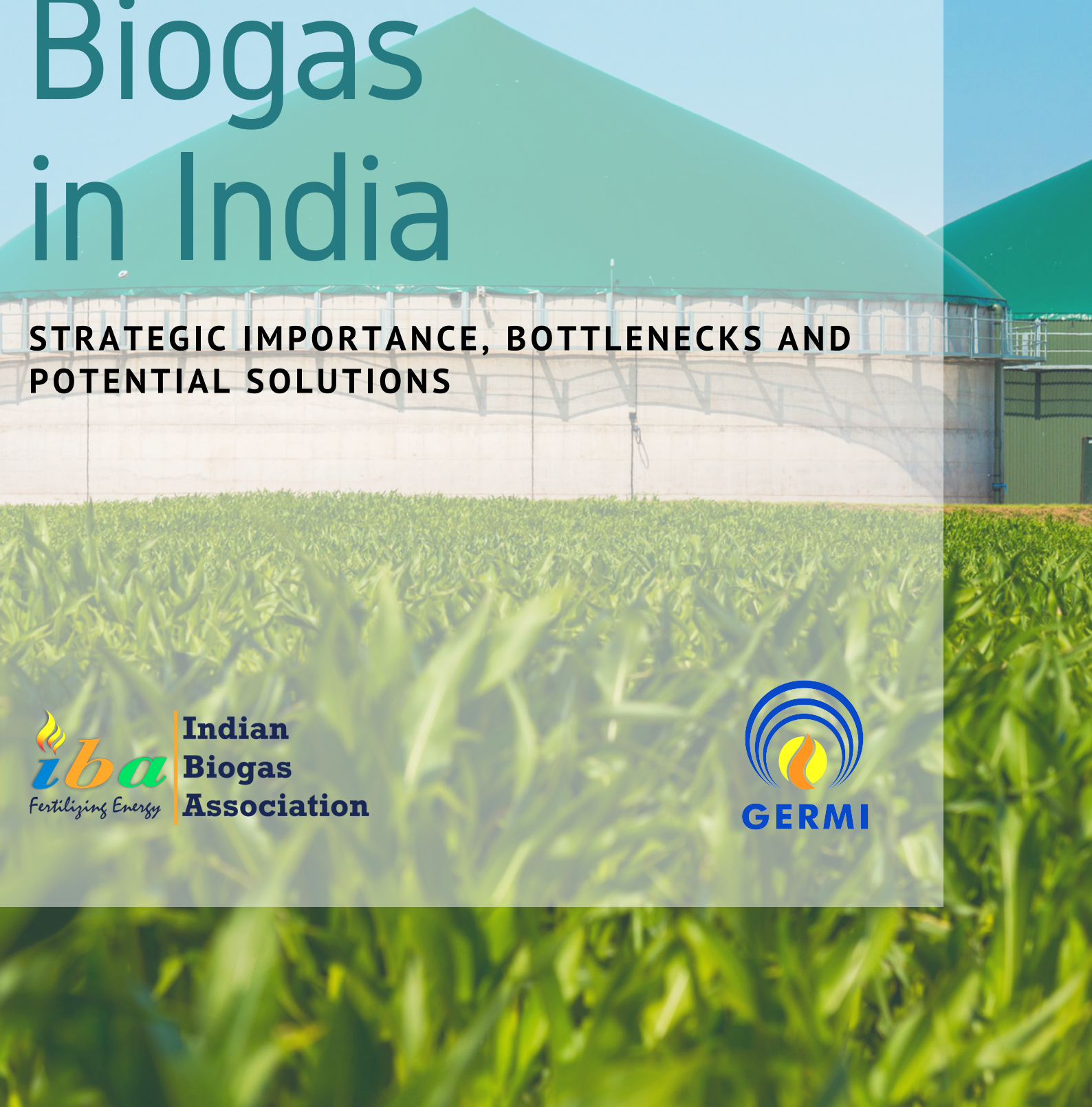
A GERMI **THOUGHT PAPER**

Jumpstarting Biogas in India

STRATEGIC IMPORTANCE, BOTTLENECKS AND POTENTIAL SOLUTIONS



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Executive Summary

Renewable Energy (RE) technologies have started to play a greater role in the energy mix of most nations across the world, especially led by the European Union (EU). India too has been promoting renewable energy aggressively and has one of the largest RE expansion programs in the world.

