Pumped Hydro

Project Concept REPORT

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

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PREPARED BY:
Alan Brewer MSc
Business Development Director
PSECC Ltd
39 Woodhay Walk, Havant, Hants, PO9 5RD, UK
Email alan@psecc.co.uk www.psecc.co.uk
Tel +44 (0) 2392 471860 Mbl +44 (0) 7510 977203

Table of Contents

Project Concept Report

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.

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.

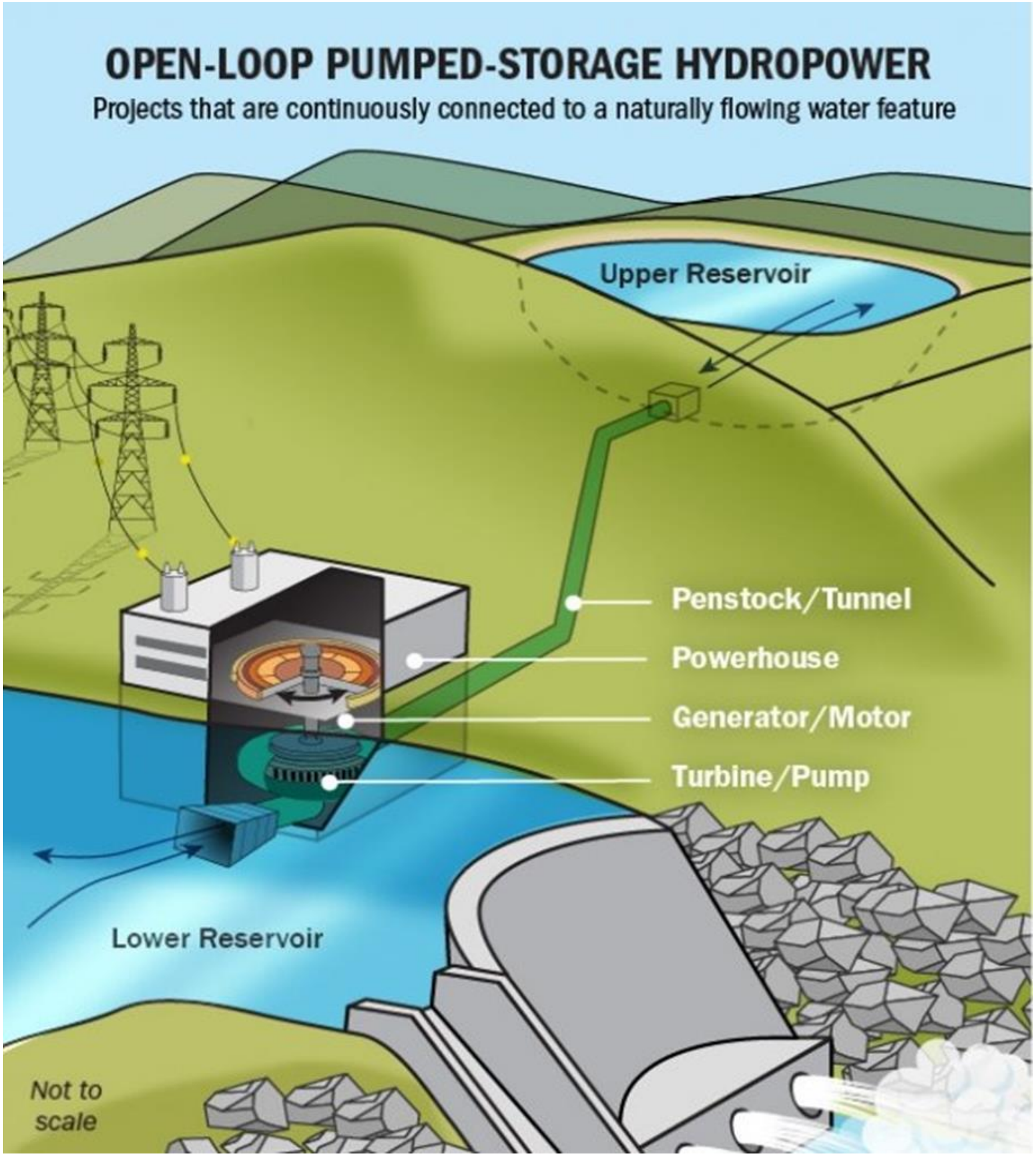
According to Energy and Petroleum Authority (EPRA), Kenya has installed hydroelectricity capacity of 826.23 MW, roughly a third of total installed capacity [1]. Most of the hydropower plants are large hydro with capacity greater than 10MW while only 15 MW are small hydro plants.

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.

