertainties and the likelihood of other potential infectious disease outbreaks, there is a need for robust adaptation options that have the primary objective of supporting sustainable water resource use.

Conclusion

Access to clean and safe drinking water is a problem faced by almost half of Kenya's population. The demand for adequate and clean water supply is rising due to the increasing population, and in the response to global aim in the achievement to meet Sustainable Development Goals (SDGs). To address the water scarcity issues, a strategic plan has been put in place through the construction of large and medium dams to store water as well as investing in groundwater storage through managed aquifer recharge by making use of stormwater generated during the rainy seasons. Some challenges such as forest fragmentation, poor water management and contamination of water sources are possibly solvable, the frequency and droughts and floods occurrence are an indicator of climatic change which is likely to become more unpredictable in the future.

When considering largescale Agricultural activity then consider also energy requirement – Solar Farms & Solar Harvesting the Sun Twice.

Large 50MW Solar Farms will provide electricity for irrigation water pumping to the largescale farms and Cities along the Lapsset Corridor

Another new Smart Technology project

Fig 5. Solar PV with food project already in Kenya

Our partners have built the first Solar PV with food project already in Kenya

“Harvesting the Sun Twice”

40% savings in water and in some cases 300 increase in growth of crops due to shading aspects.

PSECC Ltd are working with the University of Sheffield in order to promote the Harvesting the Sun twice project in the Lapsset Corridor if required.

PSECC ltd was the lead company along with the University of Greenwich on a UK Government funded project by Innovate UK working with partners in Ghana the Food Research Institute on a Cassava processing equipment plant. The University of Greenwich will support this Lapsset Corridor project.

www.agritechsolutions.co.uk

a PSECC Ltd initiative

Improving Energy Access in Rural Africa

Mini-grids provide reliable, predictable power supply for rural Africa that has low electrification.

Powering Rural Africa

Solar mini-grids offer the most widely applicable and viable mechanism to provide electricity for under-served rural areas of Africa, where sunlight is abundant through most of the year. The generated electricity is supplied – directly or indirectly via batteries – to clients who are connected to this mini-grid electricity network. A group of people who live close to each other, in for instance a village, can be easily connected to the grid.

Water from Dams can be channeled in canals across Agricultural Corridor and the canals covered with Solar PV to provide additional renewable energy for irrigation, refrigeration of crops when harvested and general agricultural use in order to develop a good agricultural base in the Lapsset Corridor.

Another Smart technology is a Kenya BIO-FUELS (E-10) PROGRAMME - THE BIOFUELS PROJECT For Lapsset Corridor

President Ruto to take steps towards curbing Greenhouse Gas (GHG) emissions in the Transportation Sector of the economy. This could lead to the establishment of a new LCDA Renewable Energy Division of with the responsibility to nurture a National Initiative for the development of sustainable Biofuels Industry Programme for Kenya through partnership with accredited investors.

We are pleased to present OSNO Biofuels Project in the Lapsset Corridor, the first Biofuels Project in the Kenya Biofuels Programme to drive the alternative renewable energy pursuit of the Government E10 Policy.

OBAX USA is a forward-looking USA energy and engineering company, doing business across the globe with offices mainly in the USA and Nigeria. OBAX USA major focus areas include, front-end-engineering-design (FEED), developing oil & natural gas processing assets (Offshore/Onshore), liquefied natural gas (LNG), Pipelines & Storage, tanks, industrial facilities, refining, chemicals. It also covers engineering, procurement, construction, installation (EPCI) and operations & maintenance (O&M) activities.

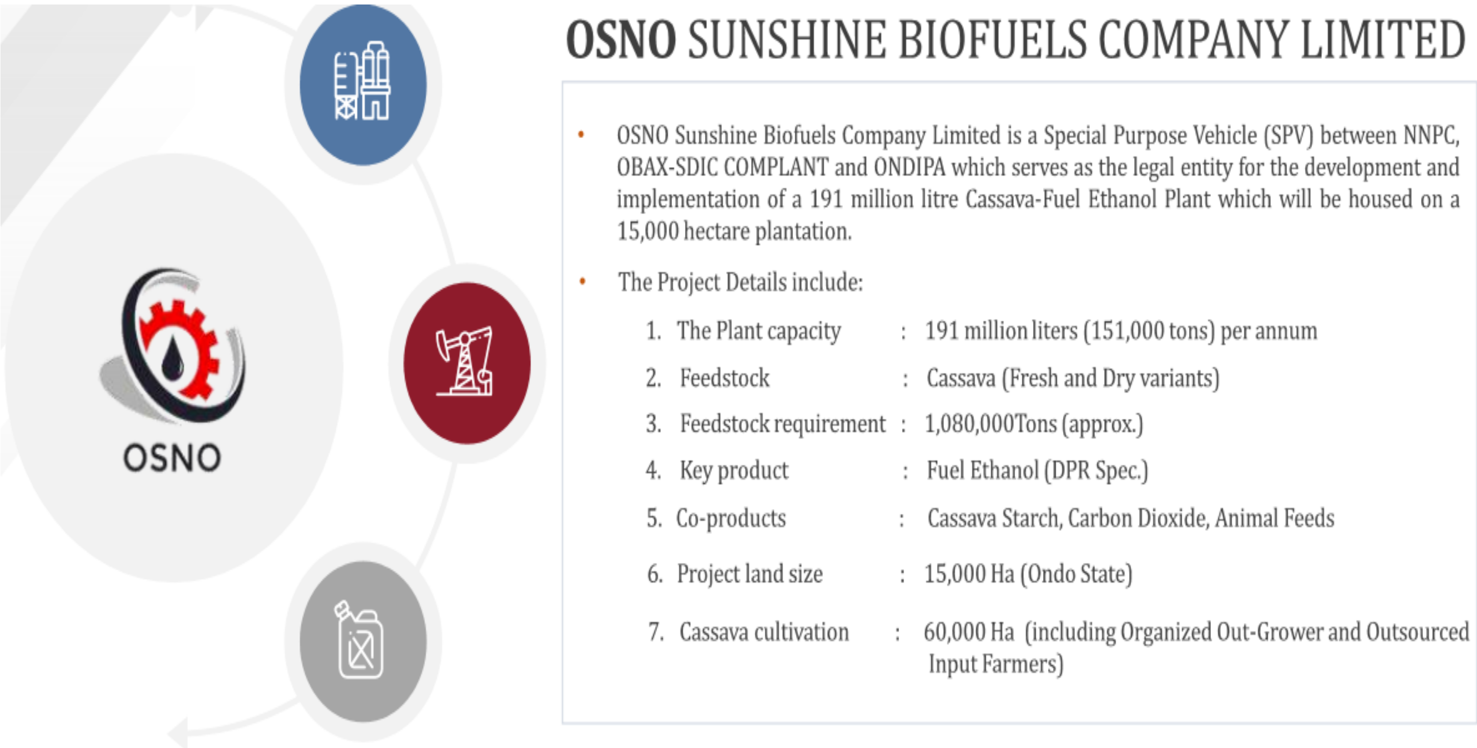
In response to the international aspiration to tackle Global Warming and mitigate the negative impact of Climate Change, the Kenya Government, mandated -

We are qualified as major technology partner, OBAX USA currently will establish a Special Purpose Vehicle (SPV) with LCDA to execute the industry programme of the Kenya Automotive Biofuels sector. Possible Kenya mandate could specify E10 policy (10% Blend of Fuel-Ethanol in PMS) and the B20 policy (20% Blend of Biodiesel in Petro-Diesel) as the fuel quality standards for the transportation sector. This Biofuels Fuel Programme emanated from the Paris environmental Accord signed by many Presidents in 2016.

To kick-start the production of Bio-Fuels in Kenya, the partnership between OBAX, PSECC Ltd, Headway USA the Government of Kenya for this project hopefully will lead to the formation of a special purpose vehicle (SPV) known as Kenya Sunshine Biofuels Company Limited where States can join the partnership for providing land for the production plant (refinery) and cassava plantation farms.

Lapsset Corridor Development Authority (LCDA) and the British Petroleum company (BP) will be the off-takers of all the ethanol production in Kenya. The Government Renewable Energy Division and OBAX shall produce all the E10 needed in Kenya now and in the future and will therefore build six (6) ethanol plants across the country using cassava or sugarcane to be grown in each State in the Lapsset Corridor. Our enthusiasm is hinged on what we could achieve together with the other projects in the Kenya Biofuels Programme, it is our hope that when Lapsset Corridor (the first project in the programme) is accomplished, it would promote a sustainable ethanol value chain in Kenya, improve livelihood for out- growers/small-holder farmers and contribute to the global agenda by reversing global warming through Clean Development Mechanism initiatives such as any Biofuels Programme. This initiative will also maintain the right balance between business growth, environmental protection and social responsibility by fostering sustainable development while guaranteeing investors' returns.

Fig 6. To serve as an example to Kenya – our Nigeria project:



Proposed Operations

PROJECT OVERVIEW

- **OSNO SUNSHINE BIOFUELS COMPANY LTD** was incorporated in November, 2020 for the purpose of the establishment and operation of an integrated Cassava Plantation and Fuel-Ethanol Plant complex in Okeluse, Ondo State, Nigeria.
- The Project life will be for 15 years (construction period of 2 years plus 13 years of operation).
- The cost of this project will be $190 million. The project will be financed through Debt - Equity ratio of 80%:20% (US$152 million as Debt Investment and US$38.00 million as Equity Investment).
- Domestic Off-takers will include PPMC and Major Marketers while NPSC will handle storage on behalf of NNPC.
- Export Off-Takers: British Petroleum (BP) Singapore PTE issued a non-legally binding purchase agreement for offtake of the Product.
- Timeline of activities since incorporation;

01 — SPV Incorporation activities 27/11/2020

03 — Shareholder Agreement Execution 25/06/2021

04 — Board Inauguration Meeting 26/07/2021

PROJECT BENEFITS

The major benefits include:

1. The project will provide excess of 1.3million job opportunities via increased Direct and Indirect Employment;
2. The Export Margin will provide Nigeria the much needed foreign earnings
3. Enhancing Regional Socio-Cultural and Economic Integration;
4. Encouraging the Sourcing and Attraction of Foreign Direct Investment's into the Region;
5. Facilitating Youth Skills Development Through Backward Integration;
6. Accelerating State Industrialization Programme;
7. Increasing Revenue Generation Drive;
8. Reducing the Pressure on Existing Urban Infrastructure and Increasing their Longevity;
9. International Recognition as Leader in Compliance to Paris Accord

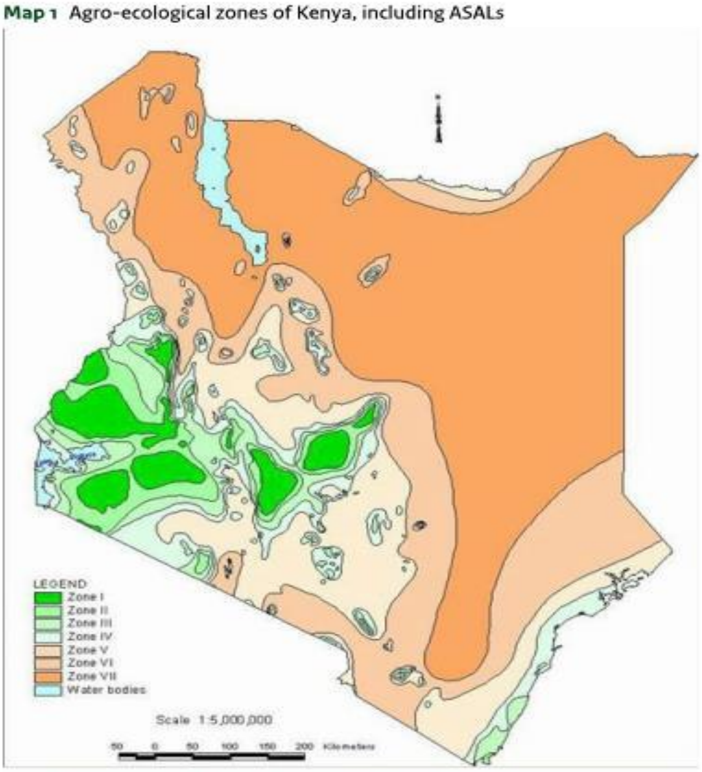
PROJECT REQUIREMENTS

The major requirements include:

1. Funding
2. Land and Equipment
3. Labour
4. Regulatory compliance such as EIA, DPR License, FIRS tax and VAT filings)
5. Offtakers
6. EPCIO&M
7. Transaction Advisers
8. Legal Advisers

Fig 7.

Map 1 Agro-ecological zones of Kenya, including ASALs



Zone	
I. Agro-Alpine	
II. High Potential	
III–IV. Medium Potential	
V. Semi-Arid	ASALs
VI. Arid	
VII. Very arid	

Source: http://www.infonet-biovision.org/default/ct/690/agrozones

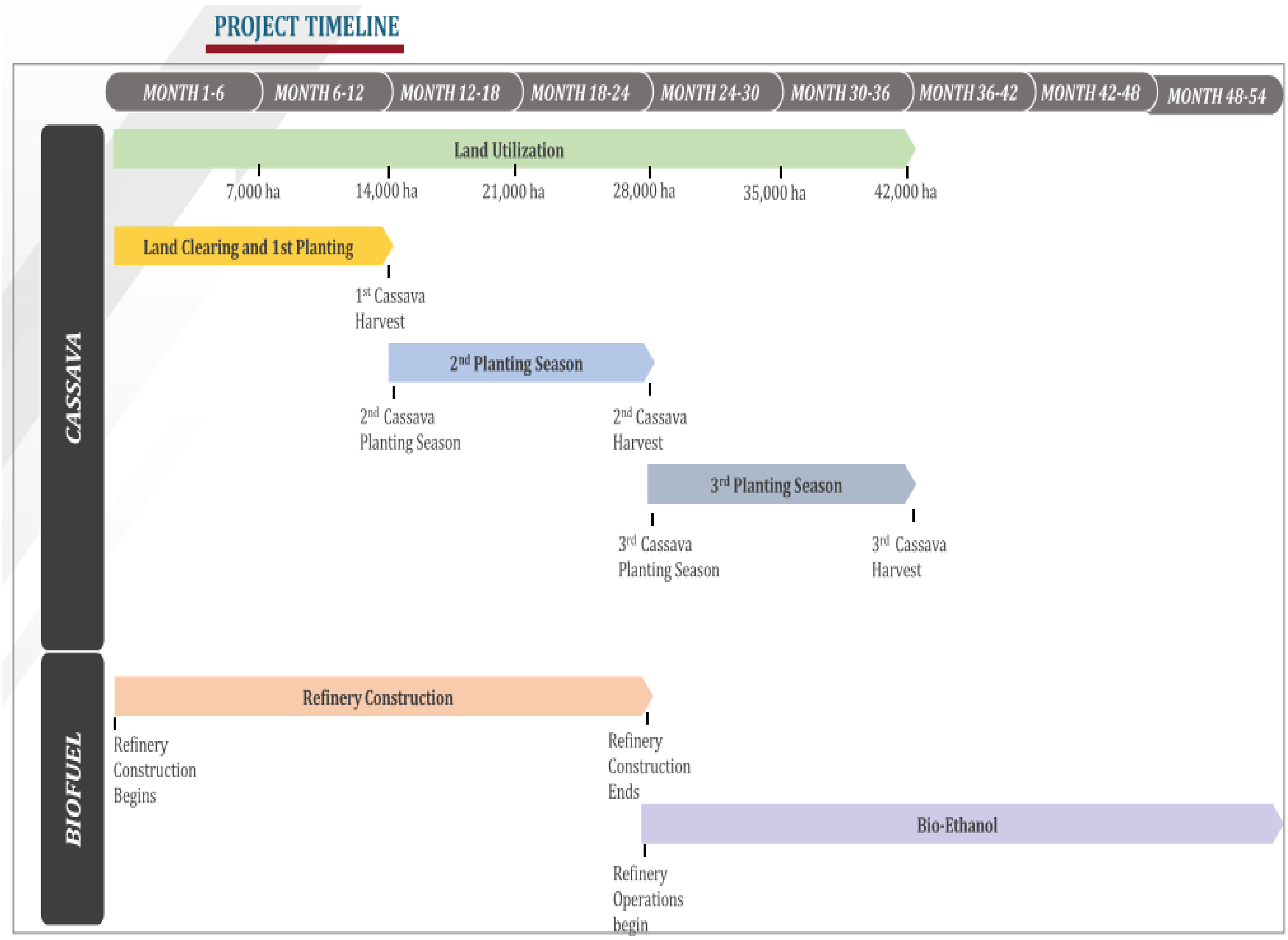
TIMELINE

Table 2.

Following is the tentative timeline of the Solar PV food programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2024
Phase 2:	Five Solar Farms	1,500MW	2024 to 2026
Phase 3:	Bioethanol plant Harvesting the Sun Twice (Ten)	341 M Ltrs 500MW	2024 to 2007 2024 to 2030

Fig 8.



Management Summary of Solar Irrigation for Crops

Intec's and Swissjoule and local associates are developing several Solar Irrigation project initiatives in the Area of Turkey and hopefully soon in Kenya.

Within the last year the cost of energy has doubled to power the pumps for irrigating crops as pistachio, corn, grain, rapeseed, produce, cotton or fruit trees. The following OBAX information describes to replace power from the grid with renewable Solar power.

The applying irrigation associations received authorization by parliament to re-structure and organize energy supply independently. This is based on the legislation for renewable Energy.

Water for irrigation is pumped out of the reservoir at Atatürk dam and runs in open canals up to 100 km to the plantations. During last mile distribution, delivered amounts are metered and invoiced to the farmers by the applying irrigation association.

Replacing all the power consumed over the vegetation period requires a 100 MWp solar plant. As net metering is offered for the given purpose, the financials are straight forward. 200.000 MWh p.a. are consumed. Cost for this has doubled to a current rate of 0,1014 $ / kWh.

After obtaining energy license the current rate for off-taking is at the same 0,1014 $ / kWh, This tariff will be used for paying interest and paying back.

Based on a Capital Expenditure of 900 $ / kWp full payback is possible within 6 Years.

Based on the local legislation a utility has to off-take electricity created, if the installation is furnished with a production license. To utilize this mechanism as a payback warranty to the financier, the utility will accept a declaration of assignment of funds directed to the financier. Declaration of assignment in combination with the transfer of ownership of the SPV owning the installation will grant the funds to pay back incl. 8% interest.

The below describes a first pilot project of 100 MWp. Other local irrigation associations will account to a total installation size of 435 MWp in the region only.

Next to a financing solution as described below, a PPP structure can be discussed. In this case the public partner will receive Shares of the SPV according to the repayment of the debt and reduces the payments for the energy self-consumed. This structure will be provided upon request.

After acquisition of financing for this 1st pipeline, other regions will be acquired with the same blueprint and methodology.

All players are more than committed to replace power from the grid and get independent from all kinds of cost fluctuations.

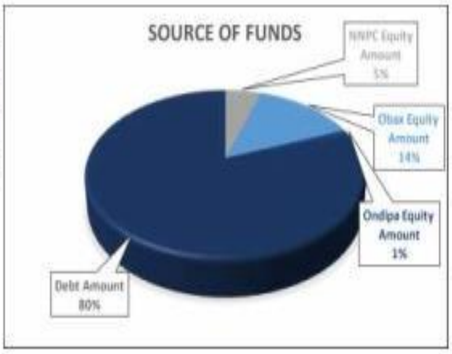
COSTS

Fig 9. OBAX Bioethanol plant Financials

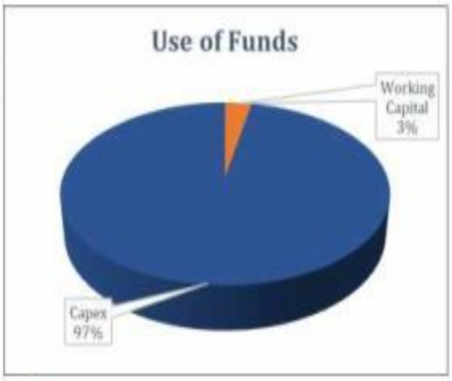
Financial Assumption

S/N	Assumptions	Unit	Parameter
1	Number of Days in a month	Days	30
2	Number of Months in a Year	Months	12
3	Naira to Dollar Conversion	NGN/US$	₦520
4	Bio-Ethanol Plant Capacity per Month	Litre/Month	15,916,667
5	Bio-Ethanol Plant Capacity per Year	Litre/Annum	191,000,000
6	Plant Capacity Utilization	%	60% - 90%
7	Average Cassava Production per Month (Ton)	Tonnes	53,000
8	Average Cassava Yield per annum (Ton)	Tonnes	636,000
9	Purchase Price of Cassava per Ton ($)	$/Ton	40
10	Selling Price of Cassava starch per Ton ($)	$/Ton	338
11	Litres of Ethanol per Ton of Fresh Cassava Roots	Litre/Ton	280
12	Local Ethanol Selling Price ($/liter)	$/Litre	$0.35
13	Cost of imported Ethanol ($/liter)	$/Litre	$0.85
14	Selling Price of International Ethanol ($/liter)	$/Litre	$0.43
15	Co2 produced per month (tons)	Ton	737.50
16	Unit Cost of Production ($/ton)	$/Ton	$1.66
17	Co2 Selling price ($/ton)	$/Ton	$12.00
18	OSNO Land	Hectares	15,000
19	OBAX Land	Hectares	25,000
20	Other Land	Hectares	20,000

SOURCE OF FUNDS		
NNPC Equity Amount	$	10,000,000.00
Obax Equity Amount	$	28,000,000.00
Debt Amount	$	152,000,000.00
TOTAL	$	190,000,000.00



USE OF FUNDS		
Working Capital	$	5,923,578.00
Capex	$	184,415,858.65
TOTAL	$	190,339,436.65



- OSNO SUNSHINE BIOFUELS COMPANY LTD will be financed through Debt - Equity ratio of 80%:20%
- CAPEX will take up 97% of the Project Cost while the remaining 3% will be assigned to Working Capital.

Example of a 100MWp Solar PV Irrigation installation in Turkey

The details of the indicative cost are provided below (Kenya will be dependent upon exact criteria):

Table 3.

Specification of plant:			
Total nominal power:			100.000,00 kWp
Degradation:			0,40%
Blackout loss:			0,00%
Earnings:			
Electricity yield / kWp:			2.002 kWh / kWp
Power yield / year:			200.200.000 kWh / year
Feed-in tariff:			
Until kW:	:urrency / kWh:	Inflation:	Cap curr / kWh:
	0,1014	0,00%	0,0000
	0,0000	0,00%	0,0000
	0,0000	0,00%	0,0000
	0,0000	0,00%	0,0000
	0,0000	0,00%	0,0000
Ending of feed-in tariff:			after 20. year
Feed-in tariff afterwards:			0,0000 cu / kWh
Direct sales per year:			0,00%
Electricity sales price:			0,0000 cu / kWh
Electricity sales price inflation:			0,00%
Earnings by certificates:			
Certificate / fed in MW:			1 Certificates / MW
Total certificates:			140.140 Certificates
Sales price / certificate:			15,00 cu / Certificate
Certificate price modification:			0,00%
Minimum certificate price:			0,00 cu / Certificate

Financing:	
Annuity:	1
Interest rate with fixed rate:	8,00%
Interest rate after fixed rate:	0,00%
Fixed interest rate until:	
Grace period until:	
Debt ratio:	100,00%
Debt capital:	90.000.000
Credit period:	6 years
First repayment date:	Jan-24
Repayment terms:	3
	semiannual
Running costs:	
Maintenance / kWp:	8,00 cu/kWp
Insurance:	0,00%
Management:	150.000
Lease per year:	870.000
Cost inflation:	8,00%
Fiscal aspects:	
Amortization period:	15 years
Corporate tax:	0,00%
Other taxes:	0,00%
Start of operations:	Jan-24
Currency:	€
Total contract value:	**90.000.000**

Fig 10.

Assumptions Financial Model: 100 MWp Installation Size

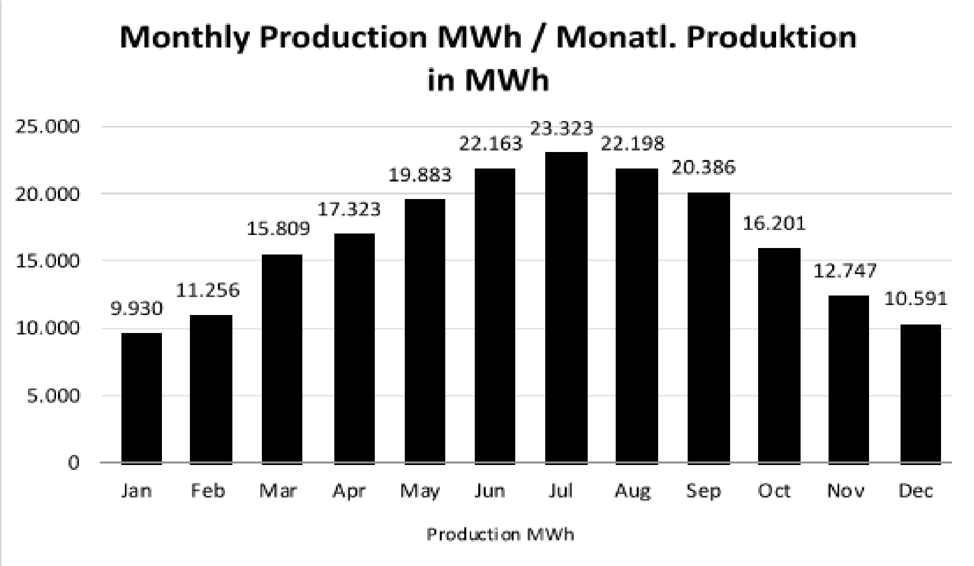


Table 4.

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

As many other countries also Turkey and Kenya are facing high electricity cost.

The climate conditions in the area require irrigation to support the growths of the crop from March to November. From December to February there was so far just a little need for irrigation.

According to information of the irrigation association the consumption in 2021 was around 197.000 MWh. Current figures show a comparable consumption in 2022. Whereas the power needed for irrigation was nearly unchanged, the cost of consumption skyrocketed: In 2021 the irrigation association paid around 14 M. $ or 0,0710 $ / kWh. In 2022 the association already paid 18 M $ or 0,1467 $ / kWh. However for the following planning a realistic 0,1014 $ / kWh shall be considered as the income for the serving (repayment and cost of financing, interest, annuity) of a potential financier.

Off-taking

As this project and the associated pipeline of projects of other irrigation service providers is clearly in the public interest and supports the stability of the agricultural sector, the off taking utility has offered net metering.

Implies that 100 % of the generated electricity can be evacuated independent from season or demand and fully consumed when needed. Net metering does not require any payments or deductions for feeding in or additional cost for consumption.

Considering last year consumption of close to 200.000 MWh, break even for the installation size to fully cover consumption is around 100 MWp.

IRR on total investment: 19,69 %

In the 6 years of financing and within the obligation to repay the financier, the Irrigation Association still has free cash flow totaling 16,4 M$.

These funds can be used at any time to temporarily bridge any defaults occurring.

The financial model is based on conservative assumptions. The irradiation forecast was created with PV-Gis for a single-axis tracking assembly structure.

Incentive for a financier is an 8% interest for a 6 year term.

Higher interest rates are possible on request.

Securities

Currently the following securities are envisioned.

1. The applying organization will incorporate an SPV and transfer the ownership of the SPV including the fully commissioned installation itself as a security to the financier.
2. After acquisition of the energy production license, the local utility has a legal obligation to off-take the electricity produced by the license holder.

The off-taker has already provided a declaration of assignment. With this the utility grants to transfer the earnings of the electricity delivered directly to the financier. This implies that the financier has a secured payback of 20,4 M $ (Year 1). Over the first 5 years of operation the declaration of assignment covers the payback of the full loan incl. an interest of 8%.

Fig 11.

OSNO Financial Projection

Financial Performance($' millions)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Total Revenue	$41	$121	$121	$133	$140	$147	$154	$162	$170	$179	$187	$197	$207	$217	$228
Total Cost of Production	$39	$112	$38	$42	$44	$46	$49	$51	$54	$56	$59	$62	$65	$69	$72
Total OPEX	$0	$2	$6	$7	$7	$7	$8	$8	$9	$9	$10	$10	$11	$11	$12
Net Profit	$2	-$14	$48	$56	$62	$68	$75	$81	$86	$91	$96	$101	$107	$113	$119
Cash Position	$3	$6	$6	$6	$5	$5	$6	$5	$9	$12	$20	$22	$29	$29	$35
Total Asset	$187	$190	$178	$174	$175	$183	$198	$245	$296	$347	$403	$452	$507	$554	$608
Total Liabilities	$148	$165	$135	$104	$74	$44	$13	$9	$4	$0	$0	$0	$0	$0	$0
Total Equity	$40	$26	$43	$69	$102	$140	$185	$236	$292	$347	$403	$452	$507	$554	$608

- The project would generate revenue from the sale of **Biofuels, Carbon Credit and Cassava Starch**. Revenues will commence from Month 25 upon completion of the refinery with inputs from the Cassava farms working under/with **OSNO SUNSHINE BIOFUELS COMPANY LTD.**

- Total Revenue is $139 million in Year 5, $170 million in Year 10 and $227 million in Year 15. Cost of Production is $44 million in Year 5, $56 million in Year 10 and $71 million in Year 15. Net profit is $62 million in Year 5, $90 million in Year 10 and $119 million in Year 15.

- Dividend Payment would commence in year 3 at $30 million. Cumulative Dividend is $90 million in Year 5, $245 million in Year 10 and $519 million in Year 15. The company would pay down its debt obligation within 7 years of operation commencement. The debt is structured as a seven year term loan with 2 years moratorium at 10% interest rate.

- Closing Coash is $5 million in Year 5, $12 million in Year 10 and $34 million in Year 15.

- Company Asset value by Year 5, 10 and 15 are $175 million, $347 million and $608 million respectively. The company asset would be depreciated over 15 years on a straight line basis. Total Liabilities winds down from Year 3 until they are fully repaid.

Fig 12.

OBAX SDIC Financial Projection

Financial Performance($' millions)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Total Income	$40.65	$35.67	$24.82	$24.82	$24.82	$24.82	$24.82	$24.82	$24.82	$28.32	$31.82	$40.22	$40.22	$49.32	$49.32
Total OPEX	$16.21	$1.32	$1.45	$1.60	$1.76	$1.93	$17.13	$2.34	$2.57	$2.83	$3.11	$3.42	$18.77	$4.14	$4.56
Net Income	$16.84	$25.25	$16.19	$16.30	$17.12	$20.60	$6.92	$20.23	$20.02	$22.94	$25.83	$33.11	$19.30	$40.66	$40.28
Cash Position	$0.68	$7.06	$6.07	$6.11	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15	$6.15
Total Asset	$37.04	$62.29	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86
Total Equity	$37.04	$62.29	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86	$60.86

- OBAX SDIC would invest $28 million in exchange for 70% equity in OSNO
- OBAX SDIC would generate income form the following:
  - Investment Income – Dividend Payment by OSNO
  - Contractual Income – Contractual services such as O&M services and other services to OSNO
- Cumulative total income that OBAX SDIC would generate by Year 5, 10 and 15 are $150 million, $278 million and $489 million respectively. Operating Expense is $22 million in Year 5, $49 million in Year 10 and $83 million in Year 15.
- Net profit is $62 million in Year 5, $90 million in Year 10 and $119 million in Year 15.
- Dividend Payment would commence in year 3 at $17 million. Cumulative Dividend is $51 million in Year 5, $141 million in Year 10 and $300 million in Year 15. Dividend Payment to shareholders si as follows:
  - OBAX - $13 million in Year 5, $38 million in Year 10 and $81 million in Year 15.
  - SDLEI – $37 million in Year 5, $103 million in Year 10 and $219 million in Year 15.

Fig 14.

Investment Opportunity

INVESTMENT REQUEST

- OBAX SDIC, the majority shareholder of the Project (with 70% of the Total Equity Shares) would like to offer the following;

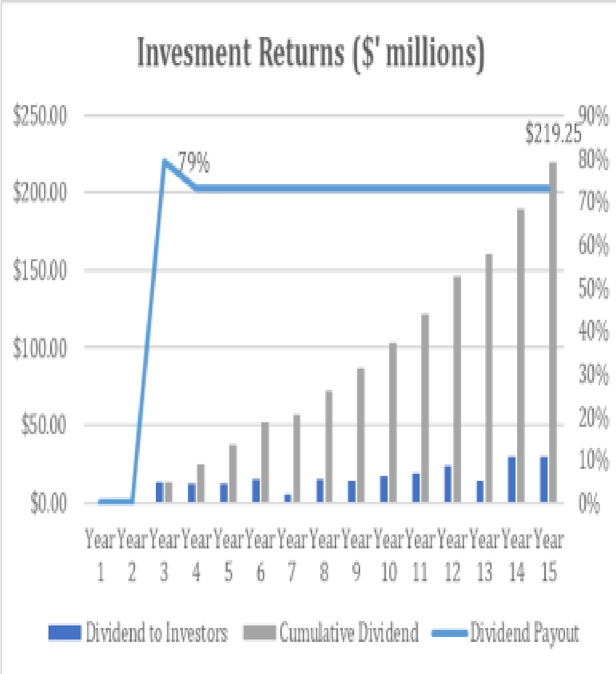
1. The opportunity to invest **$20.2million** into OBAX SDIC (Equity Investment) and therefore own **72.86%** in OBAX SDIC, thereby owning **50.99%** of Equity Stake in OSNO Sunshine Biofuels Company Limited. Investment Returns in 5 years is $37.18mn and $219.25mn in 15 years.

2. The opportunity to become a Technical Partner by providing equipment and other Technical Services to this project. This will be captured in a Technical Service Agreement between OBAX SDIC and SDLEI (or its Investors).

3. The opportunity to facilitate the financing of the Debt Portion of the Investment which represents **80%** of the Total Project Cost (i.e. $152,031,549.32).

4. Proceeds from the operation of the business via dividends will be the main source of repayment and return on investment.

5. The Investor may nominate an Executive Directors for the OBAX SDIC.



Investment Returns ($' millions)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Dividend to Investors	$0.00	$0.00	$12.83	$11.88	$12.47	$15.01	$5.04	$14.74	$14.59	$16.71	$18.82	$24.13	$14.06	$29.62	$29.35
Cumulative Dividend	$0.00	$0.00	$12.83	$24.71	$37.18	$52.19	$57.23	$71.97	$86.56	$103.27	$122.09	$146.22	$160.28	$189.90	$219.25
Dividend Payout	0%	0%	79%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%	72.86%

- Cumulative dividend for year 5, 10 and 15 are **$37.18 million**, **$103.27 million** and **$219.25 million** respectively

Table 5.

Solar Irrigation Twenty-year Projections

Finanzierung 100 MWp, Irrigation, 6 Years

Capex / Investitionsausgaben	90.000.000	900	$/kWp	100.000	EPC BOS / Installkosten		750	75.000.000		Carbon credits created		tons	reduction 0,9	
Insurance fee / Versicherung	0	0,0%	of debt		Connection, Permits		95	9.500.000		0,8 kg/kWh	161.449.347	161.449	145.304	727
Financing fee / Finanzierungsgebühr	0	0,0%	of debt		Reserves, Reserven		55	5.500.000						
Total contract value / Verragssumme	90.000.000				Total		900	90.000.000						
Equity of contract value / Eigenkapital	0	0%												
Debt of contract value / Fremdkapital	90.000.000	100%												
Interest rate / Zinssatz	8,0%													
Repayments per year / Raten pro Jahr	2													
Contract period in full years / Vertragsze	6		Escalator / yea	Inflation	Irradiation / Einstrahlung									
PPA incentive based on purchase cost / I	0,1014	$/kWh	0,00%	8,00%	2.002	PV Sys calc								

Year / Jahr	1	2	3	4	5	6	7	8	9	10
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Produktion in kWh	201.811.684	201.005.915	200.203.364	199.404.017	198.607.862	197.814.885	197.025.074	196.238.417	195.454.901	194.674.513
Turnover feed in / Umsatz Einspeiseverg	20.463.705	20.382.000	20.300.621	20.219.567	20.138.837	20.058.429	19.978.343	19.898.576	19.819.127	19.739.996
Turnover Certificates	2.119.023	2.110.562	2.102.135	2.093.742	2.085.383	2.077.056	2.068.763	2.060.503	2.052.276	2.044.082
Lease / Pachtkosten	0	0	0	0	0	0	0	0	0	0
Maintenance / Wartung	800.000	864.000	933.120	1.007.770	1.088.391	1.175.462	1.269.499	1.371.059	1.480.744	1.599.204
Management / Management	150.000	162.000	174.960	188.957	204.073	220.399	238.031	257.074	277.640	299.851
Insurance cost / Versicherung	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000
Opex / Operative Kosten	1.820.000	1.896.000	1.978.080	2.066.726	2.162.465	2.265.862	2.377.531	2.498.133	2.628.384	2.769.054
EBITDA	22.377.221	22.204.609	22.026.303	21.841.815	21.650.618	21.452.143	21.245.776	21.030.853	20.806.659	20.572.420
- Amortization / -Abschreibung	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000
EBIT	16.377.221	16.204.609	16.026.303	15.841.815	15.650.618	15.452.143	15.245.776	15.030.853	14.806.659	14.572.420
- Interest amount / -Zinskosten	6.960.412	5.963.343	4.884.914	3.718.485	2.456.875	1.092.317	0	0	0	0
EBT	9.416.809	10.241.266	11.141.389	12.123.331	13.193.743	14.359.826	15.245.776	15.030.853	14.806.659	14.572.420
P/L before tax / Gewinn,Verlust vor Steu	9.416.809	10.241.266	11.141.389	12.123.331	13.193.743	14.359.826	15.245.776	15.030.853	14.806.659	14.572.420
Corporate tax / Unternehmenssteuer	0	0	0	0	0	0	0	0	0	0
Other taxes / Andere Steuern	0	0	0	0	0	0	0	0	0	0
Profit / Loss / Gewinn / Verlust	9.416.809	10.241.266	11.141.389	12.123.331	13.193.743	14.359.826	15.245.776	15.030.853	14.806.659	14.572.420
Accumulated P/L / Kummulierter Gewinn	9.416.809	19.658.074	30.799.464	42.922.794	56.116.538	70.476.363	85.722.139	100.752.992	115.559.651	130.132.071
Cash Flow / Bargeldumlauf										
Profit Loss / Gewinn Verlust	9.416.809	10.241.266	11.141.389	12.123.331	13.193.743	14.359.826	15.245.776	15.030.853	14.806.659	14.572.420
+ Amortization / + Abschreibung	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000
Available Cash Flow / Verfügbare Mittel	15.416.809	16.241.266	17.141.389	18.123.331	19.193.743	20.359.826	21.245.776	21.030.853	20.806.659	20.572.420
- Repayment / - Rückzahlung	12.218.979	13.216.048	14.294.477	15.460.906	16.722.516	18.087.074	0	0	0	0
Free Cash flow / Freies Bargeld	3.197.830	3.025.218	2.846.912	2.662.424	2.471.227	2.272.752	21.245.776	21.030.853	20.806.659	20.572.420
Free Cash flow account / Kummuliertes I	3.197.830	6.223.048	9.069.960	11.732.384	14.203.611	16.476.363	37.722.139	58.752.992	79.559.651	100.132.071
Debt Services / Schuldendienst										
Credit sum / Kreditsumme	90.000.000	77.781.021	64.564.974	50.270.496	34.809.590	18.087.074	-0	-0	-0	-0
- Repayment / - Rückzahlung	12.218.979	13.216.048	14.294.477	15.460.906	16.722.516	18.087.074	0	0	0	0
Verbleibende Schulden	77.781.021	64.564.974	50.270.496	34.809.590	18.087.074	-0	-0	-0	-0	-0
IRR on total investment / interne Verzinsung der Gesamtinvestition	19,69%		Above figures are a rough estimation and subject to a review of the audited financials of the buyer of the last (3) three years. Subject to approval and external credit approval. Therefore, not binding.							
IRR on equity / Verzinsung Eigenkapital	#ZAHL!		All terms and conditions are provided as mere indication without any obligation on our part.							