The country has targeted a capacity of 175 GW of renewable energy by the year 2022. The current installed renewable capacity in India is 57.5 GW[1] as of June, 2017. According to the 2017 report, 'Renewables'[2], by the International Energy Agency (IEA), the Indian renewable industry will increase twofold of the present capacity by 2022 and is scheduled to overtake the EU in terms of cumulative installations.

India's renewable energy expansion program have been largely led by both wind and solar PV technologies. These technologies are now strong competitors for fossil fuel-based power plants not only in terms of technology and economic viability but also of acceptance among policy makers and the general public. Solar PV installations in India have witnessed a rapid growth owing to the strong policy support and rapidly de-escalating prices of PV modules. Similarly, India's wind energy sector is mature and is ranked fourth in terms of total installed capacity of wind installations in the world after China, US and Germany.

On the contrary, bioenergy in India has not performed satisfactorily despite the technology predating both wind and solar. The Ministry of New and Renewable Energy (MNRE) has set a goal of 10 GW of bioenergy and one

[1] pv magazine, June 2017, http://bit.ly/2sipfU7
[2] Renewables, 2017, http://bit.ly/2gcVpcW

hundred thousand family sized biogas plants by 2022[3]. Given the current status of bioenergy in India, the goal looks distant. Most of the family sized biogas plants have failed. On the other hand, countries such as Germany, Hungary, Denmark and Sweden, have long demonstrated the economic and technological viability of biogas. Factors like supportive regulations, technological advancements, attractive incentives, easy availability of feedstock and lack of complex sociological relations have made it easier to promote and implement biogas technology in these countries. Germany, in particular has been remarkably successful and is the largest biogas producer in Europe.

India has been promoting biogas technology for the past three decades but has been unsuccessful despite several favorable environmental and sociological conditions. The country is blessed with optimal ambient temperatures, a strong agricultural economy and a high cattle population. This paper aims at answering the following pertinent questions,

1. ***"Why has biogas failed in India?" and***
2. ***"What are the specific interventions required to kick-start the market?"***

In answering these two questions, the paper also discusses the current status of the Indian biogas market with the aim to evaluate government initiatives, probable reasons for erstwhile failure, and potential solutions that could result in a vibrant biogas sector in India. Biogas technology and a detailed analysis of policy and regulations has intentionally been left out of this paper. For this, there are an adequate number of resources available on the internet.

[3] MNRE Annual report 2016-17, http://bit.ly/2jrFhZc

Introduction

The German Scenario

Germany was the largest producer of biogas in the European Union as of 2015[4] and other European countries too are catching up. Around 9,000 biogas plants and 190 biomethanation plants (biogas plants with biomethane injection) are currently operating in Germany with a total installed capacity of more than 4,000 MW[5]. Of the 50 TWh energy generated from bioenergy in 2015, 30.1 TWh (62%) electricity was generated from biogas plants. The German Biogas Association (GBA) estimates that the biogas capacity will increase by 200 MW per year from 2020 to 2022. The biogas plants utilize energy crops and manure as feedstock and generate electricity using the CHP (combined heat and power) technology. The electricity is fed into the grid and the heat is used for in-house heating purposes. The success of biogas technology in Germany is attributed to various factors - ample incentives in terms of a long-term guaranteed power purchase agreement (PPA), various bonuses for energy crops, utilizing heat and use of manure outputs.

