

# Trends of Biogas Development and Usages in Developing Countries-A Case of Bhutan

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## Abstract

Renewable Energy Sources are a much-talked topic in recent times in the field of the energy system. As significant threats and challenges are poised for the health and environment by fossil fuel-based energy sources in meeting the energy requirements, there are initiatives and approaches taken to promote the usage of renewable energy. The thirst for green energy and sustainability approach is a promising move. Significant advancement has been taken on renewable energy worldwide including Bhutan which is cautiously investing in renewable energy sources for energy self-sufficiency and export too.

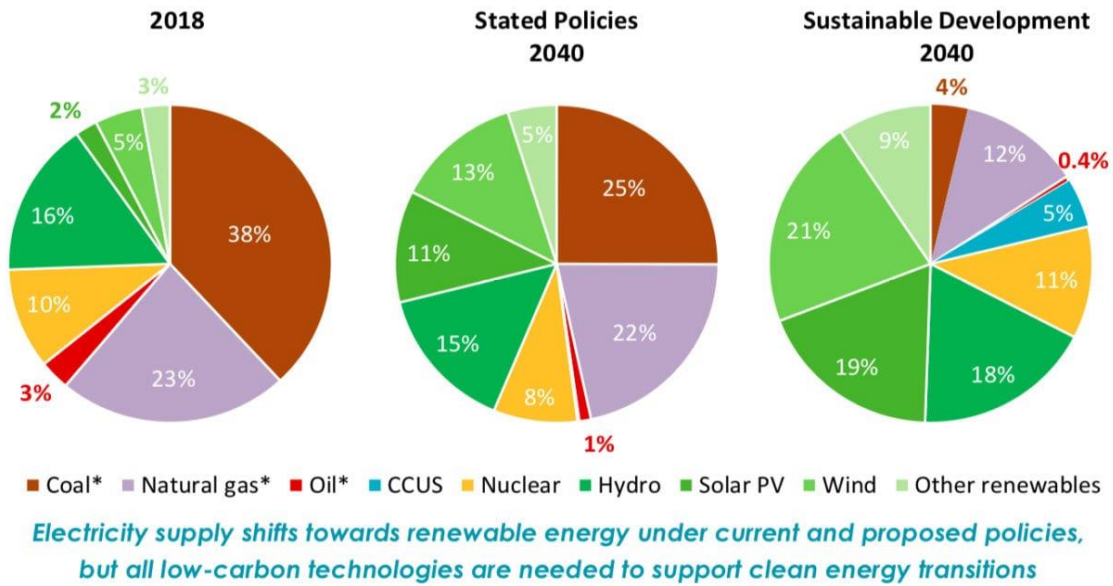
One of the promising incorporations Bhutan has made in usages of biogas fuel in small scales meeting the household demand of cooking fuel which otherwise has to be from wood-based, Liquid Petroleum Gas (LPG) and electricity. The study showed the trend of increasing development of biogas plants and usages of biogas in the case of Bhutan in a recent decade than was actually initiated in 1980. There is a clear indication of conducive and favorable policies, guidelines and support measures by the identified nodal agencies. The success of the Bhutan Biogas Project (BBP) in realizing the growth of biogas in recent times in Bhutan is impressive whereby the trend of firewood and LPG usage have been compensated to the greater extends especially in rural sectors of the country where access to other clean sources of energy is still quite expensive and challenges. Multiple dimensions of strategies are vital for energy transition whereby the relevant policies, guidelines and timely support proved to be one crucial action that can facilitate users to switch into cleaner approaches (especially biogas). Such promises of experiences from the actions from Bhutan in the promotion of biogas can be handy in strategic planning of similar actions elsewhere where the promotion of biogas has not been quite impactful.

## Keywords

Renewable Energy, biogas, fossil fuel, clean sources, Bhutan

## INTRODUCTION

Globally there is increasing pressure mounting day-by-day for the judicious choice of energy sources in meeting the energy demand. Discussion and initiatives through strategic interventions have been taken across the globe in realizing the Sustainable Development Goals (SDGs) and being climate ambitious. In energy sectors, renewable sources are preferred over fossil fuel due to their inherent environmental benefits as most sought and countries are prioritizing the same. As we have to go for sustainable development keeping in mind our energy consumptions, the need to strategize on the policies and regulations which are targeted to sustainable development are key indicators that can create a transition in energy sectors and their services. Sustainable planning, executing and utilizing of energy resources play major roles in realizing the transition to greener energy where roles played by all walks of people become vital.



