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Solar Farms Project Concept REPORT

Project No. PSECC003

[Report Date]

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.

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

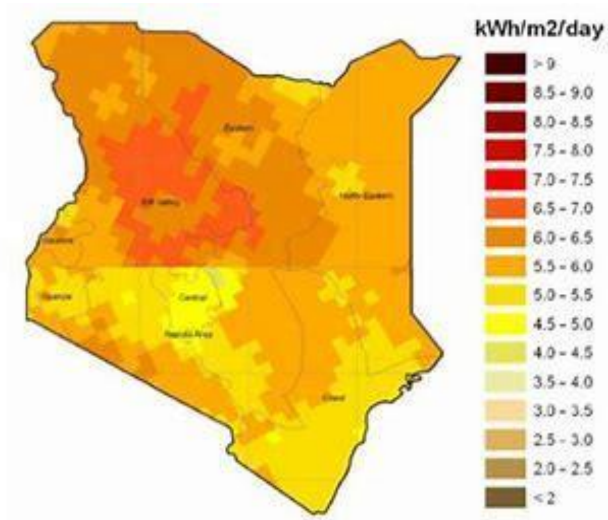
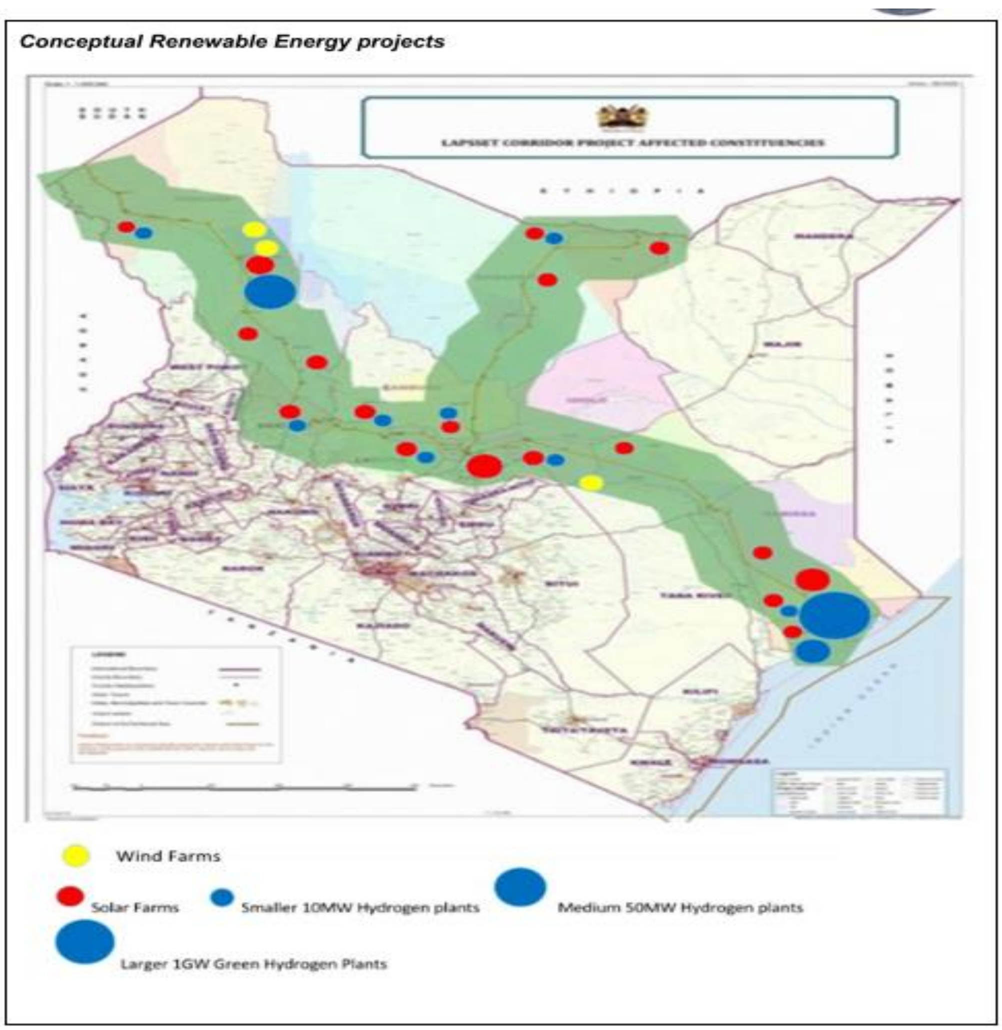


Fig 2. Renewable Energy technology deployment for Lapsset Corridor



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

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 Y earAnnual 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 Gener ation=3000MW×0.20×8760hours/year

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

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

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

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.

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:

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

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 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 CO_2 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

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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