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Research Article

Feasible Wind Power Potential from Costal Line of Sindh Pakistan

Mazhar Hussain Baloch, Ghulam Sarwar Kaloi and Jie Wang
Department of Electrical Engineering, Shanghai Jiao Tong University, Shanghai 200240, P.R. China

Abstract: The energy is the serious issue, directly or indirectly, in the whole practice of advancement, development and existence of all the existing creatures. It plays a very important part in socioeconomic growth and social prosperity of any country, at least 1/3rd of the country has no access of energy like electricity. Globally Pakistan is an electricity lacking country, however deficient in oil and gas. Pakistan is rich in sources like water, coal, wind and solar energy. Electricity is the basic needs of all human's comfort and in addition to overcome power crises in common, Pakistan desires in the way to utilize its natural power assets similar to hydel power plant, sunlight and wind potential for the generation of electricity. Pakistan has surely considerable latent for exploiting wind energy. Additionally about 1000 km lengthy shoreline in southern and northern hilly areas offers an outstanding reserve of wind potential. The efforts need for utilization of wind energy in the country. This study includes only twenty selected regions of southern regions of Sindh province for power generation from a natural source of wind energy.

Keywords: Wind coastal areas of Sindh etc., wind energy potential, wind speed curve

INTRODUCTION

Energy is a fundamental element of combined human being growth in terms of development. The power situation and fossil fuel have three major concerns, the impact of environment, depletion resources and energy supply issues. The non-conventional resources are much more important for the human development. Suppose biomass used for heating, cooking and steam production, wind potential and hydro power to generate the electricity. The renewable energy sources are environmentally friendly. Power crisis, increasing day by day, the Production ratio of fossil fuel was reported by reverse of North of America, Europe and Pacific Asia was 10, 57 and 40 years respectively (Makkawi *et al*., 2009). It is necessary to reduce reliance on oil to achieve stable energy supply. The wind energy power potential is one of the renewable energy sources which can meet the increasing demand of the country (Harijan *et al*., 2009). In this research study it employs the chief hourly ideals of wind potential speed to draw the wind speed, duration curves and to analyze the wind potential produces electricity from 20 sites in the coastal line of the southern region of Sindh.

Geographical profile of Pakistan: The Pakistan is 8,03,950 km^2 in area, it is divided into five regions called provinces Baluchistan, Sindh, Punjab, Gilgitbaltistan and Khyber Pakhtun Khawa (KPK) including Tribal Areas (FATA and FANA). It has large mountains in ranges of the Karakorum's, Himalayas and the Hindukush from Pakistan, northern uplands of KPK Northern Tribal Areas. Baluchistan Plateau is mostly dry soil, surrounded by dry mount. Thar Desert is on the east, the Ran of Kutch is on the west of the Kirther in Sindh provinces. Punjab provinces are generally in a straight line, alluvial natural with five major rivers overlook the higher area, ultimate unification the River Indus flows from south towards the Sea of Arabian (Mirza *et al*., 2003). The Islamic republic of Pakistan is located between latitude 24-37' North and longitude 62-75' East. In the east of Pakistan is Hindustan, in the west, Iran, China north side, north-west side is Afghanistan and Arabian Sea on the south side. Geographic map is shown in Fig. 1.

PAKISTAN ENERGY PROFILE SITUATION

The Pakistan energy profile is well reliant on oil, liquefied gasoline and natural gas, it is about eighty 5% of the whole supply of 44465 (million tons oil equivalent). The Coal contribution is not more than 4.5% of the overall supplies, 1.1% is the nuclear energy and the lasting 9.2% is abounding by hydro electricity (Mirza, *et al*., 2003). In 2000, country was producing nearly 56000 barrels of crude oil/day get-together. Almost 15% of the domestic oil demands. The enduring

Corresponding Author: Mazhar Hussain Baloch, Department of Electrical Engineering, Shanghai Jiao Tong University, Shanghai 200240, P.R. China, Tel.: +8613262625182

Fig. 1: Geographic map

85% was traded in from the Middle East with a rate of 2.4 billion US Dollar, which is equivalent to 30% of the state entire export income (GoP, 2001). The country's economy is more dependent on oil imports. The solid petrol coal assets are in the huge capacity of approximately 2265 metric tons relatively better. On the other hand the domestic coal is not utilized to a large extent in Pakistan due to its low class in provisions of heating significance and large quantity of sugar. For that reason, the instant of household creation of coal is only of million 3.3 tons annually (World Energy Council, 2001). In the period of 2008-09 energy resources such as natural gas, oil, nuclear, coal and Liquefied Petroleum Gas (LPG) contributes 48.3, 32.1, 11.3, 7.6 and 0.6% respectively of the primary energy supply in a row. The share of primary energy supplies by various sources in MTOE (PEYB, 2009).

