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Desert Power Potential in India – A Case Study

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***Abstract*- I firmly believe that India should accelerate the use of all forms of renewable energy (photovoltaic, thermal solar, solar lamps, solar pumps, wind power, biomass, biogas, and hydro), and more proactively promote energy efficiency. However, in this article, I will only focus on the use of Concentrated Solar Power (CSP) technology to meet India's future energy needs.**

The India's Desert has the potential to become the largest solar power plant in India. Due to high levels of available sunlight, CSP plants could begin satisfying most of India's energy needs in just few years. India's potential benefits from solar power are as numerous as the sands of desert, and include reduced dependence on fossil fuels and a cleaner environment. These benefits can be realized by installing renewable energy technologies, such as CSP, to protect the environment while diversifying energy resources and helping to lower prices. Solar power can also reduce strain on the electric grid on hot summer afternoons, when air conditioners are running, by generating electricity where it is used. India has optimal conditions to use CSP to harness solar energy from the Desert. However, to take advantage of this innovative technology, potential CSP plant sites must be identified and deployment accelerated. Specifically India needs to heavily subsidize Solar and Wind Power projects just like Japan, Germany and other European nations are doing. The use of renewable energy has great potential to create more jobs in India especially in the rural areas.

***Index terms*- Concentrated Solar Power, Renewable Energy, Solar Photo Voltaic**

I.INTRODUCTION

Energy needs of the country is growing at a very fast pace to meet high GDP growth rate. To meet growing demand and to reduce supply-demand gap, there is a need of large capacity addition through conventional as well as from renewable sources. However, to achieve sustainable growth, energy security is of paramount importance.

Considering the depleting domestic fossil fuel reserves in the country as well as increasing demand for energy consumption along with environmental concern, there is a need to harness alternate sources of energy. Abundant Renewable Potential in the country presents excellent solution to meet above challenges i.e. attaining energy security – Access & Delivery at affordable price along with addressing climate change concerns.

Country has immense Solar potential, provided land is available for setting up of such large sized plants. The largest accessible but least tapped form of energy on the earth is solar radiation on desserts. India has large deserts (both Hot & Cold) viz. the Thar (Rajasthan), Rann of Kutch (Gujarat), Ladakh (Jammu & Kashmir) and Lahul & Sipti valley (Himachal Pradesh) having total geographic area (TGA) of over 330,000 Sq km out of which total wasteland area is over 148,000 Sq km. A fraction say about 5-10% of total wasteland (7400-14800 sq km) can produce 220-450 GW from solar and wind generation which can address the future energy challenges in the country to a large extent.

II. POWER SUPPLY SCENARIO OF INDIA

A. Present Power Scenario

Indian Power Sector is at a crucial juncture of its evolution from a controlled environment to a competitive, market driven regime which endeavors to provide affordable, reliable and quality power at reasonable prices to all sectors of the economy. The

Indian power sector is one of the most diversified in the world. The Sector has been continuously progressing in generation capacity addition through conventional viz. Coal, lignite, gas, hydro and nuclear power as well as non-conventional/renewable sources viz. wind, solar, small hydro and agriculture & domestic waste.

India is the world's third largest producer and third largest consumer of electricity. The national electric grid in India has an installed capacity of 364.17 GW as of 31 October 2019. Renewable power plants, which also include large hydroelectric plants, constitute 34.86% of India's total installed capacity. During the 2018-19 fiscal years, the gross electricity generated by utilities in India was 1,372Twh and the total electricity generation (utilities and non utilities) in the country was 1,547 Twh. The gross electricity consumption in 2018-19 was 1,181 kWh per capita. In 2015-16, electric energy consumption in agriculture was recorded as being the highest (17.89%) worldwide. The per capita electricity consumption is low compared to most other countries despite India having a low electricity tariff.

B. Future Power Scenario

The demand for electricity in the country has been growing at a rapid rate and is expected to grow further in the years to come. In order to meet the increasing requirement of electricity, massive addition to the installed generating capacity in the country is required. While planning the capacity addition programme, the overall objective of sustainable development is to be kept in mind.

To meet growing demand and to reduce supply-demand gap, there is a need of large capacity addition through conventional as well as from renewable sources. India will have an annual energy demand of about 14,500 TWh per year (with a moderate CAGR of 6.7% till 2050).