\* Excludes capacity equipped with CCUS.

Figure 1. The energy transmission diagram [1]

There is a clear indication from the above figure on how the energy transitions look like under the stated policies and sustainable development in 2040. The model of sustainable development 2040 foresees the wider penetration of greener energy sources which is a race every country visualizes in near future.

As the growth of renewable energy in energy sectors is seen making efforts and progress, the need for a holistic energy mix needs to be taken care of for deriving balanced contribution. The energy transitions have to be critically figured out so that significant impacts can be achieved in the right manner at the right time frames.

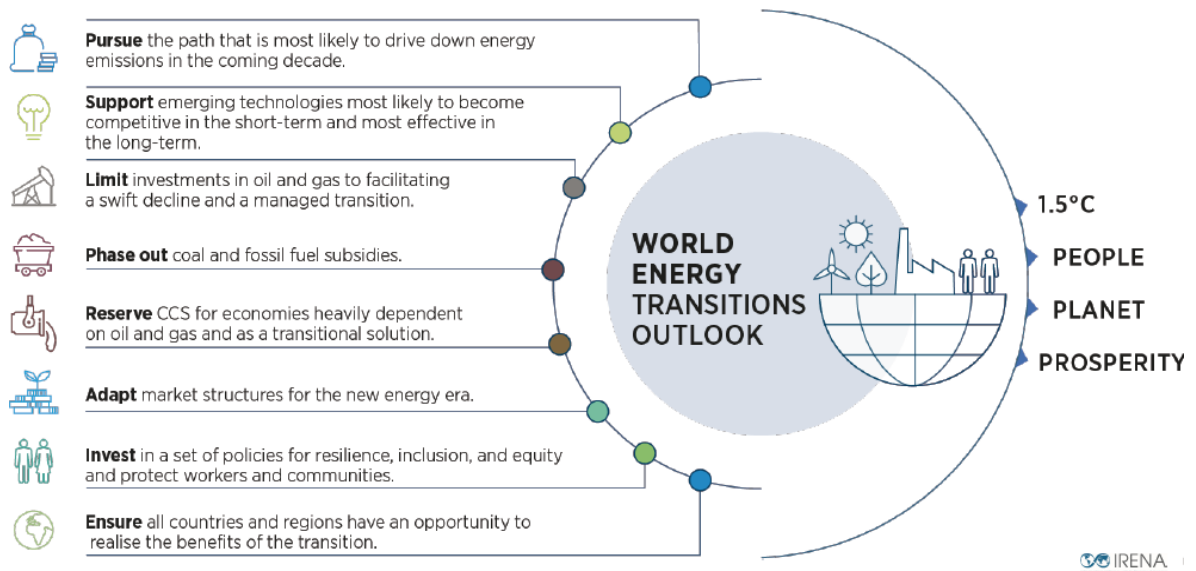


Figure 2. The Guiding framework of WETO theory of change [2]

The figure highlighted the energy transitions model that needs to be thought of when we are into the race of 1.5°C due to the significance of climate change being noticed. The approaches and participations of actions on wider aspects are vital to be realized which has direct as well as indirect impacts on these initiatives. Hence, such a guiding

framework would always prove instrumental when each country is looking for the best possible intervention in its race against climate change directing and aligning our actions on the initiatives that drive to prosperous planets in near future.

## RENEWABLE ENERGY SOURCES

Growth in renewable energy in the global energy mix has been noticed significantly in the last few years where solar and wind power have seen major increases as compared to other renewable sources.

