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A Review of the Possibility Integrating the Solar System into the Libyan Railway Transportation

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Abstract:
This study of the possibility of integrating clean energy into the Libyan railway transport system using the integration of photovoltaic cells provides the potential for electric power, whether in the development of transit trade or the production of renewable electric energy near the points of electricity consumption. In Libya, for example, by integrating photovoltaic cells at stations, up to 100% of the electricity demand at railway stations can be covered, and the surplus will support the public electricity grid. Political support (for buildings in integrated photovoltaic plants) BSIPV will contribute to the development of transit trade in Libya. This study suggests the exploitation of solar systems in the railway transport system and the distribution of renewable energy sources along the railway lines in Libya, which is a link between Africa and Europe. And I will propose innovative ideas that achieve integration between railway transportation and solar energy.

Keywords: (Buildings in Stations Integrated PV) BSIPV, Clean Energy, Photovoltaic PV, Railway Transportation.

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Introduction
To combat climate change, Libya has the potential to become a global leader in renewable energy. It has a very high daily solar radiation rate, which is approximately 7.1 kWh per square meter per day (kWh/m2/day) in the flat coastal plain and approximately 8.1 kWh/m2/day in the southern region. According to research published in the Journal of Renewable Energy, Figure demonstrates that Libya could create more than five times as much PV system if it used a PV system to harvest just 0.1% of the Earth's mass. Fig 1 shows if Libya uses a PV to harvest just 0.1% of the Earth's mass [1].

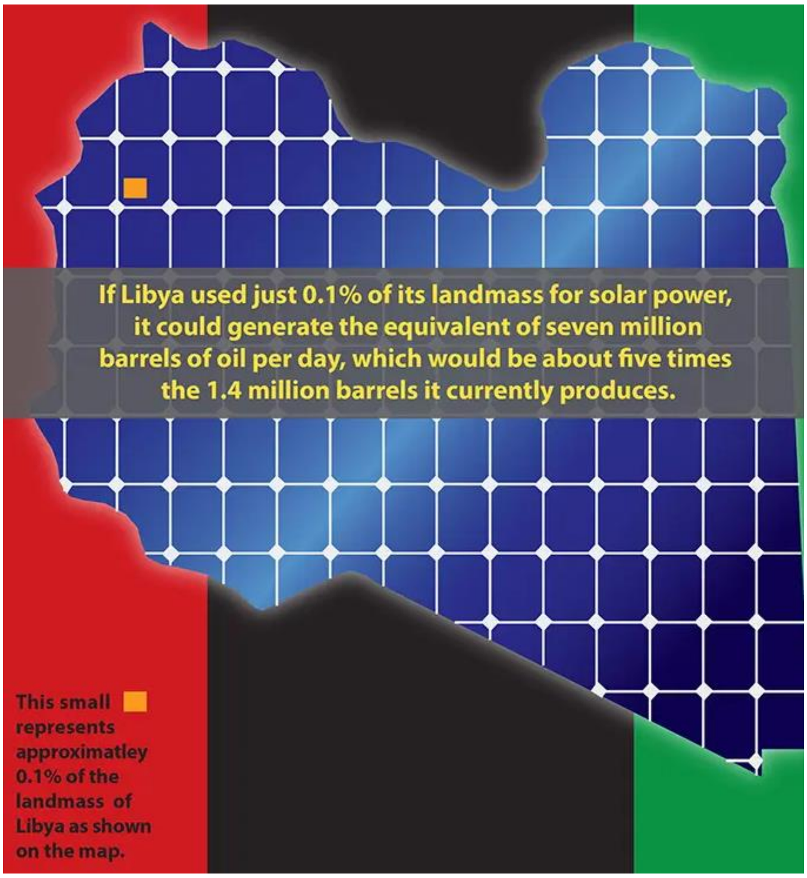

Figure 1: Libya exploits just 0.1% of the Earth's mass with a PV [1].

It is challenging to change the structure of Libya's economy because it was built on oil and natural gas production. A qualified workforce is not available in the nation to build and maintain renewable energy systems. The state can increase its current revenue base with sustainable, renewable energy with the correct investment and training. Using the renewable energy sources present in this oil-rich nation, Libya can meet all of its own electricity needs and export a sizable portion of those of its neighbors in southern Europe.

