Harnessing the Power of Nature: The Future of Renewable Energy in Bangladesh

This research article is submitted in partial fulfillment in 3rd year final semester of the requirements for the degree of Bachelor of Science in Engineering.

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The work contained in this report has not been previously submitted to meet requirements for an award at this or any other higher educational institution. To the best our knowledge and belief, the report contains no material previously published or written by another person except

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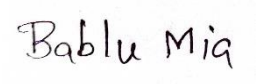

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APPROVAL

This is certified that the research article work entitled “Harnessing the Power of Nature: The Future of Renewable Energy in Bangladesh” is a research article work carried out by Bablu Mia in partial fulfillment for the award of degree of Bachelor of Science in Electrical & Electronic Engineering from Jatiya Kabi Kazi Nazrul Islam University, Trishal, Mymensingh. It is also certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the University library. The research article has been approved as it satisfies the academic requirements in respect of research article prescribed for the Bachelor of Science degree.

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ACKNOWLEDGEMENT

At First we would like to thank Almighty Allah, for his unending grace and love throughout our academic life. Without it, we would not have made it so far. We would like to thanks our supervisor, Assistant Professor Firoz Sarkar for giving us the opportunity to work on this research article and extended our sincere gratitude to him for priceless motivation, guidance and supports.

We appreciate all of our teachers and all non-teaching staffs of the Dept. of Electrical and Electronic Engineering at Jatiya Kabi Kazi Nazrul Islam University, for their contributions towards our degree. Above all, we would also like to thank our parents, family members and friends who helped us a lot in finalizing this research work.

PREFACE

This research article was written during the 3rd year, 2nd semester final research article of “Harnessing the Power of Nature: The Future of Renewable Energy in Bangladesh” This Research work carried out at the Department of Electrical and Electronic Engineering at Jatiya Kabi Kazi Nazrul Islam University. The purpose of a paper on " Harnessing the Power of Nature: The Future of Renewable Energy in Bangladesh" Renewable Energy in Bangladesh in Bangladesh. We would like to express our recognition to our advisor Firoz Sarkar for his guidance throughout this work.

Harnessing the Power of Nature:

The Future of Renewable Energy in Bangladesh

ABSTRACT

Electricity plays a crucial role in our daily lives, and we rely on various external sources such as windmills, solar panels, and kinetic energy to generate power. However, the increasing demand for energy poses a significant challenge as the availability of resources is limited for sustainable development. Therefore, it is imperative to establish cost-effective and environment friendly sources of inexhaustible energy to meet these growing demands.

Because of its versatility, electrical energy is regarded as the foundation of daily existence. Everybody uses it in one way or another during their daily routines. However, in order to have access to sources, we are forced to rely on renewable energy sources. The rate at which natural processes replenish renewable resources can be equal to or higher than the rate at which they are depleted. In actuality, renewable energy is produced by naturally occurring resources such as sunshine, wind, tide, geothermal heat, ocean energy, etc. According to predictions, 28% of the energy generated in 2030 will come from renewable sources.

Despite Bangladesh's abundance of natural resources, the country continues to struggle with electricity shortages, while its neighbors are making better use of their resources and are becoming wealthier and experiencing faster economic growth. The goal of achieving 10% economic growth by 2017 can be achieved by properly utilizing renewable energy resources to support our nation's sustainable development. This paper presents an analytical analysis of Bangladesh's recent energy situation and discusses the possibilities for accessible renewable energy resources that ought to be included in national energy planning.

Keywords: Biomass, Hydro, Nuclear, Renewable Energy, Solar, Wind.

I. INTRODUCTION

With a population of almost 17 crores spread on 148460 km2, Bangladesh is located in southern Asia and borders India to the west and east, Myanmar to the southeast, and the Bay of Bengal to the south.

Bangladesh, a rising country, has been able to sustain 6.7% annual economic development, which has resulted in a strong demand for power every year for the past ten years [1]. But the real need cannot be met because of mismanagement, insufficient production, and poor energy management in the past and today. Thus, load shedding has grown to be widely discussed and considered an everyday occurrence. Only 59.50% of Bangladeshis have access to electricity, and the country uses only 180 kWh of energy per person, which is quite less when compared to other nations[2].Due to this shortage, those living in rural areas do not have access to the same power facilities as those living in cities.But Bangladesh is a nation that depends so heavily on dependable energy sources—oil, gas, hydropower, etc.—that it will be unable to meet the challenge of future demand if renewable resources are not taken into account and used effectively [3].