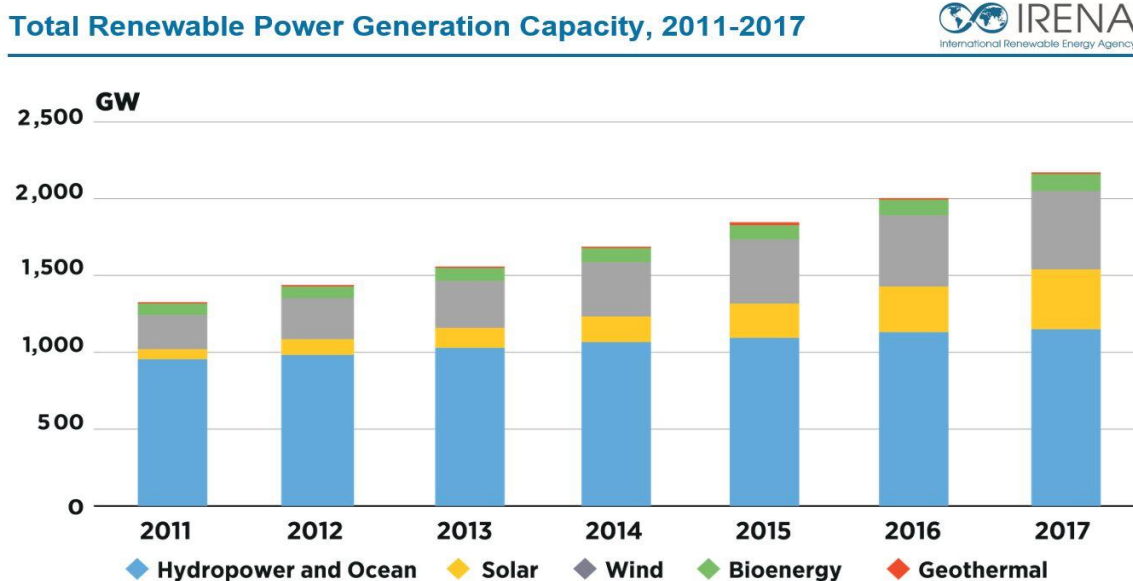


Figure 3. The trend of Renewable Energy Power Generation [3]

The trend as seen from the figure above is quite promising as bioenergy is steadily making the penetration too in its share for renewable energy. Since 2011 along with substantial increases in solar and wind energy, the rise in bioenergy is noticed and it can be due to actions countries initiates their action against climate change and promoting cleaner and greener energy. The race of renewable energy sources can be achieved from small initiatives that can be addressed in all energy sectors which is renewable but it has to be initiated and appreciated at our level.

The investment in biofuel can be thought off where there are options available for ripping the strategic benefits. A small country Bhutan which is though known to be a carbon-neutral country though has potentials for mega hydropower projects, still is exploring possible renewable energy mix approaches for its sustainability. At the time it is also seen making significant progress in biofuel sectors where an initiative like supports and promoting of biogas projects are continuously prioritized in the last few years.

## BACKGROUND AND PROCEDURE

Initiative in clean and green energy is important in our thirst for renewable energy. The background understanding growth of renewable energy and energy usages transitions is some key initiative to combat climate change. Bioenergy is one such promising renewable energy source but its potentials have not been realized due to several technical as well as financial issues. As a result, the strategic planning and actions in promoting bioenergy from potential sources are essentials and will certainly supplement the energy needs, especially at the household level.

This research is based on secondary data that are derived from relevant sources and have merit to consider as critical literature. The information from reliable secondary sources are thus been critically reviewed before incorporation and drawing the result as well as conclusions. A clear understanding of the energy scenarios pertaining to global as well as Bhutan contests is visualized from the literature. Thereon the focuses were given more on

Biogas in terms of trends and growths over time. The data from such sources are used as the baseline for arriving at results and discussion along with deriving the conclusion.

## RESULT

### 1. Global Trends in Biogas as energy sources

The growth of biogas can be seen from the global perspectives.

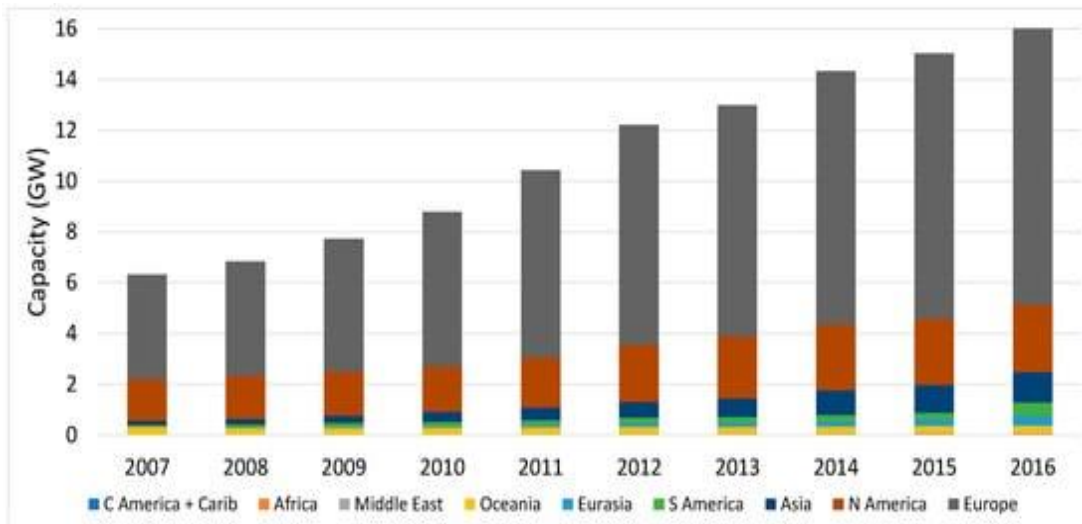


Figure 4. The trend of Biogas growth globally [4]