If there are support policies from the Libyan government to integrate PV into the railway station, photovoltaics will become the most powerful technology for electricity production in railway stations, and the surplus of electrical energy from solar panels is integrated with the electrical grid in Libya to cover part of the excess demand for electrical energy in the summer. Development and growth of certified BSIPV components in the global market and from the point of view of technical, architectural, and legal certainty, facilitating the easy and large-scale integration of photovoltaic generators in buildings of railway stations. The case for exploiting renewables in operating Libya's railway system. The railways are large energy users and highlighted that photovoltaic and hydrogen renewables can be used to reduce operational costs, fuel use, and carbon emissions and protect the environment. Libya's geographic location can help its railway project generate solar energy to operate administrative buildings, telecommunications, air conditioning, and lighting [2].

Directly installing equipment of PV on the cars or locomotives of trains is an innovative approach to utilizing renewable energy in railway traction. For instance, India outfitted six train carriages with 16 solar panels on top, which were mostly used for energy storage devices that could provide 72 hours of electricity, fans, and headlights. Another illustration is the introduction of the world's first entirely solar-powered train by Australia [3].

The first solar system project in Libya

The Libyan General Electricity Company signed an agreement with Total to implement projects to generate electricity from the photovoltaic system's energy with a capacity of up to 500 megawatts. The start of implementation of the first solar energy project in Libya comes to solve the electricity sector crises. As the electricity deficit in the country reached about 2,500 megawatts per day. This has led most Libyans to rely on private generators. The General Electricity Company seeks to raise its capacity to 14,834 MW by 2025, and 21,669 MW by 2030. Interestingly, is interesting that Libya receives 8.1 kilowatt-hours of solar radiation per square meter in the southern regions and 7.1 kilowatt-hours per square meter in the coastal sections on a daily average. In addition, there are 3,500 hours of average annual sunshine and 140,000 TWh of intense annual voltage [4].

Clean energy exploitation in Libyan railway transportation

The railway project in Libya: First, the project builds a railway line and seeks to construct 3,170 km of anticipated railway lines across the nation, together with 168 bridges and an estimated 75 stations. The project will connect the towns of Ras Ajdir and Musaed, the Libyan international borders with both Egypt and Tunisia, via a coastal line that is anticipated to pass through the most significant cities in Libya as well as a variety of geographical regions, including deserts, mountains, and agricultural areas. And a second line that will connect Al-Hishah south of Misurata and west of Sirte with a length of 800 km, and from Then, at some point, southern Libya. It may reach Niger. Fig. 2 shows the implementation and management of the Libyan railway [5].

According to the contracts signed in 2008 and 2009, the Italian company "Ensaldo" is responsible for the construction of the signaling system for two railway lines, one of which connects the city of Ras Ajdir and the city of Sirte on the Mediterranean coast, and an internal line that connects Al-Hishah and Sebha for a total distance of 1,450 kilometers, while the Russian Railways Company is responsible for RGD is constructing the main section of that network that extends between the cities of Sirte and Benghazi, and the China Railway Construction Company is responsible for constructing the line linking Sirte and Al-Khums with a length of 352 km, and the line linking Tripoli and Ras Ajdir, in addition to other branch lines [6]. In Figure 2 shows the Implementation and management of the Libyan railway.