PAKISTAN POWER SECTOR PROFILE

At the Pakistan independence, it was 60 MW energy production potential for population 31.5 million, resulting in 4.5 kWh/individual utilization. In 1964-1965, power generation capacity rises to 636 MW, in 1959 and energy production to about 2500 kWh. By the end of 1970, production increases from 636 to 1331 MW with the installation of thermal power houses and hydroelectric. In the year 1980 touched 3000 MW capacity of the system, which quickly climbs to more than 7,000 MW in 1990-91. A rapid development in Karachi in the 1990s also witnessed tremendous industrial and commercial houses built leading up to the sudden boost in demand for electricity. As a result, it has been approved Karachi Electric Supply Company (KESC) license for generation, transmission and

Table 1: Installed power generation capacity by sector wise

Year	Hydro plant capacity (MW)	Nuclear plant capacity (MW)	Thermal (Pvt) plant capacity (MW)	Thermal (Pub) plant capacity (MW)	Wind plant capacity (MW)
2011	6516	650	8880	4829	0
2012	6516	650	8381	4841	0
2013	6733	650	8381	4841	50

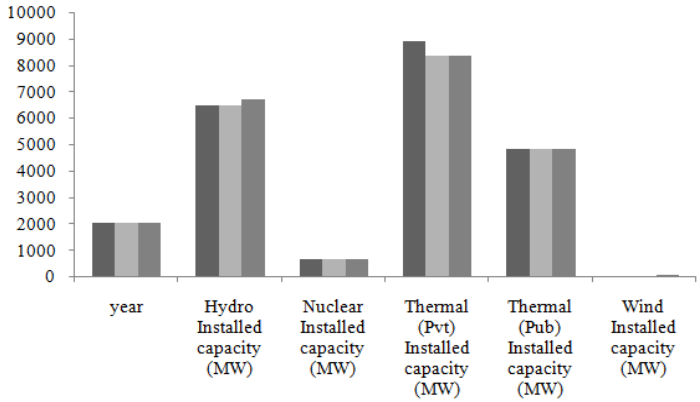

Fig. 2: Installed power generation capacity by sector wise

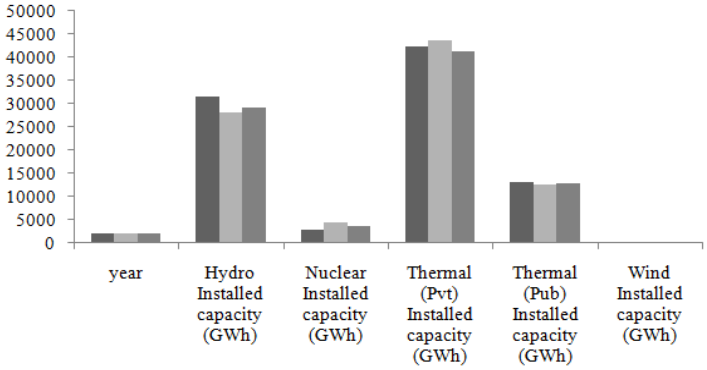

Fig. 3: Power generation by sector wise

distribution of power in its licensed area. The restructuring of the energy sector in 1998 with the formation of Pakistan Electric Power Company (PEPCO). Before 1998, there were two vertically incorporated utilities, the Karachi Electric Supply Company served in the Karachi region where as Water and Power Development Authority served in the rest of the part of the country. Afterward, it has been structured wing power in WAPDA to a distinct corporate entity, which consists of 4 Generation Company (GENCOs) and eleven distribution company's discos and one Transmission Company (NTDC). Ten Discos are responsible for delivering power to the consumer.

In the 2000s, the annual electricity use in the residential sector has increased. In the year of 2006, the Asian bank approximated that 45% of Pakistan resident's lack of power (Pakistan Energy Book, 2001). Power crisis worsens in Pakistan in 2008 and the shortage of electricity has increased up to 4000 MW.