The trend critically reflected the growth that is happening at a regular pace for a decade across the globe. It is a reflection that almost all countries are in the progress of scaling up the biogas plants in their thirst for clean energy. Europe is seen progress much better in terms of biogas usages from the figure as shown above and there might be more to learn from the initiatives that are taken.

There are major countries whose trend in biogas plant growth and some of the impacts in recent time which might due to the impact of current pandemic. The figure below indicated that the biogas initiative across the globe in the major economy is also impacted in recent years (especially 2020) but that trend has bettered in 2021. It is well understood the current COVID-19 pandemic has impacted many initiatives in 2020 including biogas initiatives.

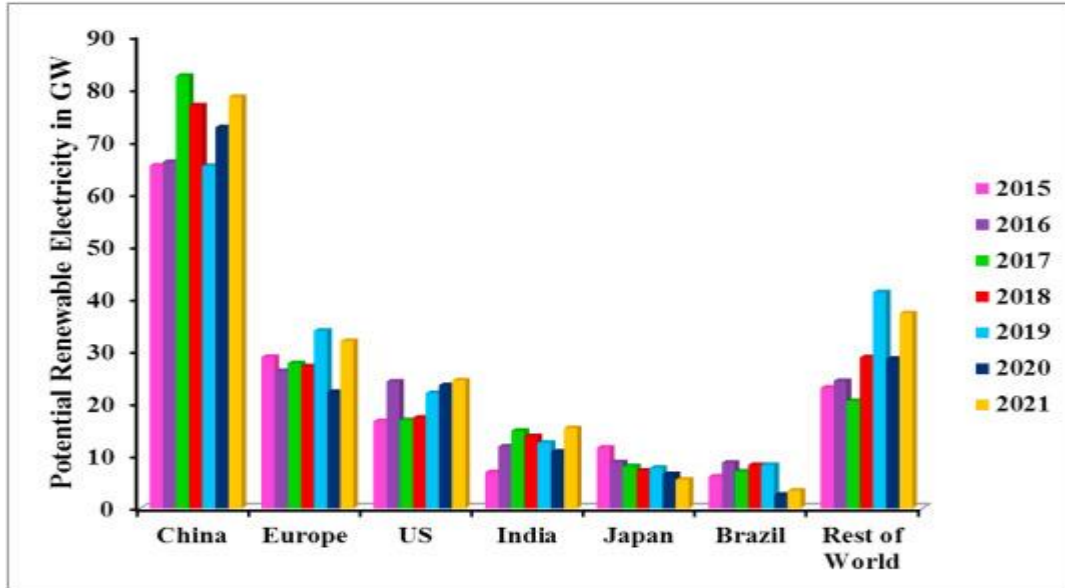


Figure 5. Trends of major countries in biogas production [5]