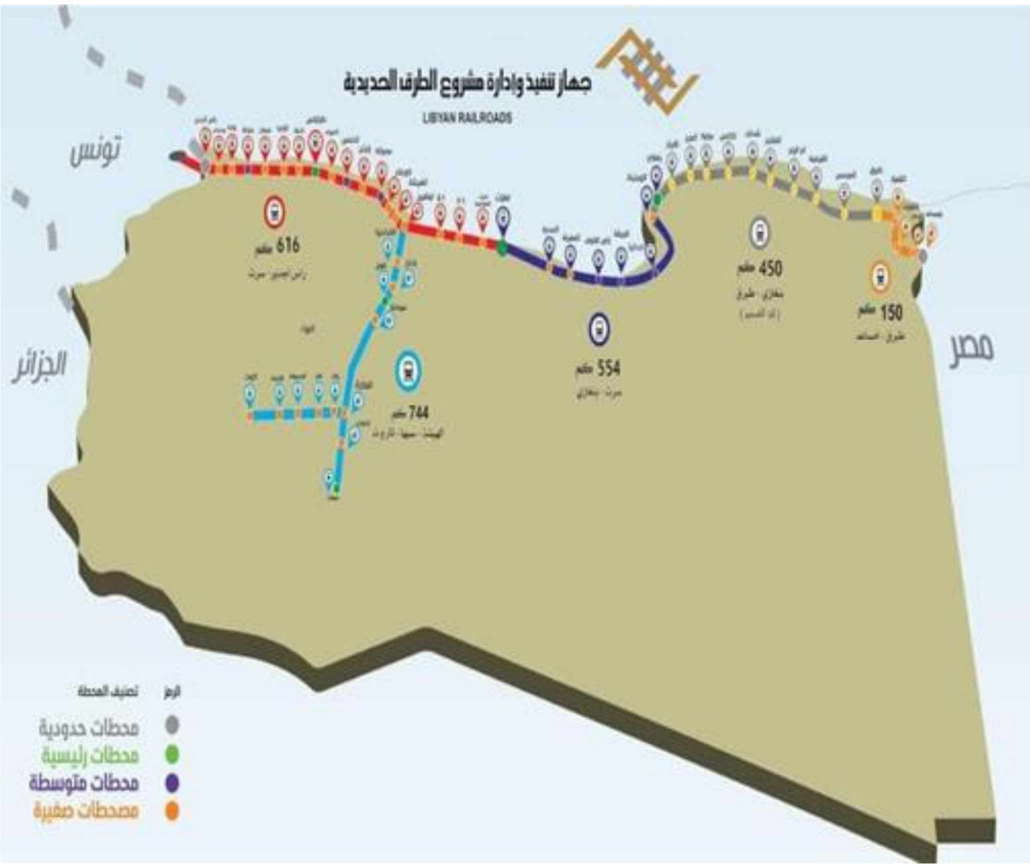

Figure 2 Implementation and management of the Libyan railway [6].

Transit Trade Project in Libya: Transit Trade Project in Libya can help regional development on the southern border of LIBYA and can help stem the flow of illegal immigration from sub-Saharan Africa. And pointed out that there are 400 million consumers in sub-Saharan Africa for Libya to benefit from economically. So far as to say that "Libya will own sub-Saharan Africa" economically if it builds its railway system. "Without a railway system, there can be no Libyan transit trade policy," he stressed. According to Libyan Railways, its current objective is to prioritize the movement of raw materials and commerce while concentrating on connecting inhabited towns, ports, free zones, and dry ports. To strengthen and diversify the domestic economy, it also takes into account how these lines are connected to neighboring nations. It claimed to have begun researching project finance via a budgetary allocation from the Libyan government or local and foreign investors in order to its ambition. Additionally, it intends to rehabilitate and train domestic laborers who will help with building and operation [7].

Utilizing Renewable Energy in Railway Transportation: Although technology isn't a novel form of renewable energy, it is not widely used in train transportation. In China, it is impossible for planners to methodically plan and build rail transit that integrates renewable energy. To order to synthesize and present the use of clean energy for railway transportation, this section primarily discusses the background and trends of low-carbon operations in railway transportation as well as the development and implementation of renewable energy technology along railway lines [8]. Approximately 4 exajoules (EJ) of renewable energy were consumed in 2018, which was 3.7% of the demand for transportation fuel. 93% of total renewable energy was provided by biofuels, with the remaining 4% coming from renewable power. Over the forecast period (2019–24), biofuel production is expected to increase by 24% (0.9 EJ), while renewable electricity use in transportation is anticipated to rise by 70% (0.2 EJ), thanks to increased use of electrified rail and electric vehicles as well as higher renewable electricity generation percentages.