II. CURRENT ENERGY SCENARIO IN BANGLADESH

There is currently an extreme lack of power in Bangladesh, both in urban and rural areas.
Of the total population, only two thirds have access to electricity, with an annual consumption per person of 279 KW-Hr [4]. Numerous challenges exist, such as security issues related to rising fuel imports and an over reliance on energy resources like coal and gas, which aren't producing enough electricity to meet demand.
Nearly 62% of our energy needs must come from natural gas [5]. Bangladesh's current power state is approximately 12578 MW, with a generation of approximately 8305 MW in March 2017. As of February 2017, the total installed capacity of BPDB power stations was 15379 MW. Figure 01 below illustrates the BPDB power plant's installed capacity as of February 2017 February [6].

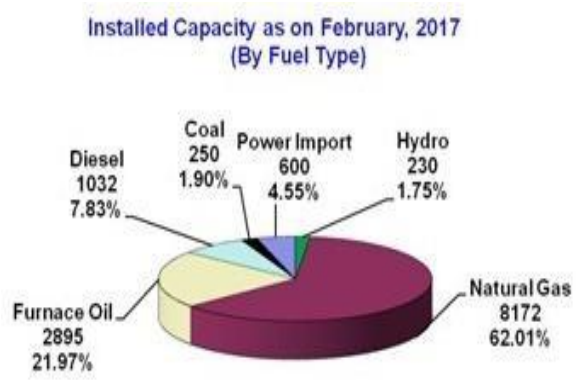

Figure 01: Installed power capacity scenario

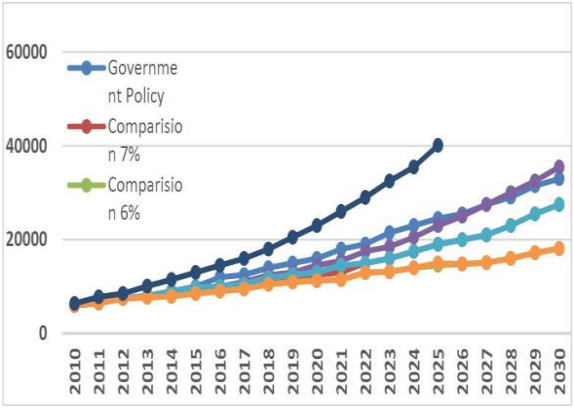

Figure 02: Study year-wise peak demand forecast

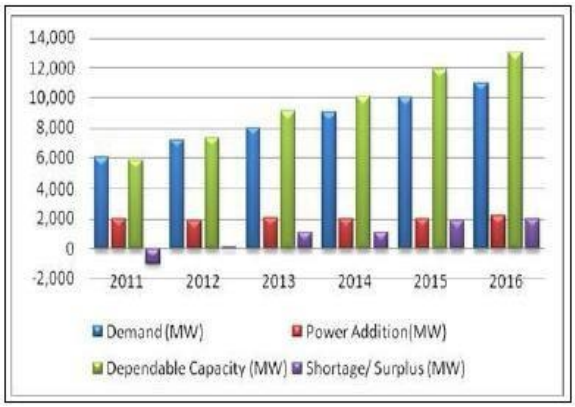

Figure 03: Power shortage for a period of seven years

Fig. 03[8] shows the expected increased electricity for the period of 2011–2016. The output capacity of the current power plants does not grow to keep up with the growing demand for electricity. Bangladesh aims to generate 10% of global power production by 2020 through the utilization of renewable energy sources, including waste, air, and solar energy [9].

According to this solar radiation chart, which is shown in Table 01, the maximum solar radiation is found in May and June and is approximately 5.786 KW/m2/day. The lowest daily radiation is found in August, when it is approximately 4.048 KW/m2/day. Additionally, the annual average radiation is 4.758 KW/m2/day.