Year / Jahr	11	12	13	14	15	16	17	18	19	20
	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Produktion in kWh	193.897.241	193.123.073	192.351.995	191.583.996	190.819.064	190.057.185	189.298.349	188.542.542	187.789.753	187.039.969
Turnover feed in / Umsatz Einspeiseverg	19.661.180	19.582.680	19.504.492	19.426.617	19.349.053	19.271.799	19.194.853	19.118.214	19.041.881	18.965.853
Turnover Certificates	2.035.921	2.027.792	2.019.696	2.011.632	2.003.600	1.995.600	1.987.633	1.979.697	1.971.792	1.963.920
Lease / Pachtkosten	0	0	0	0	0	0	0	0	0	0
Maintenance / Wartung	1.727.140	1.865.311	2.014.536	2.175.699	2.349.755	2.537.735	2.740.754	2.960.014	3.196.816	3.452.561
Management / Management	323.839	349.746	377.726	407.944	440.579	475.825	513.891	555.003	599.403	647.355
Insurance cost / Versicherung	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000	870.000
Opex / Operative Kosten	2.920.979	3.085.057	3.262.262	3.453.643	3.660.334	3.883.561	4.124.646	4.385.017	4.666.219	4.969.916
EBITDA	20.327.300	20.070.399	19.800.743	19.517.279	19.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
- Amortization / -Abschreibung	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	0	0	0	0	0
EBIT	14.327.300	14.070.399	13.800.743	13.517.279	13.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
- Interest amount / -Zinskosten	0	0	0	0	0	0	0	0	0	0
EBT	14.327.300	14.070.399	13.800.743	13.517.279	13.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
P/L before tax / Gewinn,Verlust vor Steu	14.327.300	14.070.399	13.800.743	13.517.279	13.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
Corporate tax / Unternehmenssteuer	0	0	0	0	0	0	0	0	0	0
Other taxes / Andere Steuern	0	0	0	0	0	0	0	0	0	0
Profit / Loss / Gewinn / Verlust	14.327.300	14.070.399	13.800.743	13.517.279	13.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
Accumulated P/L / Kummulierter Gewinn	144.459.371	158.529.771	172.330.513	185.847.792	199.066.664	217.970.960	236.543.186	254.764.420	272.614.193	290.070.369
Cash Flow / Bargeldumlauf										
Profit Loss / Gewinn Verlust	14.327.300	14.070.399	13.800.743	13.517.279	13.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
+ Amortization / + Abschreibung	6.000.000	6.000.000	6.000.000	6.000.000	6.000.000	0	0	0	0	0
Available Cash Flow / Verfügbare Mittel	20.327.300	20.070.399	19.800.743	19.517.279	19.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
- Repayment / - Rückzahlung	0	0	0	0	0	0	0	0	0	0
Free Cash flow / Freies Bargeld	20.327.300	20.070.399	19.800.743	19.517.279	19.218.872	18.904.296	18.572.226	18.221.234	17.849.773	17.456.176
Free Cash flow account / Kummuliertes I	120.459.371	140.529.771	160.330.513	179.847.792	199.066.664	217.970.960	236.543.186	254.764.420	272.614.193	290.070.369
Debt Services / Schuldendienst										
Credit sum / Kreditsumme	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
- Repayment / - Rückzahlung	0	0	0	0	0	0	0	0	0	0
Verbleibende Schulden	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

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PSECC LTD

Nuclear Energy Plants
PROPOSAL

December 2023

Prepared By: Alan Brewer MSc.
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Project No. PSECC010

PREPARED FOR:

Mr S. Ikua
Director General / CEO

LAPSSET CORRIDOR

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Baseload Transitional Clean Energy

Net ZERO

Rolls-Royce www.rolls-royce-smr.com/
www.rolls-royce.com/innovation/small-modular-reactors.aspx#/

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PSECC Ltd

Portsmouth Sustainable Energy &
Climate Change Centre

SMALL MODULAR REACTOR

Rolls-Royce Small Modular Reactor (SMR) has been established with a clear vision to deliver clean, affordable energy for all.

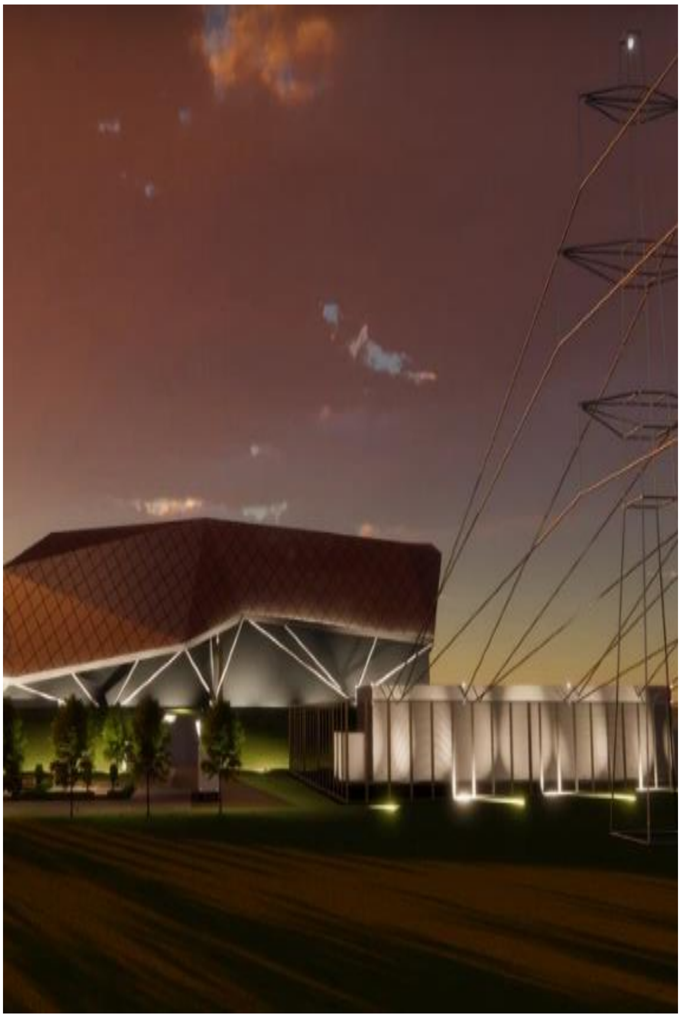
COP28 indicated the importance of Adaption and to "Transition" into a Net Zero economy - Kenya targets to kick off the construction of its first nuclear power plant in 2027 as the country seeks to further diversify its energy generation amid rising demand and push for zero-carbon energy. Our world and Lapsset Corridor need more low-carbon clean power than ever. Rolls-Royce SMR Ltd has been established to develop an affordable Nuclear power plants that generate electricity using a small modular reactor - an intelligent way to meet our future energy needs. To achieve this goal, speed and certainty are critical. Because Rolls-Royce SMR is able to produce a repeatable factory-built power station, that relies on tried and tested nuclear technology, it can be constructed and made operational far more quickly than conventional bespoke nuclear design and build technology.

PSECC Ltd & Afri-Fund Capital introduce the Rolls-Royce SMR to Lapsset Corridor – this approach lowers cost, reduces uncertainty and risk for the Government of Kenya and developers and crucially, allows Kenya to address their urgent need for low carbon energy.

ADVANTAGES

Nuclear energy is the most powerful source of 'always on' clean energy, however, it must be competitive for it to be widely embraced. Rolls-Royce SMR Ltd has designed a factory built nuclear power plant that will offer clean, affordable energy for all.

- Proven technology for 60 years of use
- Fast deliver – less build time
- One tenth the size of a conventional plant
- Lower environmental / ecological impacts
- Small footprint
- Less complex construction
- Reduced Risk
- innovative delivery
- Business experts
- Lower running costs
- Climate Change Mitigation
- Transition to Net Zero
- Stable long-term Energy
- Clean, affordable Energy for all
- Low-cost Baseload Electricity
- Scalable
- Can support Green Hydrogen plants

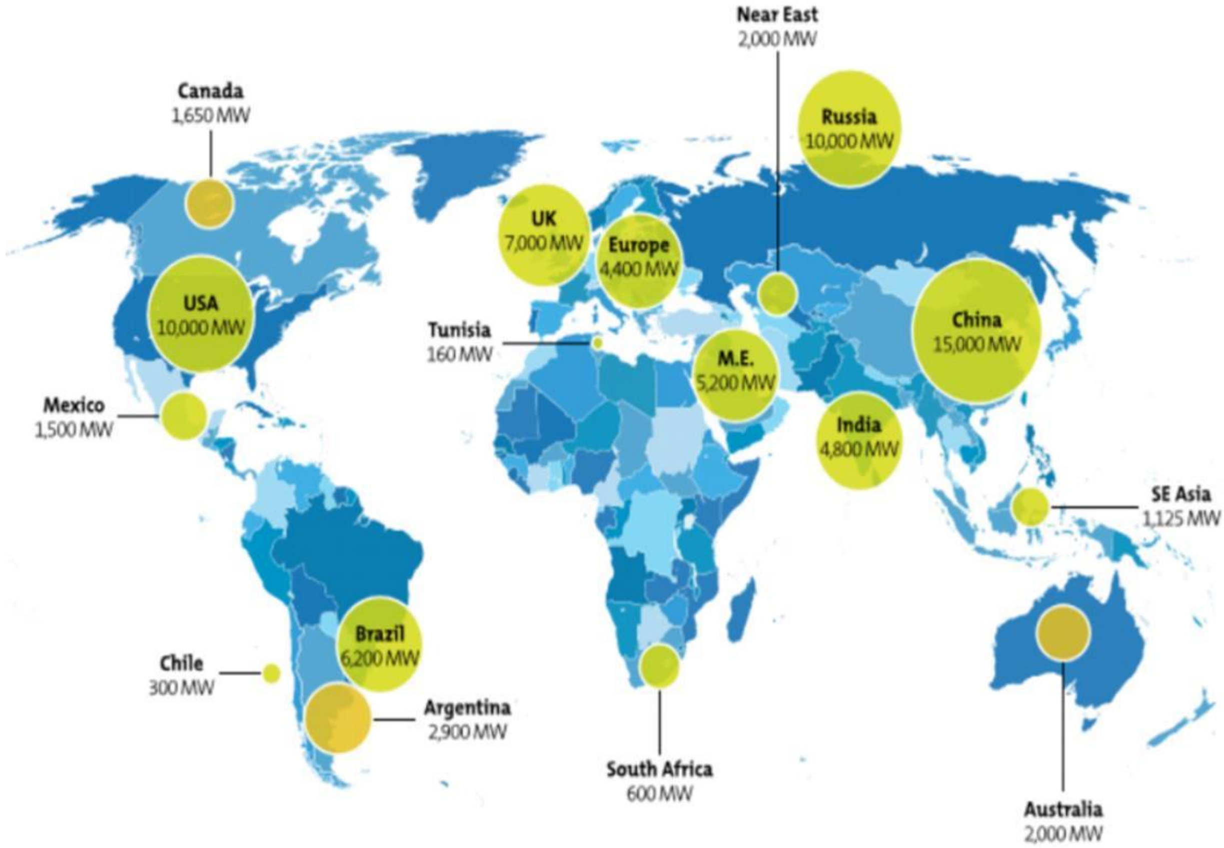


- **PROVEN ESTABLISHED TECHNOLOGY**

Small Modular Reactor (SMR)

- Rolls-Royce SMR uses established nuclear technology and knowhow, to offer a sustainable, low cost, repeatable and scalable product, that can be rolled out in Kenya and Lapsset Corridor and around the world.

Rolls-Royce company Market deployment markets - could be of interest to Kenya



The Kenya Government have a fifteen-year Nuclear programme - www.nuclear.co.ke
The Nuclear Power and Energy Agency, formerly Kenya Nuclear Electricity Board (KNEB), is a State Corporation established under the Energy Act 2019. It is charged with the responsibility of promoting and implementing Kenya's Nuclear Power Programme, carrying out research and development for the energy sector.

Towards attainment of its mandate, the Nuclear Power and Energy Agency shall develop policies and legislation, undertake public education and awareness, identify suitable sites for the construction of Nuclear Power Plants; carry out research, development and innovation on energy technologies as well as capacity building for the energy sector.

Rolls-Royce plans to build small nuclear power plants in Britain that Kenya could utilise over time.
Backed by the government and other investors, the industrial giant proposes to build as many as 16 generating plants.

A UK SMR will deliver growth for the economy of Kenya

Solid foundations

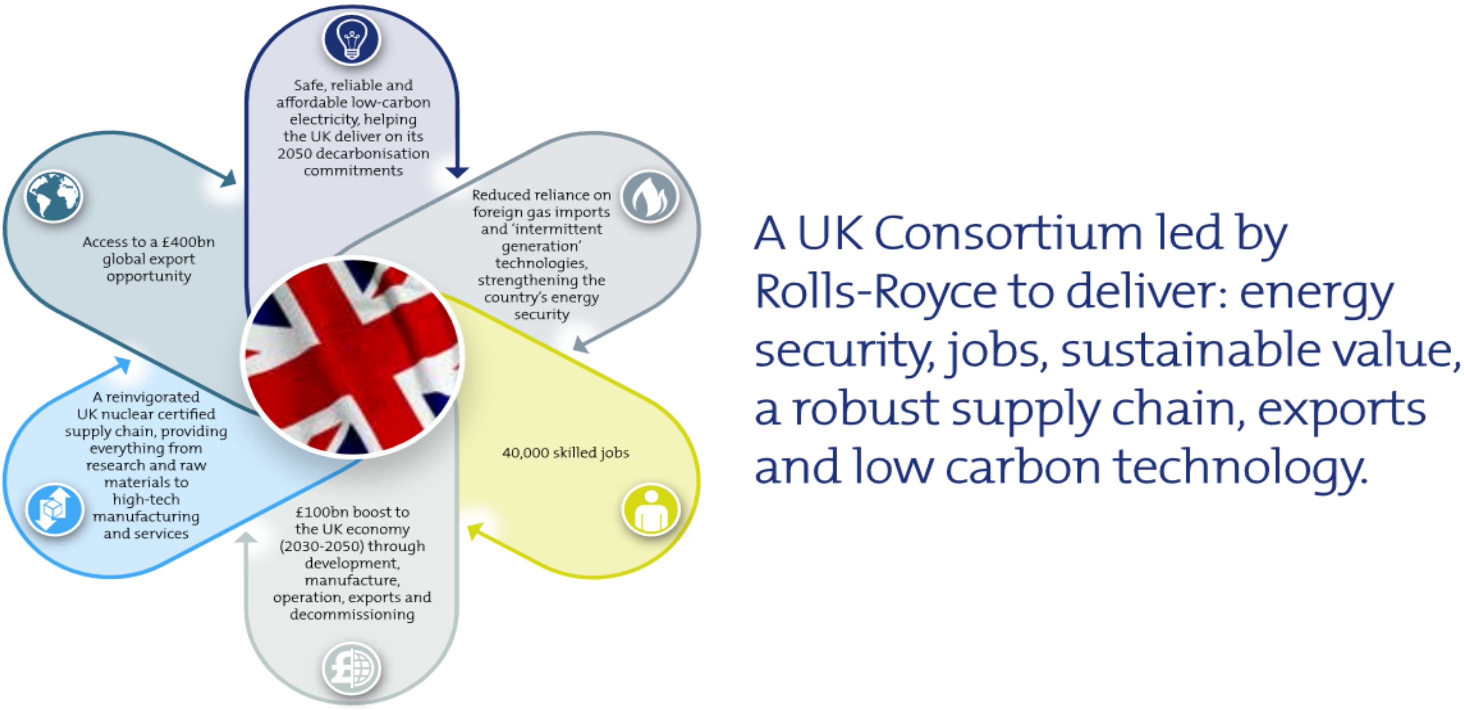
Our SMR generates power in the same way as a larger nuclear reactor. Energy is generated by splitting uranium atoms to create steam, turn turbines and produce electricity. The process produces no carbon emissions. One of the key innovations lies in its foundations. A seismic bearing pad resting on a specially engineered platform acts as a giant shock absorber to neutralise movement from any seismic activity.

Teaming up to bring SMRs to the UK an International markets

We have brought together a cross-sector collaboration of engineering, manufacturing and construction partners working to make our SMR vision a reality.

Our aim is to be part of a joint venture manufacturing and assembling small nuclear power stations for customers such as utility companies. The UK SMR Consortium plan could embed long-term jobs, skills and prosperity in communities across the UK.
Further afield, SMRs could make clean, low carbon nuclear power available to remote communities, small countries and emerging economies across the world.

A Small Modular Reactor (SMR) programme represents a once in a lifetime opportunity for UK nuclear companies to design, manufacture and build next generation reactors to meet the UK's energy needs. The UK Government has the chance to maximise British content, creating and sustaining intellectual property, high-tech, high-skills employment, a reinvigorated UK supply chain and positioning the country as a global leader in innovative nuclear technologies that present tremendous opportunities in international export markets.
Rolls-Royce believes a UK SMR programme has the potential to deliver:



Rolls-Royce believes its SMR design will:

•Provide 220MW to 440MW of power, depending on the configuration, that's the equivalent of up to 150 onshore wind turbines.

•Supply power to the grid in a timely manner at lower cost to the taxpayer and consumer, generating electricity that is at least as cheap (per MW) as power generated by today's large-scale reactors – potentially even cheaper when SMRs go into volume production.

•Represent the lowest risk by using proven technology and best value by using a high degree of commercial or standardised off-the-shelf components.

•Open up opportunities for UK supply chain companies to enter into volume manufacturing as over 75% of the
design (by cost) is modular.

•Appeal to a UK commercial or international utility company or power station operator.

•Be so compact (16 metres high and 4 metres in diameter) it can be transported by truck, train or even barge.

•Sit within a power station that would be roughly five and half times the size of the pitch at Wembley, which is just one-tenth the size of a typical large-scale reactor site (40,000m2 vs 400,000m2).

•Take just 5 years from the start of construction to the generation of the first electricity.

•Be up and running by 2028, maximising the UK's first-mover advantage in the race for exports.

•Minimize operating costs such as refueling and the burden of decommissioning.

•Last for 60 years.

A UK SMR will deliver growth for the economy – possible for Kenya

A Rolls-Royce - led UK SMR solution will deliver an estimated Gross Value Added (GVA) indirect contribution of £71bn to the UK economy, according to our research.
A peak benefit of 40,000 UK jobs will be created over the new build phase (2030 – 2050), with jobs split 60:40 between direct employment in the SMR Supply Chain and indirect employment in supporting areas. An UK SMR programme based on 7GWe in the UK and a conservative international export of 9GWe could deliver a total benefit to the UK economy of £188bn for the period 2015 to 2115, according to Rolls-Royce estimates, with the majority (£100bn) in the period 2030 to 2050. This includes a direct benefit of around £117bn, which will be created through the development, manufacture, operation, exports and decommissioning of SMR plants.

In comparison, UK Office for National Statistics (ONS) data from 2014 showed that nuclear energy provided £3.5bn to the UK. Kenya will experience GDP growth as a result of Nuclear Energy.

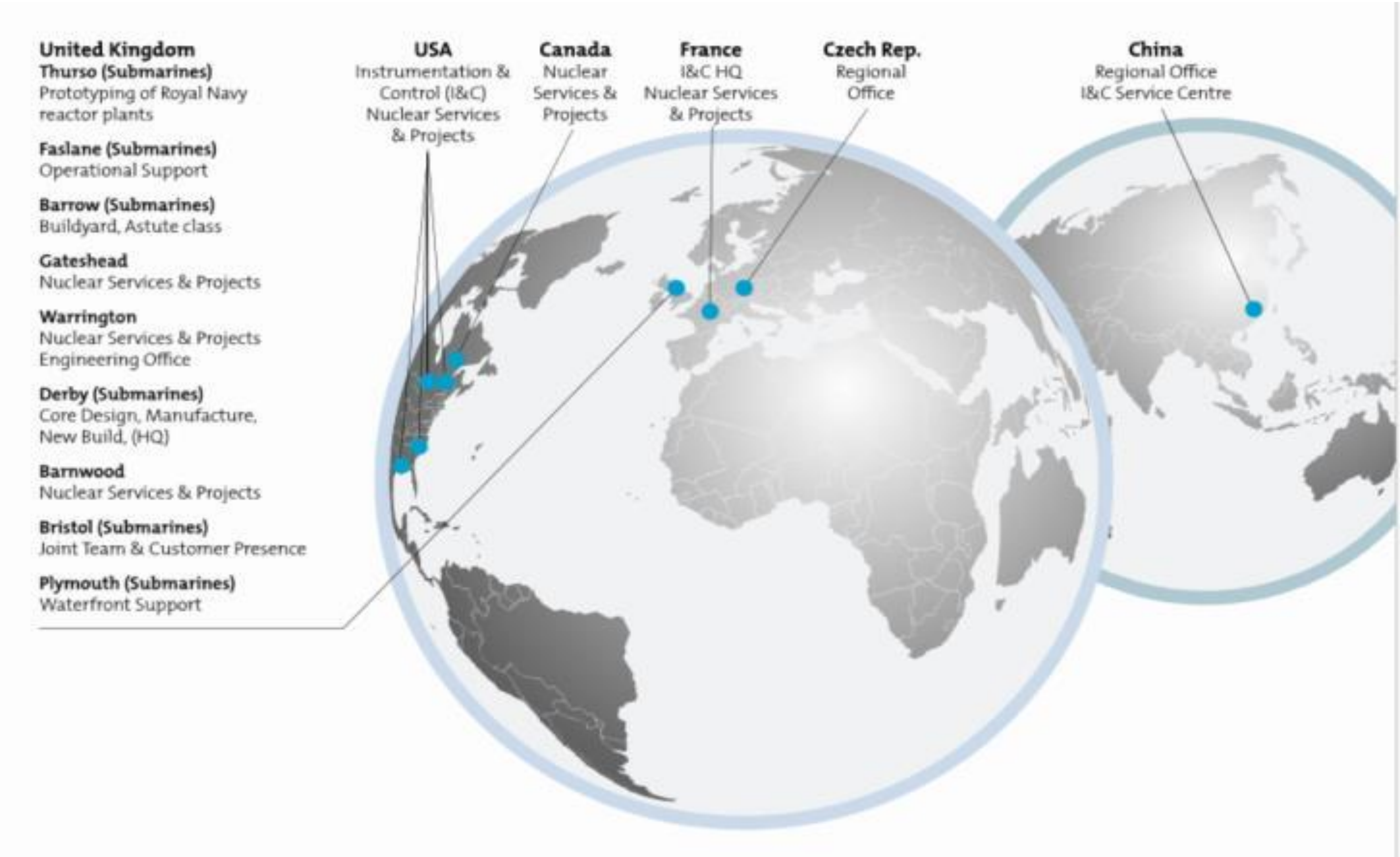
Rolls-Royce will help deliver one of UK's largest engineering collaborations

Development of the UK SMR plant promises to be one of the largest national engineering collaborations ever undertaken and Rolls-Royce is ideally placed to champion a British consortium. We are the largest employer of nuclear engineers and scientists in the country and with our decades of experience in producing compact nuclear pressure water reactors (PWRs), we believe we can meet the needs of the SMR opportunity in the civil energy market.

Our nuclear business includes many of the key capabilities needed to undertake an SMR design and build programme. We have 3,000 highly experienced engineers working today on key nuclear island design, manufacturing, procurement and operational support covering the entire lifecycle from inception to life extension and decommissioning, Job creation for Kenya will also result.

We are the only private Western reactor designer that is also a reactor plant operator, as we have responsibility for the operation of the onshore test reactor in the UK. We operate two further nuclear licensed sites: a nuclear core manufacturing facility for naval reactors and an engineering site, both situated in Derby. This combination of capabilities is matched by only a small number of organisations worldwide. We have been a nuclear reactor plant designer since the inception of the nuclear submarine programme in the UK. in the 1950s. Since then, Rolls-Royce has designed reactors for seven classes of submarine and two separate land-based prototype reactors. We have developed three separate reactor generations and each has seen significant improvements in reactor plant performance, core lifetime and safety.

In addition Rolls-Royce led the development of the first integral reactor design during the 1980s and early 1990s. This reactor, designated "SIR" (Safe Integral Reactor), was 330 MWe in power, and is arguably the starting point for all subsequent integral reactor designs.
Rolls-Royce has been working on the genesis of the SMR development programme for civil nuclear applications since the early 1990s.



Bringing together Britain's best brains

A Rolls-Royce - led UK SMR Programme will utilise a broad range of interdisciplinary technical expertise to deliver a commercially viable, sustainable solution to energy security using low-carbon technology. We would also look to utilise support available through regional and local government.

In partnership with UK Government, Rolls-Royce formed the Nuclear Advanced Manufacturing Research Centre (NAMRC) in Sheffield and has continued to support it with funded manufacturing development activity. Rolls-Royce has also established a network of over 25 University Technology Centres (UTC) in the UK and is currently funding a variety of UK University research programmes. We would expect our Consortium to involve a broad range of research organisations including the NAMRC, The Welding Institute (TWI) in Camdridge, the Manufacturing Technology Centre (MTC) in Coventry, The University of Birmingham, The University of Cambridge, The University of Derby, Imperial College London, The University of Manchester, The University of Oxford, The University of Sheffield and The University of Surrey.

CLIMATE CHANGE MITIGATION

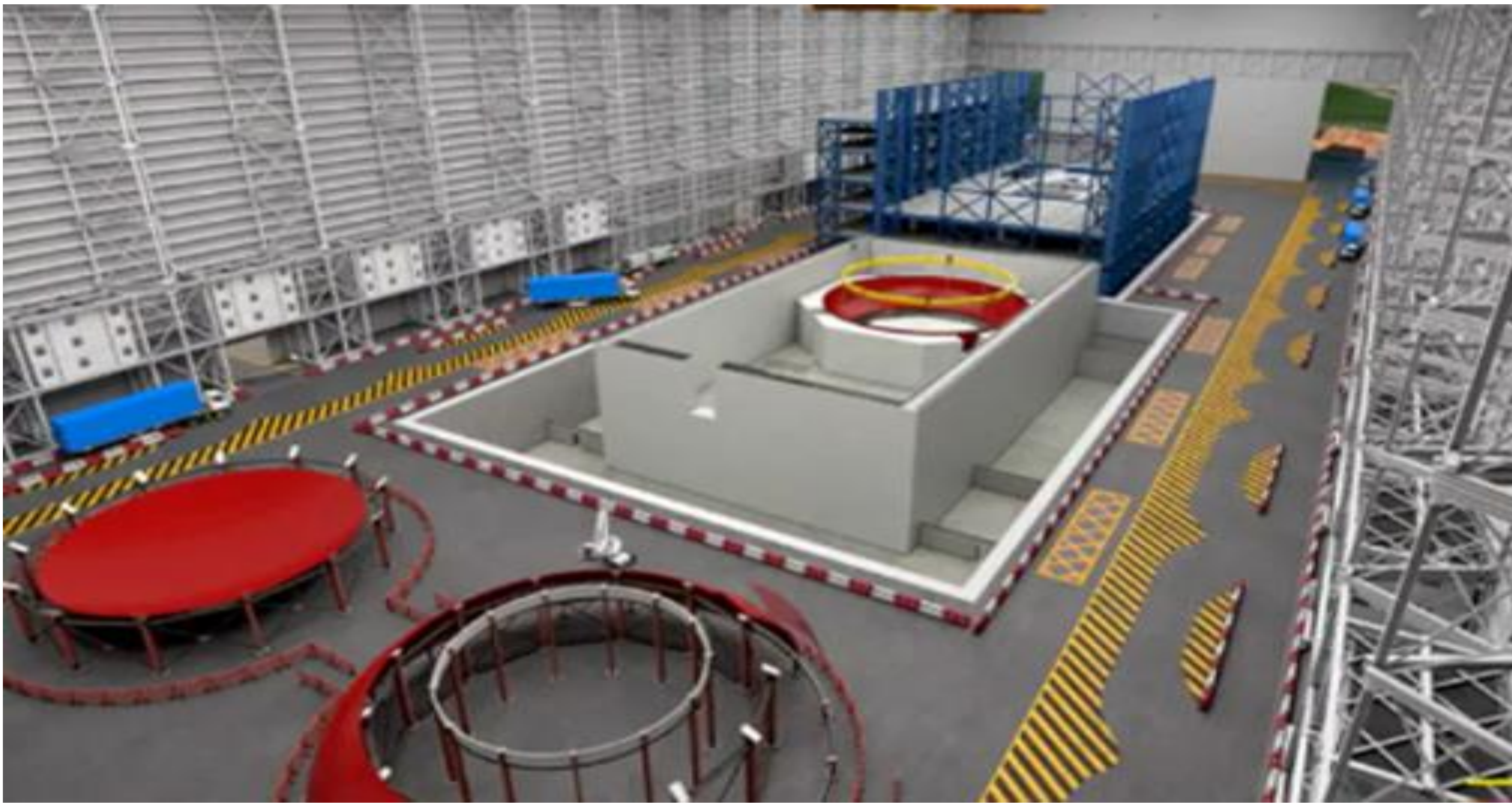
The Small Modular Reactor (SMR) business is one of the ways that Rolls-Royce is helping to ensure the UK and other Countries continue to develop innovative ways to tackle the global threat of climate change – our plants are ZERO carbon emissions.

With the Rolls-Royce SMR technology, we have developed a clean energy solution which can deliver cost competitive and scalable net zero power for multiple applications - from grid and industrial electricity production to hydrogen and synthetic fuel manufacturing.

Rolls-Royce brings together global industry leaders in energy generation and engineering, who will harness the potential of this ground-breaking approach to sustainable nuclear power.

Climate Change Mitigation

Rolls-Royce is a Great British company and has developed the SMR technology as a solution to global energy security.



ALIGNMENT WITH LAPSSET CORRIDOR STRATEGY

Kilifi and Kwale our ideal sites for Nuclear Energy Plants

Kilifi and Kwale are counties in Kenya, and they are part of the LAPSSET Corridor project - Kilifi County is located on the coast of Kenya, and Kwale County is also situated on the coast, to the south of Kilifi. Kenya targets to kick off the construction of its first nuclear power plant in 2027 as the country seeks to further diversify its energy generation amid rising demand and push for zero-carbon energy.

Kenya plans to utilize nuclear power for electricity generation by 2034 in order to meet its decarbonisation targets, improve stability and reliability of supply as well as lowering the cost. Energy Principal Secretary Alex Wachira says nuclear energy would provide a suitable baseload alongside geothermal to help spur Kenya's economic development – PSECC Ltd recommend Rolls-Royce to Kenya for consideration.

Energy Ps Alex Wachira addressing the delegates for Nuclear power infrastructure development training. "Nuclear energy is an indispensable tool for achieving the global sustainable development agenda. It has stood as a beacon of promise in this regard, offering clean, reliable, and continuous energy generation," said PS Wachira.

Delegates drawn from seventeen countries will be in Mombasa for two weeks for the Interregional Training Course on Nuclear Power Infrastructure Development. The delegates are drawn from Algeria, Egypt, Senegal, Uganda, Zambia, Nigeria, Ghana, Ethiopia, Bangladesh, Sri Lanka, Indonesia, Mongolia, Thailand, Turkey, Jordan Poland and Kenya.

Acting CEO of the Nuclear Power and Energy Agency (NuPEA) Justus Wabuyabo told the Business Daily the agency has advanced plans to float international tenders for the construction of the in either Kilifi or Kwale counties.

The revelation follows approval by the International Atomic Energy Agency (IAEA) in 2021 for Kenya to go ahead with setting up the infrastructure for the plants.

"We will do the bidding stage, as anytime between 2026 and 2027 and start construction in 2027. Construction ranges six to ten years so we are looking at 2034-35 to commission the first plant," Mr Wabuyabo said.

"We are now focusing on Kilifi and Kwale as our ideal sites. They have met most of the criteria but before we determine the final site we have to do a detailed scientific study as provided for by IAEA like seismic tests," he added.

The plant is expected to have a capacity of 1,000 Megawatts (MW), which if successfully delivered will be key to helping boost the electricity supply to the economy and help reduce reliance on dirty thermal plants.

TENTATIVE TIMELINE

Following is the tentative timeline of the Nuclear programme, divided into 3 phases:

Phases	Name	Description	Time Frame
Phase 1:	Implementation / Feasibility	Strategic pathway	2027
Phase 2:	Small Modular Reactor	470MW	2028
Phase 3:	Small Modular Reactor	470MW	2031

COST

The details of the indicative cost are provided below (dependent upon exact criteria):

Title	Cost (USD)	MWh per year
Phase 1. Implementation / Feasibility Study / EIA etc (approximately)	$300,000	
Phase 2. Small Modular Reactor	$2.90 Billion	Approximately 4 million MWh
Phase 3. Small Modular Reactor	$2.66 Billion	Approximately 4 million MWh

Items	Cost
PSECC Ltd coordination	
Coordinator	To Be Determined
Project Manager	To Be Determined

REVENUE

PSECC Ltd calculations (to be confirmed by Rolls-Royce once plant is operational and O&M considered) – indicative.