In 2024, biofuels will make up 90% of the renewable energy used in transportation. So the use of renewable energy in transportation slightly rises to 4.6% by 2024. (5.1 EJ). Due to the 3% rise in demand for fossil fuels in transportation, this increase is rather insignificant (3 EJ). Additionally, the majority of biofuel requirements only call for blending amounts of 10% or less; however, Thailand, Brazil, and Indonesia have notable exceptions to this rule. Figure. 3 shows Renewable energy in transport in 2018 and 2024 [9].

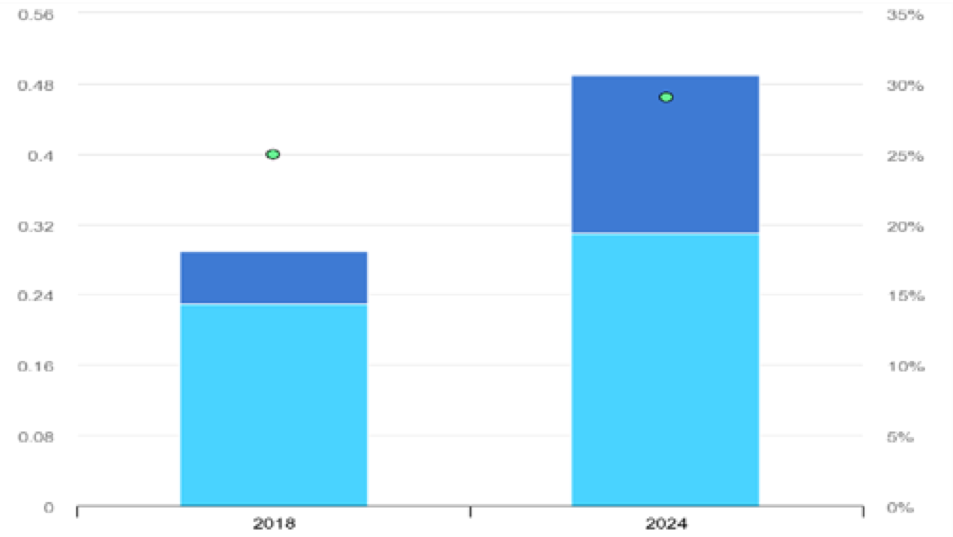

Figure 3 Renewable energy in transport 2018 and 2024 (8).

Utilizing Photovoltaics for Railway Transportation: Utilizing new and renewable energy extensively, many new high-speed railway stations also actively use solar photovoltaic systems to supply electricity. The promotion of new energy and renewable energy utilization technology is currently accelerating in several places due to the unintegrated heating stations, workshops, and office buildings, as well as the production of living energy along the remote railway. Railways have more stations along the lines, greater size, and a more concentrated consumption of energy than other forms of transportation, which creates the ideal environment for the use of new and renewable energy. The infrastructure for other modes of transportation is few and dispersed, and they all involve point-to-point travel [10].

The railway is a type of commonly used low-carbon mode of transportation where large-scale train propulsion can be powered by new and renewable energy sources. The percentage of electrified railroads is the primary determinant of how much new and renewable energy is used in the railroad industry. The railway sector can become the first industry to fully realize low-carbon or carbon-free growth through the use of new energy and renewable energy sources. But this still requires the government to continue implementing pertinent legislation and providing strong support [11].

A 42,000 m2 solar power-producing producing system with a 6 MW installed capacity is built on the roof of the Xiongan high-speed train station. 5.8 million kWh of electricity can be produced annually, which would reduce carbon dioxide emissions by 45 million tons a year and provide nearly 20% of the country's overall electrical needs. Zhiming et al. research the best way to plan distributed photovoltaic generation (DPVG). And energy storage systems (ESSs) for the high-speed railway's traction power supply system (TPSS). The potential and applicability of DPVG and ESS to the high-speed rail sector are demonstrated [12].

As a case study, the high-speed railway (HSR) between Beijing and Shanghai is used. With a lifespan generating capacity of 155 TWh or around 12% of China's total new installed capacity in 2020, it has a total PV potential of 5.65 GW (of which the station potential accounts for 264 MW or roughly 4.68% of the overall potential). Studies on the photovoltaic potential of railway systems have been conducted all around the world. Combination photovoltaic systems with batteries are being considered for the rail transportation infrastructure [13].