III. FUTURE RESOURCES FOR RENEWABLE ENERGY

Bangladesh has an abundance of renewable energy sources, including wind, sun, biomass, and more. However, there remains a concerning issue: Bangladesh is still unable to effectively utilize its resources in order to provide people with access to power. Though the cost of investing in renewable energy technology is higher than that of the fossil fuel option. Additionally, this alternative is observably more cost-effective when considering health risks, environmental costs, and reduced running expenses.

Additionally, this alternative is observably more cost-effective when considering health risks, environmental costs, and reduced running expenses. One benefit of renewable energy is its environmental friendliness, making it ideal for developing nations like our own that face the threat of climate change. The good news is that the government is making significant efforts to integrate renewable energy sources so that the entire nation can satisfy its desired electricity demand.

3.1. Solar Energy

Solar power is energy that is extracted from the sun and transformed into electrical or thermal energy. This is the purest and most abundant renewable energy source that exists in our surroundings. Solar power is literally the conversion of sunlight into electrical energy, either through photovoltaic or concentrated solar power. The operational fee is quite modest, despite the large initial investment fee. Bangladesh is a semitropical nation with enough sunshine, falling between 20.30 and 26.38 degrees north latitude and between 88.04 and 92.44 degrees east latitude. The country's daily average solar radiation ranges from 4-6.5 KWh/m^2. Sunshine, falling between 20.30 and 26.38 degrees north latitude and between 88.04 and 92.44 degrees east latitude.

The country's daily average solar radiation ranges from 4-6.5 KWh/m^2. Table 01, as shown below [11], provides data on solar radiation in Raujan, Chittagong, Bangladesh, during different months of the year.

According to the solar radiation chart shown in Table 01, the maximum solar radiation is observed in May and June, measuring around 5.786 KW/m^2 per day, while the lowest radiation is recorded in August, with a daily radiation of approximately 4.048 KW/m^2 per day. Additionally, the annual average radiation is 4.758 KW/m^2/day.

Month	Clearness Index	Daily Radiation ($KW/m^2/d$)
April	0.646	4.597
February	0.628	5.126
March	0.596	5.634
April	0.550	5.760
May	0.527	5.786
June	0.390	5.786
July	0.368	4.335
August	0.398	4.048
September	0.418	4.224
October	0.555	4.083
November	0.601	4.725
December	0.649	4.409
Average	0.513	4.758

Table 01: Solar radiation throughout the year

Centralizing solar photovoltaic plants has been made possible by national grid energy in over 50% of about 10,000 business markets and other rural marketplaces. Conventional techniques include the use of candles, oil lamps, kerosene, and other similar items in a variety of off-grid homes, workplaces, and institutions. In a few locations, diesel generators are used to generate energy, which is something that ought to be moved under solar technologies such as solar water heaters, solar thermal pools, and solar vehicles, cookers, and air conditioners, among others.

3.2. Wind Energy

One good source of sustainable energy is wind. Bangladesh is a good fit because of its extensive coastline. Here, the wind blows in a variety of patterns depending on the season. Bangladesh's coastal regions are swept by a strong southwest wind that arrives during the Indian Ocean monsoon season. Because of this, the average wind speed is between 3 and 6 m/s from March to September, and it is likewise lower from October to February. Additionally, the maximum wind speed is observed around June through July [13]. In order to meet our need and assist the national grid, it would be preferable if wind turbines were installed along the coast.

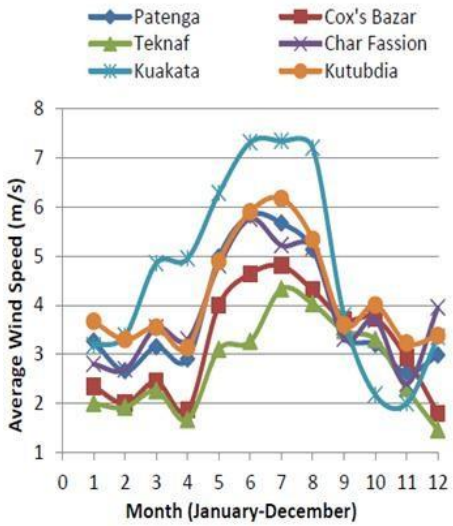

Figure 05: Average Wind Speed in Six Different Coastal Spots (Monthly)

