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Assessing the Feasibility of Harnessing Hydropower from Libya's Artificial River Drinking Pipes: A Renewable Energy Opportunity

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تقييم جدوى تسخير الطاقة الكهرومائية من أنابيب شرب النهر الاصطناعي في ليبيا: فرصة للطاقة المتجددة

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Abstract:
Water is an essential element in human daily life and a limited natural resource. Small hydropower represents an efficient and reliable form of clean, renewable energy. It is environmentally friendly and easy to operate, with low operating costs. The question of whether Libya's working artificial river could modernize its extensive network of drinking water pipes with hydroelectric turbines is an interesting one. However, this question has not been widely answered. However, the research presented in this article aims to address this issue by exploring the untapped potential of artificial river drinking pipes in Libya as an energy source. In Libya alone, there are 3,700 kilometres of drinking water pipelines running under the artificial Libyan River. We have previously published this study by designing and analysing the Libya Artificial Rivers Hydropower Model (LMR HEM) at the Renewable Energy Laboratory at Bright Star University. In addition, microtubule turbines (MPT) have been developed and used in tap water pipelines. The MPT is powered by the kinetic energy of water, which drives the generator to produce usable electrical energy through the conduction shaft. This energy is then used to charge the water supply pipeline (WSP) detector battery after transmitting an AC electrical signal. Ultimately, this system achieves the conversion of fluid kinetic energy into mechanical energy.

Keywords: Renewable energy, hydro power, turbine, flow drinking pipes, design step

الملخص
الماء عنصر أساسي في حياة الإنسان اليومية ومورد طبيعي محدود. تمثل الطاقة الكهرومائية الصغيرة شكلاً فعالاً وموثوقًا للطاقة النظيفة والمتجددة. إنها صديقة للبيئة وسهلة التشغيل، مع تكاليف تشغيل منخفضة. إن مسألة ما إذا كان النهر الاصطناعي العامل في ليبيا يمكنه تحديث شبكتها الواسعة من أنابيب مياه الشرب باستخدام توربينات الطاقة الكهرومائية هي مسألة مثيرة للاهتمام. ومع ذلك، لم تتم الإجابة على هذا السؤال على نطاق واسع. ومع ذلك، يهدف البحث المقدم في هذا المقال إلى معالجة هذه المشكلة من خلال استكشاف الإمكانات غير المستغلة لأنابيب الشرب النهرية الاصطناعية في ليبيا كمصدر للطاقة. وفي ليبيا وحدها، هناك 3700 كيلومتر من خطوط أنابيب مياه الشرب تجري تحت النهر الاصطناعي الليبي. لقد سبق أن نشرنا هذه الدراسة من خلال تصميم وتحليل نموذج الطاقة الكهرومائية للأنهار الاصطناعية في ليبيا (LMR HEM) في مختبر الطاقة المتجددة بجامعة النجم الساطع. بالإضافة إلى ذلك، تم تطوير توربينات الأنابيب الدقيقة

(MPT) واستخدامها في خطوط أنابيب مياه الصنبور. يتم تشغيل MPT بالطاقة الحركية للمياه، والتي تدفع المولد لإنتاج طاقة كهربائية قابلة للاستخدام من خلال عمود التوصيل. يتم بعد ذلك استخدام هذه الطاقة لشحن بطارية كاشف خط أنابيب إمداد المياه (WSP) بعد إرسال إشارة كهربائية تيار متردد. وفي نهاية المطاف، يحقق هذا النظام تحويل الطاقة الحركية للسوائل إلى طاقة ميكانيكية.

الكلمات المفتاحية: الطاقة المتجددة، الطاقة المائية، التوربينات، أنابيب الشرب الجريانية، الخطوة التصميمية

Introduction:

The primary goal of the Libyan authorities was to harness the potential of the Sahara aquifer, which includes four vast freshwater basins that have been trapped under the Sahara for 38,000, 14,000 and 7,000 years, respectively. This aquifers were discovered during oil exploration in 1953. Subsequently, in the 1960s, the Libyan authorities, who were in control of power at the time, began to exploit this huge reserve of fresh water, which is estimated at more than 30 thousand cubic kilometers. This endeavor was implemented in multiple phases. [1] This project was previously considered the most important water delivery project in the world, and is now in the halting stage. The Libyan government wanted to benefit from the desert aquifer.

The massive freshwater reservoir, thought to be more than 30,000 cubic kilometers, was first exploited in the 1960s by Muammar Gaddafi, who was in power at the time. The work was done in stages.

The first phase enabled the development of the Tazirbo pumping field, which consists of production wells and metric monitoring wells that supply approximately one million cubic meters of water per day. In 1991, only 98 out of 108 of the Tazirbo field's producing wells were in use, with the others held in reserve [2].

