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PSECC LTD

SOLAR PV FOR SEZ'S

PROPOSAL CONCEPT

November 2023

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Project No. PSECC002

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Transitional Clean Energy Net ZERO

PSECC Ltd

Portsmouth Sustainable Energy & Climate Change Centre

November 2023

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Portsmouth Sustainable Energy & Climate Change Centre

NATIONAL STRATEGY

Solar PV installation

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.

Table 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>

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Leading the Way

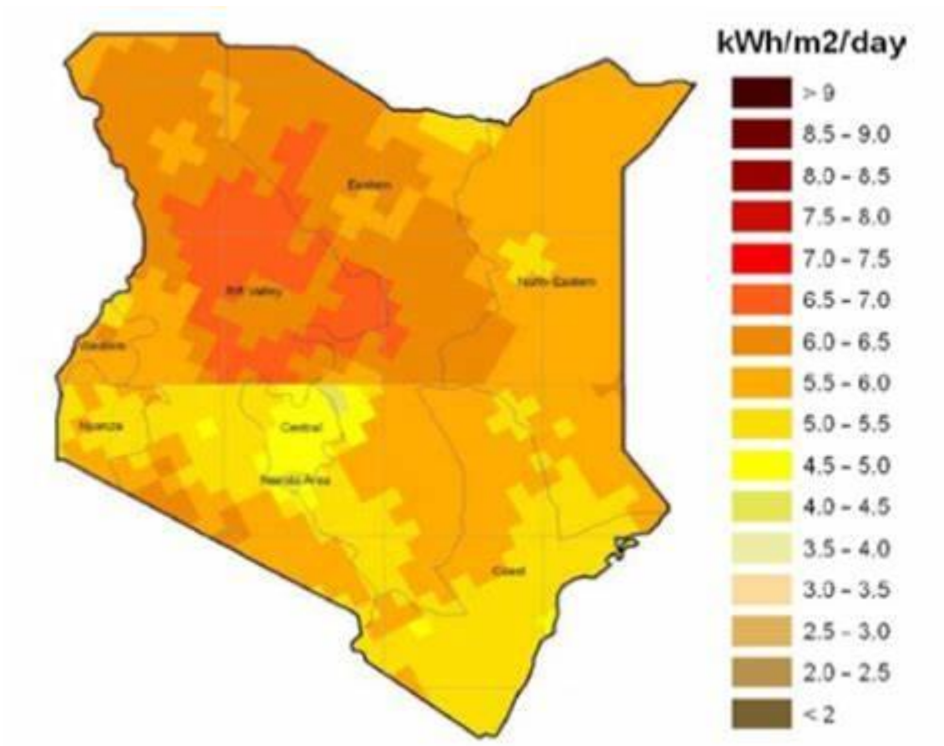
It is estimated more than 30,000 units of Solar PV panels are being sold locally every year, Kenya is ranked the biggest marketplace for home solar products in Africa.

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.
13.

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.

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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 Nuclear 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	$2 million to $4 million per MW	$333 million to $666 Million
Phase 3. SEZ 2	of $2 million to $4 million per MW	$333 Million to $666 Million
Phase 4. SEZ 3		$333 Million to $666 Million
Total	1,000MW	$1 Billion t0 $1.332 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

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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/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.

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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