III. DESERT POWER POTENTIAL

In order to assess economic potential of renewable power generation in deserts and chalk out its phased development plan, India has facilitated waste-land data for the States of Gujarat, Rajasthan, Himachal Pradesh and Jammu & Kashmir to carry out present study.

A. Wasteland Utilisation

Data comprises information on district wise wasteland availability in the States of Gujarat, Rajasthan, Himachal Pradesh and Jammu & Kashmir. It comprises thirteen (13) types of waste land, classified in following categories:

- Gullied and/or Ravinous Land
- Upland with or without Scrub
- Waterlogged and Marshy Land
- Land Affected by Salinity/Alkalinity Coastal/Inland
- Shifting Cultivation Area
- Under-utilised/Degraded notified Forest Land
- Degraded Pastures/Grazing Land
- Degraded Land under Plantation crop
- Sands-Inland/Coastal
- Mining/Industrial Wastelands
- Barren Rocky/Stony Waste/Sheet Rock Area
- Steep Sloping Area
- Snow Covered and/or Glacial Area

As this study is primarily confined to harness desert power potential in Hot deserts viz. The Thar in Rajasthan & Rann of Kutch in Gujarat and Cold deserts viz. Ladakh in J&K & Lahul & Spiti Valley in Himachal Pradesh, Waste land data is segregated for the districts falling under the above deserts only. Out of above 13 types of wastelands, detailed study has been carried out on suitability of type of wastelands for setting up Renewable generation plants.

As per Study four (4) types of wasteland is Difined, which are found suitable for setting up of Renewable Generation Plants.

- Upland with or without scrub
- Under-utilised/Degraded notified Forest Land
- Sand/Inland/costal
- Barren Rocky/Stony Waste/Sheet Rock Area

B. International efforts on Desert Development

Internationally also, lot of work is being carried out in the domain of Desert Power Potential development. In 2009, the DESERTEC Foundation was founded by public figures, private individuals, politicians and scientists from North Africa, the Middle East and Europe with this aim: to support the systematic use of renewables in deserts and arid regions worldwide as laid down in the DESERTEC Concept. DESERTEC foundation is exploring towards future energy challenges of Europe, Middle

East and North Africa (EUMENA) through development of renewable potential of North African Deserts. Objective of this project is to produce electricity from renewable energy sources in the resource rich desert areas of North Africa and exported to regions through transmission facilities having high demand as the“ DESERTEC Vision” .The vision of generating electricity in the Sahara desert and exporting it to Europe came into lime light after Mediterranean Solar Plan (MSP) was launched in 2008.

The objective of solar plan is to create 20GW of renewable generating capacity in the Mediterranean region by 2020. Another program in this series i.e. Desertec Industrial Initiative (DII) aims to provide 15% of European electricity consumption as well as a significant proportion of domestic demand in North Africa by 2050. Desertec Industrial Initiative (DII) is a private industrial consortium working towards enabling this vision in Europe, the Middle East and North Africa (EUMENA). It is envisaged to develop renewable projects in Sahara desert to generate 100GW by 2050 and export to Europe and African continents under this initiative. The overall objective of DII is to create a market for renewable energy from the deserts.

IV. DESERT POWER INDIA

Realising need of large scale development of solar power including identification of infrastructure requirement & its grid integration upto 2050, Ministry of New and Renewable Energy (MNRE) have entrusted POWERGRID to make an assessment of renewable generation potential and evolve infrastructure requirements including transmission arising out the likely large renewable power projects in India’s desert regions of the states of Rajasthan (The Thar), Gujarat (Rann of Kutch), Himachal Pradesh (Lahul & Spiti valley) and Jammu & Kashmir (Ladakh), for up to 2050 time horizon, with phased development plans.

In view of the availability of the desert waste land data at the moment, above Terms of reference is divided into different phases. Phase-1, the present study, covers following scope of works:

- Estimated cost of Renewable Capacity
- Demand assessment
- Transmission infrastructure requirement for renewable evacuation & its integration into grid
- Associated grid balancing and spinning reserve infrastructure requirements to address intermittency & variability
- Impact of large scale renewable power on local communities, including positive economic spillovers etc.

A. The Thar (Rajasthan)

Great Indian desert-Thar is spread over the states of Rajasthan, Punjab, Gujarat and Haryana. In present case, Thar region spread over Rajasthan has been considered.

As per the information, Total Geographic Area (TGA) of Rajasthan is 3,42,239 sq km out of which about 30% (1,05,639 sq. km) is classified under 13 nos. wasteland categories in Rajasthan.