Items	Revenue (USD)
Yearly Energy Generation from 470MW plant producing 4 million MWh – electricity sold at $0.05 KWh	$200 Million
Government 35% share of revenue per year	$70 Million
Total revenue generation over 60 years	$12 Billion
Total Government revenue share over 60 years	$4.2 Billion

CARBON DIOXIDE SAVINGS

Nuclear Energy plant	Savings in Carbon Dioxide per year
1	4.7 Million (tCO_2)
2	4.7 Million (tCO_2)

Proposed Energy projects for Lapsset & Kenya

Energy Source	Capacity (MW)	Estimated Emissions Reduction (tCO_2/MWh)	Annual Carbon Reduction (tCO_2)
Geothermal	5,000	0.01	50,000,000
Solar PV	1,000	0.02	2,000,000
Solar Farms	3,000	0.02	6,000,000
Wind Farms	500	0.02	1,000,000
Waste to Energy Plants	360	0.05	1,800,000
Green Hydrogen Plants	2,200	0.00 (assuming zero emissions)	0
Hydroelectricity Dams	1,296	0.00 (assuming zero emissions)	0
Bioethanol Plants	341	0.05 (assuming emissions similar to waste-to-energy)	1,705,000
Nuclear Plants	940	0.01	9,400,000
Clean Coal Plants	2,040	0.7 (assuming lower emissions for cleaner coal technology)	14,280,000
Total Carbon Reduction			**85,185,000**

ASSURANCES

- Baseload Electricity supply to Lapsset Corridor – 4 Million MWh per year
- Proven track record
- Low-Cost electricity supply, We have 3,000 highly experienced engineers
- Revenue Generation for the Government of Kenya
- Carbon Dioxide savings of 4.7 million (tCO_2) per year to help Net ZERO

CONTACT US

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Website: www.psecc.co.uk

LAPSSET CORRIDOR

Clean Coal Technology PROPOSAL Concept

PREPARED BY

Alan Brewer MSc

Business Development Director

PSECC Ltd

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December

2023

PSECC Ltd

Portsmouth Sustainable Energy & Climate Change Centre

PREPARED FOR

Mr S. Ikua

Director General / CEO

LAPPSET CORRIDOR DEVELOPMENT AUTHORITY - LCDA

Chester House, 2nd Floor, P.O.Box 45008-00100, Koinange Street, Nairobi, Kenya

Project No. PSECC011

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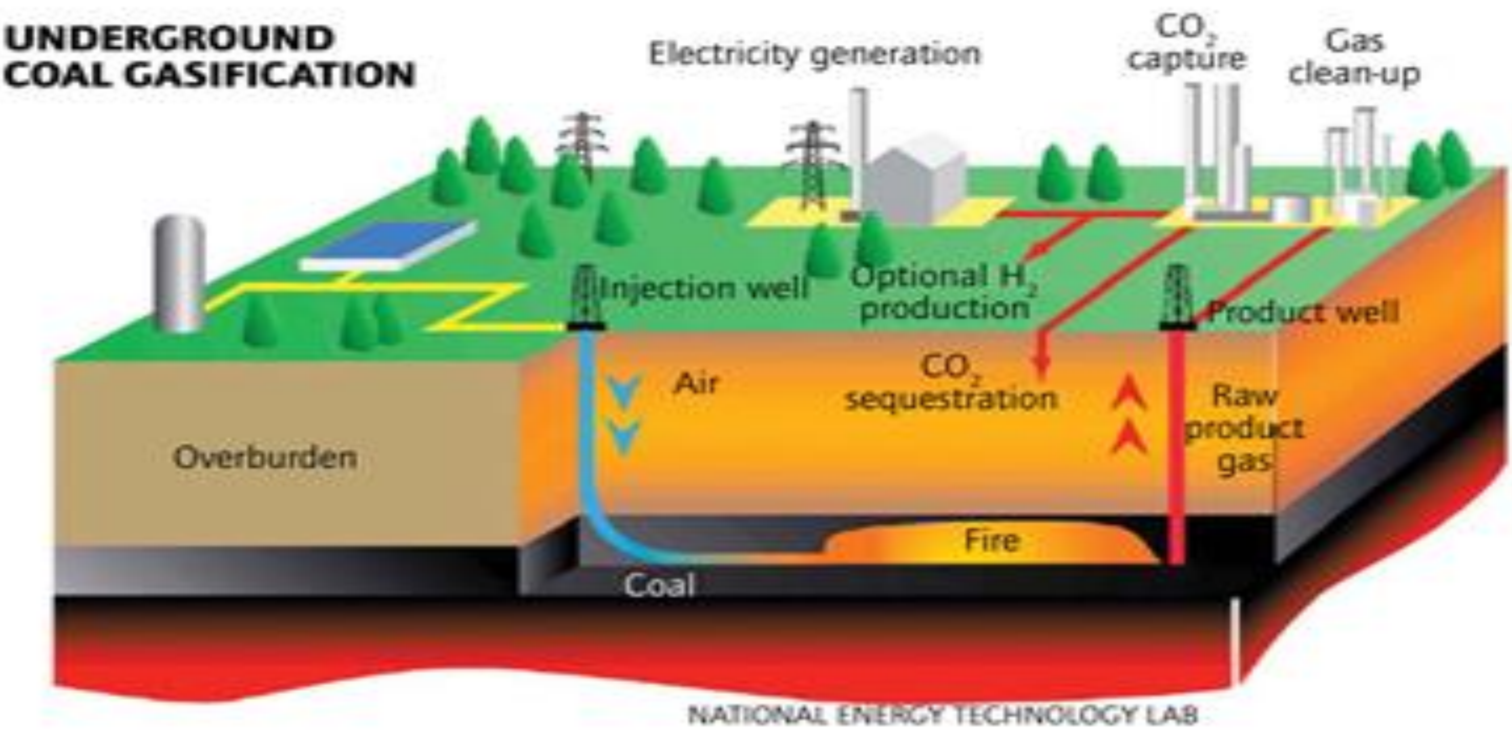


EXECUTIVE SUMMARY

COP28 indicated the importance of Adaption and to "Transtion" away from Fossil Fuels, however if Kenya still wanted to have coal fired power stations then have Clean Coal technology as part of a transition program. Kenya had plans to set up a 960MW coal-fired power plant in Kitui in the Lapsset Corridor, which will be Kenya's second coal project after the Lamu coal plant. This is, according to the Government treasury's report for public-private partnership (PPP) projects which has flagged the power plant as among the proposed State mega undertakings at the time.

Let us make Kitui Coal plant Clean

PSECC Ltd & Afri-Fund Capital introduce Carbon Capture Clean Coal Technology and also Underground Coal Gasification (UCG) takes advantage of the same chemical reactions of coal to produce product gases, as those occurring in conventional gasifier reactors. The main difference is that in UCG the underground coal seam itself becomes the reactor, so that the gasification of the coal takes place underground instead of in a manufactured gasification vessel at the surface. Obviously, this has the one great cost-saving and simplifying advantage of not requiring the coal to be mined in order to be gasified. UCG eliminates the need for mining, and the dangers to miners and environmental degradation that are associated with it. It also makes deep or difficult to access coal seams into usable energy assets, as only one-sixth to one-eighth of the world's coal reserves are economically mineable. Scientists estimate that with UCG, the U.S. usable coal reserves could increase by 300%, this might be the case also for Kenya.

COAL USE

What is coal used for in society….

Coal has historically been used for various purposes in society due to its energy content and versatile properties. However, its use has been evolving, and in recent years, there has been a global push towards cleaner and more sustainable energy sources.

960MW in size

The power plant could still be situated on eastern side of Mui Basin in Kitui County via an IPP (independent power producer) framework. The Energy ministry, the contracting authority, says the coal project will help diversify Kenya's power mix and drive growth.

Kenya has in recent years discovered coal deposits within the Mui Basin in Kitui, having struck more than 400 million tonnes with further exploration ongoing but mining yet to begin. Electricity will be priced in the same range as geothermal power at US $7.52 per unit, almost a third of what diesel-fired plants charge on average. (PSECC Ltd aim for $0.05 KWh).

Kenya has announced plans for its second coal-fired power plant, following finding coal deposits in Kitui. Feasibility studies are being launched to assess the possibility of developing the power plant in the town east of Nairobi.

AMERICA'S FIRST

CLEAN COAL PLANT

Example - Petra Nova project, not far outside of Houston, captured carbon dioxide from the process of coal combustion for the first time in September, and has now piped 100,000 tons of it from the plant to the West Ranch oil field 80 miles away, where the carbon dioxide is used to force additional oil from the ground. The companies say that the plant can capture over 90 percent of the carbon dioxide released from the equivalent of a 240 megawatt, or million watt, coal unit, which translates into 5,000 tons of carbon dioxide per day or over 1 million tons per year. They're calling it "the world's largest post-combustion carbon capture system."

Description	Purpose	Amount
Feasibility Study for Lapsset Plants	Pass EIA and cost criteria to meet $0.05KWh for electricity supply to Lapsset Corridor	$300,000 (dependent uopn exact criteria)
EPC Build costs	Constructiuon of Clean Coal Plant	To be determined
Carbon Dioxide savings	Climate Change Mitigation	14.28 million tons year
		$210,000.00

EXIT STRATEGY & NEW STRATEGY

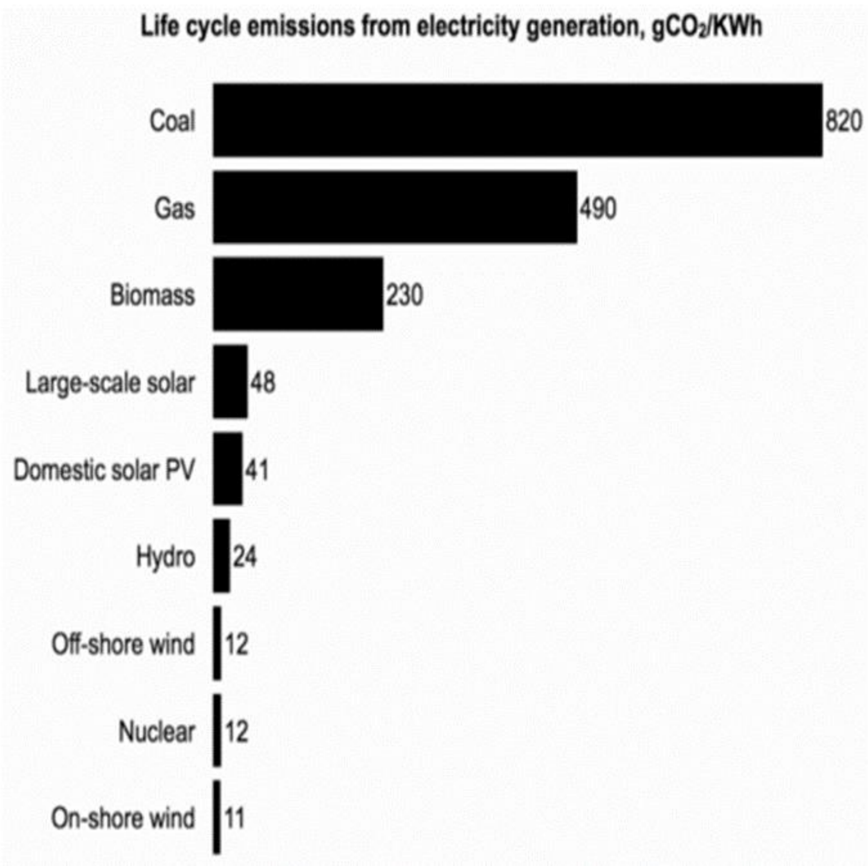
The proposed Lamu Coal Power Station had a potential for 1,050 MW (1,410,000 hp) coal-fired thermal power station in Kenya. The proposed plant would be developed on 865 acres of land and feature a 210-meter-tall smokestack, which would become East Africa's tallest structure. It would have been the first ever coal power plant in Kenya.

Kenya national government and media have been largely positive about the economic benefits from the coal plant activity. However, community advocates and some local government officials expressed concern over whether the benefits would be well distributed, whether the jobs would really materialize, and the lack of discussion over possible negative effects from the project.

As of June 2017, recent coverage has centered on the lack of economic viability and need for the proposed Lamu coal plant, citing a range of experts in news and analysis pieces. International accountability organisations also the people of Lamu challenged the environmental and social impact assessment license that Nema granted the project, in willful ignorance of the impacts, the project was halted on 26 June 2019 – Exit Strategy. New Strategy – Make them Clean Coal plants - There are 21 carbon capture projects worldwide on a large scale that are either operating or have been built, but relatively few of these are in the power generation sector — making Petra Nova and Kemper quite novel in context of the United States. In Canada, the Boundary Dam Carbon Capture and Storage Project, also a “post-combustion” capture plant using coal, has been operational since 2014. he 960MW project for Kenya had been flagged by the nation’s Treasury report for public-private partnerships (PPP).

Carbon Dioxide Emissions per energy source

When choosing an energy type to be developed it is now important to take note of the CO_2 emissions per KWh generated. The aim would be to reduce the emission from coal if Clean Coal Technology was used.



The carbon dioxide (CO_2) savings per ton of coal when clean coal technology is used depends on the specific type of clean coal technology employed. Clean coal technologies generally aim to improve the efficiency of coal combustion and reduce emissions of pollutants, including CO_2. Two common clean coal technologies are supercritical and ultra-supercritical steam cycles, and integrated gasification combined cycle (IGCC) another is Underground Coal Gasification UCG). Here are some general considerations:

Supercritical and Ultra-Supercritical Steam Cycles:

These technologies increase the efficiency of coal-fired power plants by operating at higher temperatures and pressures. By improving efficiency, they can reduce the amount of coal needed to generate a unit of electricity and consequently lower CO_2 emissions per unit of electricity produced.

Integrated Gasification Combined Cycle (IGCC):

IGCC involves converting coal into a synthetic gas (syngas) through gasification before combustion. This process can facilitate the capture and storage of CO_2 emissions. Additionally, IGCC plants are designed to be more efficient than traditional coal-fired power plants.

Carbon Capture and Storage (CCS):

Some clean coal technologies involve the capture and storage of CO_2 emissions. This is often referred to as carbon capture and storage (CCS). CCS can significantly reduce the amount of CO_2 released into the atmosphere.

Proposed Energy projects for Lapsset & Kenya

Energy Source	Capacity (MW)	Estimated Emissions Reduction (tCO2/MWh)	Annual Carbon Reduction (tCO2)
Geothermal	5,000	0.01	50,000,000
Solar PV	1,000	0.02	2,000,000
Solar Farms	3,000	0.02	6,000,000
Wind Farms	500	0.02	1,000,000
Waste to Energy Plants	360	0.05	1,800,000
Green Hydrogen Plants	2,200	0.00 (assuming zero emissions)	0
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Nuclear Plants	940	0.01	9,400,000
Clean Coal Plants	2,040	0.7 (assuming lower emissions for cleaner coal technology)	14,280,000
Total Carbon Reduction			**85,185,000**

If two Clean Coal power plants are to be built on Kenya then the total installed capacity would be 2,040MW saving 14.28 million (tCO_2)

COAL USE

Here are some traditional and contemporary uses of coal in society:

1. **Electricity Generation:**
    - Historically, one of the primary uses of coal has been for electricity generation. Coal-fired power plants combust coal to produce steam, which is then used to generate electricity.
2. **Industrial Processes:**
    - Coal is used in various industrial processes, such as steel production. In a process called coking, coal is heated in the absence of air to produce coke, a crucial component in the iron and steel industry.
3. **Heating:**
    - In some regions, coal has been historically used for heating homes and businesses. However, this practice has declined in many places due to environmental and health concerns associated with coal combustion.
4. **Chemical Production:**
    - Coal can be a feedstock for the production of various chemicals, including coal tar and other compounds used in the chemical industry.
5. **Infrastructure and Construction:**
    - Coal by-products, such as fly ash and bottom ash, have been used in construction materials like concrete. These by-products can provide certain engineering and environmental benefits when used in construction.
6. **Historical Transportation:**
    - In the past, coal was a primary fuel for steam locomotives and ships. However, in modern transportation, there has been a shift away from coal towards cleaner energy sources

Coal can be a feedstock for the production of various chemicals, what are the chemicals:

Coal can serve as a feedstock for the production of various chemicals through processes such as gasification, liquefaction, and pyrolysis. Some of the chemicals that can be derived from coal include:

1. **Coal Tar:**
    - Coal tar is a viscous liquid byproduct obtained during the carbonization of coal. It is a complex mixture of organic compounds and is used in the production of various chemicals, including phenol, creosote, and naphthalene.
2. **Coke:**
    - Coke is a solid carbonaceous material derived from coal through the process of coking. It is used as a fuel and a reducing agent in the production of iron and steel.
3. **Synthetic Fuels:**
    - Coal can be converted into synthetic fuels through processes like coal liquefaction or Fischer-Tropsch synthesis. These synthetic fuels can include synthetic gasoline, diesel, and jet fuel.
4. **Ammonia:**
    - Coal can be used in the production of ammonia through a process called gasification. Ammonia is a key component in the production of fertilizers.
5. **Methanol:**
    - Methanol, also known as wood alcohol, can be produced from coal through gasification. Methanol is used in various industrial processes and as a feedstock for the production of chemicals.
6. **Hydrocarbons:**
    - Coal can be a source of hydrocarbons, which are essential building blocks for the petrochemical industry. Hydrocarbons derived from coal can be used in the production of plastics and other synthetic materials.
7. **Aromatic Chemicals:**
    - Aromatic hydrocarbons derived from coal tar, such as benzene, toluene, and xylene (BTX), are important precursors in the production of various chemicals and polymers.
8. **Phenol:**
    - Phenol is produced from coal tar and is used in the manufacture of resins, plastics, and pharmaceuticals.
9. **Pitch:**
    - Pitch is a byproduct obtained during the distillation of coal tar. It is used in the production of carbon materials, such as electrodes and carbon fibers.

It's worth noting that while coal can be a source of these chemicals, the environmental and sustainability concerns associated with coal usage have led to increased interest in alternative, cleaner feedstocks and processes. Many industries are exploring and investing in technologies that reduce the environmental impact of chemical production.

The Ministry of Energy has developed a Draft Energy White Paper setting out a vision for how Kenya will transform its energy sector by 2040. In the development of the paper, we have mapped the energy journey of Kenya up to present day and done a critical analysis of the current state of the sector to identify key challenges and opportunities.

The draft White Paper put forward four ambitious outcomes as follows: (i) To establish energy as a transformational public good that is inclusive and serves the needs of Kenya's population; (ii) To establish Kenya as a global leader in the drive toward decarbonized economic growth; (iii) Drive Kenya to take a quantum leap to increase installed capacity by 2040 underpinned by renewable energy sources; (iv) Establish Kenya as an investment destination of choice for industries that are seeking to decarbonize. Recognizing the scale of our ambitions, the paper captures critical shifts and related strategic actions to ensure a matching energy system architecture that provides the requisite support.

It's important to note that while coal has played a significant role in the development of societies, there are growing concerns about its environmental impact. The normal combustion of coal releases pollutants, including carbon dioxide (a major contributor to climate change), sulfur dioxide, nitrogen oxides, and particulate matter. As a result, many countries and regions are working towards reducing their dependence on coal and transitioning to cleaner and more sustainable energy sources, such as natural gas, renewable energy (solar, wind, hydro), and nuclear power – coal could still play a role as a Flagship project if Clean Coal Technology is adopted.

Waste-to-Energy

"EXPRESSION OF INTEREST (EOI) TO DESIGN, BUILD, FINANCE, MAINTAIN & OPERATE AND TRANSFER A WASTE TO ENERGY PROCESSING PLANT IN DANDORA"

Circular Economy Transition - ZERO Waste ZERO Landfill

To - The County Secretary and Head of County Public Service Nairobi City County Government, P.O Box 30075-00100, Nairobi, Kenya

Danny Cruz CEO and Managing Director HEADWAY USA**, 4445 Corporation Ln Ste, 264 Virginia Beach, VA, 23462-3262 United States also offices in** Washington DC / Orlando, Florida www.headwayus.com Email – druz@headwayus.com Tel - +1 (202) 486-8771 PSECC Ltd website www.psecc.co.uk **Alan Brewer** CEO PSECC Ltd 39 Woodhay Walk, Havant, Hants, PO9 5RD Tel – 02392 471860 Email alan@psecc.co.uk

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Example of Waste-to-Energy & Recycling plant – Full funding provided and a 10% revenue share in each plant for the Government.

The plant (s) will pay for themselves from Power Purchase Agreements

HEADWAYUSA

Proprietary and Confidential Information

January 23, 2023

The Honorable County Secretary and Head of County Public Service
Nairobi City County Government
P.O. Box 30075-00100
Nairobi, Kenya

LETTER OF INTENT
Funding the Waste-to-Energy Program in Nairobi, Kenya

To the Honorable Sirs:

Headway USA, as a collaborator with the UK company, PSECC, is a leading project management and project finance group in the United States, and is pleased to state its intention to provide management and funding support, to the fullest extent possible, for the facilities and services being proposed for the evaluation, selection, implementation, and operations of a Nairobi **Waste-to-Energy program (the "Program")**.

This letter of intent ("LOI") outlines the interest and capability to participate in the proposed Program under PSECC and is subject to the execution and closing of a definitive agreement ("Definitive Agreement" or "Contract").

We propose the initial project phase to include the planning and engineering design works for a planned either one large plant processing 2,500 TPD (Tons Per Day) of MSW (Municipal Solid Waste) or five plants each processing 500 TPD MSW. This is envisioned as a $385 million USD project.

1. Financing the Waste-to-Energy Programs from US Eximbank, ESG oriented funds and US and European large financial institutions

Program funding is achieved by a combination of low-interest rate, near-concessional rate US government loans to the government of Kenya via US Eximbank, and private-sector funding via specialized ESG (Environmental, Social, Governance) oriented funds. In particular, a new ESG fund mechanism being developed by Headway and several US and European financial institutions will be tapped for this Program.

Loan Financing from the US government, is typically denominated at 1-1.5% above the US Treasury Rate (currently US 10-year Treasury rate is 4.25% per annum, which would entail a gross rate of 5.25-5.75% per annum to Kenya) and for 10-year or 18-year duration, this will be facilitated by Headway, together with the US Department of Commerce and the US Export-Import Bank, along with Headway's banking partners. In conjunction, private funding, which is provided on an equity investment basis (no debt, but share of earnings of the enterprise), will also be arranged directly by Headway, along with the investment committee of the new ESG fund mechanism. Close coordination will be required with the official governmental and financial regulatory bodies in Kenya to provide assurances in terms of repatriation of funds and earnings, and, in the case of loans, repayments of the loans.

Repayment of the funding can be structured via power purchase agreements from the selling of recycled materials generated from the Waste-to-Energy Program. This also takes into account a planned revenue sharing with the various local government structures as negotiated.

2. Technology and Services Offering to the Waste-to-Energy Program

The technology involved in Waste-to-Energy is constantly evolving and improving, in terms of capability, operability and profitability. Headway has pre-established relationships with the leading Waste-to-Energy companies throughout the US and globally; however, Headway shall work closely with the relevant authorities in Nairobi to evaluate the latest developments, alongside their operating limits and benefits, to establish the optimal solution for Nairobi for this program.

3. Structure of the Relationship

A new special purpose vehicle (or newco) corporate entity will be launched in Kenya for the Program. The new entity shall include the various stakeholders in the Program, i.e. Kenyan government, municipal players in the waste market, private sector players, facility operators, financing players, PSECC and Headway representatives. Once the new company is formed, that entity's agreements and covenants, as satisfactory to all the parties, will govern the development and operations of the project. The funding is then provided to that new entity.

4. Next Steps: Phase I and Phase II

Phase I: Feasibility and Engineering: $10 Million

Headway recommends a preliminary feasibility and engineering phase for the Waste-to-Energy program at the single site or the five sites, respectively, at locations to be determined based on recommendation and preferences presented by each of the stakeholders. This phase one feasibility and engineering plan entails a $10 million process to develop a technical and economic feasibility study, in addition to the initial engineering design plan. This will be arranged by Headway and provided via an Eximbank loan. The action steps needed are as follows:

- ⇒ Negotiate and sign a commercial agreement between Nairobi and the Headway, outlining the Waste-to-Energy program for the one or five identified sites. Typically, the contract is signed should be signed by the local government and a national government minister. This will require close coordination among those respective governments and ministries.
- ⇒ Submission of an Eximbank loan application. The application process is detailed and complex, thus Headway will utilize its expertise to support and coordinate the Kenyan government through the entire application process to ensure an efficient turnaround. The application must be signed and submitted to US Eximbank by the Minister of Finance of Kenya.

Phase II: Implementation of five (5) WTE Plants: $375 Million

- ⇒ Upon approval of the $10 million fund for feasibility, Headway will manage and develop and finalize the technical and economic feasibility study, in addition to the initial engineering design

HEADWAYUSA

Proprietary and Confidential Information

plan. During this stage, Headway will prepare submission to Eximbank for the remaining funding of roughly $375 million for the one or five sites.

Headway hereby states and affirms its intention to fully support the evaluation, selection, implementation, and operations of this proposed Program. We look forward to further discussions regarding the Waste-to-Energy Program for Nairobi and we envision subsequent near-term missions from the US with our funding and/or technical partners, to conclude any necessary agreements with you.

Sincerely,

Danny Cruz

Danny Cruz
CEO and Managing Director
HEADWAY PM, LLC
Washington DC / Orlando, Florida, USA
www.headwayus.com

PSECC Ltd Company No. 10652586
39 Woodhay Walk
Havant
Hampshire, PO9 5RD United Kingdom

Executive Summary

This ZERO Waste ZERO Landfill waste project could have one large 2,500 tpd MSW Waste-to-Energy Gasification & Recycling plant or five plants each processing 500 tpd MSW. Our Gasification is 45% more efficient than Incineration and much cleaner. Our proposal could lead Nairobi into a Sustainable Circular Economy Transition, create wealth for the Government and Job creation. Following our formal submission by the 2nd February 2023 and if we receive our formal acceptance letter to proceed we will make available the funding from US EXIMBANK with no requirement for the Government to repay the funding loan as these payments will be made from Power Purchase Agreements (PPA's) – the plant (s) pay for themselves.

Project costs are estimated at $385 million for the plant (s) and to do Feasibility study Phase 1 Engineering the first $10 million is released and will start with a Feasibility study and 90 days thereafter the remaining $375 million funding will be in place. We have had a two-year development program in Kenya with Kisumu County and have won that Waste-to-Wealth Tender in November 2022 to assist the Government towards Vision 2030. Our proposal to use Gasification is in line with the National Solid Waste Management Strategy, which highly recommends thermal treatment of waste as it leads to the generation of useful products besides waste treatment. The Financial breakeven, payback period of the plant (s) is 7.55 years.

Our Engineering, Procurement and Construction companies have built over 1,500 power plants. Our large Gasification & Recycling plant or five plants proposed for Dandora are scalable and can easily process the 2,500 tpd of MSW in Nairobi further plants in Kenya over the next five years if required. As well as the Waste-to-Energy function we can have Recycling of some plastics, all the glass and metals and can also produce Fertilizers and transport fuels and introduce also Manufacturing plants to make new products from the Recycled Glass, some plastics and metals and building blocks from ash when added to cement. We will increase the MSW collections rates each day if required by the provision of 200 new trucks & 1,000 Gas powered Rickshaws. Dandora cleanup costs and Cost Estimate of Cleanup of Illegal Dumpsites can be added onto the Dandora Waste-to-Energy plant (s) project costs and made available by Headway USA via the US EXIMBANK if negotiated.

Introduction

Waste-to-Wealth - Circular Economy Transition for Nairobi County

Your Vision 2030 - In Vision 2030, one of the flagship projects is the Solid waste management initiative which calls for relocation of the Dandora dumpsite and the development of solid waste management systems in five (5) leading municipalities and in the economic zones planned under vision 2030.

Headway USA/ PSECC Ltd Consortium Submission documents and proposal for the development, operation and maintenance of a Waste to Energy project through a framework on a Design, Build, Finance, Operate and Transfer the “DBFOT basis. The waste project could have one large 2,500 tpd MSW Waste-to-Energy plant or five plants each processing 500 tpd MSW and this will assist the Vision 2030.

The plants (s) will pay for themselves from Power Purchase Agreements.

We will increase the MSW collections rates each day if required by the provision of 200 new trucks and 1,000 Gas powered Rickshaws.

We have had a two-year development program in Kenya with Kisumu County and have won that Tender in November 2022 and to assist the Government towards Vision 2030 and soon we hope the Governor of Nairobi with this EOI submission.

We understand that KenGen did engage last year another waste company to do feasibility study for a 45MW Waste-to-Energy plant at RUAI to process 3,000 tpd, which was approved by NMS (Army) & KenGen MoU, however there have been delays in regulatory approvals including from the Treasury. The Government now wants a plant for Dandora and we are able to provide one large plant processing 2,500 tpd or five Waste-to-Energy plants, each processing 500 tpd MSW, fully funded and will be in Nairobi and also provide funding for the closure aspects of Dandora dumpsite remedial works and it should be turned into a park or for redevelopment.

Waste to Wealth

To assist the Circular Economic Transition of Nairobi and to deal in a sustainable way with the MSW then our plants can be engineered to provide Waste-to-Energy, Recycling, process tyres and some Medical waste and also use the Recycled material in Manufacturing plants for Glass, Metal and building blocks.

MSW

Recycling Plant

Medical waste

Tyres

Recycled glass

Recycled metals

We will work with Nairobi Government Officials and teams to ensure that all the MSW fractions are used in the most appropriate manner and meet all the Government's requirements. We can obtain Waste-to-Energy and also the recycled glass, metals, some plastic and ash can then be used in our new Manufacturing plants set up on site to produce new plastic, metal and glass products and the ash used with cement to produce building blocks for affordable homes. Tyers can also be processed and this together with wood and plastic can be used for energy recovery and the production of electricity.

Please review the following website that has been designed in order to convey and assist the Government to understand our offer.

Our large plant or five plants proposed for Dandora are scalable and can easily process the 2,500 tpd of MSW in Nairobi, further plants in Kenya over the next five years if required. As well as the Waste-to-Energy function we can have Recycling of some plastics, all the glass and metals and can also produce Fertilizers and transport fuels and we hope our approach was much needed for Nairobi in order to deal sustainably with waste management. The Circular Economy concept has grown in desirability and as such PSECC Ltd together with Headway USA have brought together different waste company technology providers to provide Recycling, Waste-to-Energy Gasification, now more efficient and Fuel production. If adopted by Nairobi County Government would lead the City & County into a Sustainable Waste Management and commence Circular Economic Transition – Waste-to-Wealth – real value for money and lead to a "Sustainable Urban & Rural life" in Nairobi and job creation.

Electricity

Building Blocks for house building

If adopted by Nairobi and County Government:

- It would lead the County into Sustainable Waste Management and commence Circular Economic Transition – Waste-to-Wealth – leading to a “Sustainable Urban & Rural life” in Nairobi.
- An Integrated Waste Management Facility processing 2,500 tpd MSW,
- National Determined Contributions on Climate Change Mitigation would be enhanced and many Sustainable Development Goals (SDG’s) met.
- Hundreds of jobs created and new Manufacturing Industries established using the Recycled materials of glass, metals, ash and building blocks made for affordable homes.
- The Renewable Energy mix of Nairobi also would be increased offering increased electrification and stable supply of electricity.
- Nairobi County will have a 10% shareholding in the plant if interested. No Government

money to build – Full Funding will be provided.

The National Solid Waste Management Strategy highly recommends thermal treatment of waste as it leads to the generation of useful products besides waste treatment. A clean circular economy also focuses on eliminating toxic chemicals and closing material loops through better design, maintenance, repair, reuse, refurbishing, and recycling. This offer we are making and submission to Nairobi will ensure a smooth transition into the Circular Economy. To understand this further then a study of Life-Cycle-Analysis is required to understand all the energy used and emissions from, for example producing 1 ton of plastic. The following website is a good place to start on LCA. Our Engineering, Procurement and Construction companies have built over 1,500 power plants.

What is Municipal Solid Waste?

www.ellenmacarthurfoundation.org/life-cycle-assessment-for-the-circular-economy

Municipal solid waste (MSW), more commonly known as garbage or trash, consists of non-hazardous refuse items that are thrown away by residential consumers, commercial businesses and public institutions.

What Materials Can Be Processed?

Because MSW is a mixture of waste, there can be a wide variety of items that can be processed for recycling in our plants. The most common items found in MSW are organic food, product packaging, cardboard, furniture items, clothing, glass and plastic bottles, food scraps, consumer paper waste, consumer electronics and appliances, and batteries.

We are interested to process all fractions of MSW.

Why process and Recycle MSW?

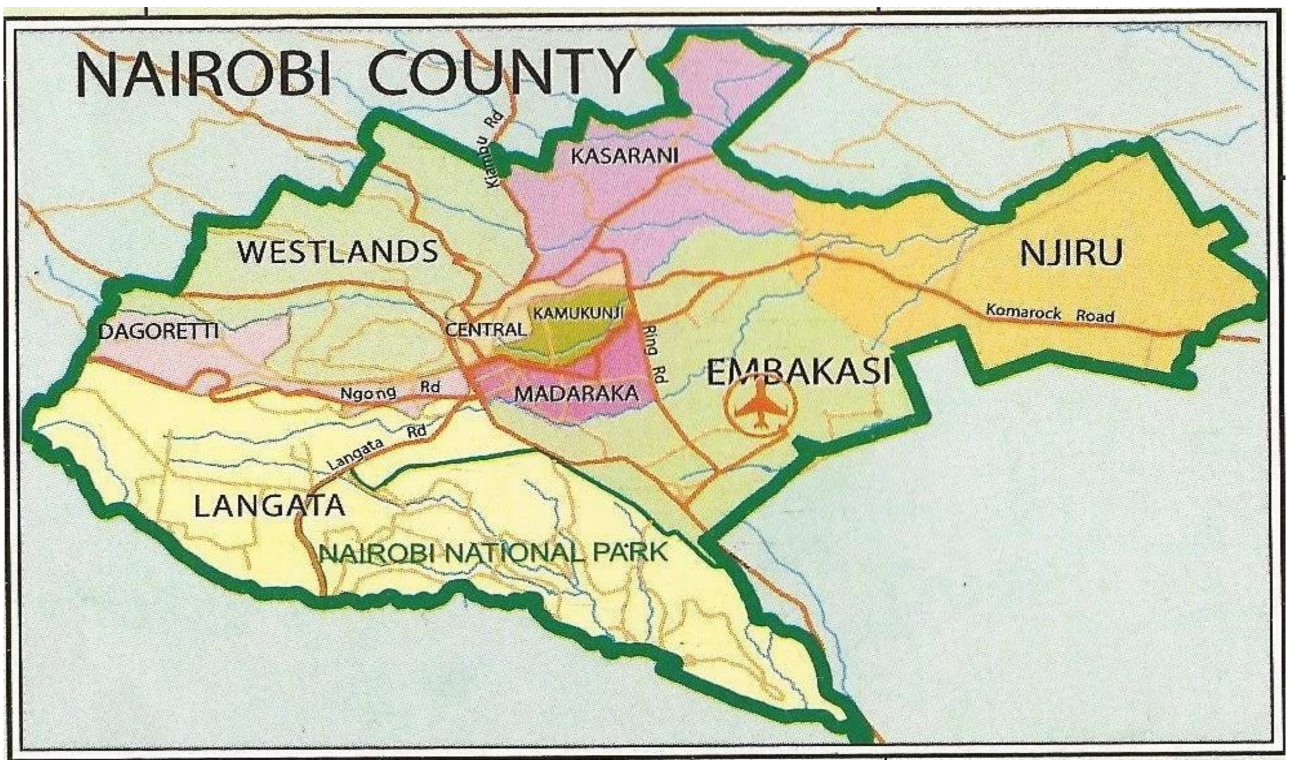
In many ways, MSW processors have the same goals to separate valuable materials from the non-recyclables and less valuable items. When MSW commodities like metal, wood, cardboard, glass, and plastic are recycled, the amount of virgin raw materials

Fig 1. Circular Economy - Our Plants are Zero Waste - Zero Landfill

The reason for the Circular Economy is that our current Linier economy extracts resources, manufactures products, people buy and use the products and then dispose of the old products into Landfill dumpsites. In the process of extraction and manufacturing energy is used and many emissions of pollutants. In order to reduce energy and pollutants then a Circular Economy is required whereby we only extract resources once, reduce energy usage, we recycle and reuse together with recover energy and materials from the waste and re-manufacture them into new products but eliminating the need to exstract new resources. We can also clear the Dandora dumpsite and use that waste in the Gasification plant and return the site back to a park or for redevelopment.

We understand NAIROBI current waste management

Fig. 2 – Nairobi County map



The principal impacts from the open dumping of waste include the contamination of groundwater, surface water and soil due to leachates from solid waste dumps. In addition, the waste entering the dumpsite is mixed, and thus it is highly probable that it contains toxic chemicals and hazardous materials. This increases the chances of pollution but also puts the health of the scavengers, waste pickers and dumpsite workers at risk as they do not have the appropriate protective gear to be handling waste. In addition, these individuals are also prone to cuts and infections as a result of stepping on glass, tin and/or syringes while scavenging for valuable materials. The Dandora Landfill dumpsite has now been closed.

The open burning of waste is another challenge as it results in the release of toxic pollutants and emissions such as sulphur dioxide (SO2), nitrogen oxides (NOx), dioxins and furans. These gases can cause respiratory diseases when inhaled, and others like dioxins and furans are carcinogenic and known to aggravate bronchial and asthmatic disorders. This also results in air pollution which can adversely impact on human health especially for communities living near landfill sites. Greenhouse gas (GHG) emissions are one of the most significant environmental impacts associated with the conventional landfill and combustion of solid waste. These GHG namely methane and carbon dioxide are also released during the break- down of biodegradable materials. These gases in particular are of concern because of their high global warming potential. Other risks associated with open dumping include bad odour, aesthetic nuisance, fire outbreaks and the proliferation of insects, mosquitoes, flies, cockroaches, rats and rodents. Such dumping sites often become breeding grounds for vectors of ailments like cholera, dysentery, diarrhoea and yellow fever.

Sustainable Urban & Rural Life

Stop the need to burn waste in Landfill sites - Helps prevent pollution and enhances Duty-of-care in Nairobi Jobs offered to pickers to bring waste to the new plant. The Recycled products can be used in new Factories, new concrete building blocks to build the new homes in Nairobi from Recycled, Glass, Ash and then cement added and also CO_2 used in food production and enable vegetables such as Tomatoes to be grown.

Prior to the establishment of Kenyan Environmental Management and Coordination Act (EMCA) of 1999, solid waste management was the sole responsibility of local authorities. The Act was enacted to provide the appropriate legal and institutional framework for the protection, management and conservation of the environment (Republic of Kenya 1999). The EMCA also emphasizes citizens' right to a clean and healthy environment and the duty to safeguard and enhance the environment through disposing of waste in designated areas (Republic of Kenya 1999). The waste management regulations within the Act apply to all waste categories and specify the requirements for handling, storing, transporting, treatment and disposal of waste (Agong et al. 2008; Republic of Kenya 1999). In 2008, the EMCA was complemented by environmental bylaws which specified the appropriate waste practices and outlined the penalties for failing to adhere to the stipulated standards. Moreover, these bylaws allowed local authorities to contract private waste collectors licensed by the National Environment Management Agency (NEMA).

Improper management of waste poses a threat to Climate Change and eventually in the achievement of sustainable development. Waste being one of the contributors of greenhouse gases, affects climate change and it is for this reason that as a country, the development of sustainable waste management technologies and initiatives is underway to curb this growing global challenge. Through our commitment to sustainable development, Kenya aims to balance the broader economic and social challenges of development and environmental protection. For this reason, the Country subscribes to the vision of a prosperous and equitable society living in harmony with our natural resources. This is also reinforced in the constitution under the fundamental right to a clean and healthy environment.