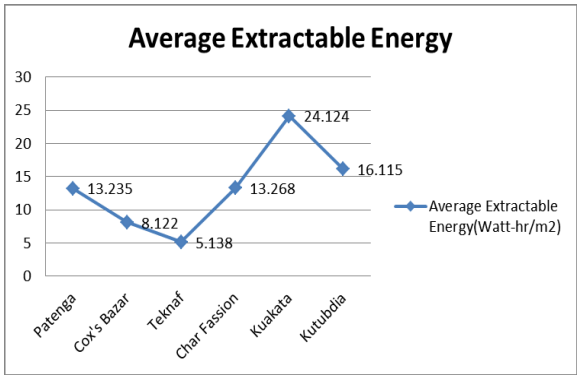

Figure 06: Average Extractable Wind at six WEST stations

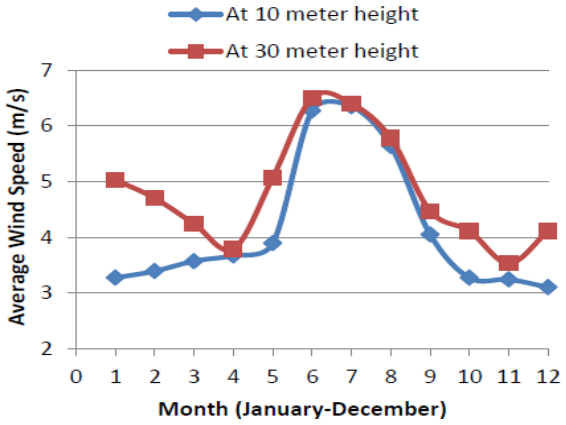

Figure 07: Monthly average wind speed difference according to height of the of tower.

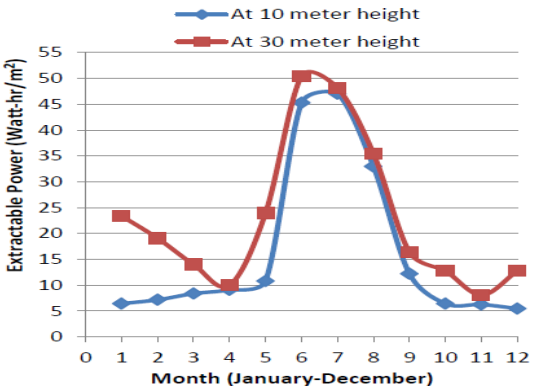

Figure 08: Extractable power difference according to height of the of tower

Additionally, the average extractable wind energy is displayed in Fig. 06 below. Height has an impact on wind turbine power extraction as well. With increasing height comes a higher average wind speed. According to a BMD research conducted on Saint Martin Island, more than 39% more power can be extracted compared with the current towers if they are raised from 10 to 30 meters in height [15].

3.3. Ocean Wave Energy

The ocean's wave directly produces the ocean's wave energy. It goes without saying that this energy source can assist in eliminating the dangerous greenhouse gas emissions associated with power generating. For this, it's a significant and possible source of electricity in Bangladesh. 'The oscillating Water Column Method' is exactly possible and has become economically good in this purpose. Already, many countries are using this type of wave energy harnessing device [16].

3.4. Tidal Energy

Bangladesh is really blessed for having the Bay of Bengal and longer coastal belt which is about 740 KM. In Bangladesh's coastal areas, tidal power, a clean renewable energy source, is an appropriate power source [17]. The tidal stream generator is a means of producing tidal power [18]. Even though it's not utilized much, this could be used to produce electricity in the future. Thus, tidal energy is more anticipated than wind and solar energy [19]. Because of the latest advancements in turbine technology and design, tidal power availability may exceed previously estimated levels due to these developments. Bangladesh, which has a sea to the south, may be able to obtain more energy from the tidal waves if two technologies are applied: low head tidal

movement (two to five meters' head) and medium head tidal movement (five meters or more) [17].

Here, sluice gates and levees in the coastal regions of Khulna, Satkhira, Barishal, Bagerhat, and Cox's Bazar allow for the establishment of low head tides. If water is caught in a coastal basin during high tide and a dead difference is produced during low tide to power the turbine, these water heads could be used with ease. This approach is being used in several wealthy nations [20].