The Great desert of Thar, in Rajasthan is spread over 12 districts of Rajasthan viz. Bikaner, Barmer, Churu, Hanumanghar, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagpur, Pali, Sikar and Shriganganagar encompassing 2,08,751 sq km TGA out of which about 57,539 sq. km (54% of total wasteland) area falls under identified four categories of wastelands.

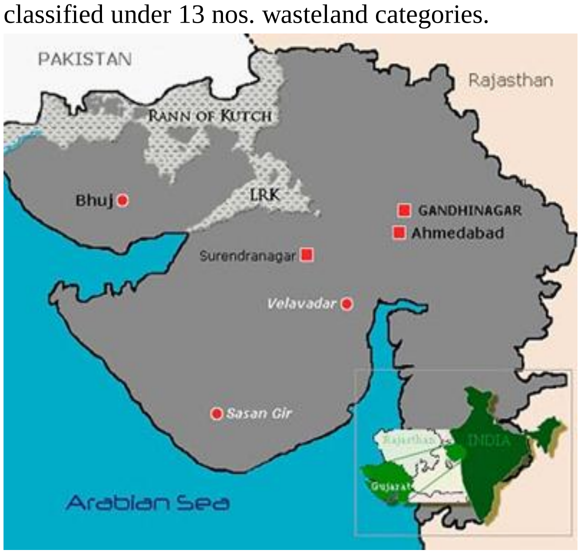
As some of the area falls under “Protected Area” classification, 15 % of land utilization is being considered out of above identified area of wasteland (57,539 sq. km). In other ways, categorized wasteland area is half of the total wasteland in Rajasthan, therefore proposed wasteland scenario of 15% shall be accounting for only 8% of total wasteland (1,05,639 sq. km) in Rajasthan.

Further, as desert of Thar has good Wind Potential also, Hybrid model of Wind & Solar potential is envisaged to be harnessed utilizing identified wasteland in an optimal manner also reaping out benefit of diversity of resources. In such model, typically 30% of the wasteland area is proposed to be utilized for Wind Turbine installation and balance 70% towards Solar Generation. The 70: 30 ratio (Solar: Wind) is adopted for optimal utilisation of land as solar generation yield per sq km (30-40 MW/ sq km) is 3-4 times more compared to wind generation (8-9 MW/ Sq km).

Choosing a lower land utilisation for Solar like 60: 40 (Solar: Wind) may reduce the total installable renewable potential. Further, an optimistic land utilisation scenario like 80:20 (Solar: Wind) may devoid the benefit of diversity of natural resources which may behave complementary at times.

B. Rann of Kutch (Gujarat)

Total Geographic Area (TGA) of Gujarat is 1, 96,024 sq km out of which about 22% (43,021 sq. km) is classified under 13 nos. wasteland categories.



Rann of Kutch, is a salt marsh, or "salty desert" of Kutch (Kutch is the district of which this region belong to). This seasonally marshy land covers a region of more than 12,000 Sq.km and is divided into Little Rann of Kutch and Great Rann of Kutch. Great Rann of Kutch, reputed as the largest salt desert in the world, spans an area of 7505 Sq. km. The Little Rann of Kutch occupies 4,953 sq. kms of land and is spread over majorly in the Kutch district, which has been considered. Some of the area of little Rann of Kutch is also extended in the districts of Surendranagar, Banasakantha, Patan, and Rajkot in Gujarat as it falls on these district boundaries.

As mentioned above, the Rann of Kutch, is spread mainly in Kutch district of Gujarat. Kutch district has total 45,652 sq km TGA comprising over 12,607 sq. km in four categories of wasteland , which is about 29% of total wasteland area (43,021 sq. km) of Gujarat. In view the limitation of the data exclusively for Rann of Kutch, it is assumed that majority of the above wasteland shall be falling in Rann.

As majority of the above area in Rann falls under “Protected Area” classification as well as the terrain condition, only 10 % of wasteland utilization is being considered out of above identified four (4) categories of wasteland (12,607 sq. km). In other ways, categorized wasteland is 29% of the total wasteland in Gujarat (43,021 sq. km), proposed wasteland scenario of 10% utilisation constitute only 3% of total wasteland (43,021 sq. km) in Gujarat.

Further, as Rann of Kutch also has good Wind Potential, Hybrid model of Wind & Solar potential is envisaged to be harnessed utilizing identified wasteland in the ratio of 70% (Solar) : 30% (Wind).