Sound environmental management entails use of waste reduction technologies in production, sustainable product design, resource efficiency and waste prevention, re-using products where possible; recovering value from products. Although, elimination of waste entirely may not be feasible, systematic application of modern waste management systems should be explored and implemented. To efficiently manage solid waste in Kenya, these actions are recommended. The National Government should ensure that the National Waste Management Strategy is fully implemented in all counties for effective waste management in Kenya. Additionally, the Government through the concerned agencies should wholly enforce the legal frameworks on waste management.

The County Governments should ensure that waste is frequently collected
at collection points so that waste does not accumulate and is not an irritant to the public. As a long-term solution, County governments should venture into recycling as a way of managing the generated waste Normally provision of solid waste services is an expensive undertaking, and resources are required to purchase the appropriate equipment and infrastructure, fund the maintenance and daily operation of vehicles and equipment and train or upskill personnel. The scarcity of resources (financial, technical and logistical) is a major hindrance to effective solid waste management practices in Nairobi. Our consortium is here to assist Nairobi with the technology and funding to make this task sustainable.

General waste management in the Counties' Waste management programme is a major challenge in Kenya, especially in rapidly growing urban metropolises and coastal areas. Investigations conducted by NECC in the Major cities in the Country including Nairobi, Mombasa, Nairobi, Eldoret and Nakuru listed the following findings: Nairobi City produces around 2,500 tons of waste every day, of which only 38 per cent is collected and less than 10 per cent recycled (JICA, 2010).

The remaining 62 per cent is disposed of at the uncontrolled Dandora dumpsite, illegally dumped on roadsides and waterways, or burned releases toxic air emissions and particulate matter. Illegal dumping and burning are particularly common in low-income areas of the city, which are home to over 2.5 million people who cannot afford waste collection services.

Nairobi, was initially a Green city in the sun owing to its geographical location, built on an interesting mix of rainforest and savanna grasslands, with several rivers running through. Since its establishment in 1899, the city has exponentially grown both in development and population, and there is a downside to that.

Pollution of air, water, and soil. Environmental degradation is a part played by everyone existing in a community, County, Country, Continent, and eventually the universe. We all play a part in polluting the environment from the time we wake up to when we go to sleep. We are consumers of products and services and everything we use to enhance our daily living from food to the haircut you get at the barbershop pollutes the environment in one way or the other.

The brighter part about this, however, is that you are in control of the impact on the environment of your daily consumption whether it is a service or product. Nairobi residents dispose of between 2,400 & 2,500 Metric Tonnes of waste on a daily basis. This means that if residents don't embrace individual responsibility, the city will soon be covered in trash and a disastrous break out of communicable diseases. This negative impact will carry on to the next generation. To experience change in Nairobi County and eventually in our country, you have to live change to make a change and our Waste-to-Energy & Recycling plants will enable that change.

Dandora Landfill dumpsite

The Dandora Dumpsite in Nairobi City currently has now been closed and was an open dumping site lacking in management and thus causing bad odour, garbage scattering and production of landfill gases that ill-affect the surroundings. To reduce further contamination of the area it is necessary to close this dumpsite by applying technical burying procedures.

Implementation of Dandora Dumpsite Urgent Improvement Plan.

It is preferable to close the Dandora dumpsite as much as possible at the earliest time. However, as described in Subsection 4.4.3, there is no choice but to continue using the Dandora Dumpsite for an additional six years (2011~2016) until the new landfill site will be in service in 2017. However, since it will not be desirable in terms of social and environmental consideration to continue operation of a landfill under the current operation, it will be necessary to implement the following countermeasures aimed to improve the current conditions for the landfill.

Fig 3. Layout Closure Plan of Dandora Dumpsite.

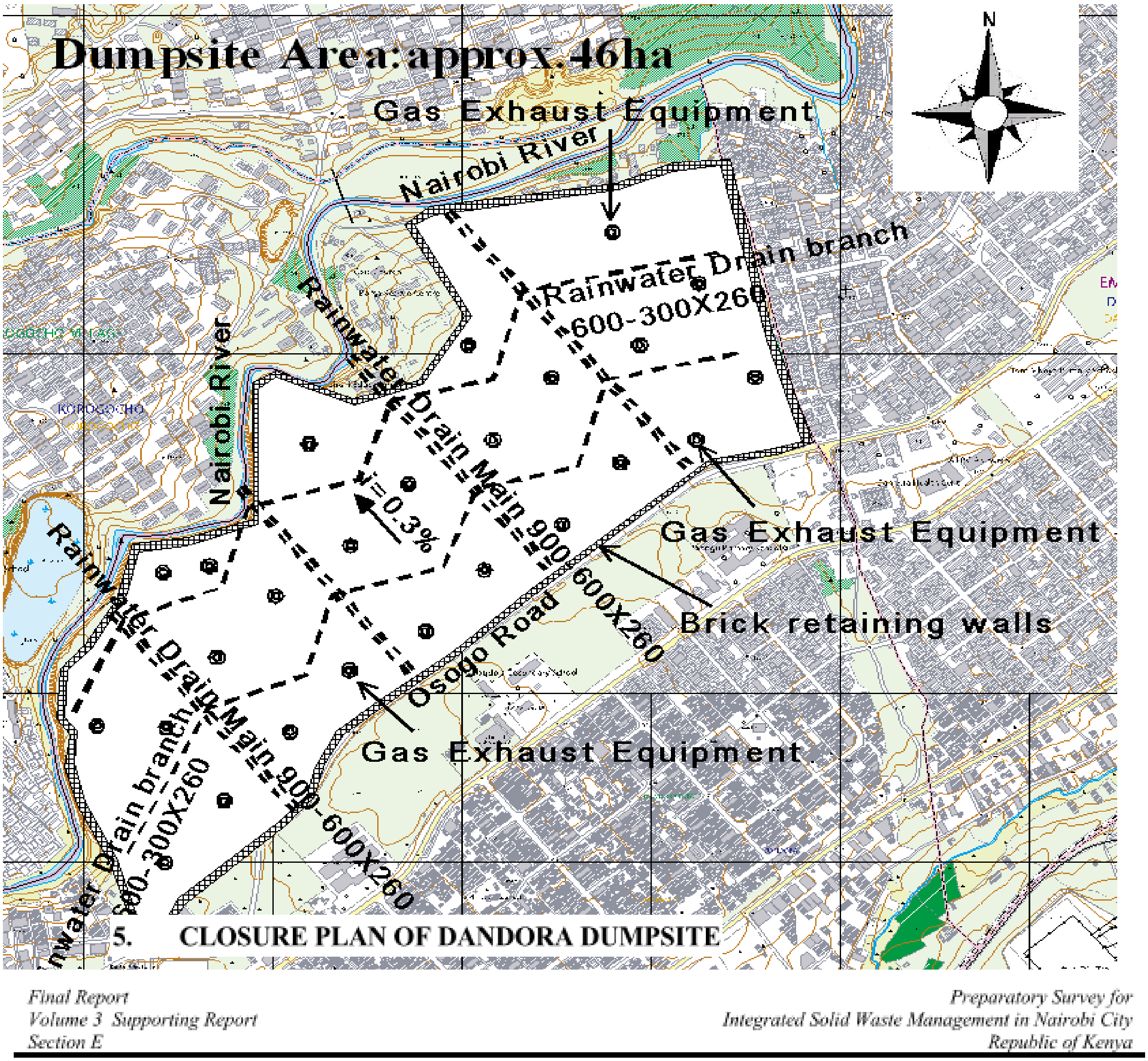


Table 1 Cost Estimate of Cleanup of Illegal Dumpsite

Works	Unit Quantity (m^3) (Division Total Waste Amount)			Unit Price (KSh)	Cost (KSh)		
	Makadare	Kasarani	Westlands		Makadare	Kasarani	Westlands
Wheel loader	840	2,000	520	350	294,000	700,000	182,000
Truck	840	2,000	520	1,570	1,318,800	3,140,000	816,400
Sub-Total					1,612,800	3,840,000	998,400
Overhead				25%	403,200	960,000	249,600
Total					2,016,000	4,800,000	1,248,000

Works	Unit Quantity (m^3) (Division Total Waste Amount)			Unit Price (KSh)	Cost (KSh)		
	Dagoretti	Embakasi	Langata		Dagoretti	Embakasi	Langata
Wheel loader	560	580	480	350	196,000	203,000	168,000
Truck	560	580	480	1,570	879,200	910,600	753,600
Sub Total					1,075,200	1,113,600	921,600
Overhead				25%	268,800	278,400	230,400
Total					1,344,000	1,392,000	1,152,000

Works	Unit Quantity (m^3) (Division Total Waste Amount)			Unit Price (KSh)	Cost (KSh)		
	Starehe	Kamukunji	Markets		Starehe	Kamukunji	Markets
Wheel loader	1,000	1,240	1,554	350	350,000	434,000	543,900
Truck	1,000	1,240	1,554	1,570	1,570,000	1,946,800	2,439,780
Sub Total					1,920,000	2,380,800	2,983,680
Overhead				25%	480,000	5,95,200	745,920
Total					2,400,000	2,976,000	3,729,600

Final Report
Volume 3 Supporting Report
Section E

Preparatory Survey for
Integrated Solid Waste Management in Nairobi City
Republic of Kenya

These Cost Estimates of Cleanup of Illegal Dumpsite can be added onto the Dandora Waste-to-Energy plant (s) project costs and made available by Headway US via the US EXIMBANK if required. We can include an in-depth analysis of those in the phase 1 study of our Dandora Waste-to-Energy project.

Good practice

Nairobi Municipal Solid Waste Composition and characteristics relevant to a Waste-to-energy

A Cascadia Consulting Group inc analysis in 2003 indicated in high population density zones in Nairobi, the composition averaged 64.2% putrescibles, 14,4% plastic, 12.4% LWTR, 7.9% inorganics and 6.4% paper. In low population density zones, the composition averaged 56.5% putrescibles, 15.8% plastics, 4.2% L WTR, 11.4% inorganics and 12.3% paper. The overall composition of waste in Nairobi averaged 58.8% putrescibles, 13.8% plastic, 7.8% LWTR, 8.3% inorganic and 11.3% paper.

The waste was oven dried and the moisture content averaged 69% for high population density zone, 69.5% for medium density population zone and 63.6% for low population density zone. The calorific value was determined according to British standard 1016: Part 5:1967 and was found to be 17.17 MJ/kg for paper, 16.63 MJ/kg for L WTR and 15.4 MJ/kg for putrescibles. The mean calorific value was calculated as 12.48 Ml/kg. The density varied between 282 kg/nr' and 296 kg/rn', the higher density being experienced in high population density one while the lower density being experienced in the low population density zone. An estimate of the energy content of the waste was 2.1 MJ/kg or 2100 KJI tonne and with an energy efficiency of 54.1%. The electricity output is estimated at 0.197 kWh/kg or 197 kWh/tonne.

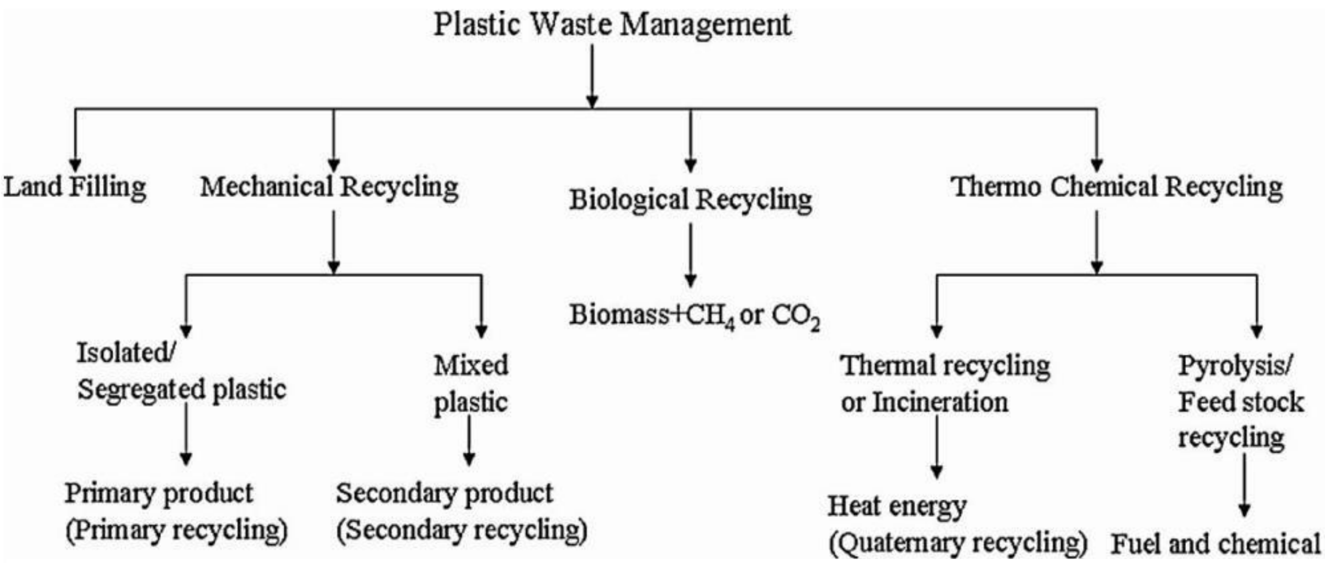
The calorific value was determined according to British standard 1016: Part 5:1967 and was found to be 17.17 MJ/kg for paper, 16.63 MJ/kg for L WTR and 15.4 MJ/kg for putrescibles. The mean calorific value was calculated as 12.48 MJ/kg. The density varied between 282 kg/nr' and 296 kg/rn', the higher density being experienced in high population density one while the lower density being experienced in the low population density zone. An estimate of the energy content of the waste was 2.1 MJ/kg or 2100 KJI tonne and with an energy efficiency of 54.1%. The electricity output is estimated at 0.197 kWh/kg or 197 kWh/tonne – 84,907 KWh per 431 tonnes of MSW this is without Plastics.

Table 2. Nairobi

Percentage composition of MSW

Waste category	High population density zone (Dandora & Kibera)	Medium population density zone (Kariobangi south & Buruburu	Low population density zone (Loresho)	City centre
Plastics	14.4%	12.9%	15.8%	13.5%
Papers	6.4%	9.3%	12.3%	22.6%
Putrescibles	64.2%	63.8%	56.5%	52.8%
LT	12.4%	5.7%	4.2%	7.8%
In-organics	7.9%	8.3%	11.4%	3.3%

Fig 4. Different routes for Plastic waste management



Thermolysis of waste plastics to liquid fuel A suitable method for plastic waste management and production of value added products – A world prospective

Article · November 2017

Calorific values of plastics compared with conventional fuels.

Fuel	Calorific value (MJ/kg)
Methane	53
Gasoline	46
Fuel oil	43
Coal	30
Polyethylene	43
Mixed plastics	30–40
Municipal solid waste	10

Table 4

Comparison of waste plastics fuel to regular gasoline.

Properties	Regular gasoline	Plastic waste fuel
Colour, visual	Orange	Pale yellow
Specific gravity at 28 °C	0.7423	0.7254
Specific gravity at15 °C	0.7528	0.7365
Gross calorific value	11210	11262
Net calorific value	10460	10498
API gravity	56.46	60.65
Sulphur content(by mass)	0.1	<0.002
Flash point (Abel) (°C)	23	22
Pour point (°C)	<−20	<−20
Cloud point (°C)	<−20	<−20
Reactivity with SS	Nil	Nil
Reactivity with MS	Nil	Nil
Reactivity with Cl	Nil	Nil
Reactivity with Al	Nil	Nil
Reactivity with Cu	Nil	Nil

Plastic content per 500 tonnes of MSW

13.8% is equal to 69 tonnes per day from each 500 tpd MSW plant.

Plastic Calorific value is 2,160 MJ/Kg
Or 2,160,000 MJ/Tonne

So, 2,160,000 x 69 = 14,904,000 MJ

If 1 J = 2.776 KWh

Then 14,904,000 x 2.776 = 41,373,504 KWh per day additional energy.

As we have seen before, The electricity output of Nairobi MSW is estimated at 0.197 kWh/kg or 197 kWh/tonne – this is without Plastics.

So, (500 – 69) x 197 = 84,907 KWh

Then 84,907 KWh + 41,373,504 KWh = 41,458,411 KWh per 500 tpd plant.

The 6th International Conference on Energy and Environment Research, ICEER 2019, 22-25 July, University of Aveiro, Portugal

Gasification of plastic waste for synthesis gas production The disadvantages of landfill and incinerating are carbon dioxide emission. Although plastic waste can be reused and recycled, in the end it will be garbage or become non- recyclable. As we have seen - Gasification is a much better technology, cleaner and 45% more efficient than Incineration. In gasification, plastic waste is reacted with gasifying agent (e.g., steam, oxygen and air) at high temperature around 500-
1300 ◦C, which can produce synthesis gas or syngas. It can be observed that the main differe nce between these methods is the obtained product. Gasification of plastic waste has been focused on this work since syngas can be further used to produce many products and fuel for fuel cell to generate electricity.

Summary of Nairobi's Waste Sources and Sinks 2009

The various waste sources and sinks in Nairobi City are summarised in **Error! Reference source not ound.** below.

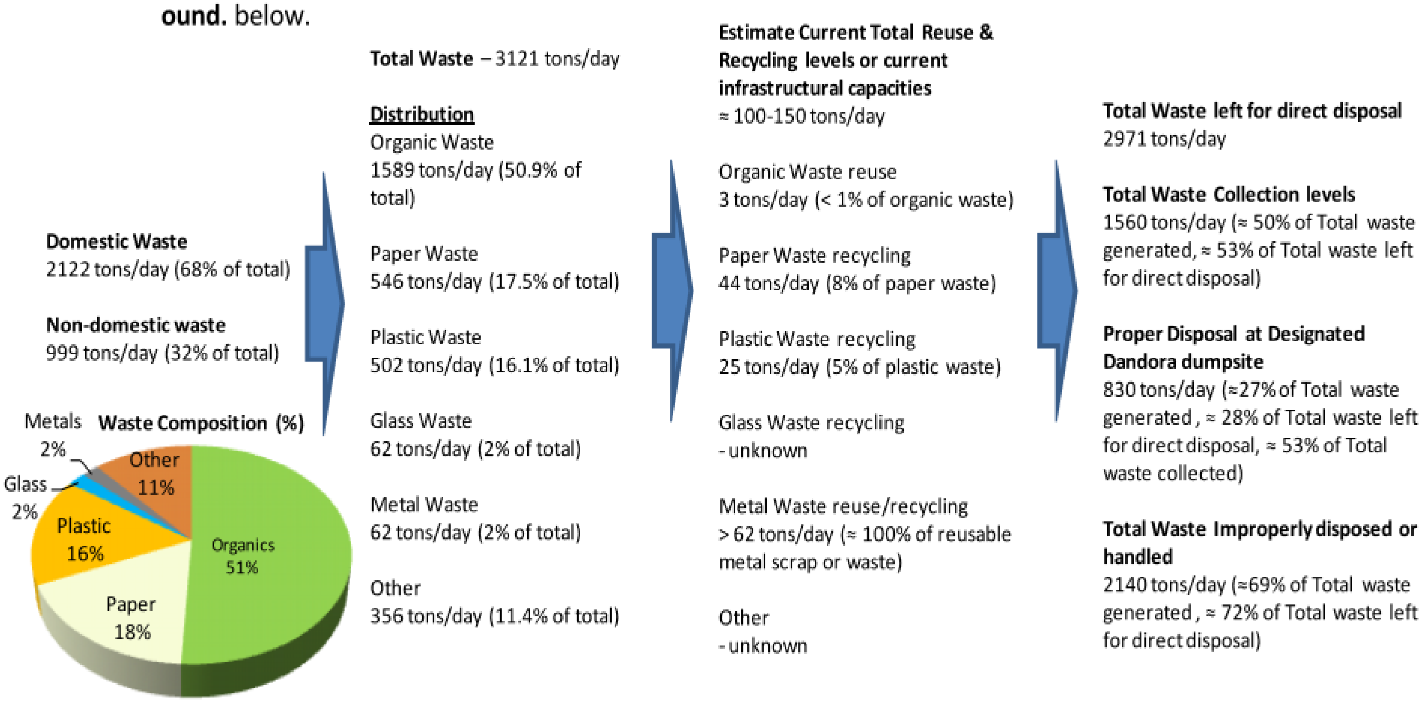


Fig. 5 Residential MSW composition in Nairobi

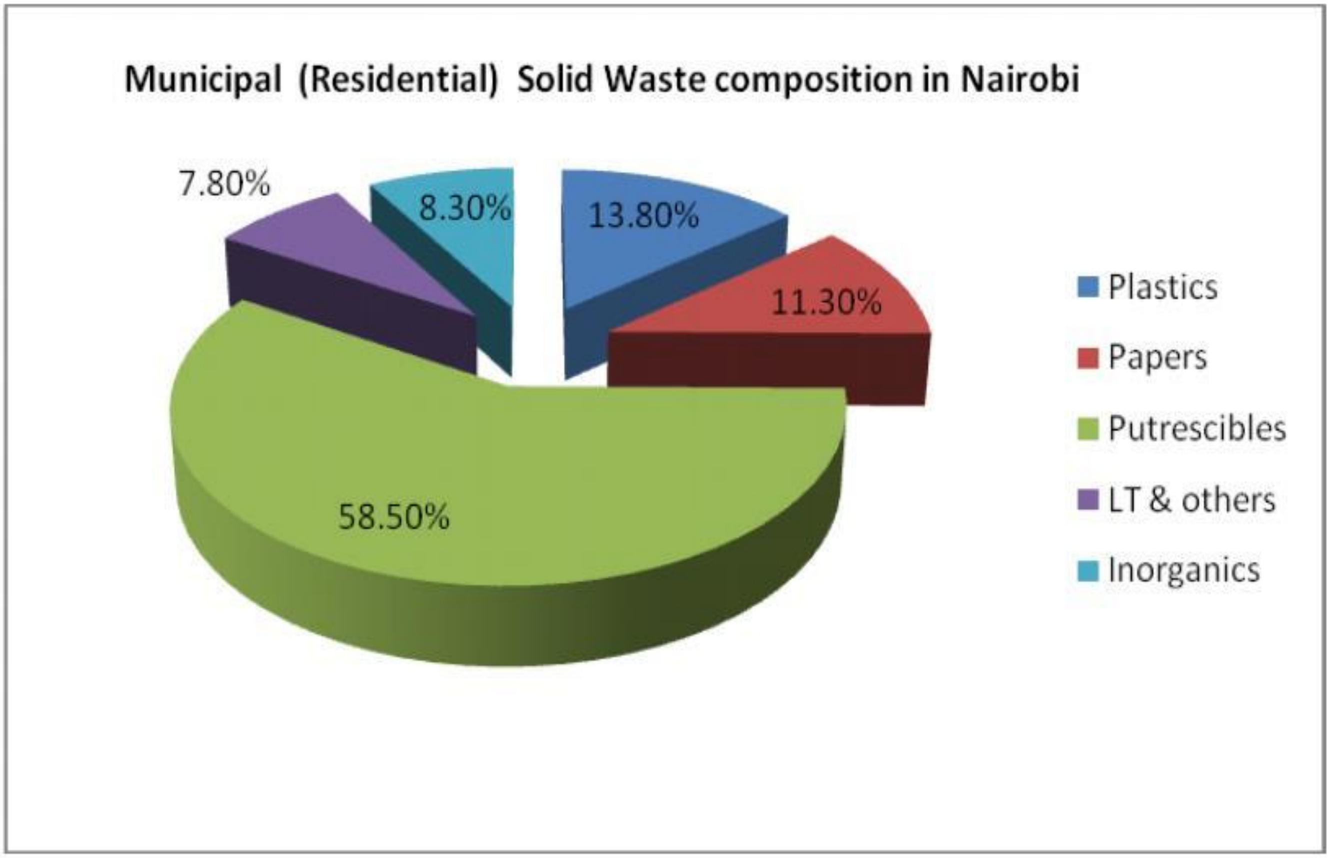
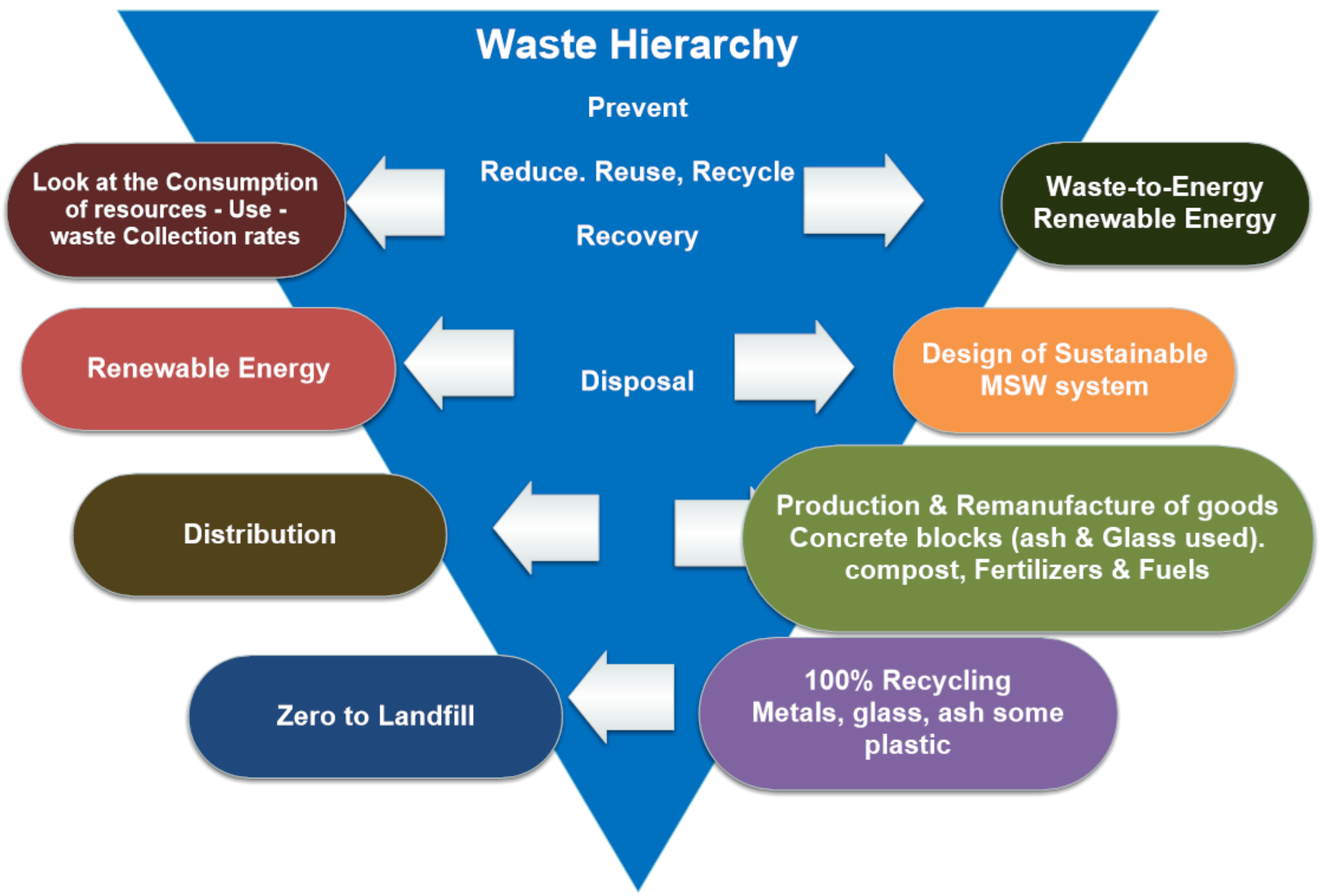


Table 5 Summary of wastes generation, collection and recovery status in major towns

Name of town	Estimated Waste generated (tons/day)	% Waste collected	% waste Recovery	Uncollected waste
Nairobi	2400	80%	45%	20%
Nakuru	250	45 %	18%	37%
kisumu	400	20%	Unknown	Unknown
Thika	140	60%	30%	40%
Mombasa	2200	65%	40%	35%
Eldoret	600	55%	15%	45%

Waste Hierarchy & the Circular Economy



Zero Waste going to landfill - Sustainable - Circular

In June of 2022 we entered negotiations with the UK AID program “Manufacturing Africa” in order to gain financial assistance for our Solar PV Manufacturing plant for Kenya and can approach them for additional funding to setup Manufacturing plants for the recycled materials from the waste plants thus creating further jobs and further wealth creation.

With Our ability to apply insights across different sectors, we are able to understand customer pain points and deliver integrated, end-to-end capabilities to customers. We have deep expertise in technology and waste management development. We design, develop and deploy cutting edge technology platforms that enable organizations to offer superior experiences for the ever-changing customer needs.

We have Solutions that enable organizations achieve greater agility, accuracy and efficiency in transforming processes, managing information, enhancing overall customer satisfaction and driving enterprise profitability.

Preferred Waste materials

MSW – organics & Inorganic plastic, metals, wood, ash, paper, cardboard,- we can also process some medical waste & Tyres

.

The system proposed will initially consume up to 2,500 tpd in the plant for the City of Nairobi, the County has more MSW available in the Nairobi County area, so further plants can be built over time and Technology & funding provided by us. Some plastic will be used for manufacturing of new products.

WASTE-TO-WEALTH

Zero Waste - Zero Landfill dumps - Circular Economy Transition

CONSORTIUM

☐ Current Waste Collection company in Nairobi

☐ **HEADWAY USA**

Forty-years of Developing Nations Infrastructure development & Funding Project Management & funding arranger.

☐ **PSECC LTD UK**

Twenty-seven years in Climate Change Mitigation - Waste Management, Energy Policy & Strategy and Renewable Energy

☐ **Agra Energy**

Waste-to-Energy, Agricultural waste & MSW - Dynamic Renewable Energy technology,reducing the carbon footprint - energy, fertilizers & fuels.

☐ **Alset Power Company Inc**

Waste-to-Energy Gasification Zero Waste - Zero Landfill dumps

☐ **SARRALLE SPAIN**

In SARRALLE we care about the Environment, therefore Recycling is one of our business lines. We process used material (waste) into new useful products, reducing the amount of raw materials. Recycling also uses less energy and a great way of controlling air, water, and land pollution.

At SARRALLE we work to manage in the most efficient way the waste resulted from the industrial activity and obtain energy from it. We work close to the best technologist in the waste recovery area, giving the best solutions adapted to our customer needs.

SARRALLE supplies engineering and construction services in :

- Incineration.
- Biomass.
- Gasification.
- Urban solid waste treatment.
- Energy recovery.
- Sludge Treatment.

☐ **ESG - Funding -** **fully private-sector funding via specialized ESG (Environmental, Social, Governance)-oriented funds,**

☐ **DEUTSCHE BANK GERMANY**

Replacing ageing infrastructure, upgrading transportation and improving energy efficiency create a need for private financing through the debt markets. Deutsche Bank provides administrative services to project, acquisition, corporate and other financing across the infrastructure and energy markets

☐ US EXIMBANK

Qualification of Bidders

Headway USA

I. Copies of certificate of incorporation/ business registration.

Electronic Articles of Organization For Florida Limited Liability Company

L17000109960
FILED 8:00 AM
May 17, 2017
Sec. Of State
lyarbrough

Article I

The name of the Limited Liability Company is:

HEADWAY PM, LLC

Article II

The street address of the principal office of the Limited Liability Company is:

8003 BAYSIDE VIEW DRIVE
ORLANDO, FL. US 32819

The mailing address of the Limited Liability Company is:

8003 BAYSIDE VIEW DRIVE
ORLANDO, FL. US 32819

Article III

The name and Florida street address of the registered agent is:

DANNY CRUZ
8003 BAYSIDE VIEW DRIVE
ORLANDO, FL. 32819

Having been named as registered agent and to accept service of process for the above stated limited liability company at the place designated in this certificate, I hereby accept the appointment as registered agent and agree to act in this capacity. I further agree to comply with the provisions of all statutes relating to the proper and complete performance of my duties, and I am familiar with and accept the obligations of my position as registered agent.

Registered Agent Signature: DANNY CRUZ

Article IV

L17000109960
FILED 8:00 AM
May 17, 2017
Sec. Of State
lyarbrough

The name and address of person(s) authorized to manage LLC:

Title: MGR
DANNY CRUZ
8003 BAYSIDE VIEW DRIVE
ORLANDO, FL. 32819 US

Title: AP
DIANE ROBINSON
8003 BAYSIDE VIEW DRIVE
ORLANDO, FL. 32819 US

Signature of member or an authorized representative

Electronic Signature: DANNY CRUZ

I am the member or authorized representative submitting these Articles of Organization and affirm that the facts stated herein are true. I am aware that false information submitted in a document to the Department of State constitutes a third degree felony as provided for in s.817.155, F.S. I understand the requirement to file an annual report between January 1st and May 1st in the calendar year following formation of the LLC and every year thereafter to maintain "active" status.

PSECC Ltd

CERTIFICATE OF INCORPORATION OF A PRIVATE LIMITED COMPANY

Company Number **10652586**

The Registrar of Companies for England and Wales, hereby certifies that

PSECC LTD

is this day incorporated under the Companies Act 2006 as a private company, that the company is limited by shares, and the situation of its registered office is in England and Wales.

Given at Companies House, Cardiff, on **4th March 2017**.

The above information was communicated by electronic means and authenticated by the Registrar of Companies under section 1115 of the Companies Act 2006

Companies House

REGISTRAR OF COMPANIES FOR ENGLAND AND WALES

THE OFFICIAL SEAL OF THE REGISTRAR OF COMPANIES

II. compliance certificates OR equivalent

Headway USA - Copies of PIN and Tax compliance certificates OR equivalent

x

State of Florida
Department of State

I certify from the records of this office that HEADWAY PM, LLC is a limited liability company organized under the laws of the State of Florida, filed on May 17, 2017.

The document number of this limited liability company is L17000109960.

I further certify that said limited liability company has paid all fees due this office through December 31, 2021, that its most recent annual report was filed on February 22, 2021, and that its status is active.

Given under my hand and the Great Seal of the State of Florida at Tallahassee, the Capital, this the Twenty-ninth day of April, 2021

GREAT SEAL OF THE STATE OF FLORIDA
IN GOD WE TRUST

Secretary of State

Tracking Number: 2641541663CU

To authenticate this certificate,visit the following site,enter this number, and then follow the instructions displayed.

https://services.sunbiz.org/Filings/CertificateOfStatus/CertificateAuthentication

Dear Alan John Brewer

Activation Code for PAYE for Employers

Your activation code is:
258632821201

This Activation Code will expire on 07/11/2019. If you do not use the code by this date, you will have to request a new one.

You will need to request a separate Activation Code for each online service you want access to.

To get access to the PAYE for Employers online service you need to:

1. Go to **www.gov.uk/hmrconline**
2. Select 'Sign in'.
3. Sign in using your Government Gateway user ID and password.
4. Select 'Activate' for PAYE for Employers.
5. Enter your Activation Code.
6. Select 'Get access'.

If you need help, phone the PAYE for Employers helpline on 0300 200 3600.

EACD HMRC 08/18

Submission status

Submission status:
Submitted
Submission date:
3 October 2019
Submission time:
08:46:09
Acknowledgment reference:
5SHP EEJV J46I FKJ

Taxes you have requested to register

You have requested to register:

- as a limited company for Corporation Tax
- for PAYE as an employer

Director details

Name	National Insurance number
Mr Alan John Brewer	YT145764D

Submission status

In what capacity are you completing this registration?
Director
I declare that the information I have provided in this registration is accurate and complete to the best of my knowledge
Ticked

III. Relevant factory operating licenses.

Relevant factory operating licenses.

- **Permits**

The codes and standards for waste-to-energy plants are relatively well defined, and the Nairobi County plant (s) will be permitted to process municipal waste in the future. Permits provided for the plants will be evaluated and the project team will determine if additional permits or modifications to the requested/applied ones are necessary prior to PPA finalization.

Regulatory Resources for Buildings

- International Code Council – Model Building and Construction Codes and Standards
- National Fire Protection Association – Model Building and Construction Codes and Standards
- International Association of Plumbing and Mechanical Officials – Model Building and Construction Codes and Standards

	Permit type	Activity#	Complete Date	Issuance Date	Summary of Action
F-14-033	Renewal	APE20140002	6/25/2014	11/10/2014	Renewal and administrative amendment

SECTION A - PERMIT AUTHORIZATION of INEZ Gasification Plant

Pursuant to a duly submitted application the Kentucky Division for Air Quality (Division) hereby authorizes the operation of the equipment described herein in accordance with the terms and conditions of this permit. This permit has been issued under the provisions of Kentucky Revised Statutes (KRS) Chapter 224 and regulations promulgated pursuant thereto.