3.5. Hydro Energy

One environmentally benign energy source is hydropower. Bangladesh is a land-flat country with very few exceptions, hence there is no hydropower potential. The main rivers carry a lot of water for five to six months during the monsoon season, but less during the winter [21]. Large hydropower plants and small hydropower plants are the two categories into which the hydropower plant can be divided.

The only dam in Bangladesh where hydroelectric power plants are used to produce energy is the Kaptai Dam. It is located 65 kilometers from Chittagong on Rangamati, on the Karnaphuli River at Kaptai. 1962 saw the start of the Kaptai Dam construction.When operating at maximum capacity, the reservoir can store 6477 million cubic meters of water and 230 megawatts of energy [22]. Additionally, two locations have probably been found for additional hydropower plants, and they can be found in Matamuhuri and Sangu. According to a recent assessment by US-based consulting firm STI, there is a potential for 140 MW of power to be generated by two rivers in the Chittagong hill tracts. The analysis found that the Sangu and Matamuhury, which are designated by the BPDB, have the potential to produce 58.33 MW and 75 MW, respectively. Table 02[23] describes a few possible small hydro sites that BPDB and BWDB have found.

District	Name river/chara/stream	Potential of electrical energy in KW
Chittagong	Foy’s Lake	4
Chittagong	Chotokumira	15
Chittagong	HinguliChara	12

Chittagong Hill Tracts	Sealock	81
Chittagong	Lungi Chara	10
Chittagong	BudiaChara	10
Sylhet	NikhariChara	26
Sylhet	Rangapani Gung	66
Jamalpur	Bhugai-kongsa at 2 miles U/S of Nalitabari P. S	69 KW for 10 months 48 KW for 2 months
Jamalpur	Marisi at Dukabad near Jhinaigati Thana Head Quater	35 KW for 10 months 20 KW for 2 months
Dinajpur	Dahuk at Burabari Chawai at U/S of Chawai L.L.P Talam at U/S of Talam L.L.P Pathraj at Fulbari Tangon at D/S of Nargun L.L. Punarbhaba at Singraban	24 32 24 32 48 11
Rangpur	BhurikhoraChikli at Nizbari Fulkumar at Raigang Bazar	32 48

Table 02: Prospective Hydro Power Plant Sites

3.6. Biomass

Bangladesh is mostly an agricultural nation. There are plenty of agricultural wastes accessible for this. Biomass resources are therefore among the most promising sources of renewable energy. Bangladesh possesses abundant biomass resources, which can provide over 55% of the nation's energy needs [24]. The many forms of residues comprise about 48 percent of the overall biomass and are classified into two categories: (1) Field residue; (2) residue from processing. A significant quantity of energy can be extracted from waste materials such as crop

residues, sugarcane biogases, rice husk, jute sticks, etc. if sustainable optimal techniques are developed. Bangladesh receives 42 MT of agricultural crop leftovers annually, of which 37% and 63% are field residue and process residue, respectively [25]. Considering wood and wood wastes, we can find that there are materials such as leaves, roots, twigs, planer shavings, bark, etc. that have a 100% recovery factor and a yearly recoverable amount of almost 8.871 MT [25]. In Bangladesh, there are over 5000 commercial poultry farms, from which a significant quantity of poultry waste is obtained on a daily basis.

With almost 20619 MT of recoverable animal waste and poultry dropping, the recovery factor for dropping is 50% and for animal waste it is 60% [26]. In addition, a significant quantity of energy can be created from human-made solid waste and municipal solid waste. According to World Bank statistics, the rate of production in rural areas is 0.15 kg/capita/day, while in urban areas, it is between 0.4 and 0.5 kg/capita/day, with a recovery factor of 100%. The estimated amount is approximately 14.793 MT. One kilogram of manure can produce 0.037 m3 of biogas, and the available cattle manure can easily produce 2.50 billion m3 of gas, which is equivalent to 1.28 MT of kerosene or 2.56 MT of coal [25]. [26]. Furthermore, an estimated 4 million biogas plants might be built nationwide, according to an IRRD analysis. where 20% is made up of poultry waste, 75% is made up of cow dung, and the remaining 5% is made up of another biomass [27].