C. Lahul and Spiti (Himachal Pradesh)

As per the information, Total Geographic Area (TGA) of Himachal Pradesh is 55,673 sq km, out of which about 57% (31,659 sq. km) is classified under 13 nos. wasteland categories in Himachal Pradesh (Fig 3-17). Lahul & Spiti district comprise over 2,394 sq. km in identified four (4) categories of wasteland, which is about 7.5% of total wasteland area (31,659 sq. km) of Himachal Pradesh.

In view of the very tough terrain conditions of Lahul & Spiti, only 5% land use scenario has been considered out of identified wasteland area (2,394 sq. km). In other ways, proposed wasteland scenario (5%) will constitute only 0.4% of total wasteland (31,659 sq. km) in Himachal Pradesh. Since, Lahul & Spiti doesn't posses good wind Potential, only Solar potential is envisaged to be harnessed utilizing identified wasteland.

D. Ladakh (Jammu and Kashmir)

Total Geographic Area (TGA) of Jammu and Kashmir is 1, 01,387 sq km out of which about 64.5% (65,444 sq. km) is classified under 13 nos. wasteland categories in J&K. Ladakh cold desert comprises of Ladakh & Kargil districts which is over 31,212 sq. km in selected in four categories of wasteland, about 48% of total wasteland area (65,444 sq. km) of Jammu and Kashmir.

In view of the very tough terrain conditions of Ladakh, only 5% land use scenario has been considered out of above area of wasteland (31,212 sq. km). In other ways, proposed wasteland scenario of 5% land use shall constitute only 2.4% of total wasteland (65,444 sq. km) in Jammu and Kashmir.

Further, as Ladakh have good wind potential for large scale generation as well, Hybrid model of Wind & Solar potential is envisaged to be harnessed utilizing identified wasteland in the ratio of 70% (Solar): 30% (Wind).

V. RESOURCE ASSESSMENT ON DESERT WASTELAND

From above identified waste land in four (4) deserts, renewable generation potential in each of the desert has been assessed.

In view of the above, installable Solar & wind generation has been considered as 35 MW/sq km & 9 MW/sq km respectively for present analysis.

Concept of hybrid system combining wind turbines and Solar PV/CSP systems is also gaining importance as researchers have come out with an analysis that combining wind turbines and photovoltaic systems results in up to twice the amount of electricity being generated across the same surface area, while shading losses caused by wind turbines amount to a mere 1 to 2% – much less than previously thought. Further, this model provides an additional benefit as this may not require additional grid expansion because RE plants generate wind and solar power at different times of day and during complementary seasons (typical yearly pattern of Wind/Solar in Fig-3-19), which may utilise the same transmission system. This also ensures Renewable energy fed into the grid is steadier than that of wind or Solar PV/CSP alone.

It is assessed that desert may offer renewbale potential development of about 315 GW depnding of the usability of wasteland (5-15% of selected 4 wasteland categories), as indicated above. With the increased usability of wasteland, installable potential would be far higher than above estimates.

However one of the most important aspects of development of such a huge qauntum of desert solar potentai is its economic viability. Therefore subsequent section discusses the grid parity projections for utility scale solar generation.

VI. CONCLUSION

This study was carried Considering the depleting domestic fossil fuel reserves in the country as well as increasing demand for energy consumption along with environmental concern,. During the course of the study, solar and wind power projects sites were visited to develop understanding on the environmental externalities of the projects.

REFERENCES

[1] http://www.globalconstructionreview.com/perspectives/indias-grand-plan-turn-its-deserts-solar-farms6253/.
[2] https://niti.gov.in/writereaddata/files/175-GW-Renewable-Energy.pdf
[3] L. Horvath, Potential of Renewable Energy Sources in Croatia, Energy Institute Hrvoje Požar.
[4] Energy Institute Hrvoje Požar, Energy from Biomass,http://www.menea.hr/wp-content/up-loads/2013/12/7_biomasa.pdf, accessed: 6 July 2014.
[5] Sherwani, A. F., Usmani, J. A., Varun, & Siddhartha. (2011). Life cycle assessment of 50 kWp grid connected solar photovoltaic (SPV) system in India.
[6] International Journal of Energy and Environment, 49-56.
[7] http://www.mnre.gov.in/mission-and-vision-2/mission-and-vision/ . (n.d.).