PAKISTAN PRESENT ENERGY SCENARIO

Installed different power sector: Table 1 shows the total installed power generation from different sectors in the Pakistan in the year 2012-2013 (ADB, 2006). Figure 2, shows the installed power generation capacity through the sector wise by the year 2012-2013, from Fig. 2, it is observed that from wind energy, which is free source available not to utilize for the generation of electricity.

Power generation by sector wise (reports): Figure 3 shows the generation capacity by sector wise in the year 2012-2013, from the graph it is observed that different sources have been utilized for the generation of electricity even wind energy, but the ratios of wind potential for the generation of electricity near to zero, the source which can never be finished.

Power demand sector wise (reports): Figure 4 shows the total power consumed in different sectors.

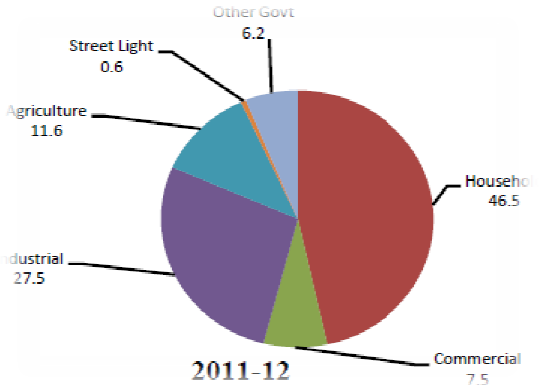

Fig. 4: Electricity demand sector wise

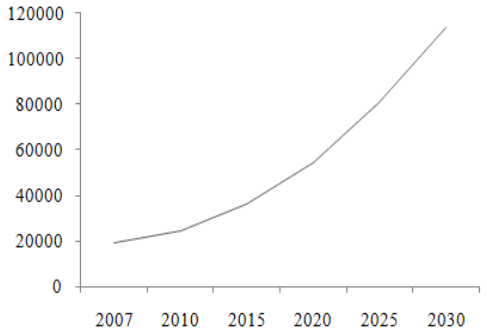

Fig. 5: Load forecast by country

Load forecasting: In Pakistan the demand of power energy, increasing day by day and is projected to continue high due to increasing demand of the consumer. The total demand is projected with increase factor between approximate 5.6 to 8.2 only. Several features of-fects the load growth and these features are tough to forecast and estimate (Reports. Electricity demand forecasted based on regression analysis 2008-2030). Figure 5 shows the load forecasts of Pakistan, where it is observed that in future Pakistan facing difficulty.

GLOBALLY WIND POWER SECTOR SCENARIO

Globally, China is top of which had installed capacity of almost 75,324 MW in 2012 and as compared to 404 MW in 2001. Similarly, USA had installed capacity of 60,007 MW in 2012 in comparison of 2001 that was only 4,275. Spain has always tilted toward protecting the environment and the spread of the widespread use of wind turbine technology reiterate the country's requirements of green energy. Began with nearly 3337 MW in capacity and 2001 installed increase of up to 22 796 MW in 2012. The India each year jumped from 1456 MW in 2001 to approximately 18 421 MW in 2012. It is expected that in the future

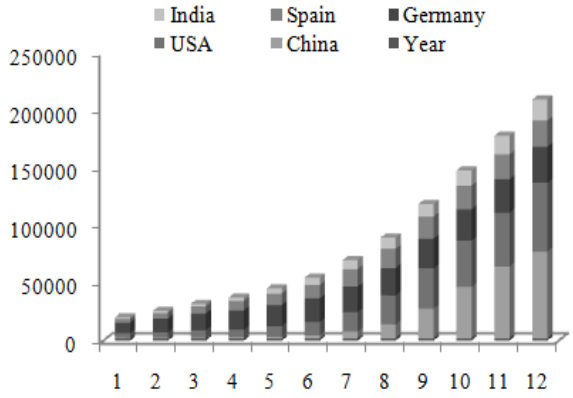

Fig. 6: Globally, wind power plant scenario

India may actually exceed the nation's largest and most sophisticated that use alternative energy (Fig. 6).