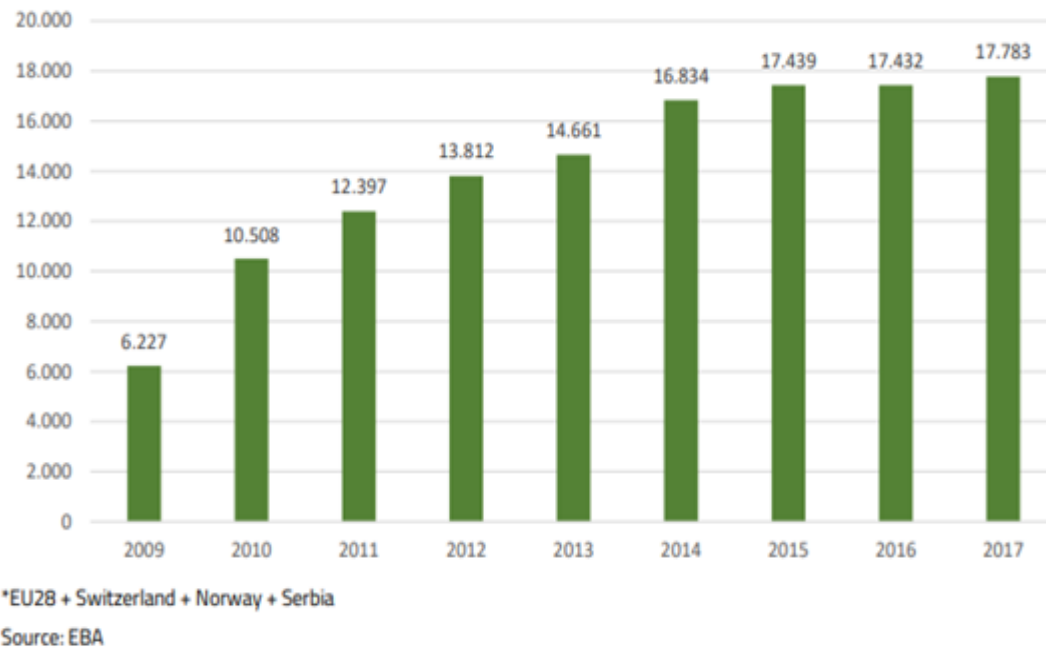


Figure 6. Biogas Plants in Europe [6]

A separate statistic particularly for the trend of Europe is a clear indication of growth in biogas plants in Europe in a decade. The initiatives and supports measures are some of the key initiatives that have been taken in Europe reflected as main indicators in the literature for such transition resulting in an almost threefold increase in biogas plant withing 2009 to 2017. Such a trend should indicate that there is a strong potential of biogas when critically researched and implemented in required scales globally.

## 2. Bhutan Trends in Biogas as energy sources

Bhutan due to its strategic location and its geographical conditions do pose a series of advantages especially in

the field of renewable energy sources. The greater potential for hydropower through its fast-flowing river is crucial for the overall welfare of the country's economy. On top of it, due to its richness in forest resources and the regards of the country on its environment which is bagged by policies and constitutional mandates the country stands well in the prospects of bioenergy. As reported in national media the forest cover in the country in 2020 was 83.90% of which little over 70% are trees and around 13.13% as shrubs [7] and constitute of Bhutan mandate 60% forest coverage at all times to come [8]. The noble philosophy of development as followed in Bhutan is a holistic developmental approach that is bagged by 'Gross National Happiness (GNH)'. This holistic developmental philosophy of GNH is supported by 4 pillars where two of the pillars focuses on the environment and sustainability. This is further supported by 9 domains having multiple sub-indexes, indicators and variables [9]. The constitution of Bhutan also strictly spells out the need for all citizen to hold fundamental duties in safeguarding the pristine environment and the rich biodiversity of the country.

### **Sustainable & Equitable Socio-Economic Development**

**Environmental  
Conservation**



**Good  
Governance**

**Preservation & Promotion  
Of Culture**

Figure 7. The FOUR pillars of Gross National Happiness (GNH) [9]

Bhutan has been consuming about 1.0 to 1.2 million tons of fuel-wood per year; about 70% of this amount is used by households for cooking and heating. Bhutan's fuel consumption of about 1.2 tons per capita per year is among the highest in the world. In addition, Bhutan has been importing large quantities of fossil fuels – 5.7 million tons of LPG and 5.2 million tons of kerosene in 2008 – for cooking, heating and lighting. These data indicate that there is a high need to provide an alternative to supplement conventional cooking fuels, mainly fuel-wood and biogas plants could be a suitable option in consideration for clean energy approaches. Biogas was first introduced in Bhutan in the 1980s as a clean and renewable energy source for household cooking to help cut down firewood consumption [10-12].

With the daily dung production from cattle and allied animals is around 3,622 tons, having the capacity to produce 130,398 m<sup>3</sup> of biogas it is promising for Bhutan to explore biogas plants. From the same report, it was discovered that 68,576 families (78 percent) in the country own at least one head of cattle, with 50,115 households (73 percent) producing enough cattle manure to meet the requirements of a modest family size biogas plant. This accounts for that around 57% of households in Bhutan can have enough feed to produce household biogas through biogas plants [13].

A feasibility study conducted in Bhutan in 2008 by SNV the Netherlands Development Organization concluded that a small-scale domestic biogas program is possible with a technical potential of about 20,000 biogas plants especially in the southern belt and inner mountain valleys. It is also highlighted a few of the challenges starting from not able to attract the support of private sectors, geographical challenges, technological gaps and other associated

issues highlighting the needs for capacity development, motivation and support structures [14].