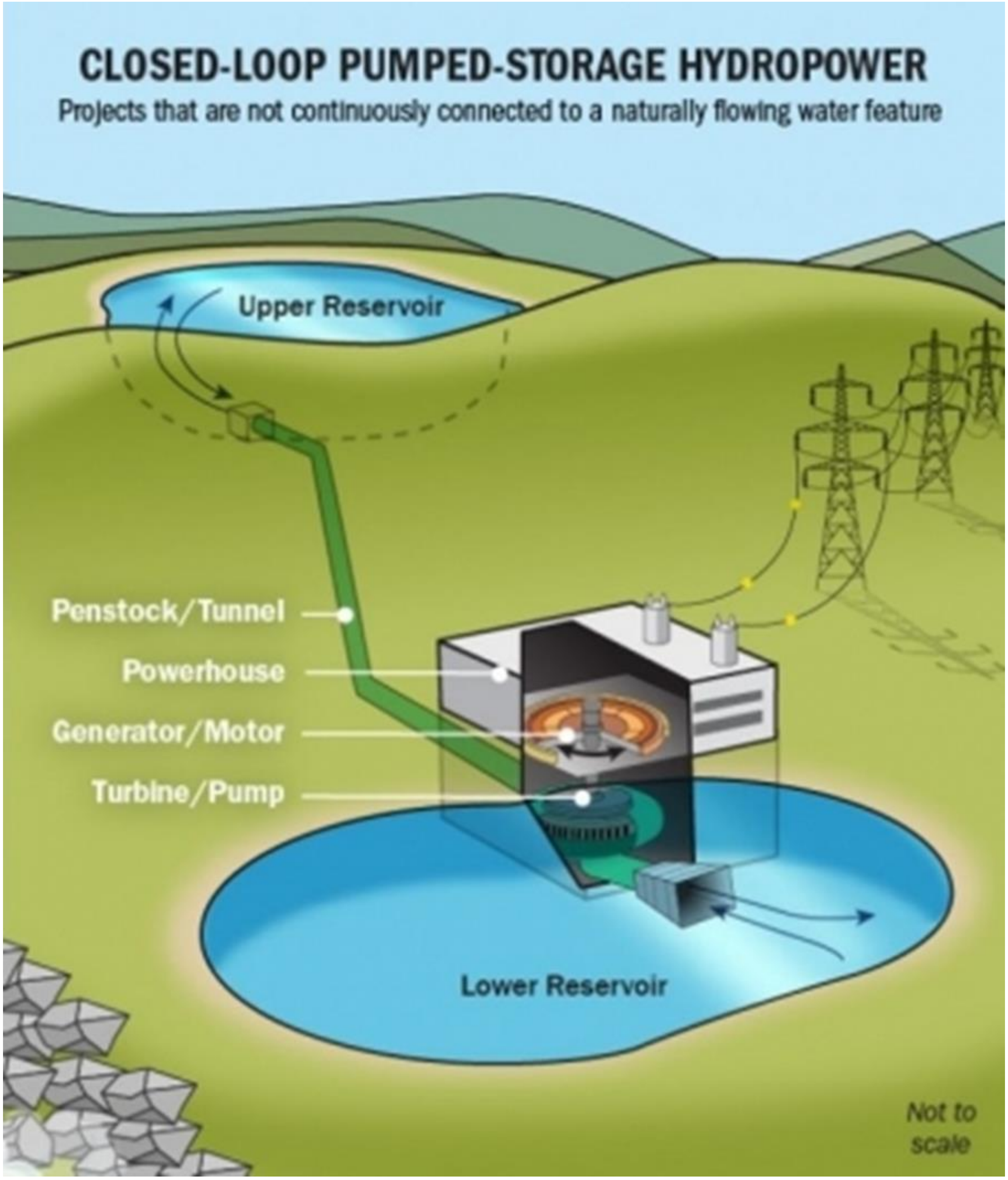
In a typical pumped hydro project, the head is determined by the height difference between the upper reservoir (feed lake) and the lower reservoir (hydroelectric dam). The potential energy of the water is harnessed as it flows downhill from the higher elevation to the lower elevation, turning the turbines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

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)	Prodution (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 [illegible]
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
		Type	Height (m)	Prodution (m^3/d)	Land tenure		Domestic (people)	Irrigation (Acres)	Power Generation (MW)			
	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

PSECC LTD

CONTACT

Contact:

Alan Brewer MSc
Business Development Director

PSECC Ltd
39 Woodhay Walk, Havant, Hants, PO9 5RD, UK

Email alan@psecc.co.uk   www.psecc.co.uk
Tel +44 (0) 2392 471860   Mbl +44 (0) 7510 977203