The original German Renewable Energy Sources Act (EEG) provided a guaranteed grid connection and a feed-in-tariff for 20 years dependent on the technology and size of the project. Most RE technologies including biogas benefitted from these schemes and Germany witnessed a surge in the RE installations. Bioenergy plants (biomass and biogas) were the second highest recipients of feed-in-tariffs after solar PV in 2015[6]. The EEG was subsequently

[4]Statistical report, 2016, http://bit.ly/2hL3TJB
[5]Biomass Magazine, August 2016, http://bit.ly/2gF5fI2
[6]Clean Energy Wire, September 2016, http://bit.ly/2y2w5fx

amended in 2014 and the act showed a distinct difference from the original legislation. The revision replaced the feed-in-tariff with direct auctioning for installations above 150 kW in case of biomass powered plants. Installations of size less than 150 kW will continue to receive the determined feed-in-tariffs. The developers or plant operators are now directed to market their own electricity. The remuneration for this will be in form of a market premium for the difference between the fixed payments and spot-price at the energy exchange. As a result of the limited market premium in all the RE technologies, the market premium is set to decrease. This decreasing trend poses a challenge to the developers and investors. The reform has caused a marked decline in the number of installations in bioenergy plants[7] and reduced the growth of biogas in Germany.

> *"The market for biogas in India has been largely scattered and rural oriented.*

[7]Troubled Pillar of the Energiewende, Clean Energy Wire, September 2016, http://bit.ly/2yeEx0s

Status | Indian Biogas Market

India has promoted biogas technology since the early 1900s. The National Project on Biogas Development (NPBD) was launched in 1981 by the Central Government and later renamed as the National Biogas and Manure Management Programme (NBMMP) in 2003-04 by the Ministry of New and Renewable Energy (MNRE). The programme targeted to promote biogas technology especially in the rural sector, by providing a subsidy for the installation of biogas plants. In addition to this, the MNRE also provides subsidies for community scale and large-scale projects under different programmes. Despite the attractive subsidies and schemes designed by the government, a strong agricultural economy, a substantial livestock population and favourable environmental conditions for the technology, the biogas sector has not flourished as expected. The market for biogas has largely been scattered and rural oriented. There has been a lack of emphasis on large scale, professionally managed, investor owned biogas plants in India. India can learn from Germany, by introducing appropriate tariffs and reducing the risks and uncertainty around marketing gas and power output for investors. The offtake of the digestate (or fertilizer) output from the biogas plants are also uncertain.

Overall, India has failed to make the transition from a highly capital subsidized - government driven market, to an incentive supported developer driven market. In fact, India has already made that transition in both the wind energy and solar PV market and could do well to learn from both of these. Critically, the Government of India, led by the MNRE must start viewing biogas to be of strategic importance to India's energy security (discussed in a later chapter). The MNRE must change its view about biogas from being a rural, community driven technology to a one that is developer driven, which in turn could significantly alter India's energy landscape.

Strategic Importance of Biogas to India

Quite like any renewable energy technology, biogas offers a range of benefits such as reduction in Greenhouse Gas Emissions (GHG), ensures energy security and offers a sustainable alternative to conventional energy sources. However, in the Indian context, there are the following important reasons as to why we think biogas must be given a much stronger push that it is being given currently.

Government subsidies and imports

Under the *Pradhan Mantri Ujjwal Yojana* (PMUY), the government has been promoting and providing LPG connections at a subsidized rate to the poorer section of the country. This move towards a cleaner fuel has caused the kerosene consumption to decline substantially in the country. According to the Petroleum Planning and Analysis Cell (PPAC), the kerosene consumption fell from 6.8 million tonnes in 2016 to 5.3 million tonne in 2017. The government has thus decided to gradually reduce the subsidy on kerosene in a bid to promote LPG.

India's liquefied petroleum gas (LPG) imports have escalated by 23% in 2016-17 to 11 million tonnes making us the second largest importer of LPG in the world. The overall LPG consumption jumped by 9.8% with around 32 million new gas connections added since 2016. It is estimated that the LPG consumption is likely to further rise as the government aims to provide LPG to 80% of the households by March 2019. As of April 2017, the total coverage is 73% of all households[8].