Sindh wind power sector scenario: Globally, cumulative production capacity is forecast to increase almost 500 Giga watts by 2016. This is more than double the figure recorded in 2011. Sindh coastal line winds speed, approximate about 5 to 7 m/sec (Sheikh, 2010). It is investigated that Pakistan has supplementary wind power generation potential about 20,000 MW out of which about 11000 to 14000 MW capacity in the coastal line of Sindh. Globally, renewable power wealth has huge potential and can meet the world power mandate. The world can boost power source into the markets, safe and secure extended periods of the viable power supplies and diminish global atmospheric conditions. It also offers commercially smart opportunities to come across the definite prerequisites for energy services mainly for rural areas and developing countries, then it will produce occupation openings for local public, and it will also become the promise of indigenous trade for the industrial side for manufacturing point of view. It is therefore expected that proper utilization of wind potential within Sindh then it may fulfill the mandate of power crises. Alternative Energy Development Board signed the agreement in 2004 to install wind farms. In this admiration, at the moment sixteen engineering wind farm selling that stay delivering wind turbines. The plan was to complete wind power capacity of about 2000 MW at the end of year 2010 (Muneer and Asif, 2007).

Study area: The windy area in mapping is about 1000 km of coastal line of Sindh. According to the survey, windy areas of Sindh coastal line are given here (Reports. Pakmet). The 20 selected sites have been chosen for wind power potential. Badeen, Baghhan, Chuhr Jamalee, DHA Khi, Ghharo Golarchee, Haks bay, Haiderabad, Jaamshoro, Jatee, KHI, Katee Bandr, Matlee, Mirpursakro, Nooryabad, Sajawal, ShahBandar, Talhaar, Thano Bula Khan and Thattaas shown in Fig. 7.

Fig. 7: Map of windy areas of Sindh region

Table 2: International wind power generation classification

		At 30 m altitude		At 50 m altitude	
S. No.	Class	Wind speed (m/sec)	Wind power (watt/m^2)	Wind speed (m/sec)	Wind power (watt/m^2)
1	-	0-5.1	0-160	0-5.6	0
2	Marginal	5.1-5.9	160-240	5.6-6.4	200-300
3	Moderate	5.9-6.5	240-320	6.4-7	300-400
4	Good	6.5-7	320-400	7-7.5	400-500
5	Excellent	7-7.4	400-480	7.5-8	500-600
6	-	7.4-8.2	480-640	8-8.8	600-800
7	-	8.2-11	640-1600	8.8-11.9	800-2000

International wind power generation classification (Jannati *et al*., 2014): It is necessary to make simpler wind potential classification and it is a collective exercise to all outsides for installing the wind mill unit. In Table 2 shows the classification of wind, each class showing the wind speed in m/sec and wind power in watts/m^2 at 30 m height and at a 50 m altitude beyond the earth level. The international standards of wind power generation classifications shown in Table 2. The sites being settled using large wind power generation turbine are marked in class number 5 and above that approach in outstanding categories. Class number 4 also is also being considered for future development for further development of the country. The category number 1 and 2 are only designed for smaller wind.

Technical survey data: Figure 8 shows the potential of wind at 20 selected region of the Sindh at 10 m height.

Figure 9 shows the potential of wind at 20 selected region of the Sindh at 30 m height.

Figure 10 shows the potential of wind at 20 selected region of the Sindh at 50 m height.

ESTIMATED RESULTS AND DISCUSSION

Typically, power generation by wind energy technologies is a significant factor; meanwhile it