SECTION B - EMISSION POINTS, EMISSION UNITS, APPLICABLE REGULATIONS, AND OPERATING CONDITIONS (CONTINUED)

Commonwealth of Kentucky
Energy and Environment Cabinet
Department for Environmental Protection
Division for Air Quality
200 Fair Oaks Lane, 1st Floor
Frankfort, Kentucky 40601
(502) 564-3999

Final

AIR QUALITY PERMIT
Issued under 401 KAR 52:030

Worldwide rights to sell the technology as developed at Inez Power belongs to MDGS

Permittee Name:	**Inez Power, L.L.C.**
Mailing Address:	**P.O. Box 367, Allen, Kentucky 41601**
Source Name:	**Inez Power, L.L.C.**
Mailing Address:	**900 Middle Fork Wolf Creek Road, Debord, Kentucky 41214**
Source Location:	**900 Middle Fork Wolf Creek Road**
Permit ID:	**F-14-033**
Agency Interest #:	**40472**
Activity ID:	**APE20140002**
Review Type:	**Title V, Operating**
Source ID:	**21-159-00026**
Regional Office:	**Hazard Regional Office** **233 Birch Street, Suite 2** **Hazard, KY 41701** **(606) 435-6022**
County:	**Martin**
Application Complete Date:	**June 25, 2014**
Issuance Date:	**November 10, 2014**
Expiration Date:	**November 10, 2019**

Sean Alteri

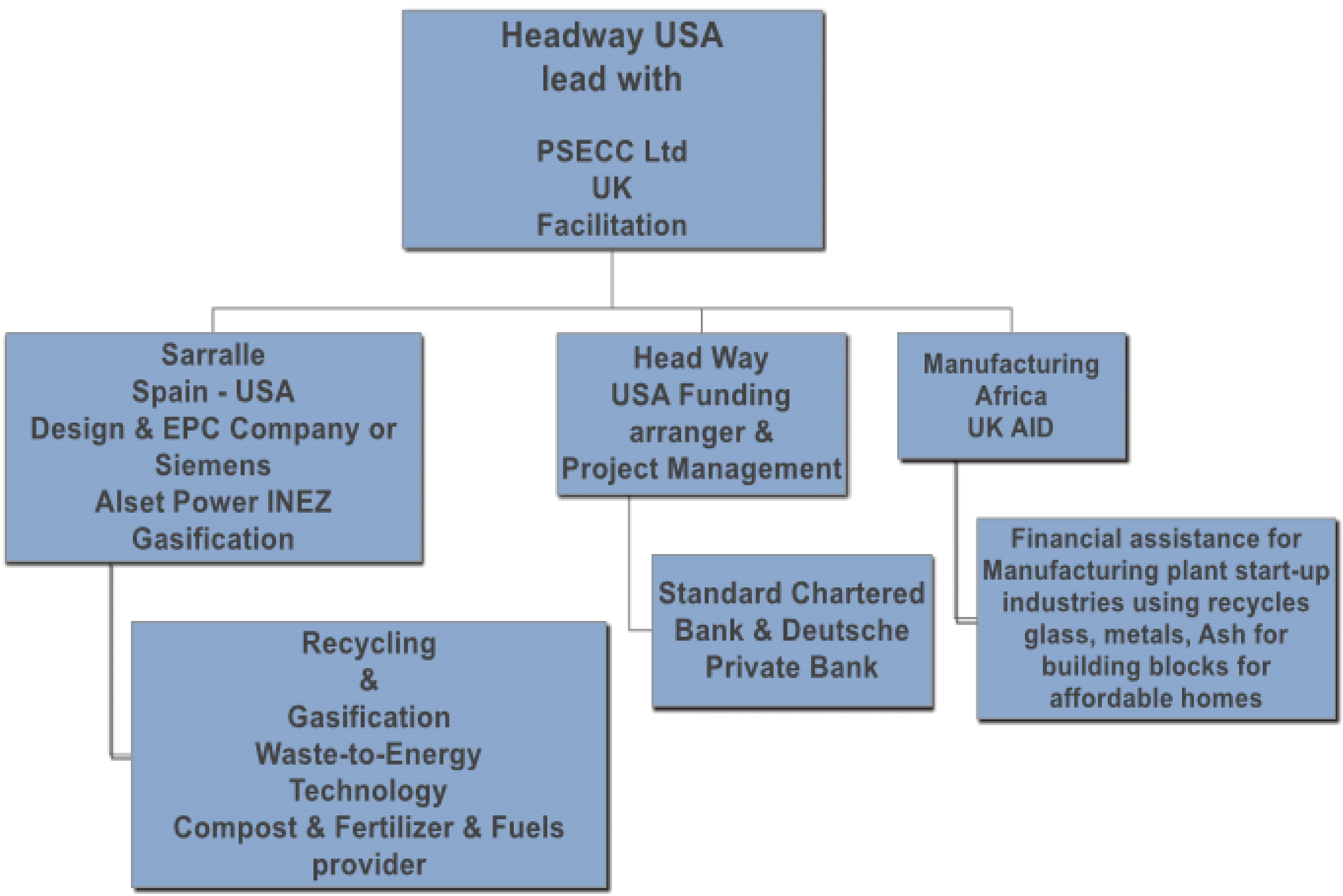
Sean Alteri, Director
Division for Air Quality

Version 10/16/13

IV. A copy of the company profile,

A copy of the company profile

Fig 7. Consortium partners



Headway USA www. headwayus.com

What We Do

Headway provides project management to infrastructure and service projects, through its own internal capabilities and by leveraging strategic partnerships with reputable organizations and subject matter experts - in the US and around the globe.

Our Commitments

Creating innovative solutions is at the core of everything we do. With the many challenges our world faces today as a consequence of poverty, climate change, population growth, pollution and more - we are committed to positively impacting the communities that deserve the opportunity to thrive.

Our Partnerships

Partnerships and collaborations with external experts and organizations are crucial to overcoming challenges. Our vast international network and strong ties with both private companies and government agencies continue to be one of our strongest edge and advantage towards success.

Our Perspectives

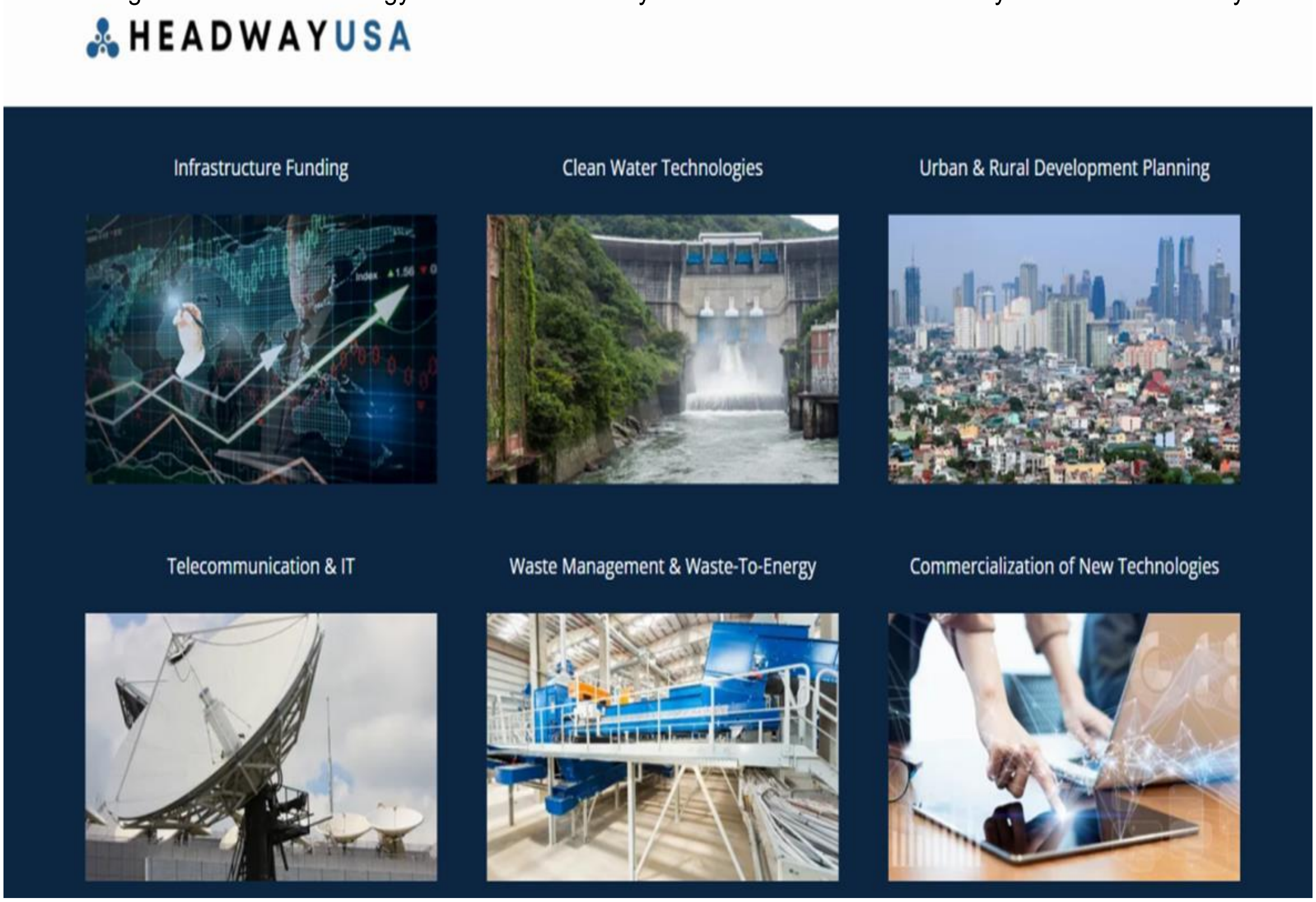
New problems require new solutions. Our decisions and actions are based on continuous efforts to research, evaluate, and adapt new cutting-edge technology to implement with our tried and tested methods and technologies. Continuous learning and flexibility are key to solving some of the world's biggest challenges.

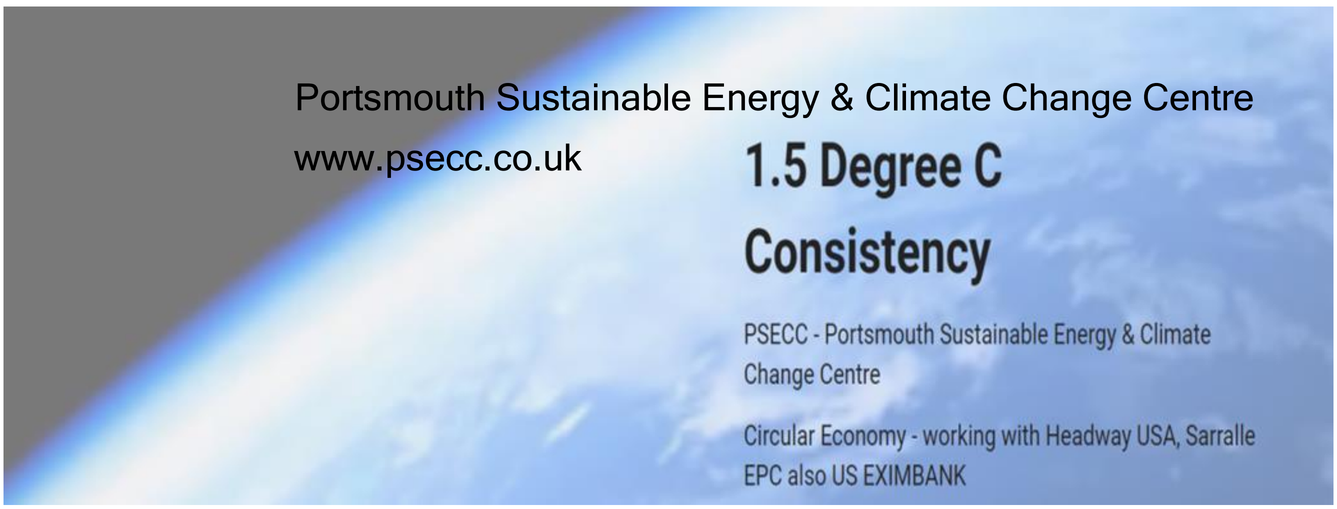
Danny Cruz
CEO & Managing Partner

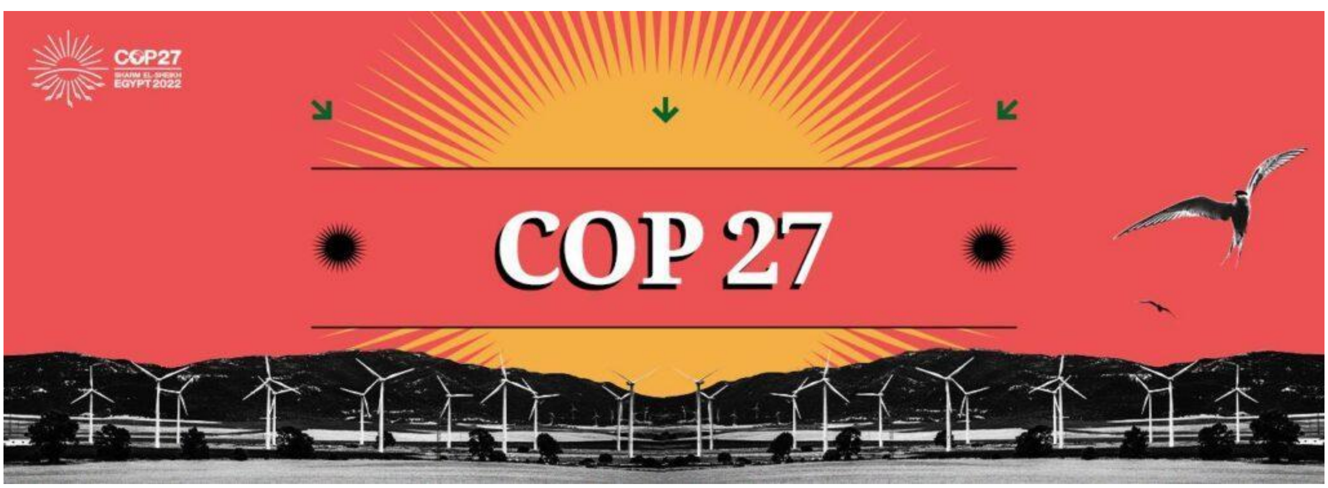
Area of Expertise

Project Management	Business Operations & Analysis	Government Project Financing
Financial & Budget Planning	Private Equity Funding	Supervision & Financial Control

Our Service & History at Headway USA, we maintain a very flexible project and organizational structure so that we can be responsive as client and project requirements change, while continuing to adhere to the principles of quality assurance and quality control. The result is the ability to develop and implement a broad array of challenging assignments effectively, on time and on budget. Headway USA, LLC is a Florida entity and a project management vehicle for several international projects. It is an offshoot of activities pursued under GWOT Solution Partners, a Virginia-based entity, engaged in technology ventures in defence-related and homeland security applications.


HEADWAYUSA
Infrastructure Funding
Clean Water Technologies
Urban & Rural Development Planning
Telecommunication & IT
Waste Management & Waste-To-Energy
Commercialization of New Technologies





We are developers & Facilitators and work hand in hand with Headway USA and Sarralle to help assist Net Zero – Zero Waste – Zero Landfill dumpsites and Paris Accord, COP26 & COP27 aspirations.

Delivered on Intergovernmental Agricultural projects in Africa funded by the UK Government - InnovateUK programme - Ghana & soon Kenya. The funding for the project is from the Global Challenges Research Fund (GCRF) and Foreign, Commonwealth & Development Office (FCDO) through the Agri-Tech Catalyst.

We have won the Tender for Kisumu waste in 2022 and now wish to assist the Governor of Nairobi with introducing our funding and consortium to assist the Circular Transition of Kenya.

We are in a position to provide Renewable Energy funding for projects in the typical range of £60 million to £10 billion. We are Facilitators & Developers - One of our Key missions has been since 2012 to promote the Circular Economy, Renewable Energy & Sustainable Waste Management in Africa.

The recent UN IPCC report indicates that to reach the 1.5 degree C Consistent Pathway then a robust - cross societal approach is required.

Our work since 1995 - much of our work has been Academic & not-for-profit, Policy, Strategy, Funding can be arranged for Renewable Energy development together with Waste Management, Integrated Waste Management Plants & Gasification is available via PSECC Ltd to assist a Circular Economic model. 2021 - Our current partners in the Energy & Waste sectors include Headway USA, Sarralle EPC, Alset Power Company Inc, Siemen's, & USA Funders such as Morgan Stanley, UK Export Finance, Standard Chartered Bank, Deutsch Bank & USA EXIMBANK.

COP26 – Governments will make their National Determined Contributions NDC pledges and International Business Investors have available £60 Trillion for Climate Change Mitigation. Businesses will lead and enable the way to the Net Zero- or 1.5-degree C consistent pathways.

We can assist all Counties such as Nairobi or Countries link into funding. Headway USA. invest in a Sustainable manner – resilient Cities – Climate Action plans – Fossil Free Cities with our Waste plants & Solar Farms together with Solar PV – Circular Economy.

PSECC Ltd Circular Economy for Nairobi possibilities

- Sustainable Waste Management
- Circular Economy Transition
- Full funding provision
- Wealth creation – 10% share ownership given to Government in each waste plant.
- Job creation
- Zero Waste – Zero Landfill dumps
- Renewable Energy generation
- Fuels, Fertilizers, compost
- Recycled products and Manufacturing company formations
- Solar PV Panel Manufacturing company formation
- Farmers Solar PV with food production
- Sustainable Housing schemes using our waste building blocks.

PSECC Ltd

2023

Alan Brewer MSc - Director PSECC Ltd - DEVELOPMENT
WASTE-TO- ENERGY & Renewables Please review www.psecc.co.uk

Mr Alan Brewer is responsible for facilitating this project with Headway USA and leading the Waste & Energy teams at PSECC Ltd. Since joining PSECC Ltd first in 2011, he has been directly involved in restructuring and continued evolution of the Waste & Renewable Energy in Africa since 2012 and advises six African Nations. Formerly Head of Climate Change at the Chambers of Commerce, Energy Network Coordinator of the HNRI programme in the UK and responsible for City Energy Policy & Strategy under Agenda 21 Sustainable Development programming in the waste and energy sectors on an international basis. Degree level in Management and a Master's Degree in Environmental Engineering from the Universities of Portsmouth & Plymouth & a Qualified Global Assessor BREEAM.

We have been in negotiation with the Nairobi County Government Ministers and Governor since 2020. We had gained support for our proposal to provide full funding and our truly sustainable waste management solution for Nairobi. Our solution has developed out of these negotiations and is one that offers "Wealth" creation from the MSW in Nairobi in the form of Renewable Energy, Recycled products such as glass, metals, Ash, some plastic and fertilizer and fuel production. We have already linked into the UK AID "Manufacturing Africa" programme for our Solar PV Manufacturing plant for Nairobi and could also link into them for financial assistance in setting up manufacturing Industrial start-ups for Nairobi to make new products from the Recycled material coming from our waste plant.

sarralle
A Universe of Engineering

www.sarralle.com/en Video at www.youtube.com/watch?v=pL6DUkZ0PqA

www.sarralle.com/en/sectors/waste-recycling

B° Landeta, C/Orendaundi N° 7 Apdo. 120730 Azpeitia (Gipuzkoa) SPAIN

Processing tonnes of municipal waste with less effort and time. Our contemporary MSW processing plants offer systematic solutions to treat each waste like MSW - paper, plastic, electronics, glass, etc. separately. As the industry is heading towards digitization, we are bringing revolutionary change giving a technological curve to get the job done professionally. Our teams of professionals and experts are systematically making the MSW process customizable to tackle the different kinds of waste in one go. We are passionate about creating a circular economy while recycling or reusing all kinds of MSW using only patented waste sorting machines.

With decades of experience in the Industrial Engineering, SARRALLE aims at suppo customers all along every step of the EPC projects. Preceded by FEED phase (Fron Engineering Design) also developed by us, we manage and provide the detail engineering, procurement of the necessary equipment and materials, the const from our own workshops, installation, commissioning and start-up of the functic facilities or assets in the Steel, Energy and Environment industries.

Our construction execution strategy is determined early in the FEED phase or at the project bid phase and our team guarantees direct assistance and quality manageme the turnkey facilities.

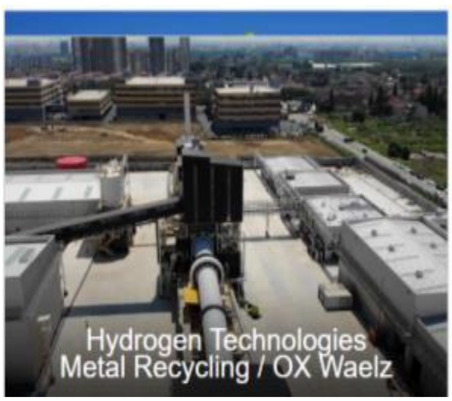
SARRALLE is proficient at managing every aspect of your project with easy access fast reply from any of our technical members. We pay constant attention to the custo relationship ensuring your installation is completed on time and within the budget.

SARRALLE provides the best service for erection, site assembly and commissioning of all the SARRALLE products.

Our know-how and international references proves our capabilities to optimize Customers' plants and increase their productivity. We are an EPC company that covers all the phases from civil works to commissioning.

Sarralle Projects in the USA

SARRALLE works to consolidate itself as a strategic supplier to the largest steel manufacturers in the United States. SARRALLE, established in 1965, is an EPC company and leader in industrial engineering and equipment supply to the steel making, rolling, environmental, and energy sectors; providing advance technological turnkey solutions to the largest international steel manufacturers. Our long successful history supports us as a strategic ally capable of undertaking complicated projects including: engineering, automation, hydraulic and electrical work, equipment manufacturing and assembly, commissioning, and follow-up support.



Incineration ,for Steelmuller in Zubieta (Spain), 2017 ONGOING

Marpol Treatment plant , SERTEGO (TANGER), 2016

SARRALLE supporting Steel Legends

Our experience and the knowledge gained over the years allows us to successfully complete as a key EPC supplier in the United States; evidenced by our last contract awards including: Arcelor Mittal and Nippon Steel Corporation (AM/NS Calvert), North American Stainless (NAS), Steel Dynamics Inc. (SDI) and Nucor Steel (NUCOR).

SARRALLE's direct involvement and project execution afforded these customers with increased productivity and product quality within their respective markets.

SARRALLE Offices in the United States

Sarralle has been operating in the US since 2013, when we opened our offices in Pittsburgh, Pennsylvania. With continued client order growth, in 2021 we decided to open our second location in Mobile Alabama. This allows SARRALLE to better serve our southern US clients attending to their requirements with fast responsive local contacts.

At SARRALLE we work to manage in the most efficient way the waste resulted from the industrial activity and obtain energy from it. We work close to the best technologist in the waste recovery area, giving the best solutions adapted to our

Technology

Enjoy the best *Gasification* or *Moving Grate WTE* and *Recycling* combined together

100% Recycling & Cleanest form of Waste-to-Energy
At SARRALLE we work to manage in the most efficient way the waste resulted from the industrial activity and obtain energy from it. We work close to the best technologist in the waste recovery area, giving the best solutions adapted to our customer needs.

SARRALLE supplies engineering and construction services in :

Incineration.

Biomass.

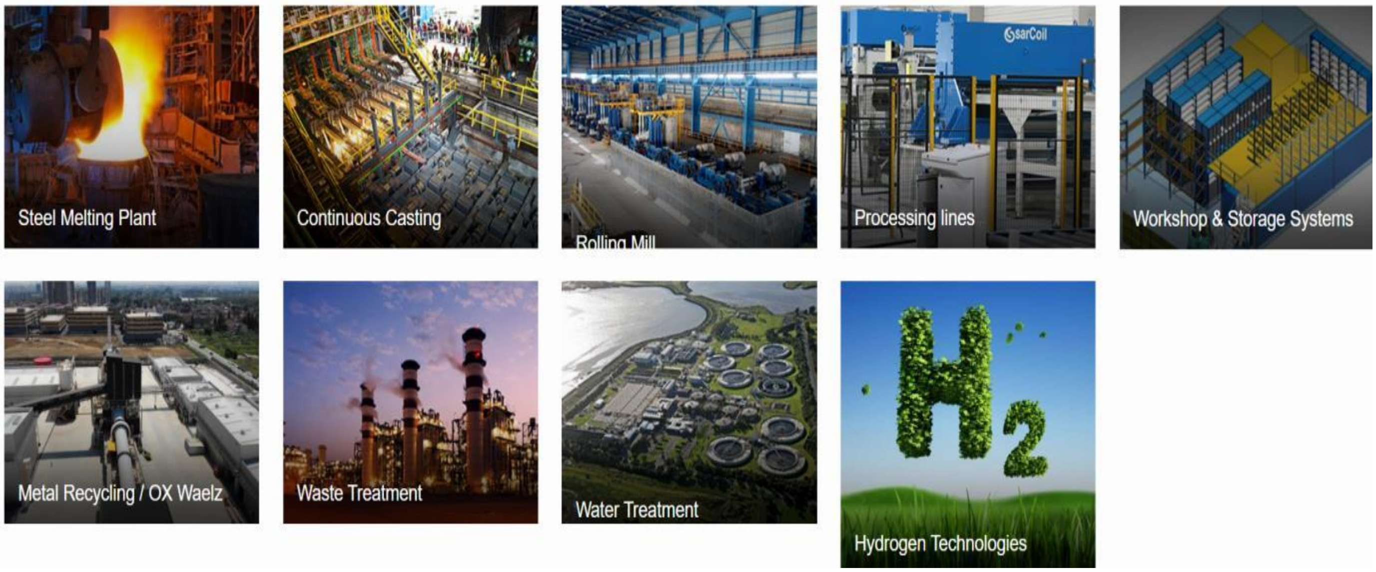
Gasification.
Urban solid waste treatment.

Energy recovery.
Sludge Treatment.

Certified

Business Lines

Innovative solutions for various industrial divisions



Customers
SARRALLE PALENCIA . Industrial Provincial Av. Tren Expreso Parcela 223 34200 ...

Rolling Mill
SARRALLE is a driver for hot rolling long product mills technology thanks to its ...

Contact us
SARRALLE AZPEITIA - HEADQUARTERS. B° Landeta, C/Orendaundi, N° 7 20730 ...

Processing lines
SARRALLE has its own production facilities for mechanical and electrical assembly ...

Steel Melting Plant
SARRALLE was founded in the 1960s.Today, with more than 50 years of ...

Workshop & Storage Systems
Since 1971, SARRALLE is engaged in the design, manufacture and supply of the ...

Career
Working hand in hand, we achieve optimum results. Join us!

Waste Recycling
Waste Treatment, Business Lines, Waste Treatment, In SARRALLE we care about ...

Continuous Casting
SARRALLE Continuous Casting Machines have been engineered through the ...

Waste to Energy
Since the Electric Arc Furnace (EAF) stepped into the industrial production of ...

SIEMENS energy

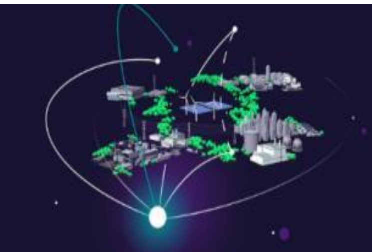
www.siemens-energy.com/global/en/offerings/power-generation.html

Using energy resources efficiently for sustainable power generation

They have built over 1,500 power plants globally. Urbanization, scarce resources, and climate change: Wherever we look, global challenges are spurring an increasing demand for efficient and emission-neutral power generation, and energy from renewable

sustainable power generation

(Siemens may also be used as they built the INEZ Gasification plant in Kentucky)



Decarbonization

occurs step by step: We improve the efficiency of existing assets. The transition away from conventional fuels comes next – from coal to gas and then to hybrid systems and cleaner fuels. Learn how we're pushing the boundaries of both conventional and renewable energy to meet the demand for sustainable, reliable, and affordable energy.

Distributed generation

is becoming more and more important in the new energy era. Do you want to integrate renewables? Bring reliable and affordable electricity to remote areas? Or achieve decarbonization goals using local energy generation and storage? Explore how on-site power generation secures your power supply for the future.

Services and digitalization

are critical for maximizing the lifecycle value of power generation assets. Our services and digital service solutions help you extend the lifespan of your assets. Discover what Siemens Energy services can do for you – and how to implement competitive and innovative methods to reduce downtime and increase output.

Individual power plants that create value

As energy consumption will continue to increase in the years to come, efficient power generation will be a vital component to reliable, eco-friendly energy systems. Fluctuations are more frequently and at shorter intervals. Energy markets around the world are demanding more and more from their participants – whether that be responding flexibly to fluctuations, observing increasingly stringent emission limits, supplying power at lower and lower costs, or ensuring supply under adverse conditions.

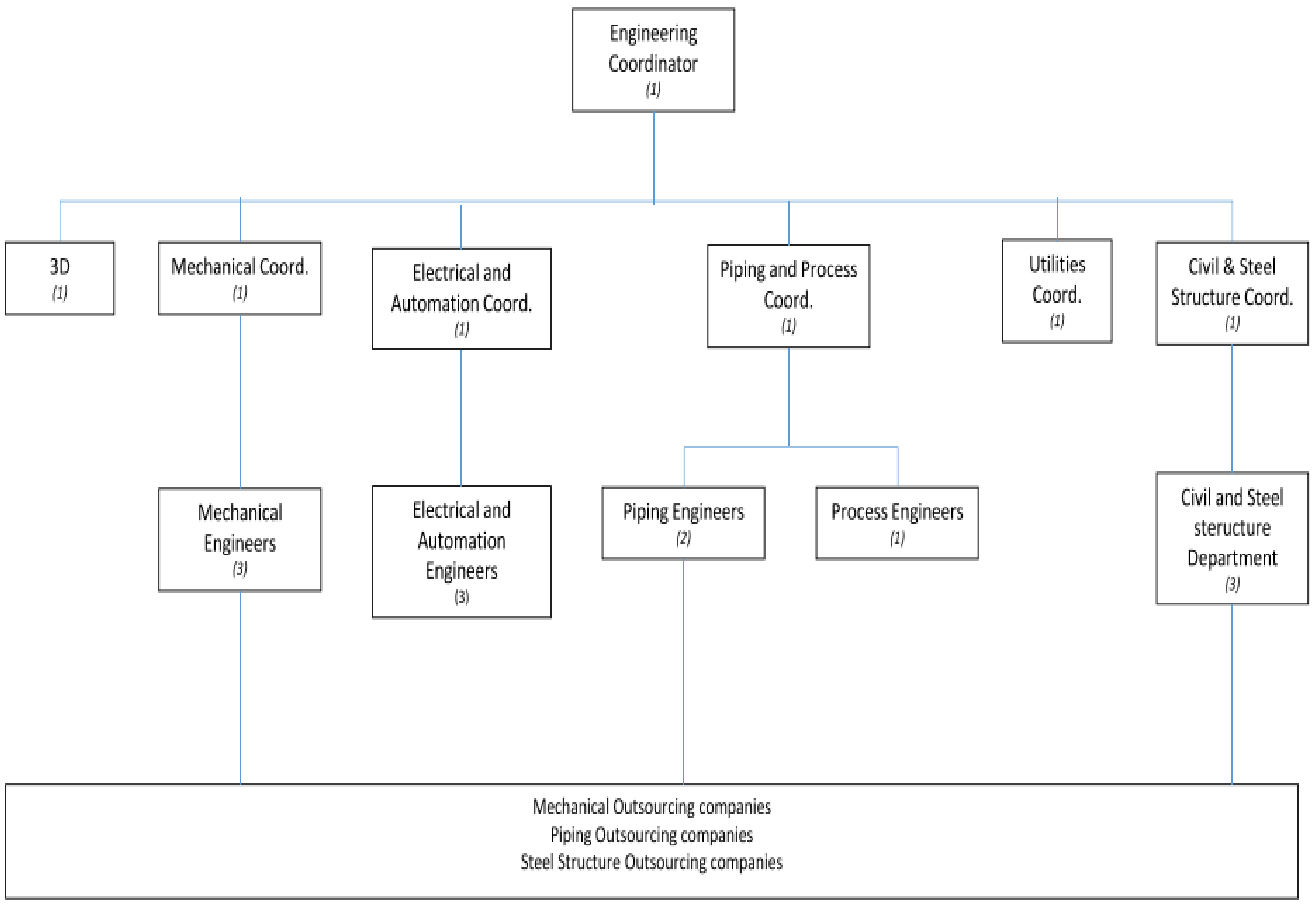
Anyone looking to stay ahead of the game needs more than an “off-the-shelf” power plant. You need an individual power plant solution aligned with your objectives? Whether it’s a small, integrated system or a heavy-duty power plant, a purely gas-fired simple cycle or a combined cycle power plant, we’ll collaborate closely with you to find and construct a solution optimized specifically for you.

V. Further demonstration of the capability to deliver the services, including:

EPC companies available to us……

Farther demonstration of the capability to deliver the services, including: EPC companies available to us……

Fig 8. Capability teams



Waste Treatment

In SARRALLE we care about the Environment, therefore Recycling is one of our business lines. They process used material (waste) into new useful products, reducing the amount of raw materials. Recycling also uses less energy and a great way of controlling air, water and land pollution. At SARRALLE they work to improve in the most efficient way the process of recycling of the different types of waste. They work close to the best technologist in the recycling area, giving the best solutions adapted to our customer needs.

We work for Your Future.

They deliver innovation and modern solutions for your company. They know how to do it. Founded in 1965, and nowadays with more than 50 years' experience on international projects, SARRALLE is your partner in the Environment, Energy & Steel Worlds. They are an innovative Design, Engineering, Manufacturing and Installation company, with more than 700 dynamic, highly-qualified and multicultural employees and located in more than 7 countries, that's why we are fast, flexible and close to you. Their unique expertise, technological capabilities and group synergies will help you to create smart ways of meeting today's challenges. They provide you turnkey solutions services, adapted to your needs, helping you optimize your productive processes because we want you to be the best company in your market and they work for their prior aim.

Using energy resources efficiently for sustainable power and heat generation
Urbanization, scarce resources, and climate change: Wherever we look, global challenges are spurring an increasing demand for efficient and low-/net-zero power generation, and energy from renewable sources is becoming more and more important. That's why energy systems are already undergoing a rapid transformation – and adapting to the high shares of renewables that will be essential for future energy systems.

SIEMENS energy

VI. Resource capability (human, financial etc),

Resource capability (human, financial etc),

We have forty-years' experience in Infrastructure projects in Developing Nations and twenty-seven years of Climate Change Mitigation. Our EPC partners have thousands of staff and workers and have built over 1,500 Power & Waste Plants.

Headway USA, a leading project management and project finance group in the United States, is pleased to state its intention to provide management and funding support at low interest rates, to the fullest extent possible, for the facilities and services being proposed by us and PSECC Ltd, for the evaluation, selection, implementation, and operations of the nationwide Waste-to-Energy (WTE) plant (s) at Dandora Landfill dump site in Nairobi. The following are some of the indicators for this provision of funding:

Financing the Waste-to-Energy Plant (s)

Headway is able to fund via the following mechanism: low-interest rate, near-concessional rate US government loans to the government of Nairobi, Kenya via US Eximbank and Headway's banking partners, in conjunction with private-sector funding via specialized ESG (Environmental, Social, Governance)-oriented funds, in particular a new ESG fund mechanism being developed by Headway and several US and European financial institutions.

Loan Financing from the US government is typically denominated at 1-1.5% above the US Treasury Rate (currently US 10-year Treasury rate is 4.25% per annum, which would entail a gross rate of 5.25-5.75% per annum to Kenya) and for 10-year or 18-year duration, this will be facilitated by Headway, together with the US Department of Commerce and the US Export-Import Bank, along with Headway's banking partners. In conjunction, private funding, which is provided on an equity investment basis (no debt, but share of earnings of the enterprise), will also be arranged directly by Headway, along with the investment committee of the new ESG fund mechanism. Close coordination will be required with the official governmental and financial regulatory bodies in Nairobi. Kenya to provide assurances in terms of repatriation of funds and earnings, and, in the case of loans, repayments of the loans from Power Purchase Agreements.

Table 6. Initial approximate Financial Breakeven of a 500 tpd plant

The plants will pay for themselves

Btu to Kwh/Income/Break Even Estimation		
BTU Electricity Estimation		
Comparison Btu	Inez Btu for MSW	Ratio
3500	5200	0.673
Ratio	Inez Elec. Prod.	Elec Prod Estimate
0.673	776	522.31
Kenya Est Kwh per Ton	Tons per Day	Daily Kwh
522.31	500	261153.85
Electricity/Tip Fee income		
Kwh per Day	PPA	Daily Elec Income
261153.85	$ 0.10	$ 26,115.38
Daily Elec Income	Days per Year	Yearly Elec Income
$ 26,115.38	335	$ 8,748,653.85
Tires & recyclables	Tons per Day	Income per year
3,856,296	500	3,856,296
Tip Income per Day	Days per Year	Yearly Tip Income
$ -	335	0.00
Yearly Elec Income	Yearly Tip Income	Yearly Income
$ 8,748,653.85	0.00	$ 12,604,949.85
Break Even Estimate		
Yearly Income	Estimated O&M	Yearly Profit
$ 12,604,949.85	$ 3,000,000.00	$ 9,604,949.85
Estimated Project Cost	Yearly Profit	Break Even payback yrs
$ 72,500,000.00	$ 9,604,949.85	7.55

All monetary values in USD.