[8] Livemint, May, 2017, http://bit.ly/2hBc6Tj

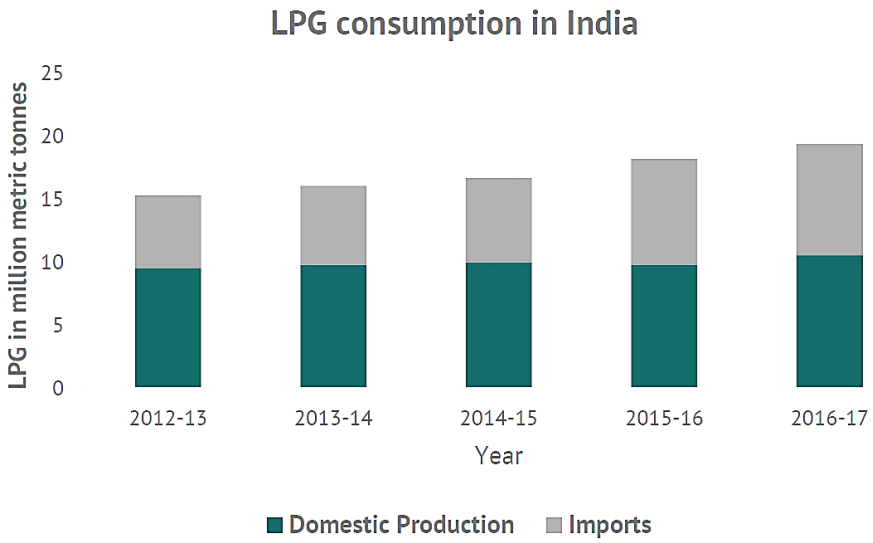

Figure 1: Share of domestic production & imports in LPG consumption in India[9]

India consumed close to 20 million tonnes of LPG in 2016-17 and is expected to grow to 23.7 million tonnes in the next fiscal year. Out of the total consumption in 2016-17, close to 11 million tonnes was imported. This shows that the domestic production is not keeping pace with the demand. Biogas energy can serve to offset a significant portion of this import requirement. The current biogas potential is estimated at 60,443 million m^3 (raw biogas) which is equivalent to 26 million tonne LPG per year[10]. This can considerably reduce India's LPG imports and further energy independence in the country.

> *"The current biogas potential can considerably reduce India's LPG imports and further energy independence in the country.*

[9] India Energy Dashboard, http://bit.ly/2z8jZWC

[10] 1 cubic meter of biogas is equivalent to 0.43 kg of LPG

Clean India

Swacch Bharat Abhiyan, or Clean India Mission, focuses on solid waste management and construction of individual and community toilets. This is to be achieved by appropriate policy changes that would ensure that waste is appropriately segregated at the source. Currently, the electricity generation from waste is around 88.4 MW according to Swachh Bharat Mission -Urban[11]. MSW contains 40-60% of organic waste which can easily be used as feedstock for biogas. By segregating waste at source and utilizing the organic waste for biogas, the landfill volume will also reduce significantly. Additionally, for urban areas, the slurry can be marketed under the City Compost Policy - 2017, thus opening the market for fertilizers as well. For rural or poor households, toilet linked biogas systems can help in achieving sanitary cleanliness and simultaneously generate energy and fertilizers. Thus, biogas can be an important component of *Swachh Bharat Abhiyan*.

Skill Development and Employment Generation

Biogas technology requires considerably higher involvement of human intervention in its construction as well as the operation and maintenance. This implies that there is a potential of creating several jobs, especially at the bottom of the pyramid. Biogas is unlike solar PV, which requires very lesser O&M over its lifetime. Additionally, biogas can employ the poorest of the poor in the waste collection phase. Opportunities for waste aggregators that collect bio material and dispatch it to biogas plants are a new segment that sounds very promising.

Other Benefits

The proliferation of biogas technology can have other important benefits. Chief among them is the reduction is collection of firewood for cooking and

[11] Swachh Bharat, http://bit.ly/2zI6wVH

water heating purposes in rural India. The dependence of rural India on firewood is a chief contributor to deforestation and loss of green cover. The burning of firewood also contributes to air pollution which in turn has a significant impact on human health. Additionally, the burning of firewood releases carbon back into the atmosphere. Community based biogas models can significantly stop deforestation.

The byproduct slurry produced can go back into the local field and help to improve the organic content and thus the fertility of the soil. This prevents the loss of soil nutrition and further enhances the ability of the soil to retain water throughout the year.