Classification of Energy Projects Small and large hydropower projects are the two broad categories into which hydropower projects fall. Many countries adhere to different regulations, with the maximum capacity of small hydropower plants ranging between 5 and 50 MW. [3] Water turbines in a small hydro system convert the energy of flowing water into mechanical energy. The generator is powered by this mechanical energy, and the generator generates electricity. Taking into account pipe friction losses and turbine inefficiencies, the overall system efficiency is usually on the order of 50% of the potential energy associated with the energy of the flowing water. For many years, micro hydro has been used in a variety of applications. The turbine varies from site to site based on the specific pressure head and design flow at each site. [4] The project is based on transporting fresh water through huge pipes buried in the ground, each of which is four meters in diameter and seven meters long. [5]

Phase I

Supplies two million cubic meters via a 1,200-kilometer pipeline that connects Benghazi and Sirte to the Ajdabiya reservoir via As-Safer and Tazirbo.

Phase II

Pumping to Tripoli and Jufra Plain from the Fezzan South Western Aquifer.

Phase III

Eight new pumping stations, 700 km of new pipeline, an increase of 1.68 million cubic meters per day (bringing the total capacity to 3.68 million cubic meters per day) and the expansion of the current Phase I system

Phase III (Continued)

500 km of new pipeline, a new wellfield at Al Jaghboub, a reservoir south of Tobruk, and a daily supply of 138,000 cubic meters to Tobruk and the coast. [4] Giving Benghazi and Sirte access to the Ajdabiya reservoir via a 1,200-kilometer pipeline that passes via As-Safir and Tazirbo and holds two million cubic meters as shown in the Figure 1. [4]

Phase IV

Extension of distribution network, construction of a pipeline linking the Ajdabiya reservoir to Tobruk

Phase V

Connection of the eastern and western systems into a single network in Sirte

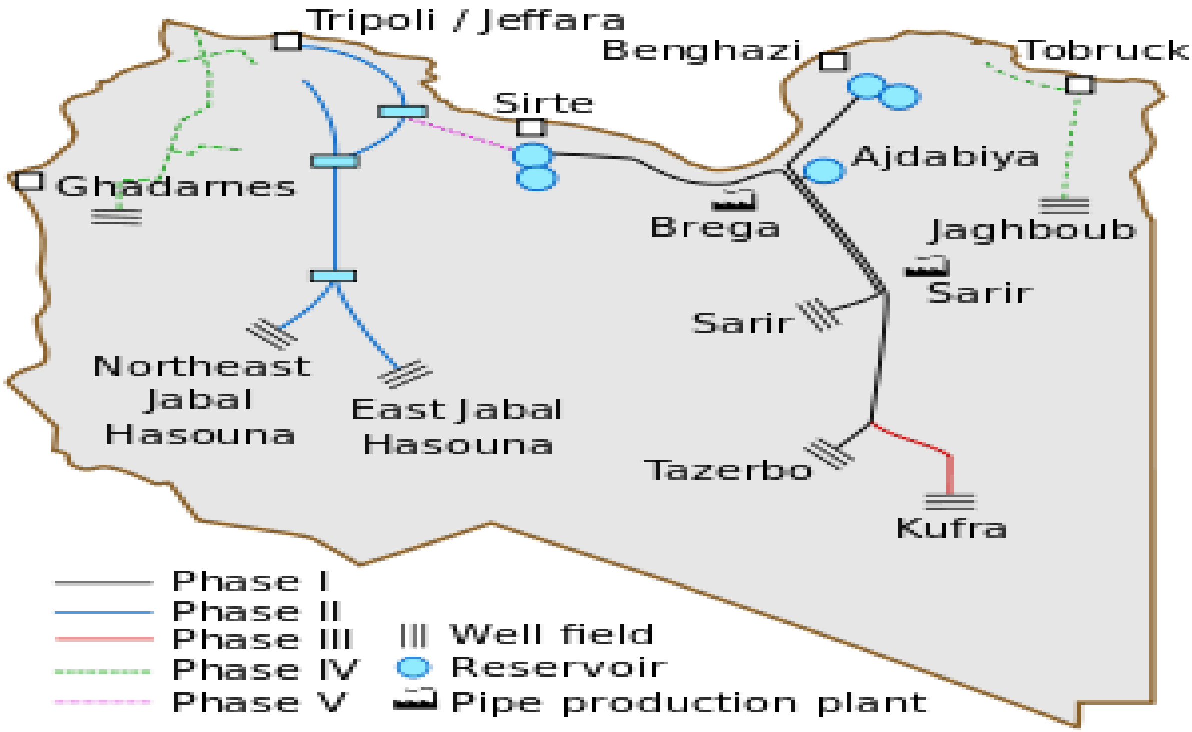

Figure 1: Map of Libya, showing the huge network of pipes underground taking water from aquifers beneath the Sahara to the coastal belt.

Figure 2: Trench digging of GMMR in the 1980s captured by Jaap Berk.

The Nubian Sandstone Aquifer System is the fossil aquifer that supplies this water. They are not being replenished at the moment; they accumulated during the previous ice age. It could require a thousand years' worth of water if the 2007 recovery rate is not raised, according to independent calculations, the aquifer may run out in 60 to 100 years. Ten percent of the desalination cost is reportedly covered by the $25 billion groundwater extraction system. [6]

Methodology:

1. Create and manufacture a man-made hydroelectric river in Libya, as seen in Figure 3.

Figure 3: the Libya Artificial Rivers Hydropower Model (LMR HEM) designing by the Renewable Energy Laboratory at Bright Star University.