Funding loan must now be paid back and O&M plus running costs and labour together

Table 7. Material prices (2010)

Type	Avg. selling price (**1998**)		Avg. selling price (**2009**)	
	KShs/kg	US$/kg	KShs/kg	US$/kg
Paper	3	0.0375	4	0.0537
Old newspapers	-	-	15 - 27	
Broken glass	3	0.0375	1	0.0134
Unbroken glass			50 cts per bottle	
Steel	5	0.0625		
Scrap iron	5	0.0625		
Plastic	5	0.0625		
PET			6	0.0805
HDPE			20	0.2685
Trash Bags			20	0.2685
Whole bottles	1-15/kg	0.0125 - 0.1875		
Bones	4	0.05		
Aluminium	12	0.15	15	0.2013
Copper	10	0.125		
Old Tyres			50 - 300 per tire	

Source: Solid Waste Management in Nairobi: A Situation Analysis Technical Document accompanying the Integrated Solid Waste Management Plan - Prepared by: Allison Kasozi and Harro von Blottnitz

Table 8. Disposal Costs to Dandora designated and Ruai landfill (2010)

Zone	**Cost/ton to Dandora (KShs)**	**Estimated Rate/ton to Ruai (KShs)**
CBD	1144	4576
Kamukunji	943	3772
Starehe	990	3960
Embakasi	852	3408
Dagoretti	1210	4840
Westlands	1155	4620
Langata	1144	4576
Makadara	849	3396
Kasarani	891	3564

VII Experience in developing and operating similar plants (all list of such plants and locations)

Experience in developing and operating similar plants (all list of such plants and locations)

Sarralle Example of Plants

1. HITACHI ZOSEN INOVA - PRIMARY AND SECONDARY COMBUSTION AIR SUPPLY SYSTEM FOR NEW INCINERATION PLANT IN VANTAA (Finland)

2. ROS ROCA – HITACHI ZOSEN INOVA - TERSA INCINERATION PLANT REVAMPING, SANT ADRIA DE BESOS (España)

3. KOBELCO ECO SOLUTIONS - PRE-ENGINEERING FOR GASIFICATION NORTHACRE PROJECT – UK

4. KOBELCO ECO SOLUTIONS - HOOTON PARK WtE GASIFICATION PLANT (UK)

5. TURNKEY PROJECT TO DEVELOP A NEW ZINC OXIDE RECYCLING PLANT AT JIANGSU (China)

Incineration ,for Steelmuller in Zubieta (Spain), 2017 ONGOING

Marpol Treatment plant , SERTEGO (TANGER), 2016

ENERGY – URBAN WASTE TO ENERGY

sarralle
Environment & Energy

KOBELCO ECO SOLUTIONS

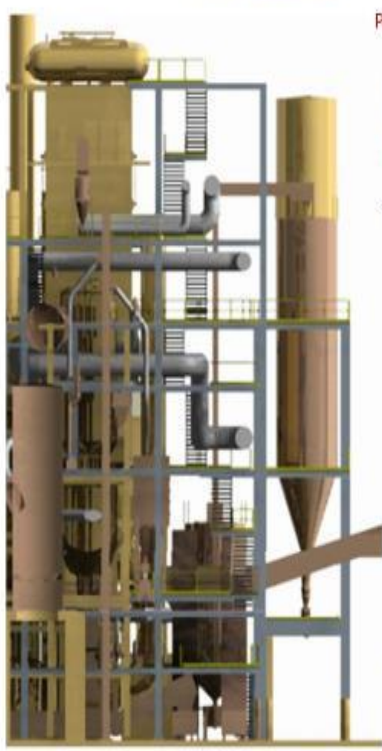
PRE-ENGINEERING FOR GASIFICATION NORTHACRE PROJECT - UK

KOBELCO ECO-SOLUTIONS CO.,LTD.

PROJECT DATA

CLIENT: **KOBELCO**

PROJECT DATE: **2018 – 2019**



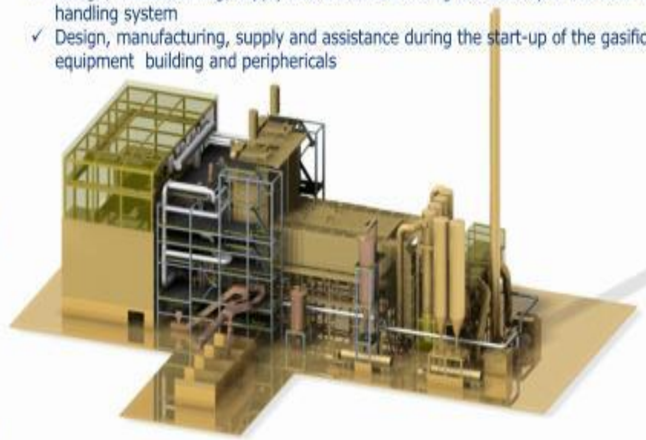
PROJECT DESCRIPTION

SARRALLE Environment & Energy was contracted by KOBELCO for engineering of the plant that will be located at Northacre in UK.

SARRALLE Environment & Energy – SCOPE

The project scope includes:

- ✓ Design, manufacturing, supply and assistance during the start-up of the GASIFICATION Furnaces for the two lines of the plant.
- ✓ Design, manufacturing, supply and assistance during the start-up of the RAW material handling system
- ✓ Design, manufacturing, supply and assistance during the start-up of the gasification equipment building and peripherhicals



ENERGY – URBAN WASTE TO ENERGY

sarralle
Environment & Energy

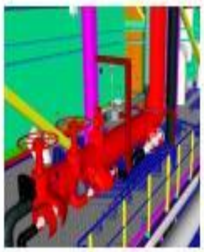
Steinmüller Babcock Environment

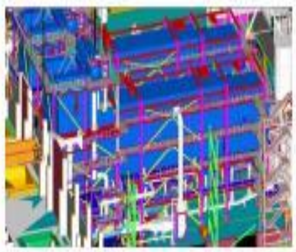
ENGINEERING SERVICES – TIME SCHEDULER & COST CONTROLLER FOR THE EXECUTION OF ENVIRONMENTAL COMPLEX OF GIPUZKOA PHASE I IN ZUBIETA (DONOSTIA)

PROJECT DETAILS:

PROJECT

CLIENT: **STEINMÜLLER BABCOCK ENVIRONMENT Gmbh** DATE: **Mach 2018 – December 2018**

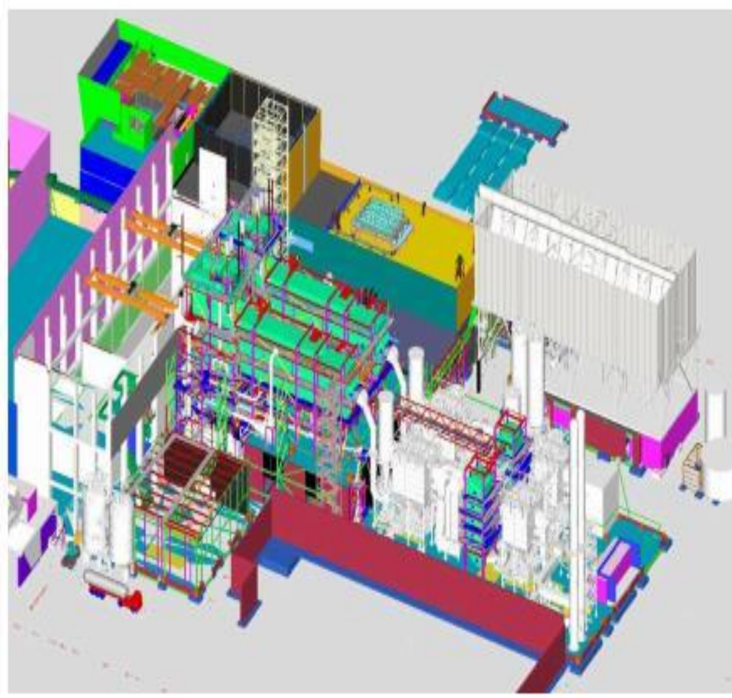




The company STEINMÜLLER BABCOCK ENVIRONMENT Gmbh, has got the contract to provide the valorization furnaces technology furnaces at the enviromental complex of Gipuzkoa Phase I in Zubieta (Donostia) awarded to its consortium with URBASER, Moyua, Altuna y Uria, Murias y LKS.

SARRALLE will be in charge of:

- ✓ Coordination of general layout 3D model from the consortium members.
  - ✓ Boiler house.
  - ✓ Flue gas cleaning system.
  - ✓ Turbine.
  - ✓ Air cooled condenser.
  - ✓ Demineralised water plant.
  - ✓ Water steam cycle.
  - ✓ Biomechanical treatment.
  - ✓ Infrastructure (as pipe bridges and cable trays).
  - ✓ Civil / civil infrastructure
- ✓ Time Management Plan.
  - ✓ Baseline for project monitoring, control and reporting
  - ✓ Progress measurement system procedure
  - ✓ Monitoring, forecasting and project execution tools
  - ✓ Critical path method implementation
  - ✓ Monitoring S-curves and KPI´s on regular basis
  - ✓ Implementation of critical path method



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ENERGY – URBAN WASTE TO ENERGY

sarralle
Environment & Energy

ROS ROCA – HITACHI ZOSEN INOVA

ROS ROCA envirotec

Hitachi Zosen INOVA

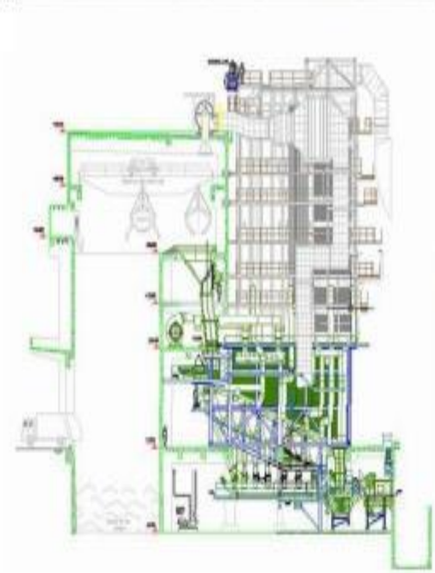
TERSA INCINERATION PLANT REVAMPING, SANT ADRIA DE BESOS (España)

PROJECT DETAILS

CLIENT: **ROS ROCA**

PROJECT DATE: **January 2012 – October 2014**

PROJECT DESCRIPTION



The Plant is located in San Adria de Besos (Barcelona, Spain) and working since 1975, operated by TERSA since 1982

Total capacity of the plant is 330,000 tpy of waste and electrical production of 155,000MW-h, yearly consumption of around 50,000 households

The scope of the project was the design, fabrication and erection for the revamping of the 3 incineration lines of the WtE plant:

- Feed hopper modification
- Grate modification and reinforcement of the furnace structure
- Primary and secondary combustion air supply system
- Slags and ashes collection system
- Supports and structures

SARRALLE Environment & Energy -SCOPE

The project scope includes:

- ✓ Detail Engineering.
- ✓ Fabrication.
- ✓ Removal of existing equipments and structures.
- ✓ Erection and commissioning of new equipment, including Project Management

Notarization & Certified
To

The County Secretary and
Head of County Public Service Nairobi City County Government
P.O Box 30075-00100
Nairobi,
Kenya Date: 30th January 2023

Reference: EXPRESSION OF INTEREST (EOI) TO DESIGN, BUILD,FINANCE, MAINTAIN & OPERATE AND TRANSFER A WASTE TO ENERGY PROCESSING PLANT IN DANDORA NAIROBI

Dear Sir

Headway USA have forty-years' experience in Developing Nations and in particular Waste-to-Energy and Waste Management together with funding provision.

Headway provides project management to infrastructure and service projects, through its own internal capabilities and by leveraging strategic partnerships with reputable organizations and subject matter experts - in the US and around the globe.

We certify all items I to IX as true, complete and exact under "Qualification of bidders".

I. Copies of certificate of incorporation/ business registration.
II. Copies of PIN and Tax compliance certificates OR equivalent
III. Relevant factory operating licenses;
IV. A copy of the company profile,
V. Further demonstration of the capability to deliver the services, including:
VI. Resource capability (human, financial etc),
VII. Experience in developing and operating similar plants (all list of such plants and locations)
VIII. References attesting to its activities in the energy and waste sectors.
IX. Proposed technology.
and in particular Notarise item V & VI.

- 1-30-2023

NOTARY PUBLIC STATE OF FLORIDA
BETHSY TORRES
MY COMMISSION # HH270041
EXPIRES: July 21, 2026

Chadwick Hardee
JAN. 30, 2023

+44 (0) 2392 471860
+44 (0) 7510977203

39 Woodhay Walk, Havant, Hants, PO9 5RD, UK

Email: alan@psecc.co.uk
Website: psecc.co.uk

PSECC LTD

SOLAR PV MANUFACTURING PLANT
PROPOSAL CONCEPT

November 2023

Prepared By: Alan Brewer MSc.
PSECC Ltd
www.psecc.co.uk

Project No. PSECC004

PREPARED FOR:

Mr S. Ikua
Director General / CEO
LAPSSET CORRIDOR
Lapsset Corridor Development Authority - LCDA
Chester House, 2nd Floor, P.O.Box 45008-00100, Koinange Street, Nairobi, Kenya

Transitional Clean Energy
Net ZERO

PSECC Ltd
Portsmouth Sustainable Energy & Climate Change Centre

November 2023

Manufacturing Plant proposal - Kenya

Assembly & Distribution followed by Manufacturing of Solar PV Panels

SySCraft

SySCraft Limited Solar Home Lighting System

&

Larger Solar PV Panels for Solar Farms

SySCraft Limited

Procmura Centre, Sports Road, Westlands, Nairobi, Kenya - +254 707 584119 - info@syscraft.co.ke

PSECC Ltd - www.psecc.co.uk

UK Offices: PSECC Ltd - 39 Woodhay Walk, Havant, Hampshire, PO9 5RD

250w Solar PV panels

Solar PV Home Lighting Systems 20w & 30w

2

Contents

Executive Summary

Kenya is one of the African Countries with a high Renewable Energy generation from Geothermal, however there is a need for Kenya to increase their Renewable Energy from Solar in line with COP26 1.5 Consistent Pathways. This is an application for USD $6 million, ROI of 18%. The Solar PV lighting systems together with Solar for schools and Solar Farms for electricity use in Kenya households will reduce use of kerosene and so reduce greenhouse gas emissions and the Government are hoping to develop 5,000MW of additional electricity to drive down the cost of electricity. This project is being developed jointly by SySCraft Limited in Kenya and PSECC Ltd in the UK, PSECC Ltd has twenty-eight years' experience in Climate Change Mitigation and Renewable Energy development projects. Successfully delivered, as the Project Lead partner on other UK Government Innovate UK funded Renewable Energy projects in Africa for Ghana, Solar Farm development in Ghana and Kenya and ten-years' experience in manufacturing environments.

The Government of Kenya has targets for Renewable Energy generation, Climate Change and to promote local manufacturing as part of the Kenya Vision 2030 and the Industrial Transition programme. Promoting local manufacturing will not only, as we have seen bring prices down to affordable levels, especially to the poor, but will also have a bigger impact on the country's economic growth. Kenya is the largest market in Africa for off-grid solar products and according to the Kenya National Electrification Strategy (KNES), off-grid solar solutions will play an important role in achieving universal electricity access for all Kenyans by 2022. Currently, it is estimated that nearly 10 million Kenyans use off-grid solar products as compared to less than a million in 2009 at the commencement of the World Bank's Lighting Africa project.

We can manufacture at lower cost by 46% of imported panels supplied from China. Year one we will have an Assembly plant and Sales & Distribution centre for the solar home lighting systems using imported solar PV panels from China then after six months we will build the Manufacturing plant then activities will be manufacturing of the solar PV panels in Kenya, assembly, sales & distribution for the lighting systems and the larger solar PV panels for Solar Farm use. Two Manufacturing systems were investigated, one from India the other from China. The Indian plant would require 10,000 square feet building, equipment cost of USD $210,000 to produce 30,000 light units per year, material costs would be USD $693,300 build cost per Solar Home Lighting system would be USD $25 to USD $28 on material costs.

Total cost for the China Manufacturing Plant - Semi-Automatic 1.272MW to 10MW capacity Equipment cost is USD $220,500 one off payment, ongoing annual material costs for solar PV panels is USD $308,621 per 1.272 MW for the lighting system, for 10MW is USD $2,468,968 per year material costs for the lighting panels and larger solar PV panels. The plant from China has been chosen due to superior quality, costs, and adaptability. Assembly & Distribution costs were USD $2,068,990 for material, so the total funding required for the two operations is USD $4,537,959 in year one for materials. Building rental costs per year is USD $13,500 for Headquarters and USD $54,000 for warehousing in three regions of Kenya – total running costs in year one is USD $821,019. Plant operational phase requires 100 KW per hour @ USD $0.16 KWh, so for one daily eight-hour shift running costs is USD $128 per day, for 350 operational days each year the cost is USD $44,800. However, over time the Manufacturing building will have the larger 250w panels on the roof to provide the electricity to run the plant.

Manufacturing plant funding required is USD $5,853,325 plus the solar roof for the plant USD $146,675 for the Manufacturing, Assembly & Distributing plant totalling USD $6,000,000, ROI 18% and if the investors are interested a further USD $11.2 million for the 10MW solar farm for Nakuru in Kenya ROI of 12.08%, totalling USD $17,200,000 over a ten-year loan period. If another Ghana 20MW solar farm is included then a further USD $23 million is required for a further ROI 23.59% totalling USD $40.2 million profit over twenty-five years. Our marketing department have indicated the solar farms give a secure outlet for the sales of the larger 250w solar PV panels from the Manufacturing plant over a five-to-ten-year period.

The Manufacturing plant for Solar PV panels will assist Kenya producing 20w panels, 30w panels and 250w panels at lower costs compared to imported panels. If we were to use those panels in a 10MW solar farm development at Nakuru then the revenue profit from the Solar Farm would be USD $39,325,365 over 25 years of operations or USD $1,573,015 per year on average.

SySCraft Ltd have four years in system integration and now requires funding of USD $6 million to start-up this venture for Manufacturing, assembly, distribution & Sales. There is evidence of imported low quality products getting into the local market. Lighting Africa's March 2016 Kenya retail report indicates that the top two key challenges solar retailers are grappling with are low quality/counterfeit products and faulty products that lower consumer trust of solar products. We at SySCraft Limited & PSECC Ltd aim to fill this gap and increase the Natural Capital, increasing the environmental gains at the same time increasing the financial gains and distribute the systems at better quality, lower cost and introduce Manufacturing in Kenya and we have studied the report on Namibian students regarding Pico to understand further the attitudes of potential buyers of our systems. As part of a larger project on climate change interventions, it was expected to provide information to be used for production of a prototype for a Kenya manufactured solar lantern. PSECC Ltd Limited are currently developing opportunities in Waste Gasification & 100% Recycling technology plants and USD $90 million funding arranged by Alset Power Company Inc via USTDA & US EXIMBANK for the first Waste-to-Energy Gasification plant for Kisumu in Kenya.

The University of Sheffield is working with PSECC Ltd and us on a "Harvesting the Sun Twice project", which provides other markets for our manufactured larger 250w solar PV panels. While ground-mounted arrays of solar panels offer several benefits related to clean energy provision, they miss opportunities to deliver livelihood benefits in addition to electricity supply, and in some cases can detract from other development goals. For example, ground-mounted arrays remove land from food production, and at a time when crop yields are threatened by a changing climate, increasing populations and insecure land ownership, we cannot risk putting further pressure on land resources. Agrivoltaic energy systems, however, can combine the delivery of solar electricity, crop production, and rainwater harvesting on the same land area. Instead of being mounted close to the ground like traditional solar power arrays, agrivoltaic systems are constructed several meters high, with gaps between the arrays, enabling crops to be grown underneath. Climate Change will provide significant growth in this sector.

Our Marketing department have further identified possible sales of the larger 250w panels in this concept could be incorporated into this Kenya project in a second development phase – for every 10MW solar farm we build in Kenya we could have one or more 500KW (2,000 panels) or larger projects below incorporated into the project. PSECC Ltd is a partner with this Sheffield University project.

www.sheffield.ac.uk/research/harvesting-sun-twice Manufacturing plant equipment supplier website www.ooitech.com

(Video of equipment & process) www.youtube.com/watch?v=u4Y2EmDt998&t=22s

Introduction

The requirement is for a 10MW plant - USD $6 million investment over a ten-year loan period for a Manufacturing, Assembly & Distribution plant for Kenya. Manufacturing plant requires USD $3,784,335 and USD $2,068,990 for Assembly & Distribution plant (USD $5,853,325). Solar PV roof fo Manufacturing plant we have costed at USD $146,675 totalling USD $6,000,000 – ROI is 16%. We could have a 20MW plant or even 25MW costing $9,335,323 with ROI of 25%.

We can manufacture the 20w & 30w solar PV panels for the lighting system 46% lower cost as panels supplied from China, we will still import smaller 10w panel due to equipment limitations – Our Material & Manufacturing cost per watt is USD $0.26116, the larger 250w panels we manufacture for USD $65.29 .

$300 million was invested in mostly Western-owned solar pay-as-you-go (PAYG) start-ups in 2020, up from $19 million in 2013. More than 8 million PAYG solar kits were sold from January 2018 through December 2021, according to Gogla, an off-grid solar industry trade group, and today about 25 million to 30 million people have access to energy via paygo solar lighting systems. Although PAYG can make a difference to middle-class homeowners and small businesses that don't want to depend on Africa's unreliable power grid, it hasn't fully succeeded in bringing electricity to the poor on a massive scale, we aim to resolve that issue by having a better-quality, in country product, more affordable to ensure greater take-up.

The Government of Kenya has targets for Renewable Energy generation, Climate Change and to promote local manufacturing as part of the Kenya Vision 2030 and the Industrial Transition programme. Promoting local manufacturing will not only, as we have seenbring prices down to affordable levels, especially to the poor, but will also have a bigger impact on the country's economic growth.

SySCraft Limited is an established company in Kenya for over four years in operation, senior staff with over thirty-five years of business acumen in Kenya. Expertise has been developed to now entre the Climate Change Mitigation & Renewable Energy sector. SySCraft & PSECC have analysed Solar PV manufacturing plant technology from India and China and identified the product ranges for the new Manufacturing Plant and Assembly to produce and have further identified a sound way forward in marketing those products with three different sized 10w, 20w & 30w Solar PV panels for the Solar Home Lighting system and the larger 250w Solar PV panel manufacturing for the Solar Farms.

SySCraft Limited in Nairobi and PSECC Ltd in the UK are submitting this joint proposal to UK AID "Manufacturing Africa" team for investment into this much needed venture. The cost comparison of our panels to be manufactured in Kenya indicate a cost per watt of USD $0.26116.

The manufacturing costs for the larger 250w panels each day will be $65.29 per panel and number of panels per year is 34,560 panels so manufacturing costs would be USD $65.29 x 34,560 is USD $2,256,422. Retail price is set at USD $120 per 250w panel is the profit of USD 54.71 per 250w panel = USD $ 1,890,777 per year. Our marketing department have identified a strong sales market - In a year, operational profit from the larger panels would be USD $1,890,777 or (USD $1.89 million) per year. However, if the panels were used in our Solar Farm projects, initially at the 25MW Solar Farm proposed for Nakuru then profits over a 25-year period from the Solar Farm are USD $90 million (USD $3.6 million each year on average).

SySCraft

www.syscraft.co.ke Experience you can count on………

SyS Craft

Renewable Energy and Waste Management System

Our work in the Circular Economy

As we have seen, Renewable Energy projects were started in Kenya by our partners PSECC Ltd in 2012 commencing with Solar PV home lighting systems and Solar Farm development at Konza & Nakuru and this new Manufacturing Plant could provide solar panels for Solar Farm developments in Kenya for years to come without the need to import panels – Industrial Transformation & Job creation.

Full product line

SHS10-2W3	235*350*17mm	10W/12V
SHS20-3W4	430*350*17mm	20W/12V
SHS30-35W4	590*350*17mm	30W/12V

For the four products the domensions are as follows:

250W 1640*992*35mm

KENYA'S

INDUSTRIAL TRANSFORMATION PROGRAMME

MINISTRY OF INDUSTRIALIZATION AND ENTERPRISE DEVELOPMENT

AN EXCITING TIME FOR KENYA

This is a very exciting time for Kenya and for our region. The world has recognised our country as one of the leading economies in Africa that will drive the growth of this region.

We have committed to our people that we will pursue an inclusive model of growth and reach one million new jobs in the near future, doubling the number of manufacturing jobs we have today. We believe that a significant portion of these jobs will come from the development of our industrial sector and the services linked to the priority sectors that we have selected in this programme.

The key to sustainable industrial growth and job creation lies in the growth of domestic companies and the attraction of local and foreign investors to invest capital and expertise into the economy. To achieve this, we have made improving the overall business climate and supporting selected sectors our top priorities. As a government, we are committed to overseeing this work and ensuring its implementation. We will play a part by actively pursuing favourable trade agreements in key markets, both regionally and globally.

Moreover, we recognise the role that the government will need to play in creating the infrastructure backbone to advance our economy. We have made significant headway on the construction of the Standard Gauge Railway, which will efficiently link the coast and the interior. The Port of Mombasa has been expanded, and we are continuing to improve the efficiency of its operations. We are actively pursuing our plans for the generation of an additional 5,000 MW of electricity to drive down the cost of electricity. We have made substantial progress on the development of LAPSSET (Lamu Port/ South Sudan/Ethiopia Transport Corridor Programme). Our international airport in Nairobi is being upgraded to become a world-class facility, positioning Nairobi as a commercial and services hub for the region. Finally, we are rapidly moving forward with the construction of 10,000 km of new roads that will form the transport corridors required to move products throughout Kenya and the region.

Our youth and small and medium enterprises will be the engine of our growth. This growth will be spread across the country, and we will support our counties by promoting the development of small businesses, creating vocational training programmes and preparing our youth with the right skills to contribute to the economy.

With a strong focus on implementation, we are dedicating the human capital and resources required to realise this Industrialization Transformation Programme. We also recognise that success can only be achieved through collaboration. We call on you – the public at large, our civil servants, business men and women, small and medium enterprises, large companies and foreign investors – to work with us to transform Kenya into an industrial hub, for the benefit of our people and the region.

H.E. Hon. Uhuru Kenyatta, CGH
President of the Republic of Kenya and
Commander-in-Chief of the Defence Forces

INDUSTRY: KENYA'S GROWTH ENGINE

As global production costs continue to rise in the traditional markets of Asia and Europe, we expect manufacturing to move to Africa. As a country, we are preparing to be at the forefront to capture this opportunity for growth. We are positioning our industrial sector to attract investments through the advantages of our well-trained labor force, low cost of operations, integrated industrial parks and our improving transportation and power infrastructure.

Kenya has extraordinary momentum today. The foreign direct investment in our country has more than doubled in the past two years and our domestic investment continues to rise. Our middle income population now comprises 45% of the populace. Our people continue to be the top talent in Africa. In fact, Kenya is ranked first in Africa for quality of educational system by the World Economic Forum. The World Bank estimates a 2015 growth rate of 6.7% per year for our region, a higher growth rate than that of Brazil, India or the rest of sub-Saharan Africa.

Industrialization has been the modernizing force in every developed and emerging economy and this will continue to be the case for Kenya. Industry will be the bedrock upon which we grow jobs, GDP and incomes. We are confident we can also transform the wealth, employment and inclusiveness of our country over the next five to ten years through a targeted approach in sectors in which we have a competitive advantage.

We believe that the industrial sector for Kenya is at a turning point. While there is significant domestic and foreign interest, a growing market and existing skills, there has not been a comprehensive effort to create an industrial hub. In this Industrial Transformation Programme, we have begun sector-specific initiatives that will turn Kenya into an industrial hub.

The achievements we have already seen while implementing part of the Industrial Transformation Programme over the past year will continue as we take advantage of our country's unique position in the region and beyond. We are excited to continue the work we have started and will call upon our colleagues in government, the private sector and the people of Kenya to support this programme

Adan Mohamed, EBS

Cabinet Secretary of the Ministry of Industrialization and Enterprise Development

IMPLEMENTING OUR PRIORITIES

We are eager to share this Industrial Transformation Programme as we seek to revitalise the economy of Kenya. This is a strategy that we believe will drive Kenya towards becoming a primary industrial hub of Africa and will enable the country to achieve its goals of creating meaningful jobs, increasing GDP and addressing its trade balance – all towards a better quality of life for Kenyans and the people of the region as a whole. The programme builds on strategies that Kenya has already developed with a strong focus on implementing our priorities.

The actions outlined in this programme are specific. Projects have clear owners and timelines, and the Ministry has developed detailed budgets to mobilize the resources required to achieve them. We have assigned dedicated implementation teams to focus on the flagship projects, drawing on resources from within the Ministry as well as relevant agencies. We are also building a dedicated Delivery Unit within the Ministry to drive the activities of the Industrialization Transformation Programme. The unit will track delivery of priority projects, ensure the appropriate levels of collaboration with other ministries, agencies and private sector players and mobilize expertise and tools to ensure success.

We will seek partners who can bring the required capital, technical and operational expertise to realise our projects. We look forward to welcoming the participation of our private sector and local and international investors who will support our journey to develop Kenya into an industrial hub for Africa.

Dr. Wilson Songa, MBS

Principal Secretary of the Ministry of Industrialization and Enterprise Development

Summary of Transformation programme

The Ministry of Industrialization and Enterprise Development (MOIED) has developed this strategic, comprehensive and integrated programme to guide Kenya on its journey to industrialization.

The programme is guided by Kenya Vision 2030, the country's economic development blueprint that aims to transform Kenya into a newly industrializing, "middle-income country providing a high-quality life to all its citizens by the year 2030". The objective of the Economic Pillar of Vision 2030 is to create a robust, diversified and competitive manufacturing sector in three ways: 1) boosting local production, 2) expanding to the regional market and 3) taking advantage of global market niches.

Over the past ten years, Kenya's manufacturing base has remained static at 11% of the country's GDP, and its industrial exports have decreased in absolute terms. Increasing this base is critical to job creation and economic growth as well as domestic and foreign investment. **We have identified opportunities that will more than double the amount of current formal manufacturing sector jobs to approximately seven hundred thousand and add USD 2 to 3 billion to our GDP.**

To realise these opportunities, we need to overcome six challenges: infrastructure and land availability, skills and capabilities in priority sectors, quality of inputs, cost of operation, access to markets and investor-friendly policies. We have developed a five-point strategy to capture these opportunities over the next ten years.

1. ***Launch sector-specific flagship*** projects in agro-processing, textiles, leather, construction services and materials, oil and gas and mining services and IT related sectors that build on our comparative advantages (Pillars 1 to 4).
2. ***Develop Kenyan small and medium enterprises (SMEs)*** by supporting rising stars and building capabilities with model factories (Pillar 5).
3. ***Create an enabling environment to accelerate industrial development*** through industrial parks/zones along infrastructure corridors, technical skills, supporting infrastructure and ease of doing business (Enablers 1 to 4).
4. ***Create an industrial development fund*** *(Enabler 5).*
5. ***Drive results*** through the newly formed Ministerial Delivery Unit.

TAX Incentives

There are applicable tax incentives and from the Government documents it is also evident that the Minister can declare a plant or factory as part of Special Economic Zone - SEZ despite the location.

This is since an investor might prefer different areas for some reasons, at the point of plant setup all the applications for exemptions can be applied for and justification given.

1. 10-year corporate income tax holiday and a 25% tax rate for a further 10 years thereafter (except for EPZ commercial enterprises)

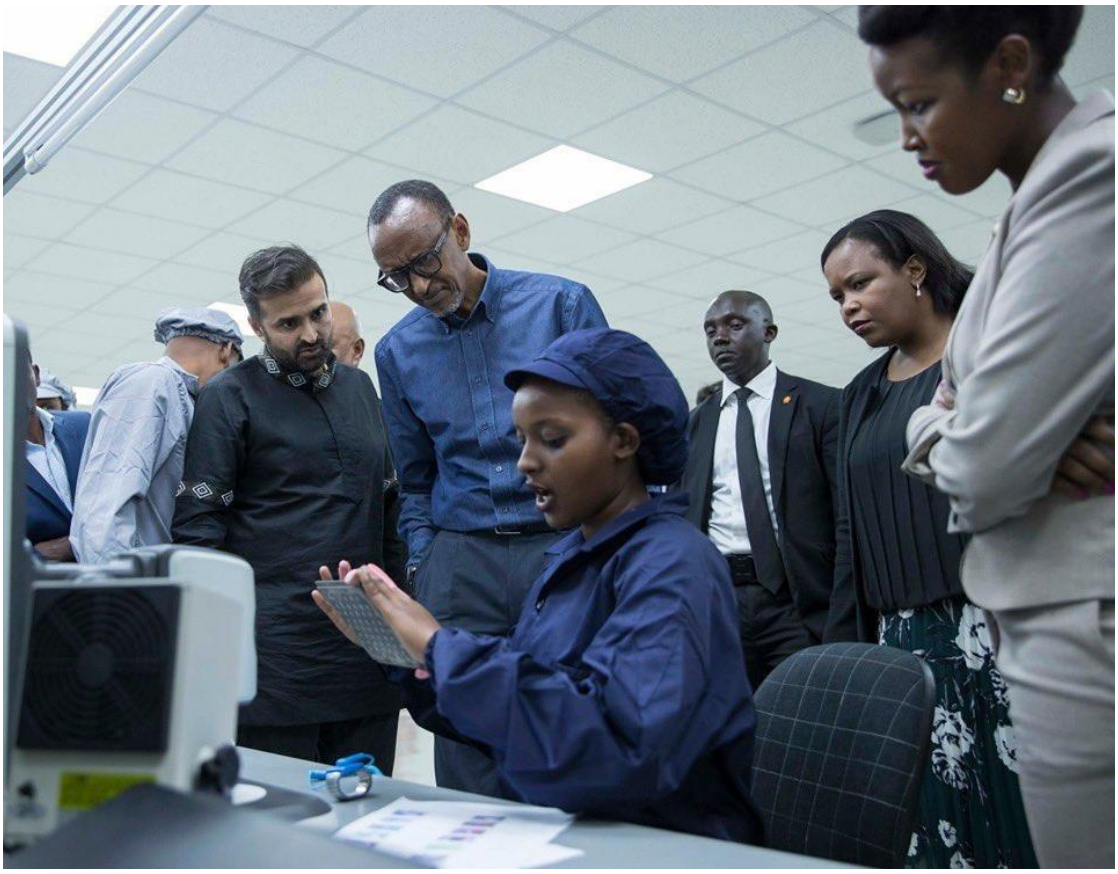
2. 10-year withholding tax holiday on dividends and other remittances to non-resident parties (except for EPZ commercial license enterprises)

3. Perpetual exemption from VAT and customs import duty on inputs – raw materials, machinery, office equipment, certain petroleum fuel for boilers and generators, building materials, other supplies. VAT exemption also applies on local purchases of goods and services supplied by companies in the Kenyan customs territory or domestic market. Motor vehicles which do not remain within the zone are not eligible for tax exemption.

4. Perpetual exemption from payment of stamp duty on legal instruments

The Manufacturing plant

The plant will be able to produce Solar PV panels for 36,000 small Solar Home Lighting Systems in year one as well as 34,560 large 250w panels for Solar Farms manufactured from month seven onwards, over a twelve-month period onwards and thus helping towards meeting the 5,000MW target of Kenya.



Manufacturing Plant and equipment layout

10,453 Square Feet of building space in Nairobi for Headquarters Manufacturing and Assembly plant

Entrance area of Factory
https://coralpi.com/properties/10383-sqft-warehouses-for-rent-along-old-mombasa-road/

Features, Amenities and Provisions

- 3 phase power.
- 20KVA power supply to each godown (Factory).
- Offices and washrooms in each godown.
- 5.5 metres gate height.
- Borehole and Council water.
- 1000 litre water storage tank for each godown.
- 18 metres wide cabro paved road between each row to facilitate easy turning for trucks.
- 24/7 security guards manning and patrolling the compound.
- Perimeter wall with electric fencing.
- CCTV surveillance in the common areas.

·

Rent Per Month: KES. 30 per square foot plus VAT.
Service Charge Per Month: KES. 27,500 plus VAT per godown (Factory)

·

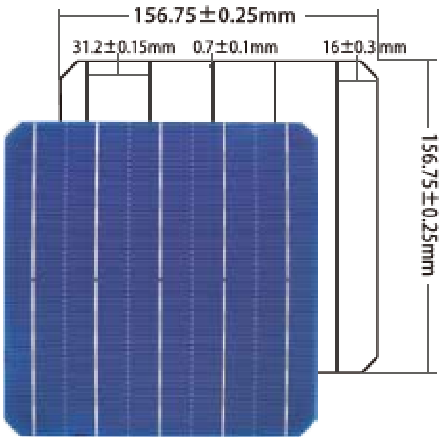
The Solar cells from China to be used in the Manufacturing plant

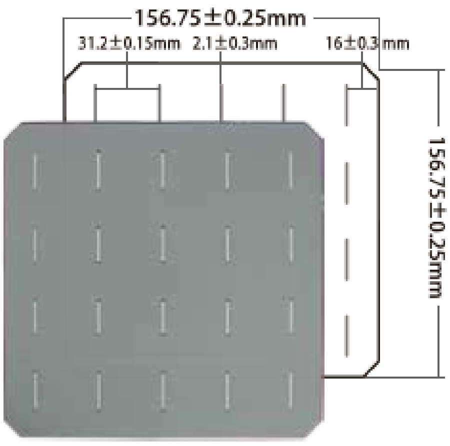
SUZHOU RUNERGY PV TECHNOLOGY CO., LTD.
Address: Room 2006.DiBao Finance Building.No.168,Chun Xu Road,Jiangsu,Kunshan,China
Sales Phone: +86-512-5792 1098

荣耀R1

Mono PERC Solar Cell (5BB-Half)
5BB单晶PERC电池片（半片）

Product specification/产品规格





Type/硅片类型	Size/尺寸规格
Monocrystalline 单晶	156.75*156.75±0.25mm Φ210mm

Front electrode pattern/正电极图形

Five busbars/五主栅

Width/宽度：0.7±0.1mm

Interval/间距：31.2±0.15mm

Finger/细栅线：108 lines

Electrical properties/电特性

Temperature coefficient/温度系数

Voc：-0.3 %/℃

Isc：0.06 %/℃

Pm：-0.39 %/℃

STC/标准检验条件

Intensity/光强：1000 W/m

Spectrum/光谱：AM1.5

Temperature/温度：25±2℃

Appearance parameters/外观参数

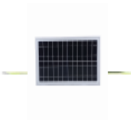
参数项目 Parameter items				Specification	公差 Tolerance	单位 Unite
正面 Front surface	A	正面细栅线数量	Finger number	108	N/A	Line
	B	正面主栅线宽度	Busbar width	0.7	±0.1	mm
	C	正面主栅线间距	Busbar interval	31.2	±0.15	mm
	D	左/右主栅中心线到左/右边缘的距离	Distance between center line of the left (right) busbar and the left (right) wafer edge	16	±0.3	mm
背面 Rear surface	A	背面主栅线宽度	Grid width	2.1	±0.3	mm
	B	背面主栅线间距	Grid interval	31.2	±0.15	mm
	C	左/右主栅中心线到左/右边缘的距离	Distance between center line of the left (right) rear grid and the left (right) wafer edge	16	±0.3	mm

Electrical performance

档位 Eff（%）	效率区间 Efficiency	功率 Pmpp（W）
HE 2250 P50	>22.5%	5.50
HE 2240 P50	22.4-22.5%	5.47
HE 2230 P50	22.3-22.4%	5.45
HE 2220 P50	22.2-22.3%	5.42
HE 2210 P50	22.1-22.2%	5.40
HE 2200 P50	22.0-22.1%	5.38
HE 2190 P50	21.9-22.0%	5.35
HE 2180 P50	21.8-21.9%	5.33
HE 2170 P50	21.7-21.8%	5.30
HE 2160 P50	21.6-21.7%	5.28
HE 2150 P50	21.5-21.6	5.25

Cost of Solar Panels from used for solar home lighting system – first six months.