This paper developed the PV model of the Tokyo power plant, which involved mounting solar modules on the roof and analyzing how shade affected the effectiveness of the nearby structures [14]. Developed a technique using photovoltaic panels to increase the power produced by solar trains. With the aid of GIS, railway routes' PV potential may be calculated [15]. Therefore suggested a technique for attaching solar panels to the M1 light metro line's roof at Istanbul Airport to power train lighting fixtures [16].
However, the long-distance transmission will result in some electrical loss because the power source is not close to the railway line. The use of new energy and renewable energy will be relatively low since the power supply structure rained by the improvement of the power supply throughout society. The design concept of integrating a solar photovoltaic power generation system and an electrified train can be taken into consideration to address this model's drawbacks. The installed capacity of a 1-km electrified railway, using 16 meters as the construction unit and 5 meters as the interval, is around 2,300kW. When traveling north to south on an electric train track. On both sides of the railway segment, solar PV modules no taller than 1.8 meters may be erected. It can also function somewhat as a soundproof wall [17].

Locations and methods of integrating PV in transportation
The installed in the proper area and connected the solar cells with the structural formation, PV systems are thought to be a good technique to generate power for railway stations. The phrase "solar systems integrated with the building in railway stations" refers to solar systems that are built and erected with the buildings in the railway.
The innovative ideas that achieve integration between railway transportation and solar energy:

The solar panels can be mounted on the umbrella rather than taking up space and being installed on the ground as shown in figure 4.
Features of this system:-
1. The system that is erected as a canopy is more effective because it permeates the shade.
2. It takes up less surface area because there is no space between the solar panels.
3. Lower costs, better efficiency, and benefit from the umbrella to sit under.

Figure 4 The use of umbrellas on which solar panels are installed [18].

It is preferable to utilize the roof by adding solar panels than to waste space on the ground as shown in figure 5 A beautiful roof with solar energy.

Features of this system:-

1. The system operates more efficiently because the panels are less sensitive to dust and flooding during rain.
2. Taking advantage of the roofs rather than pouring concrete. It is feasible to generate electricity and gain benefits from the solar panels on the roof. Integration occurs between the railway station (the building), which gains from the electricity generated, and the solar panels. Benefiting from the distance below it is cooler to cool the panels.
3. Solar power and cost-effective roofing together. Consider a solar roof if you need to replace your roof. It will cost more than a usual roof, but typically less than a typical roof plus a typical solar array with a comparable power output [19].

Figure 5 A beautiful roof with solar energy [20].

Solar panel installation at the train station as shown in figure 6.

Features of this system:-

Electricity is provided for this station in an appropriate amount because the train station is large in area.

1. The solar panels make a thermal insulator for the train stations and work to soften the air inside the train station.
2. Integration by generating electric power that feeds the train station and at the same time working to isolate the parking lot from direct sunlight.

Figure 6 Solar roofs on trains station [21].

Solar-powered parking for vehicles and buses as shown in figure 7.

Features of this system:-

1. Provides a large part of the electrical energy needed to operate the train station.
2. Benefiting from shade for car parks or buses, it is economical than executing concrete parapets at a lower cost.

3. Cars or electric buses can be charged here, and the solar panels and parking lot have been integrated. The space between each solar panel is necessary so that the shade does not cover any directly cover any of the panels.

Figure 7 Solar-covered parking cars and trucks [22].

Installing solar panels in the passenger seating areas at train stations as shown in figure 8.

Features of this system:-

1. It is used for lighting, charging mobile phones or laptops, or operating screens at the train station.
2. Instead of extending electricity cables to seating areas, the seating area is a producer of electrical energy, and it saves costs at the station.
3. The umbrella can be made of wood, because it is an environmentally friendly material, and costs less than galvanized iron or aluminum.