The initiative of the Department of Renewable Energy, Royal Government of Bhutan (DRE, RGoB) to understand the potential of biogas, as well as a measure to implement, has been materialized with the initiation of the Bhutan Biogas Project (BBP) in 2011 through the support of Asian Development Bank (ADB). The plan of DRE, RGoB was to have close to 4600 homes utilizing biogas for meeting their cooking as well as lighting energy demand within 2018 and in the next five-year span to come up with additional 5000 plants. The BBP which has started in 2011 has basically highlighted four different sizes of biogas plant that can be introduced in Bhutan with the dimension as 4, 6, 8 and 10 cubic meters respectively based on the potential each household has and it is priced in ranges of Nu. 30000-Nu. 50000 (i.e. Approximately USD: 400-670) [15].

The first pilot project from BBP was targeted in 4 Dzongkhags/Districts (i.e. Samtse, Sarpang, Tsirang and Chhukha) where within 2011-2014 (the first phase) almost 1000 biogas plants have been installed. With this success, the BBP project thus extended till 2017 [13]

A record maintained with the BBP states that in a year, a household with biogas can save 2,000 kilograms of firewood, 2,555 liters of kerosene, and 1,460 kilowatts of electricity. Besides, it has a benefit to human health and the environment since biogas turns methane gas (livestock manure) into a fuel that will also take carbon out of the air at the same time. (BBP Project [16].

BBP objectives were mostly focused on strategizing the right biogas digester, quality of biogas plant, providing technical assistance including knowledge transfer, assurance of continued operation of biogas plant, technical expertise on usages as the key parameters. Bhutan biogas project first annual progress report 2012. ([http://www.build-a-biogas-plant.com/PDF/bhutan\\_biogas\\_project\\_first\\_annual\\_progress\\_report\\_2012.pdf](http://www.build-a-biogas-plant.com/PDF/bhutan_biogas_project_first_annual_progress_report_2012.pdf)) [10]

With the onset of BBP (2011-2016) the approaches were more on technical capacity development and support a mechanism whereby a flat subsidy of Nu. 11,700 (i.e. approximately USD: 130) is provided by the government. This has increased the willingness of people to biogas plants set up in their localities [17].

With BBP making an impactful contribution in the development as well as promotion of biogas in Bhutan, there is an increase in biogas usages in the country. Report of its popularity is shared in the national media where people are steadily shifting towards biogas as clean sources [18-19]. To keep momentum and move forward, capacity development in the form of training is continuously conducted which has substantially increased the understanding as well as skills of people [20]. Also, it is noticed in recent times that the Government of Bhutan is bearing a 50% subsidy for the construction of biogas plants making the process much lucrative for low-income individuals to venture into biogas projects for their household energy consumption. Though approaches and supports were dynamic still Bhutan faced with little glitches in achieving its due to the ongoing pandemic.

Though started in the 1980s, it was not of much success where technical know-how and challenges were the main reasons for biogas plants being left unattended. But such a trend has taken a facelift since the initiation of BBP where the learning from the past was used as strategies for the promotion of clean energy technologies in the form of Biogas. Bhutan has developed a guideline 'Domestic Biogas Implementation Guideline' in 2020 prepared by the Department of Renewable Energy, Royal Government of Bhutan [12] with an aim to have conducive strategies for better outcomes. This comprehensive guideline provided the technical requirements that are necessary for setting up the biogas plant as well as requirements to operate it with higher efficiency. It contains the aspects ranging from policies, support mechanisms, technical details and drawings, constructions and usage measures including bill of quantities, measures of quality control and enhancement, operations and control measures all captured in a single platform. The status of biogas plants in all the 20 Dzongkhags (Sector/District) of Bhutan is listed below highlighting the penetration as well as the growth of biogas users in the country.