In our Assembly and Distribution proposal we had indicated the cost of the solar panels that can be bought in China as follows:

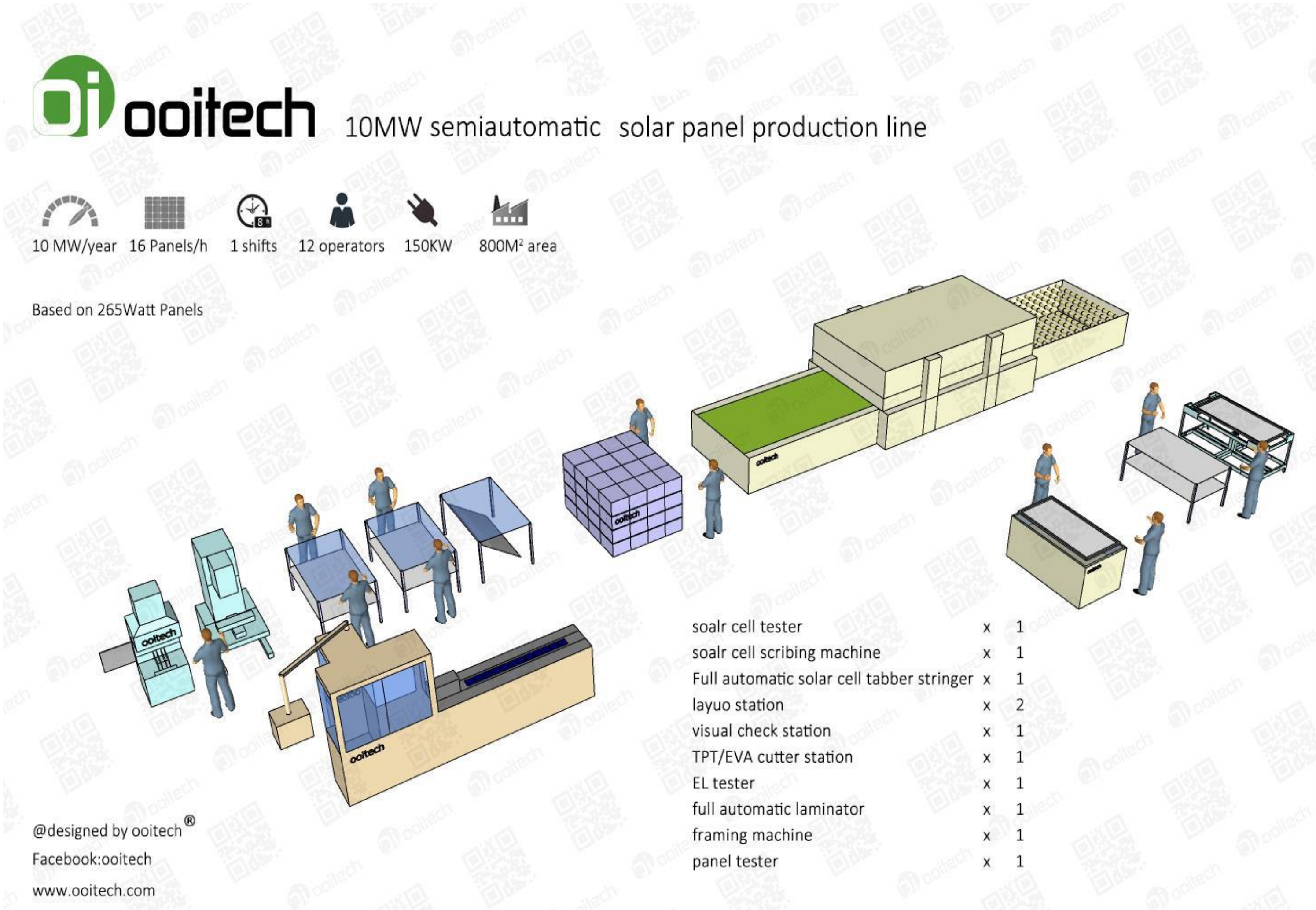
Model	Picture	Item	Description	MOQ	Unit Price FOB Shenzhen (USD)	Charging Time	Lighting Time	Packaging
Solar Panel(for SHS10-2W3)		10w	10W/12V Polysilicon panel with 5M cable		5	_	_	_
Solar Panel(for SHS20-3W4)		20w	20W/12V Polysilicon panel with 5M cable		9.8	_	_	_
Solar Panel(for SHS30-35W4)		30w	30W/12V Polysilicon panel with 5M cable		10.8	_	_	_

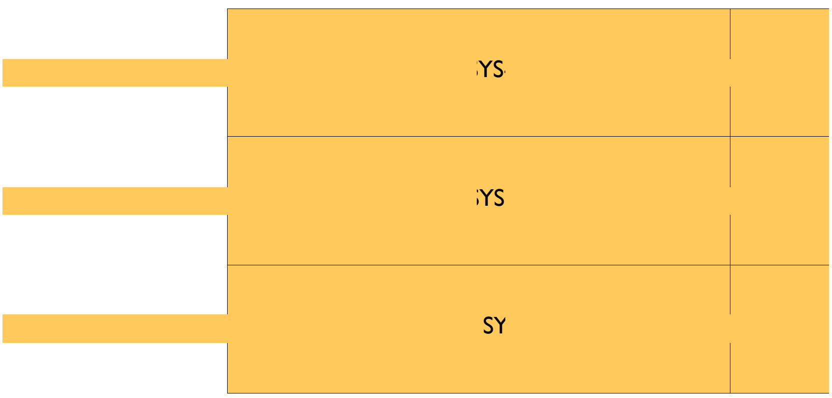
The total cost to manufacture a 20w & 30w solar PV panels will be $5.25 & $7.87 respectively (considering materials and all manufacturing costs) 46% lower cost compared to China imported Solar PV panels.

Manufacturing plant output per year

We will have two of these 10MW manufacturing plants

x 3=25MW





Supplier website www.ooitech.com

(Video of equipment & process) www.youtube.com/watch?v=u4Y2EmDt998&t=22s

Website
https://www.solarmakingmachine.com/Solar-Panel-Manufacturing-Process/?gclid=CjwKCAjwjZmTBhB4EiwAynRmDzjsKG18p_Pkcp6IRWiy-vdCWBLkQPnxMFmQPJ1Yb2hEb99wl774khoCJ8wQAvD_BwE

& Costs

WUHAN OOI PHOTOELECTRIC TECHNOLOGY CO,LTD

Add: Building 1, Zixin Industrial Park, Yangguang Ave,Jiangxia Area, Wuhan of China
Website:http://www.ooitech.com Email: Jessy@ooitech.com

Ooitech Quotation for 10 MW Semiautomatic Solar Panel Production Line

- Throughtput: 14 Panels/Hour (72 Full Cells Panel) or 7.5 Panels/Hour (144 half Cells Panel)
- Cell & Busbar: 5BB 157/158.75 Cells and 9BB 166, 10BB/11BB 182 or 12BB 210
- Module Max Size:2500x1400mm
- Line Capacity: 158.75 350Wattx14Panels/H x 8hoursx300 days=12MW;
  182 540Wattx10 Panels/H x8hoursx300 days=13MW

Date: April 26th,2022

S/N	Description		QTY	UNIT PRICE (USD)	Amount (USD)	Remark
1		**Automatic Solar Cell stringer Machine(Model:SS-1500)** 1.Soldering capacity: 1200 pcs/hour 2.Cell Size: 158 /166 Full Cell and 1/2，1/3 and 1/4 cell; 182/210 1/2，1/3 and 1/4 cell; 3.Cell Busbar: 5BB-12BB 4.Welding Method:Infrared light 5. Breakage: 160-180μm ≤0.2%（A class） 180μm and Over ≤0.1%（A class） 6. Cell spacing: 0-35mm adjustable(Accuracy ±0.2mm) 7. Ribbon sizes:Width: 0.6-0.9mm Thickness:0.15~0.23mm Ribbon Type: Flat ribbon P.S: With 3 cell kits for free	1	$63,000	$63,000	
2		**Full Automatic Laminator (Model:OCY2446)** 1. Lamination Size:2400 * 4600MM 2. Heating: Oil heating 3. Control mode: automatic 4. Lamination height: 25mm 5. Temperature mode: Intelligent Temperature Control 6. Workspace temperature uniformity: ≤ ±2 ℃ 7. Temperature Accuracy: ≤ ±2 ℃ 8. Temperature range: room temperature -180 ℃ 9. Pumping rate: 70 L/S 10. Max vacuum: 20-200pa 11. Vacuumming time: 2-6min 12. Germany Simens PLC 13.Total power: 73KW (normal working 32KW) 14. Working voltage: 380V	1	$68,000	$68,000	
3		**Automatic Solar Cell Laser cutting machine(OLS-2000F)** 1.30watt RAYCUS Fiber Laser with Servo Motor 2.Throughput: 1800 full cells/hour (calculated by single cut and auto splitting of 166mm cell) 3. Spliting Cell: 1/2 1/3 1/4 1/5 1/6 1/7 1/8 manual splitting cell 4. Scribing width:40μm 5. Max Scribing speed:500mm/s 6. Working area:245x245mm 7. Solar Cell: 156 x156~210 x210mm mono and poly 8. Breakage rate:≤0.15% 9. Power:220V/50Hz/1.5kvA :	1	$18,000	$18,000	

4		12BB Solar Cell Tester (OSCT-B) 1. Light intensity:700-1200W/M2 2. Light intensity non-uniformity:≤±3% 3. Light intensity instability degree of irradiation:≤±2% 4. Test results consistency:≤±1% 5. Single flash time:10ms 6. Effective test range:210×210mm/0.1W-15W 7. Measuring voltage:0V-0.8V(resolution 1mV) 8. Measuring current:0-20A(resolution 1mA) 9. Test parameters:Isc,Voc,Pmax,Vm,Im FF,EFF,Temp,Rs,Rsh 10.Dimension:800*600*1850mm	1	$15,000	$15,000
5		Solar Panel Tester (OSMT-B) 1. Light intensity:700-1200W/M2 2. Light intensity non-uniformity:≤±3% 3. Light intensity instability degree of irradiation:≤±2% 4. Test results consistency:≤±1% 5 Single flash time:10ms, 6. Effective test range :2500×1400mm 7. Measuring voltage:10V-100V(resolution 1mV), 8. Measuring current:0-20A(resolution 1mA), 9.Test parameters:Isc,Voc,Pmax,Vm,Im, FF,EFF,Temp,Rs,Rsh"	1	$20,000	$20,000
6		Semi Automatic Solar Panel EL Defect Tester (OEL-S2400) 1.Effective test range:2400*1400mm 2.Resolution:24Megapixels 3.Test Time: 1s~60s can be set 4.Test Methods: un contact free style 5.Power:220V/10A/1PH 6.Camero Chip: imported	1	$18,000	$18,000
7		Semi Automatic Solar Panel Framing Machine (OZK-A) 1. Air cylinder : Airtac Brand 2. solenoid valve: Airtac Brand 3. high-pressure air tube: South Korea imported 4. Maximum framing size: 2500 * 1400mm 5. Minimum framing size: 400 * 400 mm 6. Operating voltage: 220V/50Hz/1Ph	1	$6,000	$6,000
8		Solar Cell Welding Station (3 WorkPlace) 1. 3 workplace:1 String welding and 2 Single welding 2.1PCS PID Intelligent temperature control box 2.2PCS single welding heating template 3.1PCS String welding heating template 4.5PCS Exhaust Fan and 2PCS Light 5.Not included constant temperature electric soldering iron 6.Dimension:2200×1200×1850MM	1	$1,000	$1,000
9		Lay up station Aluminum Material Structure:2000*1080*850 mm 1.halogen lamp 2.ammeter 3. voltmeter 4. working surface with tempered glass. 5.With 2PCS solder iron station	2	$1,200	$2,400

10		**Manual EVA/TPT cutter** Aluminum Material Structure:3000*1200*800mm with scale ruler	1	$1,000	$1,000	
11		**Glass/Solar Module Carrier** 1.Steel Structure:1600*1000*1100mm 2.With static electricity film to protect glass surface	2	$300	$600	
12		**Ready material carrier** 1.Steel Structure: 1200*1050*1400MM (10Layer) 2.With Anti-static rubber to protect glass surface	2	$300	$600	
13		**String Cell Carrier** 1.Steel Structure:1600*800*1300mm(10Layer) 2.With heat shrink tube to protect glass surface	2	$300	$600	
	TOTAL			USD	214200	

Remark:
1.the price is based on the **FOB Shanghai port**.
2.Delievery time about 35-40 Days after order confirmed.
3.Payment: **30% T/T Deposit and rest 70% by T/T before shipping**.
4.Install & Training & Drawing Design:
Ooitech Engineers offer free Online Technical Support Customer Engineer to install and training and commissioning.(If require engineer come to customer factory to install and commissioning, cost shall be USD 20000 for 14 days)
(If customer require longer time, engineer cost shall be USD 300/Day for each person.)
-the customer will be bear for the 1-2 engineers all oversea cost like round journey Air tickets cost, local food, hotel, quarantine cost etc
5.Warranty terms:
After installation and training, the machines should be operated by the operators who have received the training.
-One year warranty after successful installation or 16 months from BL date whichever is earlier
-One year Warranty on the machines, if the machine get problem within 1 year, Ooitech will offer the spare parts(not including the consumables) to solve the problem for free. But the courier freight should be paid by buyer.
-After one year, Ooitech offer technical support and offer the spare parts when the machines meet problem, buyer would be required to pay for the spare parts.
-During warranty period,If buyer's engineers can not solve the problem, Ooitech will send engineers to buyer's plant to solve the problem. The round trip tickets, local traffic cost, hotel and food in buyer's city will be paid by buyer. If it is one year later after installation, buyer should also pay for the salary, the salary can be discussed.

Additionally - PV Ribbon Bending machine is USD $5, 000, Visual inspection unit is USD $1,000 and EVA/TPT carrier is USD $300.

Total Manufacturing Plant Equipment cost is USD $220,500

Semi-automatic 10MW MBB production line

For the new Manufacturing plant in Kenya - SySCraft Limited

Automatic Solar Cell Stringer

Model : SS-1500

Technical specification

(The information herein is totally confidential and shall not be disclosed to any third party)

Function

SS1500 Stringer adopts IR soldering method, servo motor driving, mechanical positioning and Industrial CCD detection for defective solar cell excluding automatically. The soldering effect, such as cell spacing, cell numbers of single string, soldering temperatures and etc, can be adjusted according to requirements. SS 1500 can be integrated with automatic layup machine to achieve the composing and locating of solar cell strings on tempered glass.

Equipment Advance

1. Applicable for front side and back side soldering of the cell,
2. Qualified soldering effect, which approves soldering pulling testing higher than 1N/mm on cell surface (0.6*0.25mm ribbon, 180 degree pulling angle, and except HJT cell)
3. Exchange time less than 120mins for changing different bus-bar number(9BB&12BB), including 30-

60mins for changing tools and 30-60mins for tuning and calibrating. Exchange time less than 30mins for different cell sizes (whole cell, half cell, third cell and quarter cell) while bus-bar number fixed.

4. Two Stingers requires only one operator.
5. Dual Solar cell unloading basket to avoid working interruption.
6. Ribbon extruding in advance before soldering.
7. Pre-heating before soldering to avoid cell deformation efficiently
8. Applicable for Solar cells thicker than 160um, max thickness 300um.
9. Adjustable for Ribbon soldering spacing.
10. Adjustable for Ribbon soldering length.
11. Touchable integrated PC system can support remote assistance, we can provide online technical support for after-sales issues.
12. Can be integrated with other Solar equipment conveniently.
13. Remote assistance by Internet, the factory provides the network connection.
14. Adjustable for Solar cell spacing 0-35mm, normally 1.5-5mm.
15. No pre-heating required for Ribbon before soldering.
16. No specialized engineer required for maintenance, but engineers must be trained and qualified.
17. Solar cell soldering numbers per string can be set by PC.

Equipment Hardware

1. Machine body

The Solar cell district and Soldering district are totally enclosed on machine body. The solar string unloading basket can be integrated with automatic layup machine.

The equipment adopts PLC control mode, with servo motor driving and multiply alarm system for safety guarding.

2. Rotary cell basket group

- Servo motor driving + Liner Guide rail support + Ball screw transmission.
- No friction during cell loading and unloading process, to reduce cell breakage rate
- Stratified Cell blowing structure to reduce cell breakage rate
- Alarm notify when cell basket is empty

3. High resolution industrial CCD camera

High precision mechanical positioning

4. **Ribbon handling structure**
   - Adjunctive ribbon downwards structure
   - DC gear motor driving
   - Soldering flux immersing structure for Ribbon
5. **Soldering processing structure**
   - IR soldering method, and Soldering controlled by step motor driving
   - Soldering temperature adjustable
   - Solar cell pre-heating
6. **Unloading structure**
   - Translation movement driven by servo motor
   - Lifting movement controlled by Guide Rod Air Cylinder
   - Solar cell rotary & overturn function
   - Solar string belt transmission mechanism
   - Vacuum control alarm
7. **Software control system**
   - Specialized software for conveniently edit and modification
   - Friendly Human-machine interface for easy operation and control
   - Adjustable for edit and modification of soldering orbit according to requirement Centralized Parameters can be set by keyboard through software window.
   - Main parameters can be set and saved by software directly
   - Exchange between Automatic and Manual mode for convenient debugging Soldering counting function
   - Error Alarm function

Technical Parameters

Model	SS-1500
Working Efficiency	1200-1300cell/hour （In condition of 158.75 whole cell welding and cell spacing＜2mm，average speed of continuous welding is 1200-1300 pcs/hour）
Soldering Head	1 PCS
Ribbon Soldering Welding	≤±0.2mm

Accuracy		
Breakage Rate	160-180μm	≤0.2%（A class）
	180μm and Over	≤0.1%（A class）
Solar Cell Size Available		158 166 Full Cell and 1/2，1/3 and 1/4 cell; 182 210　1/2，1/3 and 1/4 cell; （1-12 cell per string）
Bus Bar QTY Available		5BB-12BB（Requires to change Soldering Head）
Solar Cell Thickness Available		0.16mm-0.3mm
Ribbon Available	Width	0.6-0.9mm
	Thickness	0.2-0.3mm

Solar String Available	Cells number/String	Max 12 cell，Max lengthy ≤2000mm（Ribbon length included）
	Stringer Space	10-40mm
	Head/Tail length	5-20mm
	Cell Spacing	Adjustable for solar cell spacing 0-35mm，normally 1.5mm-5mm（Accuracy ±0.2mm）
	Cell Positioning Accuracy	≤±0.1mm
	String Straightness	≤1mm for 10 cells string
	Ribbon Positioning Accuracy	≤±0.3 mm for both sides

Full Automatic Solar Panel Laminator

Model: OCY-2446

[Technical Parameters]

Model	Laminated Size	Machine Size (M)	NW (T)	Power (KW)		Vacuum Pump
				Max	Working	Speed (L/S)
OCY2446	4600×2400	14.7×3.25×1.8	11	73	32	70

Operate Mode	Manual/Full Automatic	**Heating Mode**	Oil Heating
Lamination area	4600×2400	**Power Supply**	AC380V Three phase five Wires
Laminate Height	25mm	**Temperature Control**	Intelligent PID Temperature Control
Laminating Time	4-8Minutes (Including the solidify time)	**Temperature Uniformity**	±2℃
Temperature Precision	±2℃	**Vacuum time**	2~6Min
Temperature Range	30℃-180℃	**Vacuum Degree**	20-200Pa
Air Supply	0.6～0.8MPa	**Compressed air flow required**	400L /Min

[Main Parts]

1.PLC: Germany SIMENS

2. Electric parts: Schneider

3.Touch Screen: Kunlun-state10-inch

4. Cylinders:AirTAC

5. Vacuum Pressure Switch: Japan brand SMC

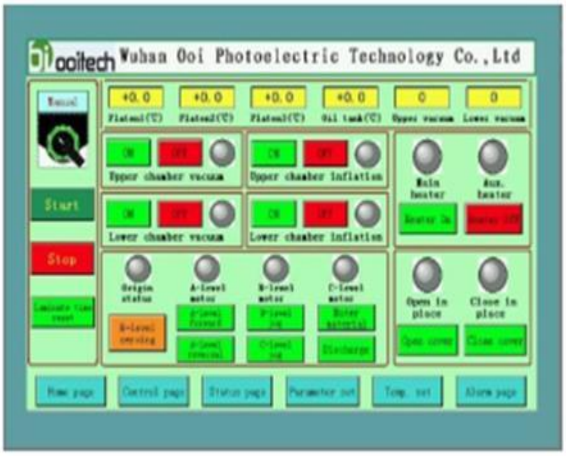
6. Vacuum Pump: China famous brand Sichuan Huaxin

[Performance characteristics]

- Intelligent temperature control system,
- Make the temperature more uniform and more easily set and control the temperature.
- Laminating pressure adjustable
- Can adjust the pressure accord to the production process requirement, makes good quality solar panel.

- 3. 24 hours continuous working in high temperature.
- 4. The advanced touch screen operation panel
- Easy operation, quickly respond, more stable performance and reduce the failure rate.
- Humanity system operation process
- The machine is equipped with several detection switch, in normal production, the operator only need to put the module component in heating platform, press close lid switch, the device will automatically laminate, curing, automatically open, waiting for the next working procedure.
- Adopt fully humanized system operation process
- The whole device is equipped with several detection switch, in normal production work, the operator only put component input on the platform, press the input switch, the device will automatically enter the component to a host of encapsulation, curing, automatically the output to the specified location waiting for operator on to the next working procedure of processing, and automatic work on to the next cycle.

[Machine Picture]



Solar Cell Laser Scribing Machine with auto Splitting

Model: OLS-2000S

Technical Specification

Suitable for scribing or cutting the Solar Cells and Silicon Wafers in solar PV industry, including the mono-si and poly-si solar cells and silicon wafer.

It can realize functions such as automatic material feeding, cell positioning, laser scribing, and boxing.

Professional control software, free maintenance, easy operation.

Machine Features

- Advanced scribing technology:
  Adopt fiber laser source, good quality laser beam, slim laser scribing line, more uniform solar cell cutting surface, small damage to solar cell, high accuracy cutting.
- High efficiency:
  High laser scribing speed, producing capacity can reach to 1500 full cells/hour
- Accuracy positioning:
  Solar cell full automatic positioning, positioning accuracy ≤±0.1mm

- High automation level:

  Solar cell automatic loading and unloading, automatic positioning, automatic scribing. Stable performance, low failure rate, easy maintenance.

Technical Parameters

Items	Parameters and configuration
Positioning accuracy	Cell automatic positioning, error range ≤±0.1 mm
Laser wavelength (nm)	1064
Maximum scribing speed	500 mm/s Adjustable
Actual output	1800 full cells/hour (calculated by single cut of 166mm cell without splitting) 1500 full cells/hour (calculated by single cut and auto splitting of 166mm cell)
Accuracy of scribing	±0.1mm
Splitting	1/2 1/3 1/4 (auto splitting optional) 1/5 1/6 1/7 1/8 manual splitting
Line width	40μm
Work table area/trip	Maximum working area: 245×245 mm (2pcs) Module max running area :300×300 mm
Material size	156 x156~210 x210mm monocrystalline silicon, polycrystalline silicon solar cells and silicon wafers
Material thickness	0.18-0.30 mm
Cell thickness deviation	±10μm
Breakage rate	≤0.15%

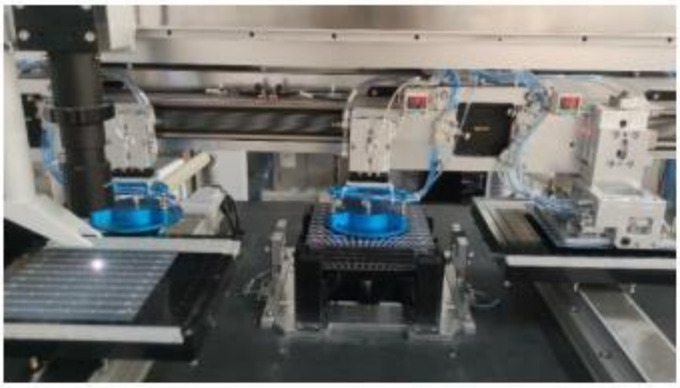
Equipment configuration

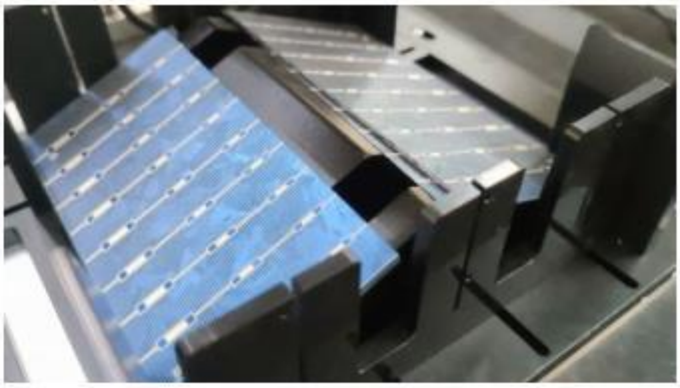
Laser Source	Raycus 30 W Q-switched λ=1064 nm
Computer	Has storage function, reserved USB interface, with display, mouse, keyboard

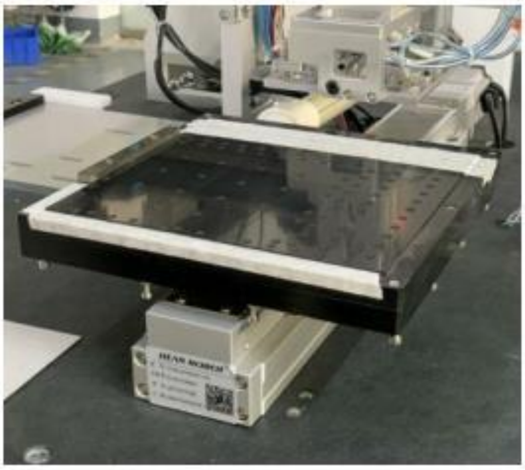
<table>
<tr><td colspan="2">Main Control Power Protection systems</td><td>Each motor load should be equipped with short circuit protection / circuit breaker, the equipment is equipped with grounding terminal, in accordance with the national equipment electrical safety regulations.</td></tr>
<tr><td colspan="2">Vacuum adsorption</td><td>Bernoulli suction cup (No trace absorption, no damage to the material)</td></tr>
<tr><td rowspan="5">Worktable module</td><td>Driver</td><td>Servo Motor</td></tr>
<tr><td>Ball-screw Module</td><td>Chinese brand (effective travel range 300 mm)</td></tr>
<tr><td>Coupling</td><td>Chinese Brand</td></tr>
<tr><td>Vacuum adsorption</td><td>Fan adsorption, automatic control of vacuum generation/breakdown</td></tr>
<tr><td>Dust removal system</td><td>Dust removal fan</td></tr>
</table>

Professional software	Friendly working interface, simple and convenient programming, motion track display
Power supply	220V/50HZ/3kVA
Safety measures	Work area machinery, laser and other dangerous parts, affixed warning signs
Noise	Noise generated during normal working conditions complies with national norms
Other	Alarm warning

More Photos







Solar Cell Tester

Technical Specification

Machine Function:

Use to test the electric performance of Mono-Si or Poly-Si solar cell pieces and record the results in files.

Machine Features:

- Key components use import abroad brand
- A grade spectrum
- A grade unevenness degree of irradiance
- four-line measurent,14-bit 4-channel high speed synchronous acquisition card
- 10 parameters display and Measurement Parameter displays in Tabulation and Graphic way

- Pneumatic and buffering contact
- Temperature automatically compensating
- Voice counts off and prompts, Counting prompt of flash times
- 24 continuous work
- Import Xenon Lamp.

Technical parameter

MODEL	OSCT-A	OSCT-B
Lamp spectrum	IEC60904-9 JISC8933 standard (AM1.5) 【A】	
Light intensity	700-1200W/M^2 continuous adjustable range	
Light intensity Non-Uniformity of Irradiance（LTI）	≤±2% 【A】	≤±3%
Light intensity instability degree of irradiation(STI)	≤±0.5% 【A】	≤±2%
Test repeat accuracy	≤±0.5%	≤±1%
Electrical performance test deviation	≤±0.5%	≤±1%
Test results consistency	≤±0.5%【A】	≤±1%
Single flash time	10ms	
Effective test range	210×210mm/0.1W-15W/5BB-12BB	
Measuring voltage	0-0.8V(resolution 1mV)	
Measuring current	0-20A(resolution 1mA)	
Test parameters	Isc、Voc、Pmax、Vm、Im、 FF、EFF、Temp、Rs、Rsh	
Power supply	AC220V/50HZ/2KVA	
Air supply	0.5-0.8Mpa	
Weight	140KGS	140KGS
Machine Dimension	800*600*1650mm	800*600*1650mm

Solar Panel Tester Solar Simulator

[Machine Function]

Use to test the electric performance of Mono-Si or Poly-Si solar modules and record the results in files.

[Machine Features]

- four-line measurement,14-bit 4-channel high speed synchronous acquisition card
- 10 parameters display,Measurement Parameter displays in Tabulation and Graphic way
- Temperature automatically compensating
- Voice counts off and prompts, Counting prompt of flash times
- 24 continuous work
- import Xenon lamp

[Technical Features]

MODEL	OSMT-A	OSMT-B
Lamp spectrum	IEC60904-9 JISC8933 standard (AM1.5) 【A】	
Light intensity	700-1200W/ M ^{2} continuous adjustable range	

Light intensity Non-Uniformity of Irradiance（LTI）	≤±2% 【A】	≤±3%
Light intensity Instability of Irradiance (STI)	≤±0.5%【A】	≤±2%
Test repeat accuracy	≤±0.5%	≤±1%
Electrical performance test deviation	≤±0.5%	≤±1%
Single flash time	10ms	10ms
Effective test range	2400×1400mm	
Measuring voltage	0-100V(resolution 1mV)	
Measuring current	0-20A(resolution 1mA)	
Power Supply	AC220V/50HZ/2KVA	
Test parameters	Isc,Voc,Pmax,Vm,Im ,FF,EFF,Temp,Rs,Rsh	
Xenon Lamp service time	100,000flash times	
Weight	500kgs	

Semiautomatic Solar Module EL Defect Tester

[Machine Function]

Used in testing the solar module Crack， breakage,Black Spot， Mixed Wafers， Process Defect， Cold Solder Joint phenomenon

[Specification]

Item	OEL-S2400
Capture Mode:	Single Camera
Run Mode：	Offline
Monitor Point：	After Laminating
Sample Stage：	Super-white Tempered Glass
Sample Size：	≤2400mm*1400mm
Operation Height：	950mm
Resolution：	4928*3264
Exposure Time：	1 ~ 60s
Current/Voltage：	10A/60V
Software：	1.Interface for barcode scanning, naming files with barcode names; 2.Defect classification, create image folder and save image files automatically.
Detection Ability：	Crack,Black Spot,Mixed Wafers,Process Defect,Cold Solder Joint.
Configuration	Testing host,computer,software

[Machine Advantage]

- Reveals invisible defects such as microcracks, breakage,finger defects, and dark areas
- Improves line yield by identifying defective modules before lamination
- Improves quality and reliability of final product
- Highest available resolution
- Flexible system can be used to test framed or unframed modules, before or after lamination

[Judging defect classification]

Welding spots	Crack	Current not match	Cell Process defect	Virtual welding	Cell contaminate
OK	OK	OK	OK	OK	OK

[Machine More Pictures]

Solar Panel Framing Machine

	Minimum	Max
Framing size	400×400MM	2500×1400MM

[Specification]

1. Air cylinder : Airtac Brand

2. solenoid valve: Airtac Brand

3. high-pressure air tube: South Korea imported

4. Maximum framing size: 2500 * 1400mm

5. Minimum framing size: 400 * 400 mm

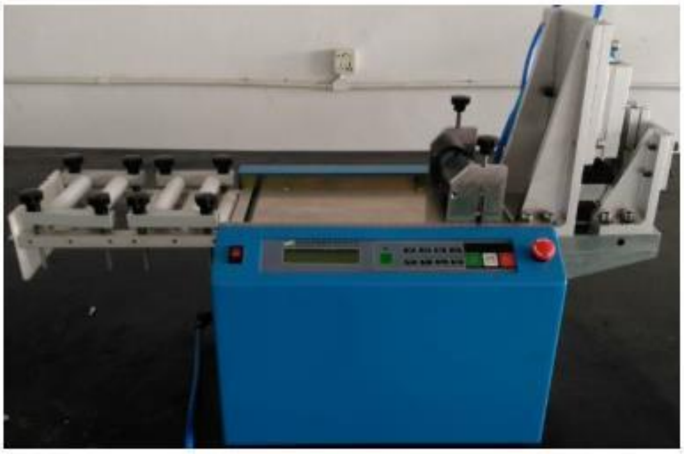
6. Operating voltage: 220V/50Hz/1Ph

7. Dimensions: 2900 * 1650 * 920mm

[Features]

- use the air cylinder and steel structure construction, achieved Aluminum frame extrusion positioning when the module laminated ,easy to fixed, fastened the aluminum frame, save time and improve product quality.
- with the rotary wheels, may guarantee the module in each direction freedom, and protects module's surface, operation nimble convenient.
- composed of the bidirectional fixed end and the bidirectional activity, may suit for the module in the wide scope to install the frame to make industry the need, in addition may satisfy some non-standard packages to enter the luggage frame's work demand.

PV Ribbon Cutting Machine



[Machine Function]

Use to cut of solar PV welding strip, mainly used for PV ribbon, wire, copper, tin and other metal films or other strip materials, featuring high precision and speed, convenient operation, low operation noise, and exquisite appearance.

1. Specifications: width: 2- 8.0mm; thickness: 0.10- 0.45 mm
2. Cutting accuracy：±(0.2+L*0.002)mm
3. Forming specifications: short side: 20-100 mm   long side: 100-350 mm

(Special forming short & long side's size can be customized)

4. Forming Angle: 90 °±5°
5. Production speed：Single bending：15pcs/Min   Dual bending：10pcs/Min

(Different length for the finished product has different processing speed)"

Manual Soldering station

Outer Dimension: 2.2×1.2×1.85M

3 work place:1 String Welding , 2 single welding

No conveyor belt

With constant temperature heating

Features: Used in a manual welding Cells.

Device weight: 330Kg

Application temperature: 40℃～100℃

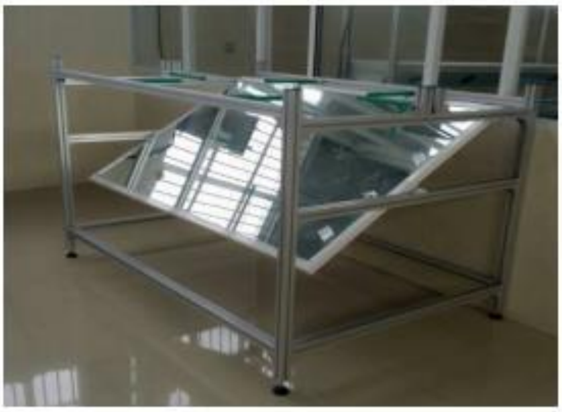
Manual EVA/TPT Cutting Station

Dimension:3000*1200*800mm
1.with scale ruler

2.Support EVA TPT use of sliding bearings

3.Material: Aluminium

Visual Inspection Station



Aluminum Material Structure: 3000*1200*800mm

1.Check the detection of panel materials and cells is impurities and make sure no breakage

2.The angle of the mirror can adjust.

3.With specular reflection, can easily and quickly find the detect of the cells

Ready Material Carrier

The steel products welding

Dimension: 1.2×1.05×1.5M (10Layer)

Lay-up Station

Material:Aluminum Molding

Dimension:2000*1080*850mm

1. 8 PCS halogen lamp
2. 4 PCS fluorescent
3. 1PCS ammeter
4. 1 voltmeter
5. working surface with tempered glass.

Solar Module Carrier

Steel structure

Ready Material Carrier

The steel products welding

Dimension: 1.2×1.05×1.5M (10Layer)

String Cell Carrier

EVA/TPT Carrier

Warranty:

After installation and training, the machines should be operated by the operators who have received the training.

-One year warranty after successful installation or 16 months from BL date whichever is earlier

- During the warranty period, the seller provides the buyer with timely maintenance services and the necessary spare parts for maintenance free of charge (not including the consumables). But spare parts courier cost shall be responsible for buyer.

-During warranty period, If buyer's engineers can not solve the problem, the seller will send engineers to buyer's plant to solve the problem. The round trip tickets, local traffic cost, hotel and food in buyer's city will be paid by buyer.