Finally, biogas can be stored locally and dispatched as electricity as and when required to support demand on the grid. This is unlike solar PV which cannot be dispatched.

Market Segmentation

Staying in line with the need to view the biogas market differently, the biogas market in India can be segmented into three major categories. In our view, each of these markets are different and need to be promoted differently. The three segments are:

1. **Family Based** (1-6 m^3): These plants are mainly owned and maintained by the consumer and is distributed mainly across the rural areas on India. These plants are used primarily for generating gas for cooking purposes; however there have been instances where this has been used for rudimentary lighting purposes. The majority of India's biogas deployments have been in this segment and a large number of these plants are not functioning.

The success of these biogas plants is strongly linked to the individual owning and operating the plant. Biogas is not a 'fit-and-forget' technology and requires considerable involvement from the owner. Not all people are capable of exercising such an involvement.

> *"There has been a systemic lack in structured investments flowing in the sector, largely attributed to many risks involved in the PPA, input feedstock and the marketing of the fertilizer output.*

2. **Community Based** (5-250kW): These plants are mainly owned by communities/societies/ NGOs etc. in rural settings and are used for electricity production. The electricity is generally linked to a small micro or a mini grid for rural electrification purposes. There have been a lesser number of community-based biogas projects in India. However, there are a few that have been very successful owing mainly two reasons: 1) the plant has a single person who exercises initiative to ensure that the plant runs optimally and takes corrective action when problems arise and 2) there is a strong sense of community among the people who own and run the plant at a village level. Usually, there is one or more persons in the community who know how to operate the biogas plant.

3. **Developer Based** (250 kW+): These plants are mainly owned by developers with a structured investment strategy and are used to feed electricity into the grid with secure power purchase agreements with power distribution companies. There has been a systemic lack in structured investments flowing in the sector, largely attributed to many risks involved in the PPA, input feedstock and the marketing of the fertilizer output.

Bottlenecks and the Potential Solutions

Despite a sustained subsidy support for the biogas program in India, the sector has largely been a failure. However, there are outstanding examples of a handful of biogas plants in India that are working very well. This section explores some of the reasons as to why biogas has been unsuccessful in India. As mentioned earlier, the challenges are unique to each segment of the market and are therefore addressed separately.

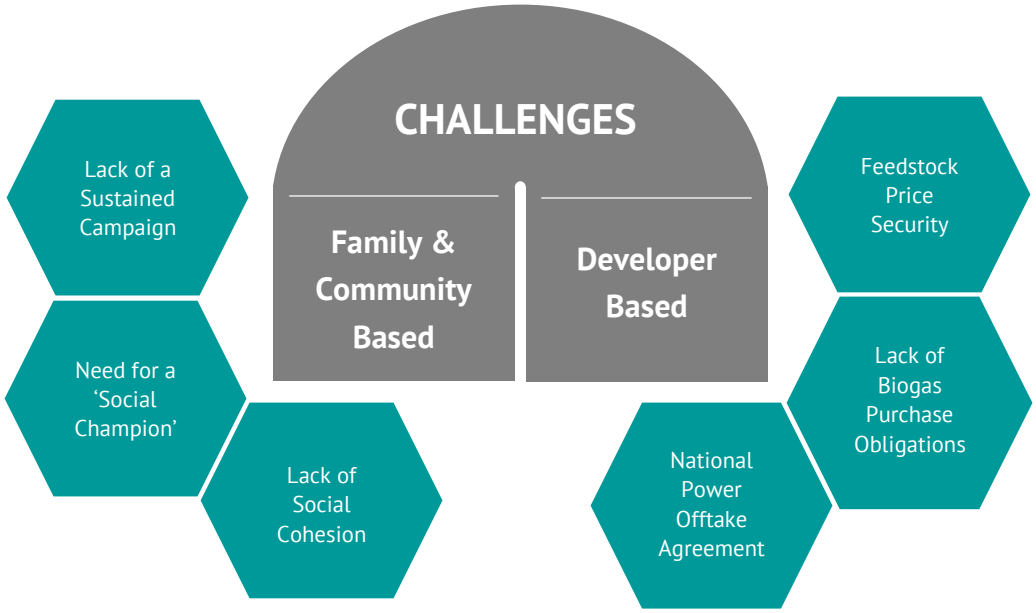

Figure 2: Overview of challenges of biogas in India

Challenges | Family Based Models (Urban & Rural)

