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PSECC LTD

GREEN HYDROGEN PLANTS
PROPOSAL CONCEPT

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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 (CH_4), split with steam into CO_2 – the main culprit for climate change – and H_2, 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.

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 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.

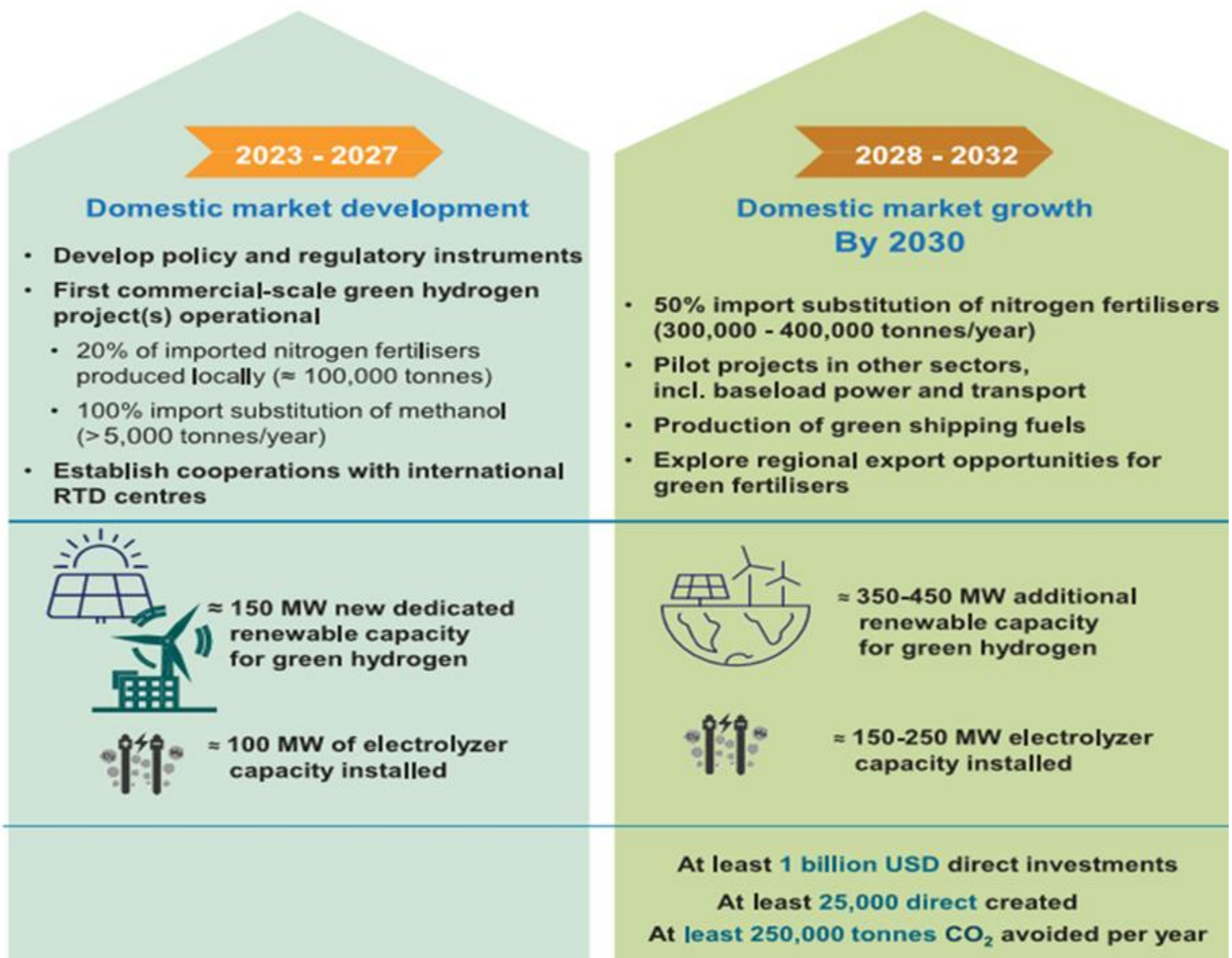
• There is unprecedented momentum around the world to

• 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

PSECC Ltd propose 2,200MW of Green Hydrogen – Eight plants in total

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BENEFITS OF GREEN HYDROGEN

Green hydrogen (H_2) 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.

ENERGY TRANSITION

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.

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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

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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 SAVINGSTO

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 CO_2 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 CO2 Savings=(221,440 MWh/year×0.5 kg CO_2/kWh)−(Electricity Consumption hydrogen 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)

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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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