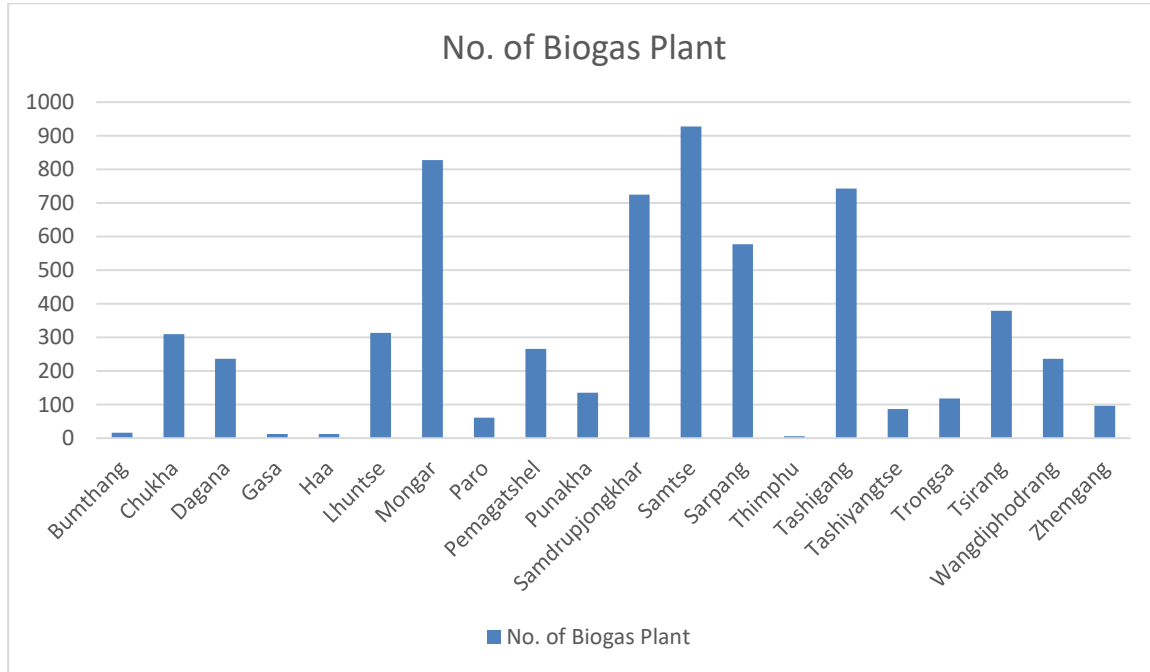


Figure 8. District wise Biogas Plant in Bhutan [12]

The report also highlighted that BBP has benefitted many households in the country with the successful installation of 6087 biogas plants all across the country till December 2019 [12]. In line with it, DRE, RGoB has also come up with the ‘National Biogas Implementation Strategy’ which focuses on key strategies ranging from management, planning, implementation, operation and monitoring of the biogas program in the country [13].

The result in the case of Bhutan is quite significant since the starting of BBP whereby the growth in biogas plants has been constantly increasing and reaching all parts of the country. The evaluation of the post-project detail survey is yet to be compiled which will certainly give a clear analysis of the power supplements that biogas has achieved as envisioned in the BBP and other relevant initiatives carried by the government of Bhutan. Still, the preliminary feedback as outlined in the national media of Bhutan highlighted the positive information from users who have incorporated the biogas plants and achieved the benefits.

## CONCLUSION

Thirst for clean energy is a well-known phenomenon which is in the case of energy countries across the globe. Bhutan is no exception though it has deeply relied on renewable energy for its major energy needs. Still then due to sustainability issues about energy generation and usage, the use of biogas energy was given priority in the last decade through support measures. The success of the biogas project and the implementation of the biogas system in Bhutan has gained its facelift in recent time due to approaches taken in BBP which has enhanced the understanding and trust of people on effective materializing the potential of meeting major of their household energy requirements from their local setting. In current times, the statistics show that turnover for setting up household-level biogas plants is increasing and people are continuously reaping the benefits of clean energy. All these successes in the last decade of initialization of BBP have been quite impactful that one can derive utmost success in promoting biogas if there are devised mechanisms in place. Such noble initiative needs to be continuously supported especially in the least developed and developing economy so that a major chunk of the population takes responsibility for meeting their energy demand from the clean energy system within their settings.

It is thus recommended to have conducive policies and guidelines be in place along with critical support measures whereby people can venture into biogas usage with trust and confidence. Though Bhutan has been capitalizing on cattle dung as prime feed for a biogas plant, the options from other potential sources as feed can be explored for materializing the benefits of increasing biogas plant and meeting the household energy demand from clean as well as reliable sources.