Need of involvement

Biogas technology, unlike rooftop solar PV requires regular intervention from owners. There are many challenges that arise during normal operations of a biogas. The production of biogas depends on a variety of factors such as temperature, input feedstock, pH, type of microorganisms and oxygen content. Variation is any of these inputs results in a reduction of biogas. This requires a high level of involvement from the owners. At the urban level, most young and professional people do not have the time, not the inclination to get involved to this extent. At the rural level, people may not have the expertise to maintain and operate it successfully.

One way to solve this would be to have a community led knowledge network on maintaining biogas plants. This can be done in most modern housing societies and apartment complexes. In fact, the operation and maintenance of the biogas plant can also be handed over to a third-party company who possesses the necessary expertise. These is a growing segment of urbanites who are partaking in the 'go green' movement and such people can be specifically targeted, especially using social media and online platforms.

Challenges | Community Based Models (Rural)

Sociological Challenges

Most of the community level biogas plants require active participation from the community at the rural level. The success of the plant requires some amount of social cohesion to operate and maintain the plant. Biogas is quite unlike solar PV, which requires no active input and is relatively free from maintenance. Any interventions such as regular feedstock input or any maintenance requires people to come together. India's complex social

hierarchy and especially the caste system is quite strong in rural areas. This results in complex social dynamics, especially related to access to common goods. What ensues are many conflicts which in turn results in the fact that the biogas system is altogether abandoned. Non-Governmental Organizations (NGO) play a vital role in bringing people together. These organizations also play a very important role in creating awareness, demonstrating the operation and maintenance of biogas plants and explaining the benefits of biogas. A good example of such an involvement of an NGO in the development of biogas plants is Bhagirath Gramvikas Pratisthan in Southern Konkan[12]. The organization has already set up over 5,000 biogas plants in a single district (Sindhudurg, Maharashtra, India).

An involvement of the community at all levels is one of the key factors for the success of any project. A monetary investment on behalf of the farmer is essential to the success of the project. A monetary contribution towards project creates a sense of ownership in the farmer and give efforts to maintain the plant well. A lack of interest leads to the failure of a plant.

> *"An involvement of the community at all levels is one of the key factors for the success of any project.*

[12] Bhagirath Gramvikas Pratishtan. Biogas. http://bit.ly/2jY1f6H

Thirdly, biogas plants are person dependent. That is, there is a need to identify a 'community champion'. A community champion is someone who is respected within the community and capable of taking responsibility for the entire community. Such people are rare, but can be trained through special rural development programs[13]. Such community champions, can take ownership of the biogas plant and ensure that the plant is technically sound and free from any social challenges too.

Lack of a Campaign Approach

There is an acute lack of awareness of the benefits of biogas in India. Moreover, the little that people know is tainted by the failure of the existing smaller biogas plants. There is an urgent need for India to promote biogas technology as a *Yojana* or a movement similar to the Swachh Bharat Campaign (Clean India Campaign) or indeed the earlier Pulse Polio Program. Such a sustained effort over a long period of time is likely to yield good results. Additionally, the necessary support infrastructure in terms of availability of skills at rural areas is necessary for biogas. One way this could be done is to partner with the existing distribution network of diesel gensets for pumping.