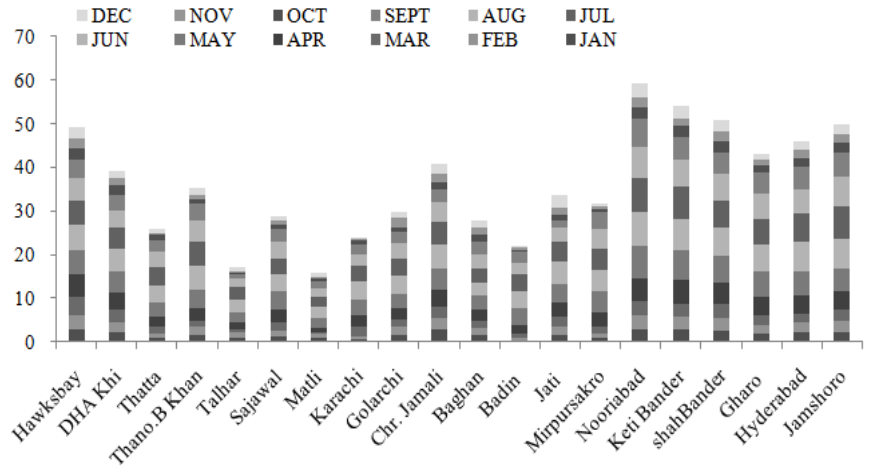

Fig. 8: Average monthly wind speed at 10 m height

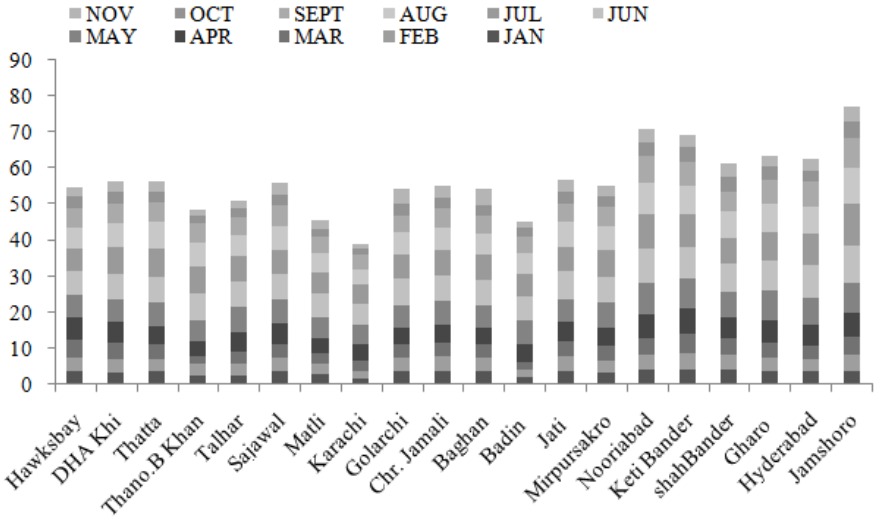

Fig. 9: Average monthly wind speed at 30 m height

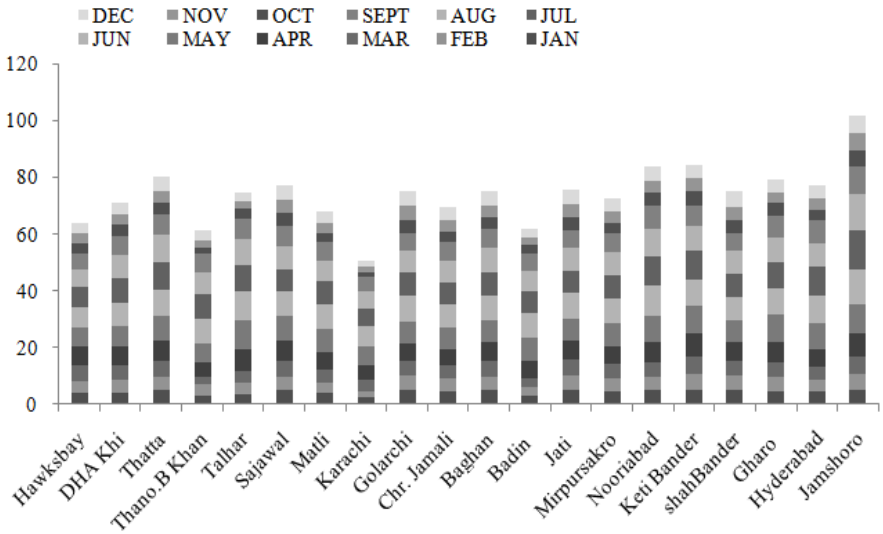

Fig. 10: Average monthly wind speed at 50 m height

Table 3: Hypothetical wind generator bonus 600/44 MK IV turbine (global statistics: 2012-2016)

Name of turbine	Pin (kW)	Windcut in speed (m/sec)	Windcut out speed (m/sec)	Rotor diameter (m)	Hub height (m)
Bonus 600/44 MK IV	600	3	25	44	50