3.7. Nuclear Energy

Bangladesh needs a strong and clearly established source of energy to supply power constantly for long periods of time because the country lacks electricity. Nuclear energy could be a solution to this issue. Over the course of their lives, no other plants can compare to a typical nuclear power station. There is an abundance of uranium and technology that can increase its utilization by sixty times if necessary. And the global mine production is six thousand tons annually. sStockpiles are one source of supply that many marketplaces receive. Electricity is produced using the majority of the supplies. Table 03 provides the typical heat value of several fuels for comparison [28].

In 1963, Bangladesh chose the Roppur location to build its first nuclear power station, and in 2001, the government received a national nuclear power action plan. Finally, in 2010, Bangladesh and Russia reached an agreement to build a nuclear power plant with a 2400 MW capacity and two reactors, each capable of producing 1200 MW of electricity [29]. It is situated

on Roppur, the Pabna subdistrict, alongside the Padma and the Ishwardi. The Roppur nuclear facility was projected to have cost $14 billion to establish.

The Bangladesh Atomic Energy Commission (BAEC) is playing a part in the project's implementation. Bangladesh should adopt the GEN3/GEN3+ reactor system, which is based on technical data and tried-and-true technology for the following considerations:

1. Digital instrumentation and control system
2. Latest safety code for reducing severe accidents, such as Chernobyl, Fukushima disaster and Psychological and physical protection.
3. Simplicity and economically liable and safety consideration.

Ingredients	Calorific value
Natural Gas	38 MJ/m3
Crude Oil	45-46 MJ/kg
Black coal (hard)	24-30 MJ/kg
Black coal (low quality)	13-23 MJ/kg
Brown coal (lignite)	10 MJ/kg
Firewood (dry)	16-18 MJ/kg
Uranium - in typical reactor	500,000 MJ/kg (of natural U)

Table 03: The Calorific Values of Various Fuel

Based on proven technological records, the Russion VVR-1000 MW/VVER-1200 MW nuclear system may be taken into consideration for this Ruppur nuclear project. The agreements state that Russia will provide all necessary support to build up the plant, including fuel and the collection of old fuel; the first unit of the plant may begin operations by 2021, and the second unit by 2025 [30].

IV. FUTURE PLAN

Bangladesh, a developing nation, requires more power to meet demand. Bangladesh has to increase production by building new small and large power plants in order to lessen the country's power crisis. The government of Bangladesh and a few private businesses have created various projects with this topic in mind. By 2017, IDCOL plans to finance 50 solar mini grid projects through a joint financial cooperation with ADB and the World Bank. BPDB

will construct a 60 MW solar park project at Rangunia, Chittagong, on an IPP basis along the Karnafuli River. In Tangail, Sirajgong, there will be a 40–45 MW solar park project, and there will be 2–3 MW in Ishwardi. Some initiatives have been taken in order to create a 15 MW wind power plant in Bangladesh's coastal districts. Wind mapping is now being done at Muhuri Dam and Mognamaghat, which are located on Feni and Cox's Bazaar, respectively.There are plans to extend the onshore wind power plants in Bangladesh's coastal region in addition to building a 50–200 MW wind power facility on Anowara in Chittagong. In addition, BPDB plans to establish a 1 MW off-grid solar diesel hybrid power plant on Kutubdia Island. Additionally, the Rampal Power Plant, a massive coal-fired power plant with a 1320 MW capacity, is part of Bangladesh's future energy generation plans. Similar to this, a new project called the Maheshkhali coal-fired power generation plant is set to be erected, with the aim of producing 1320 MW [1].

V. CONCLUSION

Electrical energy has a major role in the overall development of a society. When considering the energy's per-capital use, the overall progress is easily attainable. Undoubtedly, enhancing renewable energy is one of the most important methods. Bangladesh still needs to rely on fossil fuels to generate electricity, but these resources are extremely scarce. Renewable energy can significantly impact global climate change through the notion of carbon trading. Now is the perfect moment to start contributing to the use of renewable energy sources, such as solar, wind, biomass, hydropower, and others, to generate electricity. With the use of these resources, Bangladesh can generate power and will be able to supply the demand in the future. In order to address our power crisis, the government and private businesses must work together to equitably spotlight the use of renewable energy sources in the production of electricity.

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