## REFERENCES

- [1] IEA, “IEA world energy outlook: Solar capacity surges past coal and gas by 2040,” *Renewables.Asia*, 2019, <https://renewables.asia/iea-world-energy-outlook-solar-capacity-surges-past-coal-and-gas-by-2040/>.
- [2] IRENA, “World energy transitions outlook,” *International Renewable Energy Agency*, 2021, <https://www.irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook>.
- [3] IRENA, “Global Renewable Generation Continues its Strong Growth, New IRENA Capacity Data Shows, 2018,” *International Renewable Energy Agency*, 2018, <https://www.irena.org/newsroom/pressreleases/2018/Apr/Global-Renewable-Generation-Continues-its-Strong-Growth-New-IRENA-Capacity-Data-Shows>
- [4] F. Kemausuor, M. Adaramola, J. Morken, “A review of commercial biogas systems and lessons for Africa,” *Energies*, 11(11), 2984, 2018, <https://doi.org/10.3390/en11112984>
- [5] D. Thiruselvi, P. S. Kumar, et.al., “A critical review on global trends in biogas scenario with its up-gradation techniques for fuel cell and future perspectives,” *International Journal of Hydrogen Energy*, 46(31), 16734-16750, 2021, <https://doi.org/10.1016/j.ijhydene.2020.10.023>
- [6] K. Beckman, “Biomethane is the future [Gas transitions],” *Natural Gas World - Natural Gas & LNG News & Analysis*, 2019, <https://www.naturalgasworld.com/biomethane-has-the-future-72409>
- [7] Bhutan's Daily Newspaper, “Is Bhutan’s conservation development-oriented?,” *Kuensel Online*. 2020, <https://kuenselonline.com/is-bhutans-conservation-development-oriented/>
- [8] Bhutan, “The Constitution of the Kingdom of Bhutan,” *Royal Government of Bhutan*, 2008, <https://www.nab.gov.bt/assets/templates/images/constitution-of-bhutan-2008.pdf>.
- [9] Bhutan, “The 4 pillars of gnh – GNH centre Bhutan,” *GNH Centre Bhutan – A GNH organization in Bhutan*. <https://www.gnhcentrebhutan.org/what-is-gnh/the-4-pillars-of-gnh/>
- [10] DRE, RGoB, “Bhutan biogas project first annual progress report,” *Department of Renewable Energy (DRE)*, 2012, [https://www.build-a-biogas-plant.com/PDF/bhutan\\_biogas\\_project\\_first\\_annual\\_progress\\_report\\_2012.pdf](https://www.build-a-biogas-plant.com/PDF/bhutan_biogas_project_first_annual_progress_report_2012.pdf)
- [11] MoEA, RGoB, “Alternative Renewable Energy Policy-2013,” *Ministry of Economic Affairs*, 2013, <https://www.moea.gov.bt/wp-content/uploads/2017/07/Final-Alternative-RE-Policy-April-2013.pdf>
- [12] DRE, RGoB, “Domestic Biogas Implementation Guideline,” *Department of Renewable Energy (DRE)*, 2020, <https://www.moea.gov.bt/wp-content/uploads/2017/07/Domestic-Biogas-Implementation-Guideline.pdf>
- [13] DRE, RGoB, *National Biogas Implementation Strategy*. *Department of Renewable Energy (DRE)*, 2020, <https://www.moea.gov.bt/wp-content/uploads/2017/07/National-Biogas-Implementation-Strategy.pdf>
- [14] P. C. Ghimire, S. K. Nepal, “Biogas Market Study in Bhutan,” *SNV*, 2009, [https://energy4impact.org/sites/default/files/biogas\\_market\\_study\\_bhutan\\_2009.pdf](https://energy4impact.org/sites/default/files/biogas_market_study_bhutan_2009.pdf)
- [15] Bhutan's Daily Newspaper, “Big biogas plans after project’s success,” *Kuensel Online*. 2017, <https://kuenselonline.com/big-biogas-plans-after-projects-success/>
- [16] D. Penjor, D. Zam, “Biogas Project Overview: Bhutan. SAARC Energy Centre (SEC), Islamabad,” *SAARC SEC Learn, share, improve and grow together*, 2016, <https://www.saarcenergy.org/wp-content/uploads/2016/07/Bhutan%20presentation.pdf>
- [17] ADB, “Environmental Monitoring Report,” *Asian Development Bank*. 2016, [https://www.adb.org/sites/default/files/project-documents/42252/42252-022-emr-en\\_1.pdf](https://www.adb.org/sites/default/files/project-documents/42252/42252-022-emr-en_1.pdf)
- [18] BBS, “Biogas use becoming popular,” *Bhutan Broadcasting Service*, 2012, <https://www.bbs.bt/news/?p=20899>
- [19] BBS, “Biogas usage gaining popularity in Dorokha,” *Bhutan Broadcasting Service*, 2019, <https://www.bbs.bt/news/?p=122215>
- [20] BBS, “Biogas installation training to encourage use of clean renewable energy,” *Bhutan Broadcasting Service*, 2021, <https://www.bbs.bt/news/?p=148518>