-The warranty does not include damage or malfunctions arising from any of the following: misuse, abuse, self-demolition and modification by any party other than the Seller's authorized technicians, use of the Equipment that is inconsistent with the operation manual.

-After the warranty period, the seller still provides online services and technical guidance free of charge. Timely supply of spare parts to buyer at favourable prices.When the buyer needs to send engineer to the site to repair, the buyer will afford the air tickets , VISA,food, hotel and corresponding cost of travel expenses, and labor cost for working hours, etc. according to the seller's standards.

-The consumable parts are provided upon payment.

Ooitech Customer

S/N	Company	Country or region
1	EBTICAR SOLAR ***	Egypt (cairo)
2	GLOBAL*** FOR POWER	Egypt(NEW CAIRO)
3	Power *** Company (P.F.C.)	Egypt (Suez)
4	Solar One	Bahrain
5	Alghanim *** Inc.	SAUDI ARABIA(RIYADH)
6	SARL AURES SOLAIRE	Algeria
7	Almashreq for Industry	Syria
8	ACU*** Solar	India (Pune)
9	ADITYA ***	India(vadodara)
10	Vaayu Greens ***	India (kanpur)
11	DR ENTER***	India (karnal)
12	SUNUSA ***	India (hyderabad)
13	*** ELECTRONICS PVT ***	India (hyderabad)
14	Navitas *** Solutions Pvt. Ltd.	India (Surat)
15	Plaza Power	India(HP)
16	INFOTECH ***	Hungary
17	МамбеталиевСаматБактыбаевич	Kazakhstan (Taraz)
18	Chn constructores***	Mexico
19	Fiber ***** srl	Argentina
20	PT *** Innovative Lighting Indonesia	Indonesia
21	***Sparkpol ***	Poland
22	Tindo Solar	Australia
23	HISWILLCOMPANY Co,. LTD.	Korea
24	DONGSHIN POLYCHEM CO.,LTD.	Korea

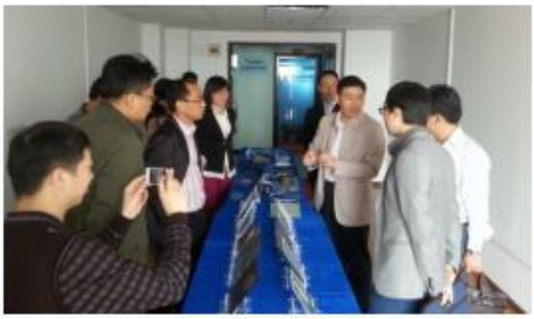
Company

Ooitech, founded in 2013, and aim to offer turnkey solar energy solution to world customer, with more than 10 years' experience in PV industry and industrial laser application. Our machines was exported to Poland, Hungary, Korea, Mexico, Egypt, Algeria, India, Saudi Arabia, Syria, Kazakhstan, etc countries. Ooitech service won many customer good praise.

Turnkey solution Includes:

- supply 5MW-500MW solar module production line
- Update Traditional PV line to newest MBB production line.
- Suggest Factory Construction

- Design facility layout
- Help customer choose Raw Materials
- Assist production procedure and install solar power station etc.



Certificate

Jessy Zhao

Wuhan Ooi Photoelectric Technology Co.,Ltd
Wuhan ooitech Trading CO,LTD

Email: jessy@ooitech.com
Website:https://www.ooitech.com
Mobile: +8615926436350
TEL: +86-27-81779060 (F)
Skype: Jessyzhao
Wechat: +8615926436350
WhatsApp: +8618571645990
Address: Building 1, Zixin Industrial Park, Yangguang Ave,Jiangxia Economic Development Zone, Wuhan of China.




发送图片到手机






Manufacturing Materials for the Solar PV Panels unit costs

Wuhan Ooitech Trading Co.,Ltd

Add: Building 1, Zixin Industrial Park, Yangguang Ave,Jiangxia, Wuhan of China

Website:http://www.ooitech.com Email: Jessy@ooitech.com

Mobile: +8615926436350 TEL:+862781779060

Raw Material COST

Mono 530w Half Cut Cell Solar Panel High Quality

Date:April 27th, 2022

Panel Power: 530w Size: 2279x1134mm QTY: 2400PCS Panels (1.272MW) Raw Materials

S/N	Description of Goods	Types	Quantity	UNIT PRICE (USD)	Amount (USD)
1	Class A Solar Cell	182x182 Mono >22.6% (144 PCS Layout)	172850 PCS	$1.10	$190,135
2	Tempered glass	2273x1128*3.2 mm	6153.466 ㎡	$4.30	$26,460
3	Back Sheet TPT	1130x0.3mm Tuv certificate	6328 ㎡	$1.75	$11,074
4	EVA High Transparent	1123x0.5mm F406P 480g/cm2 Tuv certificate	6288.80 ㎡	$2.20	$13,835
5	EVA UV-Cutoff Wavelength	1123x0.5mm F806P 440g/cm2 Tuv certificate	6288.80 ㎡	$2.00	$12,578
6	Junction Box -PottingType	3 Separate Box with 90cm cables Tuv certificate	2400 PCS	$3.40	$8,160
7	Sealant	400ml Tuv certificate	1600 KGS	$3.50	$5,600
8	JB Box Potting Glue	A & B	126 KGS	$9.00	$1,134
9	Solder Strip	Interconnected Solder Strip Busbar ribbon Tuv certificate	700 KGS	$16.00	$11,200
10	Aluminum frame	2279x1134mm 35*35mm	2400 Sets	$11.80	$28,320
11	High Temperature Sticker		500 Rolls	$0.25	$125
			Total	USD	$308,621

Remark:
1.The price is based on the FOB Shanghai port.
2.The production time is about 7 days.
3.Payment: 100% T/T in advance.
4. Raw Materials Price will change everyweek without notice.
5.Other material like Flux, customer better try to get from local.

For a 10MW per year production line then multiply by a factor of 8 = USD $2,468,968 per year, which would produce the solar PV panels for lighting systems. It is suggested that the plant is used for 10% smaller 20w panels, 10% 30w panels production and 80% for the larger solar panels of 250w in size.

Cost comparison - Larger Solar PV Panel cost examples

Factory Price **Solar Panels**, The Most **Cost**-Effective **Solar Panels** 80W-540W Mono Poly

US$ 0.2-0.26 / W (FOB Price)

100000 W (MOQ)

Warranty: 25 Years
Application: Agriculture
Number of Cells: 144PCS
Condition: New

Hebei Shaobo Photovoltaic Technology Co., Ltd. >

Factory Price 250W Standard 60 Cells 30V Monocrystalline **Solar Panel Cost**

US$ 102.38 / Piece (FOB Price)

100 Pieces (MOQ)

Warranty: 10 Years
Application: New Energy
Number of Cells: 72pcs
Condition: New

Zhejiang TTN Electric Co., Ltd. >

Buy High Efficiency Commercial Roof Top **Solar Panels Cost** 445W To 470W 800 Watt Price For Green House From China Direct

US$ 0.22-0.28 / Watt (FOB Price)

1000 Watt (MOQ)

After-sales Service: 25 Years
Number of Cells: 144cells
Warranty: 25 Years
Application: Industrial

More

SUNPAL POWER CO., LTD. >

Contact Now Inquiry Basket Chat with Supplier

High Quality Chinese Used **Solar Panel Cost Panel Solar** 600W 800W 1000W

US$ 0.2-0.25 / Watt (FOB Price)

1 Watt (MOQ)

After-sales Service: Yes
Number of Cells: 144PCS
Warranty: 25 Years
Application: Industrial

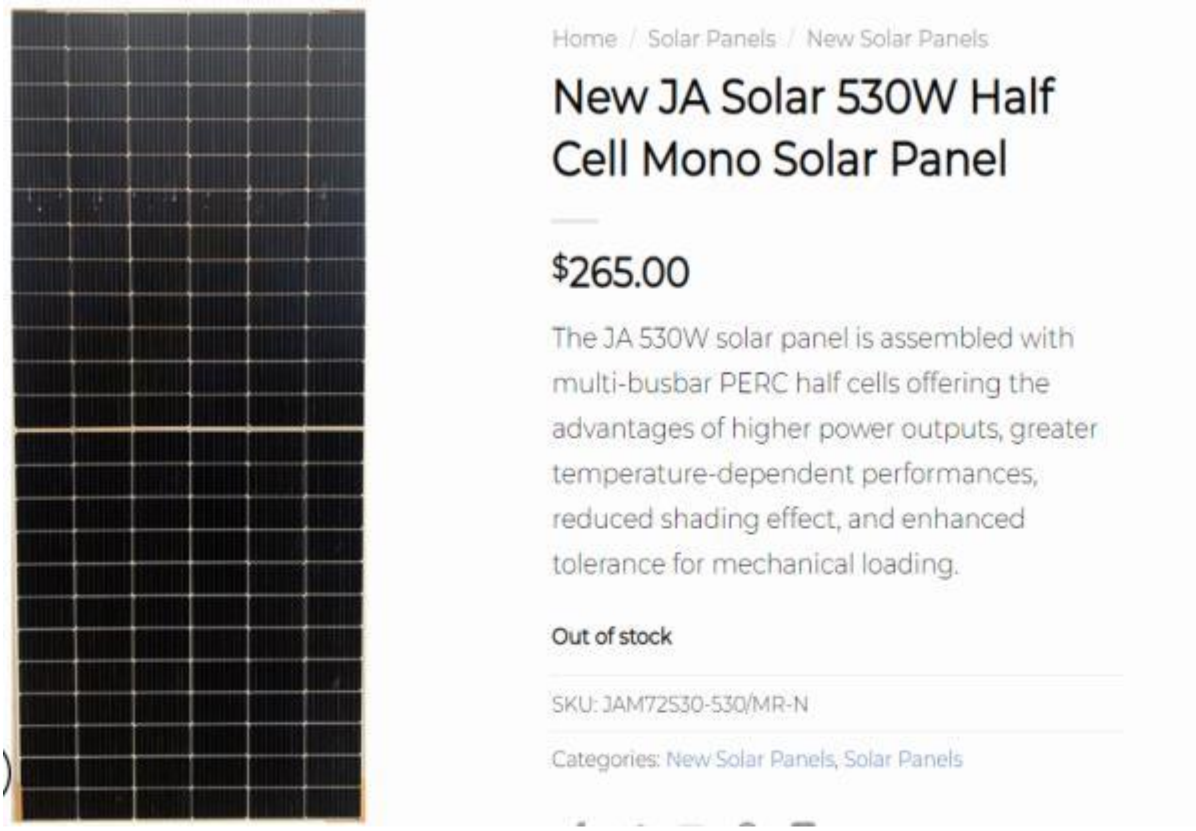
Xiamen Solar First Energy Technology Co., Ltd. >

Our material costs are $0.242626 per watt

SySCraft Limited & PSECC Ltd are submitting this proposal to UK AID “Manufacturing Africa” team for investment into this much needed venture. We have indicated cost comparison of our panels to be **manufactured in Kenya indicate a cost per watt of USD $0.26116** so a 250w panel would cost USD $65.29.

Once more we point out our manufacturing costs for the larger 250w panels each day will be $65.29 per panel and number of panels per year is 34,560 panels so manufacturing costs would be USD $65.29 x 34,560 is USD $2,256,422. Retail price is set at USD $120 per 250w panel is the profit of USD 54.71 per 250w panel = USD $ 1,890,777 per year. Our marketing department have identified a strong sales market - In a year, operational profit from the larger panels would be USD $1,890,777 or (USD $1.89 million) per year. However, if the panels were used in our Solar Farm projects, initially at the 25MW Solar Farm proposed for Nakuru then profits over a 25-year period from the Solar Farm are USD $90 million (USD $3.6 million each year on average).

Cost comparison – online product to purchase example



https://store.santansolar.com/

As a further comparison, if we did produce this Solar 530w panel

Then using our manufacturing cost per watt of USD $0.26116

Our manufacture of the 530w panel would cost USD $138.41 per panel.

Our Recommended Retail Price factor of approximately @ 2.0

Our retail price is USD $268 per 530w panel

Solar Home Solar Light system

Please use these figures in your financials.

Our manufacturing cost per watt for the Solar PV panels is USD $0.26116

20w panel cost USD $ 5.25
30w panel cost USD $ 7.87
250w panel cost USD $65.63

Recommended retail price for 250w panel would be USD $65.29 x 2 = USD $131.58,
our 250w panel will retail at USD $120

If we use factor of appx 2 to get top retail price.

So, for our 20w solar lighting system use the cost of USD $5.25 for the panel cost and then add on all our other material costs for the lights.

For our 30w solar lighting system use the cost of USD $7.87 for the panel cost and then add on all our other material costs for the lights.

Funding required is USD $5,853,325 plus the solar roof for the plant USD $146,675 for the Manufacturing, Assembly & Distributing plant totalling USD $6,000,000 - ROI 18%, and USD $11.2 million for the 10MW solar farm for Nakuru in Kenya ROI of 23%, totalling USD $17,200,000 over a ten-year loan period. If another Ghana solar farm is included then a further USD $23 million is required ROI 23% totalling USD $40.2 million.

Assembly

In year One we will have 69 Technical Assembly staff and Managers

Based on 250w panels

PAY-AS-YOU-GO (PAYG) TECHNOLOGY

Affordable PAYG will be the right technology to promote Syscraft Home products considering the income category and affordability in the targeted market is between low and middle income.

The report[23] in the Assembling & Distribution Business Plan identified two main barriers to adoption of renewable energy:

- The cost of installation and upfront costs
- The cost (or perceived cost) of maintenance and upkeep

People are unwilling to pay these large upfront costs. Additionally, those with low income are often reluctant to change from an existing system if there is a risk that costs may change. An average energy bill for those using wood, charcoal, grid electricity, or gas as their main energy source can be anywhere between 1,000 and 2,500Ksh per month, which could be as high as 10% of a household income.

We will ensure our products are better quality and more affordable for the poorer people, often in Rural communities with no electricity supply and to be paid for over a five-year period then the Lighting system is then owned by the people.

PAYG payment

This scheme people will be paying as low as 30shs every day plus a connection fee of 500 shs onetime 30 shs or 0.3 usd can be spread so that they either make the payments weekly or biweekly or even monthly depending on the plan that the customers use.so in response to the aspect of the livelihoods we have taken care of that and the longest duration for repayment will be 5 years.

USD $5 upfront payment commitment fee and then USD $ 0.3 every day.

On the starting point you will see the prepaid insurance premiums for the devices. For those devices that may get damaged or stolen or people who refuse to pay - based on %, meaning in 1st year the risk is more and gradually decreases towards 5th year.

25MW plant

Ratios	Year One	Year Two	Year Three	Year Four	Year Five
Liquidity					
Current Ratio	1.0	1.1	1.3	1.5	1.8
Quick Ratio	0.5	0.6	0.8	1.0	1.2
Safety					
Debt to Equity Ratio	10.2	4.6	2.7	1.8	1.2
Debt-Service Coverage Ratio - DSCR	0.1	0.1	0.2	0.1	0.2
Profitability					
Sales Growth	0.0%	5.0%	10.0%	10.0%	10.0%
COGS to Sales	58.4%	58.4%	58.4%	58.4%	58.4%
Gross Profit Margin	41.6%	41.6%	41.6%	41.6%	41.6%
SG&A to Sales	8.6%	8.7%	8.6%	8.7%	9.0%
Net Profit Margin	12.1%	12.7%	13.7%	14.4%	15.0%
Return on Equity (ROE)	100.0%	52.4%	38.3%	30.8%	26.0%
Return on Assets	9.0%	9.3%	10.3%	11.1%	11.6%
Owner's Compensation to Sales	0.8%	0.8%	0.9%	0.9%	1.1%
Return on Investment (ROI)	23%				

Please review - Assembly and distribution Financials excel for your perusal

Assembly start-up expenses (included in Manufacturing financials) – Assembly & Distribution have a separate set of financials to the Manufacturing Financials.

Start-up Expenses Year 1 (Starting Balance Sheet)

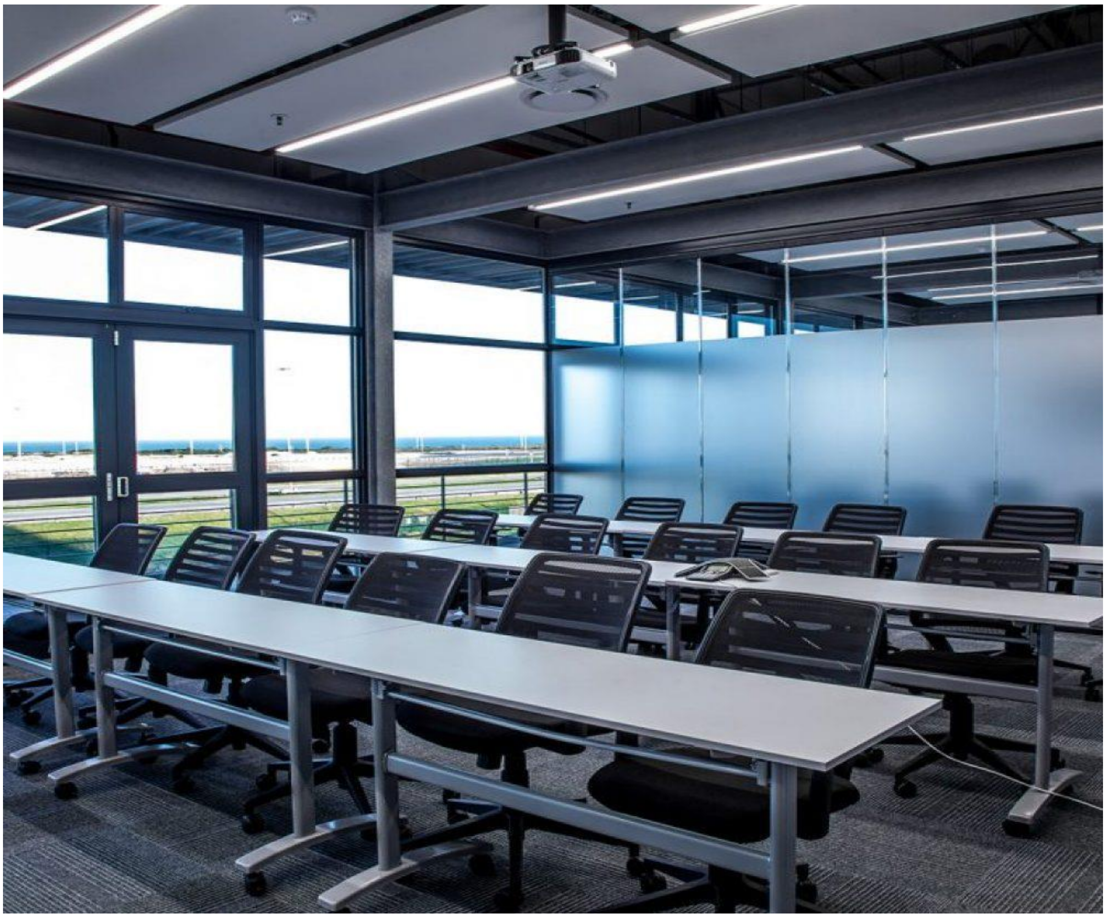
Prepared By:	Company Name:
FINANCE DEPARTMENT	SYSCRAFT LTD

Fixed Assets	Amount	Depreciation (years)	Notes
Real Estate-Land		Not Depreciated	
Real Estate-Buildings		20	
Leasehold Improvements	80,000	8	
Equipment	382,600	10	
Furniture and Fixtures	114,000	10	
Vehicles	228,600	4	
Plant & Machinery	836,661	5	
Total Fixed Assets	$ 1,641,861		

Operating Capital	Amount	Notes
Pre-Opening Salaries and Wages	554,000	
Prepaid Insurance Premiums	7,753	
Inventory	6,523,888	
Legal and Accounting Fees	30,000	
Rent Deposits	32,821	
Utility Deposits	5,000	
Funding brokerage Fees	133,353	
Advertising and Promotions	10,000	
Licenses	20,000	
Other Initial Start-Up Costs	10,000	
Working Capital (Cash On Hand)	500,000	
Total Operating Capital	$ 7,826,815	
Total Required Funds	**$ 9,468,676**	

Sources of Funding	Percentage	Totals	Loan Rate	Term in Months	Monthly Payments
Owner's Equity	0.00%				
Outside Investors	0.00%				
Additional Loans or Debt					
Commercial Loan	100.00%	9,468,676	8.00%	120	114,881
Commercial Mortgage	0.00%		9.00%	240	-
Credit Card Debt	0.00%		7.00%	60	-
Vehicle Loans	0.00%		6.00%	48	-
Other Bank Debt	0.00%		0.00%	60	-
Total Sources of Funding	100.00%	**$ 9,468,676**	Cell D 42 must equal cell C31		$ 114,881
Total Funding Needed		$ -	You are fully funded (Balanced)		

Distribution & Sales



PROMOTION

As there is awareness about the off-grid solar products in most of the counties, we will not have to invest time and energy in creating awareness about the product. However, we will promote our products through:

- Radio
- Billboard
- Branding of Shops/Agents Shop
- Social Media – Facebook, Bulk SMS
- Internet Sales sites
- Brochures

The promotion will highlight the quality and economical nature of our products. As the report points out, people are concerned about the reliability of the energy sources. The reliability factor of the solar product will be highlighted through these advertisements.

Solar Farms Potential

We have seen that if we were to use our larger 250w panels in a 10MW solar farm development at Nakuru requiring 40,000 panels for example then the revenue profit from the Solar Farm would be USD $30,992,875 over 20 years of operations. We could also have a total of 25MW solar farm at Nakuru requiring 100,000 panels. If we included a solar farm development, then an additional USD $11.2 million would be required with ROI of 12.08% or 25MW with 100,000 panels (see attached financials Appendix 2).

We have also been developing solar farms in Ghana, specifically at Simbrofo where we are proposing a 20MW Solar Farm with over 80,000 larger solar PV panels required. The Feasibility study for this project has been completed and an Electricity License was granted but will need to be renewed.

Kenya Solar Farms that can also be developed:

The University of Sheffield is working with us on a "Harvesting the Sun Twice project", which provides other markets for our manufactured larger 250w solar PV panels.

While ground-mounted arrays of solar panels offer several benefits related to clean energy provision, they miss opportunities to deliver livelihood benefits in addition to electricity supply, and in some cases can detract from other development goals. For example, ground-mounted arrays remove land from food production, and at a time when crop yields are threatened by a changing climate, increasing populations and insecure land ownership, we cannot risk putting further pressure on land resources.

Agrivoltaic energy systems, however, can combine the delivery of solar electricity, crop production, and rainwater harvesting on the same land area. Instead of being mounted close to the ground like traditional solar power arrays, agrivoltaic systems are constructed several meters high, with gaps between the arrays, enabling crops to be grown underneath.

This concept could be incorporated into this Kenya project in a second development phase – for every 10MW solar farm we build in Kenya we could have one or more 500KW (2,000 panels) or larger projects below incorporated into the project.

Solar PV & Food production

Solar power is seen as a key way of addressing East Africa's energy challenges, but the solution is not as simple as installing traditional solar panels across large areas of land. "Harvesting the Sun Twice"

Harvesting the Sun Twice project website

We are in negotiations with Sunculture in Kenya to supply their solar PV panels for the farmers water irrigation systems

https://sunculture.com/

SALES AND MARKETING

Solar Farm Nakuru – Marketing have identified this as a potential project.

For sales of our product, we will rely on modern as well as traditional approaches. We will have three types of engagement/point of contact in the market with customers to include:

- Call Centre - This will be domiciled at the head office for the main purpose of allowing customers to call in case of related queries on the solar products,

- Energy Officers – This will be the team on the ground walking into the rural homes of the potential customers for product sensitization.

- Agents – This will be recruited as existing local shops who are present in the specific county locations.

We will have a dedicated call centre to reach out to the customers to generate leads and hand it over to our field executives (Energy Officers). Apart from generating leads, call centre agents will also be managing customer queries and complaints. We will have a sales team on the field for door-to door-marketing. They will be our foot soldiers to reach the customers. Our agents will be at small kiosks, supermarkets, or shops. They will display our products and generate awareness and interest among the intended customers. They will pass on the lead to our call centre team once they identify if any customer is interested in our products.

There is also a marketing potential to own solar farms to guarantee secure markets for our larger 250w panels for the next twenty-years and more.

Financials - Manufacturing Plant Costs for 10MW production - Solar Home system panels & larger 250w panels for solar farms. (Review Appendix 1)

Start-up Expenses Year 1 (Starting Balance Sheet)	
Prepared By:	**Company Name:**
FINANCE DEPARTMENT	SYSCRAFT LTD

Fixed Assets	Amount	Depreciation (years)	Notes
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Vehicle Loans	0.00%		6.00%	48	-
Other Bank Debt	0.00%		0.00%	60	-
Total Sources of Funding	100.00%	$ **9,468,676**	Cell D 42 must equal cell C31		$ 114,881
Total Funding Needed		$ -	You are fully funded (Balanced)		

Revenue

In this case we have one factory outlet which is more like the headquarters in Nairobi. For ease of distribution and taking the solar to the rest of the country we are working on a warehouse for distribution to the other parts of the country (Up-country) in three locations (Nakuru /Kisumu/ Eldoret) thus the two items for rent/lease, the same applies for service charge.

Cashflow (Please see full financials in Appendix 1)

	Cash Flow Forecast Years 1-5					
	Prepared By:					
	FINANCE DEPARTMENT					
	Year 1 Totals		**Year 2 Totals**	**Year 3 Totals**	**Year 4 Totals**	**Year 5 Totals**
Beginning Balance						
Cash Inflows						
Cash Sales	$ 583,920		$ 613,116	$ 674,428	$ 741,870	$ 816,057
Accounts Receivable	$ 8,807,460		$ 10,950,933	$ 11,960,871	$ 13,156,958	$ 14,472,654
Total Cash Inflows	$ 9,391,380		$ 11,564,049	$ 12,635,299	$ 13,898,829	$ 15,288,712
Cash Outflows						
Investing Activities						
New Fixed Asset Purchases	$ -		$ -	$ -	$ -	$ -
Additional Inventory	$ -		$ -	$ -	$ -	$ -
Cost of Goods Sold	$ 1,268,073		$ 7,126,653	$ 7,802,363	$ 8,582,599	$ 9,440,859
Operating Activities						
Operating Expenses	$ 580,779		$ 601,323	$ 622,641	$ 644,761	$ 667,718
Payroll	$ 423,600		$ 465,960	$ 535,854	$ 643,025	$ 803,781
Taxes	$ 674,780			$ 860,614	$ 987,439	$ 1,116,764
Financing Activities						
Loan Payments	$ 1,378,574		$ 1,378,574	$ 1,378,574	$ 1,319,951	$ 1,247,911
Owners Distribution	$ -		$ -	$ -	$ -	$ -
Line of Credit Interest	$ -		$ -	$ -	$ -	$ -
Line of Credit Repayments	$ -		$ -	$ -	$ -	$ -
Dividends Paid	$ -		$ -	$ -	$ -	$ -
Total Cash Outflows	$ 4,325,806		$ 9,572,510	$ 11,200,046	$ 12,177,775	$ 13,277,032
Net Cash Flows	$ 5,065,574		$ 1,991,539	$ 1,435,253	$ 1,721,054	$ 2,011,680
Operating Cash Balance						
Line of Credit Drawdown	$ -		$ -	$ -	$ -	$ -
Ending Cash Balance						
Line of Credit Balance						

If we were to use those panels in a 10MW solar farm development at Nakuru in Kenya then the **revenue profit** from the Solar Farm would be USD $39,325,365 over 25 years of **operations.**

Balance Sheet Years 1-5

Prepared By:	**Company Name:**				
FINANCE DEPARTMENT	SYSCRAFT LTD				
ASSETS	**First Year**	**Second Year**	**Third Year**	**Fourth Year**	**Fifth Year**
Current Assets					
Cash	5,565,574	6,821,080	8,256,333	9,977,386	11,989,066
Accounts Receivable	1,703,100	1,788,255	1,967,081	2,163,789	2,380,167
Inventory	6,523,888	6,523,888	6,523,888	6,523,888	6,523,888
Prepaid Expenses	634,341	475,756	317,171	158,585	-
Other Initial Costs	8,000	6,000	4,000	2,000	-
Total Current Assets	**$ 14,434,904**	**$ 15,614,979**	**$ 17,068,472**	**$ 18,825,648**	**$ 20,893,121**
Fixed Assets					
Leasehold Improvements	80,000	80,000	80,000	80,000	80,000
Equipment	382,600	382,600	382,600	382,600	382,600
Furniture and Fixtures	114,000	114,000	114,000	114,000	114,000
Vehicles	228,600	228,600	228,600	228,600	228,600
Other	836,661	836,661	836,661	836,661	836,661
Total Fixed Assets	**$ 1,641,861**	**$ 1,641,861**	**$ 1,641,861**	**$ 1,641,861**	**$ 1,641,861**
(Less Accumulated Depreciation)	$ 284,142	$ 568,285	$ 852,427	$ 1,136,569	$ 1,420,711
Total Assets	$ 15,792,622	$ 16,688,555	$ 17,857,906	$ 19,330,940	$ 21,114,271
LIABILITIES & EQUITY					
Liabilities					
Accounts Payable	5,554,411	5,591,366	5,668,972	5,754,338	5,848,241
Commercial Loan Balance	8,824,310	8,126,461	7,370,691	6,614,921	5,859,151
Line of Credit Balance	-	-	-	-	-
Total Liabilities	**$ 14,378,720**	**$ 13,717,827**	**$ 13,039,663**	**$ 12,369,259**	**$ 11,707,392**
Equity					
Common Stock	-	-	-	-	-
Retained Earnings	1,413,902	2,970,729	4,818,244	6,961,682	9,406,879
Dividends Dispersed/Owners Draw	-	-	-	-	-
Total Equity	**$ 1,413,902**	**$ 2,970,729**	**$ 4,818,244**	**$ 6,961,682**	**$ 9,406,879**
Total Liabilities and Equity	$ 15,792,622	$ 16,688,555	$ 17,857,906	$ 19,330,940	$ 21,114,271
Balance sheet in or out of balance?	$ -	$ -	$ -	$ -	$ -
	Balanced!	Balanced!	Balanced!	Balanced!	Balanced!

Solar Farm Nakuru – Kenya - Marketing have identified this as a potential project

REPUBLIC OF KENYA
OFFICE OF THE GOVERNOR
NAKURU COUNTY

Telephone: Nakuru 2214142
E-mail: nakurucounty.governor@gmail.com

OFFICE OF THE GOVERNOR
NAKURU COUNTY

When replying please quote

P.O. BOX 2870-20100
NAKURU.

Ref: CGN/RKR/RMM/2014/001

Att. Joseph Mwai and Alan Brewer Msc 59th Floor,

parking complex, NHIF building, Ragat Road, Upper Hill,

Nairobi.

RE: AUTHORIZATION TO INTERACT AND EXPLORE IN SOLAR ENERGY.

Nakuru County have got great potential of solar energy especially in Naivasha, Rongai and Subukia areas where sunlight intensity is high.

Several companies have shown interest in partnering with Nakuru County in developing solar energy as this will go a long way with boosting the ambition of the ministry of energy in production of 6000 MW of energy.

We wish to invite your company to also explore along with others the most possible way of tapping this important resource.

Yours faithfully

RICHARD KIPSANG ROP

C.E.C – ENREW NAKURU COUNTY

Cc

H.E The Governor, OGW, GBS

Nakuru County

DESCRIPTION OF PROJECT AREA – 100,000 x 250w solar PV panels = 25MW Solar Farm SySCraft Ltd Marketing have identified this as good for sales

Project location with coordinates and relevant site maps.

The project will be in Mai Mahiu area of Nakuru County. It is adjacent to the Mai Mahiu shopping centre to the North and the kikuyu escarpment and forest to the East.

Its geographical coordinates are within the range of 0° 58'16.55"S 36 ° 35'15.91"E.

The land consists of four different but adjacent parcels of land which are owned by Kiragu Kubai on free hold titles. The four parcels of land which make up the total land area of 100 acres (40.46 Hectares or 404, 687m2) – please refer to map for location details.

This project is known as the Proposed Mai Mahiu Solar Power Generation Plant. It is located adjacent to Mai Mahiu Shopping Centre, approximately 300m off the Old Naivasha Road and address is Kubai Farm, Kijabe/ Kijabe (Mai Mahiu) Block 3245, Kijabe Mai Mahiu Road, Nakuru, Kenya.

We submitted in May 2015 our FIT EOI form for our 25MW Solar Farm in Nakuru to the Government panel and were successful in our application and have been waiting for the Certificate to be issued and signed and are hoping you may be able to elevate this to a matter of importance and get the certificate issued to us to proceed our project forward.

A pre-feasibility study of a solar power plant project was carried out by us Eco Plan Kenya Ltd, the appointed Consultancy Company in May 2015 to study and search the best location to install a concentrated solar power plant in Nakuru. The investors were determined to obtain a site with a maximum possible irradiation.

This Solar Farm complements Kenya's Vision 2030 the National Development blueprint, initiated to transform the Country into a newly industrializing, middle-income economy by the year 2030. The Vision is founded on three pillars of economic, social, and political development. Currently, energy shortages and supply disruptions coupled with high cost remain serious obstacles to the manufacturing sector (GoK, 2012a). The main objective of this project is to generate power and to feed it into the National Grid and in return earn revenue through PPA agreement with the electricity distributer which is in this case the Kenya Power and Lighting Company Ltd.

Schools Solar Project – (review full project detail in Appendix 3).

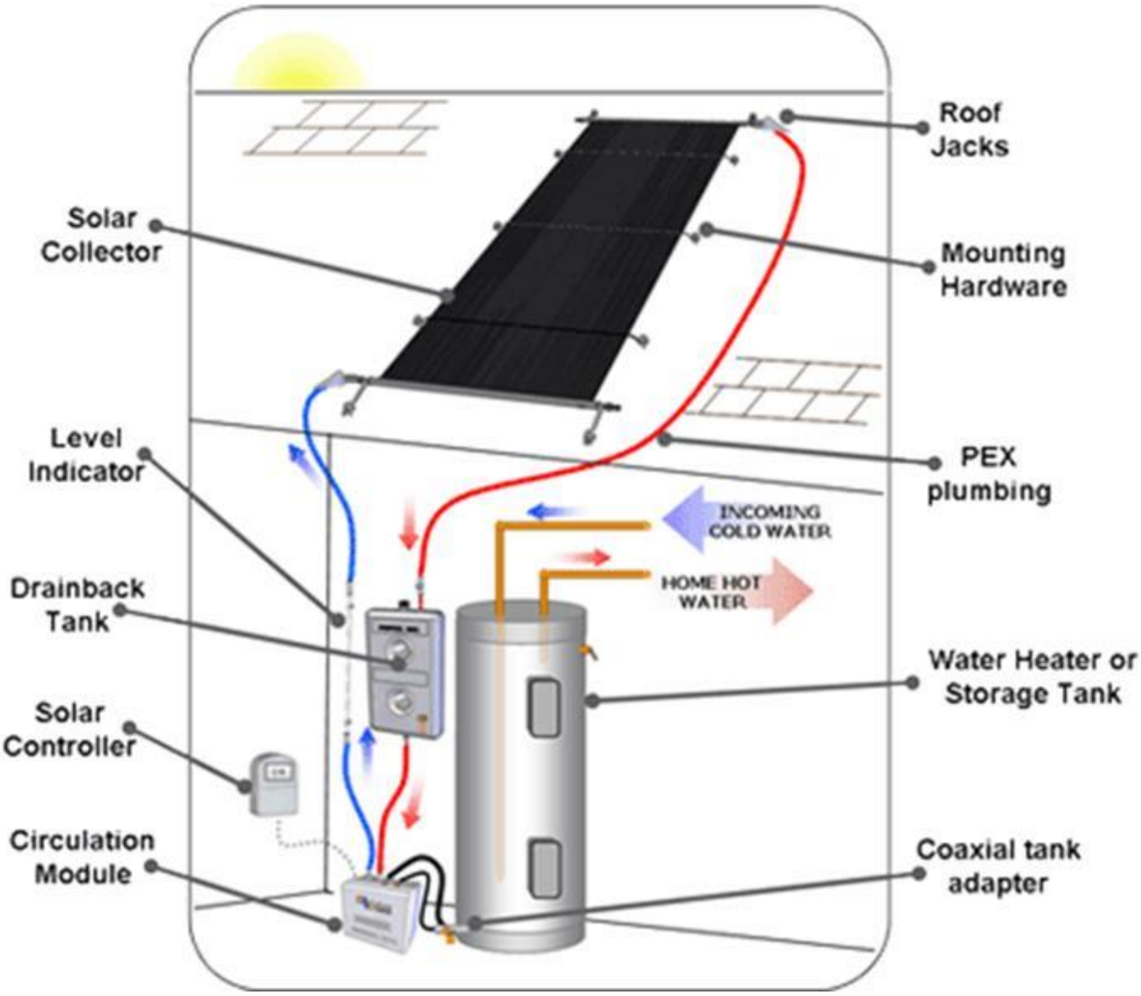
One of our systems in Ghana

Solar PV system for each school - 250w panels

SOLAR HEATED BATHING WATER IN GIRLS' SECONDARY SCHOOLS IN NYERI COUNTY KENYA

A project proposal in renewable energy to reduce schools' carbon footprint at the same time safeguarding student's health and enabling comfortable learning environment.

If they are using charcoal or firewood they will calculate 70% cost they used to purchase charcoal or firewood as total cost saved. If they are now using electricity you save 0.8 kwh per student every 6 minutes.


Roof Jacks
Solar Collector
Mounting Hardware
Level Indicator
PEX plumbing
INCOMING COLD WATER
Drainback Tank
HOME HOT WATER
Water Heater or Storage Tank
Solar Controller
Circulation Module
Coaxial tank adapter