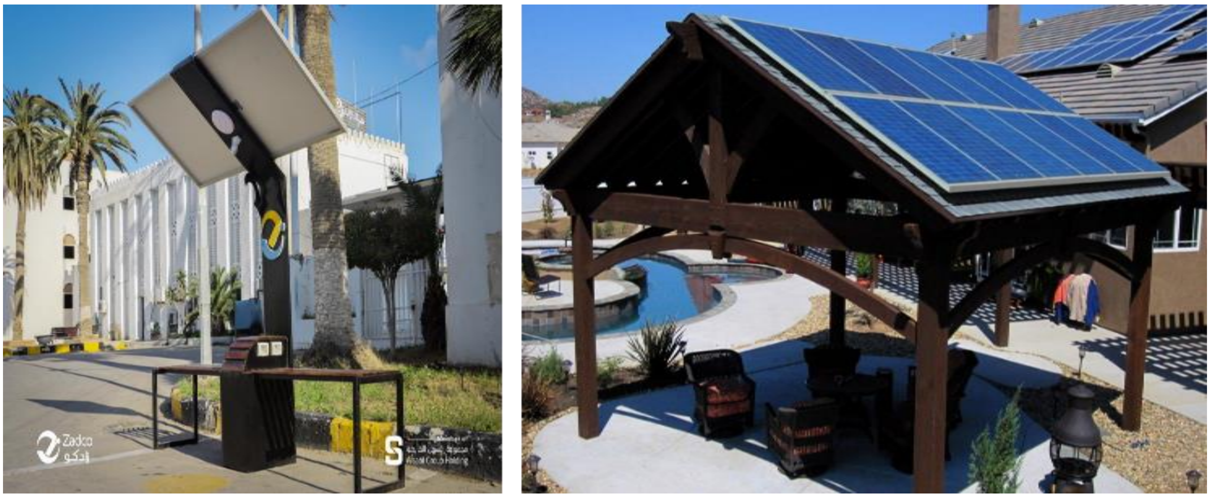

Figure 8 Solar in the passenger seating areas [23].

Solar panels are used in floating solar stations as shown in fig 9.

Features of this system:-

1. The efficiency of floating solar stations is better because it increases the generation of electricity because the water softens and reduces the temperatures that the solar panels are exposed to.
2. As a result of covering areas of the floating station, we note that the temperature in winter does not drop much, and from it, it is learned that the fish do not die from the cold because the sea water retains its temperature, and also in summer since a large part of the floating station is not exposed to direct sunlight, the temperature The water temperature does not rise to a great extent, which harms the fish.

Figure 9 Solar panels are used in floating solar stations [24].

The use of solar panels in ships or boats used for transportation stations is shown in Figure 10.
Features of this system:-

1. Its provisions electrical energy for ship engines and lighting from a clean, environmentally favorable source.
2. Lowering reliance on diesel generators, which have maintenance and operation costs.
3. Because diesel badly impacts maritime environments that are home to coral reefs and fish, and because clean energy sources are required in some industrialized nations due to reduced emissions, it is important to protect the environment sea where coral reefs and fish are found.

Figure 10 Solar panels in ships or boats are used for transportation [25].

Installing solar panels to cover fuel stations for transportation as shown in figure 11.
Features of this system:-

1. High efficiency, because it is well exposed to sunlight, and its area, is usually a large fuel station.
2. The cost of integrating the solar panels and the gas station will be recovered in three years with a very minor difference. Many Total and Mobil stations abroad use this system.
3. The use of solar panels in the canopy inside the station, the costs of which do not exceed 20% of the canopy exhausted from the concrete, and the consumption of electrical energy from the network consumed by this fuel station.

Figure 11 Solar panel Roof, fuel station [26].

Covering pedestrian walkways inside transport stations with solar panels is shown in Figure 12.
Features of this system:-

1. Solar panels covering these corridors contribute to meeting some of the transportation stations' electrical energy needs. The corridors might have both a shaded and an open portion; total shading is not necessary.
2. Passengers within the station will benefit from shade, and concrete pathways won't be necessary.
3. Electrical cable costs can be reduced because of how far apart the corridors are inside the train station.

Figure 12 Solar panels in walkways inside transport stations [27].

Conclusion

The study provided an overview of the current state of clean energy use for railways around the world. This study examined the use of renewable energy along the railway lines of the Libya project and shows the possibility of integrating renewable energy using photovoltaic systems for railway transportation and various means of transportation. And presented railway projects in Libya locations and methods of integrating solar cells with transport stations. Also suggested smart ideas that achieve integration between railway transportation and PV systems in railway transportation.

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