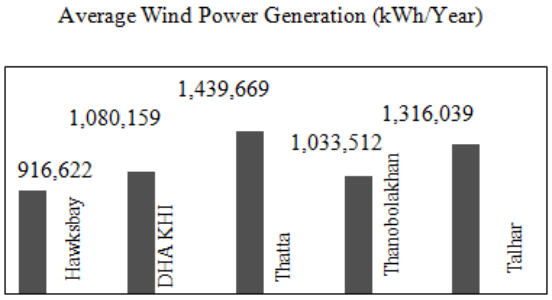

Fig. 11: Annual average generated units from different cities

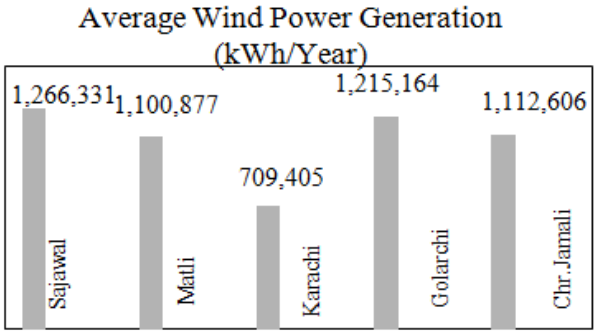

Fig. 12: Annual average generated units from different cities

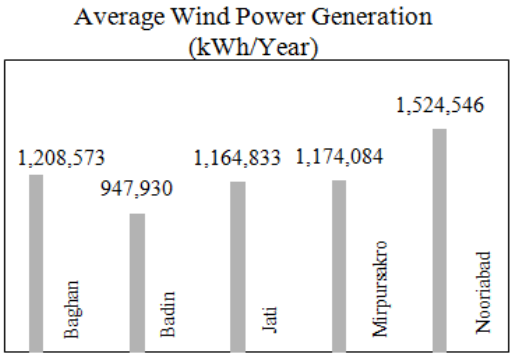

Fig. 13: Annual average generated units from different cities

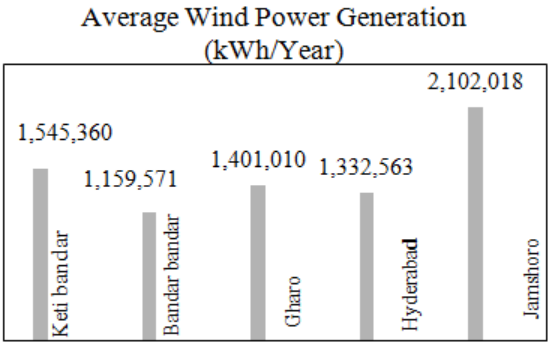

Fig. 14: Annual average generated units from different cities

concludes the wind energy yield with respect to time. Hypothetical wind generated electric power output at 20-locations of the southern region of Sindh province has been estimated by using Table 3.

Fig. 11 to 14, shows the estimated power generation from different locations. In Fig. 11 power is generated in kWh per year, so it is observed from the Fig the maximum power is generated from the Thatta region averagly.

In Fig. 12 powers are generated in kWh per year, so it is observed from the fig the maximum power is generated from sajawal regional averagly.

In Fig. 13, power is generated in kWh per year, so it is observed from the Fig the maximum power is generated from nooriabad regional averagly.

In Fig. 14, power is generated in kWh per year, so it is observed from the Fig the maximum power is generated from Jamshoro region averagly.

CONCLUSION

Sindh province has an electricity shortfall of about 1500 to 2000 MW in summer season and 1000 to 1500 MW in winter season, Sindh has a considerable possible for harnessing wind energy to generate the power, it is estimated that about 11000 MW can be generated from wind potential from Sindh coastal lines only. The study concluded the 20 locations of the Sindh region in coastal lines for wind energy. The wind energy is the free source of energy, and it is the environment friendly source. Wind energy would protect from pollution and also reduce the oil imports automatically; it will improve the socioeconomic conditions of the human life. From the result, it is observed that from 20 locations the Jamshoro has the maximum wind potential having the annual average potential wind speed is about 7 m/sec at the height of 30 m, similarly at 50 m height, average wind potential speed is about 8.5 m/sec, internationally, at 50 m and 8.5 m/sec height and speed respectively, comes in the excellent category having the annual average capacity factor of about 40%. Finally, it is suggested Sindh, Pakistan must proceed to exploit the free source for the generation of electricity.

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