2. The tools and procedures needed to develop and build a man-made river hydroelectricity (ROMR) in Libya are as follows, as illustrated in Figure 4.

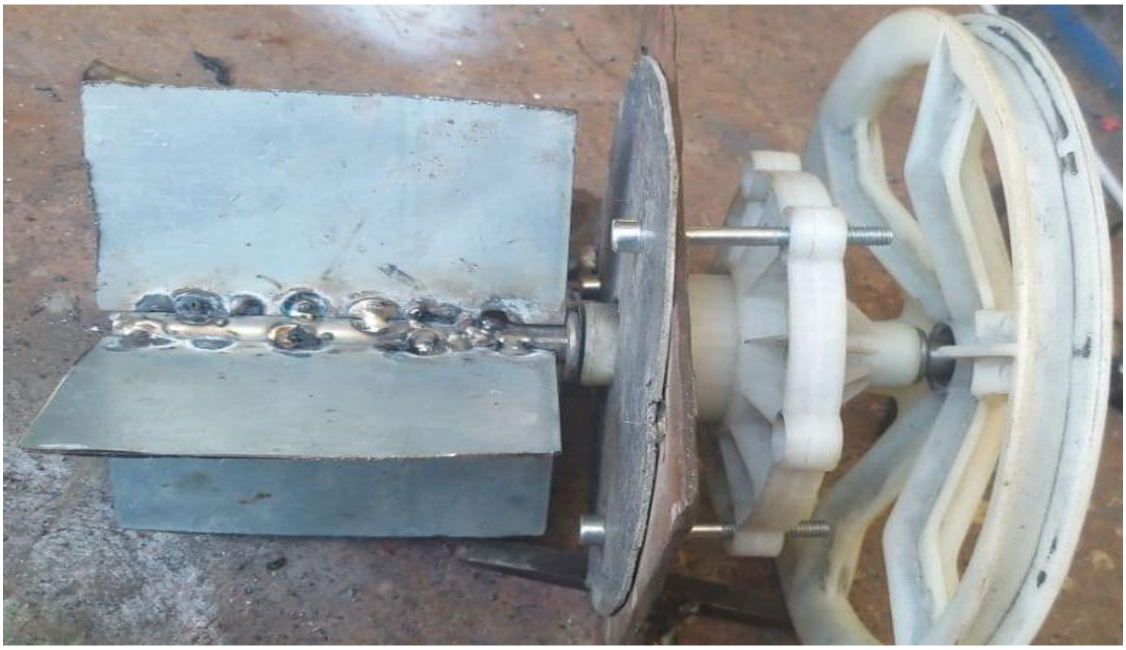

Figure 4: the Libya Artificial Rivers Hydropower Model (LMR HEM) designing by the Renewable Energy Laboratory at Bright Star University**.**

3. Calculating the amount of water flowing through pipes and open channels depends on:
I- Water speed.
II- The cross-section of the pipe or conveyor channel.

4. Calculate the amount of water flowing through pipes or conveyor channels through the following equation, which is called the continuity equation:
I. $Q=VA$
II. Q=Quantity of flowing water (l/min, l/s, $m3/s$).
III. V = flow velocity (m/s).

5. The amount of energy in water is constant:
(Bernoulli's equation) If no energy is generated during the flow of water due to processes.

First : The importance of scientific publishing.

The importance of this research lies in production Electricity through renewable energies and preserving the environment from pollution and global warming, as this process affects the lives of humans and animals. One of the most important of these is the implementation of such research in accordance with the Paris Agreement. At the United Nations Climate Change Conference (COP21) in Paris on December 12, 2015, 196 countries ratified it, and on November 4, 2016 it entered into force. [7]

The importance of technological developments in the field of scientific publishing.

Technological advancements play a critical role in the scientific diffusion of renewable energy.

1. Impact on global energy efficiency:

Utilizing renewable technology helps to increase energy efficiency worldwide. 2014 saw no significant changes in carbon emissions linked to energy use, in part because of growing usage of renewable energy sources and increasing energy efficiency.,

The development of renewable energy has exceeded expectations, as global demand for these sources has increased, especially in developing countries.[8]

2. To develop technology and reduce costs:

Globally, the capacity and output of renewable energy technologies for construction have expanded, with the majority experiencing notable cost reductions. [9]

3. Synergy between renewable sources and energy efficiency:

When the distribution of energy services improves in efficiency, renewable energies have the potential to become more significant sources of primary energy. Energy efficiency and renewable energy sources can complement each other in several ways. .[10]

To sum up, in order to advance the sustainability and effectiveness of renewable energy consumption globally, we must keep funding scientific study and sharing the findings.

Conclusion

In conclusion, by focusing on generating electric energy from clean sources, as explored throughout this paper derived from a project at Brega University, we can ensure a sustainable future for both the environment and the economy. This ongoing pursuit necessitates continuous research by all parties involved in this field. Thankfully, Libyan engineers are well-positioned to apply these advancements in real-world applications, and we are grateful to the General Electricity Company for their instrumental support in this endeavor.

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