Key Takeaways

- *Social cohesion needs to be ensured before any community driven biogas plant can be established*
- *There needs to be a 'community champion' who is respected and influential in the community. Such a person can be technically trained and made responsible for the plant*
- *Capital subsidies should go along with an investment from the members of the community*
- *The Government can use the existing Swachh Bharat Campaign to promote biogas for both individual use as well as community use*

[13] Art of Living. Youth Leadership Training Programs. http://bit.ly/2A6hoN6

Challenges | Market Based Models

The market-based segment in India has not witnessed any major capacity expansion. Incentives play a crucial role in promoting any new technology at an incipient stage. India *has* offered a fairly large subsidy support to developer-based models since 2013 under the *'Programme on Energy from Urban, Industrial waste and Agricultural Waste residues'*. States like Gujarat have also come forward and are offering attractive feed-in tariff for all waste to energy projects. The key question therefore is, despite this support why developers are not coming forward to own operate and maintain biogas assets in India. This question is especially pertinent since the solar PV sector in India has attracted several Indian and international investors.

We believe that the key reason as to why developer-based biogas models are not taking off in India is due to several risks involved along the entire value chain. The government needs to do more to de-risk the entire value chain, right from input feedstock to the output fertilizer.

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Feedstock Supply Security

Price volatility and availability of the feedstock has been one of the main reasons that developers are apprehensive about investing in biogas plants in India. There have been instances in the past where the price for the input feedstock has increased many times over, once the feedstock suppliers recognize the value in this newfound valuable by-produce. Securing feedstock and ensuring that the input price volatility does not adversely affect the investment is one of the most important de-risking strategies that need to be implemented.

There are two specific interventions that can be done by the Government. First, the Government can ensure that the waste from municipal corporations, government owned/funded *gaushalas*[14], agricultural markets (*mandis)* and municipal sewage can be handed over to developers in a transparent manner, perhaps on some reverse auction process. This would create a secure supply chain and de-risk the first challenge i.e. availability. While such a move may lead to some aggregation of waste in the market, it will be grossly inadequate if India aims to rapidly scale up its biogas program. This is where private waste aggregators can play an increasingly important role. These companies can collect waste (usually at a small fee) from households, communities, factories, etc. and provide it to developers in a timely fashion. The price dynamics can be left to the market - which if transparent will ensure some sort of security. To ensure that biogas plants that produce gas and/or electricity stay profitable in such a dynamic environment, the electricity regulator can respond to such volatility by revising the feed-in tariffs in a regular and timely manner. Generally, tariff revisions are done once a year - this can be far too sparse.

[14] Cow shelters

One solution would be to review input feedstock prices in a quarterly basis. However, the question remains if India's regulators can take up such an active role. The other solution, would be to separate the costs of the assets and that of the fuel. Any change in fuel prices can be passed on to the end consumer as a fuel adjustment charge (FAC) - a practice that the DisComs are currently employing for thermal power plants. Nevertheless, price volatility is an important factor that the Government must actively intervene to de-risk.

Offtake of Power, Gas and Fertilizer

Despite the presence of a policy to promote waste to energy such as the Programme on Energy from Urban, Industrial and Agricultural Waste/Residues, there is systemic lack of offtake at the national level. The success behind the solar PV market in India can be attributed to large public-sector companies like the National Thermal Power Corporation (NTPC) coming forward to offtake the power. In the initial phases of the National Solar Mission (NSM), NTPC bundled expensive solar power with cheaper thermal power, thereby reducing the overall price. This was an effective way of increasing the share of solar power in overall generation. A similar strategy can be adopted for biogas in India. State run power distribution companies are financially weak and are struggling to stay afloat. They lack the necessary bandwidth and the creative energy to actively procure biogas power. Therefore, companies like the NTPC and perhaps even a dedicated biogas company (quite like the Solar Energy Corporation of India, SECI) may be set up to buy biogas power in India.

CERC also suggests an attractive feed-in-tariff of INR 7.56/kWh for biogas-based electricity generation[15]. Since electricity is a concurrent subject and

[15] CERC. Tariff Order for Renewable Energy Sources. 2017. http://bit.ly/2jmO2QB

many states in India are yet to announce state specific feed-in tariffs for biogas. DISCOMs need not procure power at the prescribed FiT. For instance, power from solar PV in India is always purchased through competitive reverse auctions. Wind energy too has recently taken this path. Therefore, while FiTs may help affix a number to biogas power, it may not necessarily spur the market.

DisComs are mandated to buy a share of electricity from renewable energy as a part of their RPO obligation. This ensures an almost guaranteed offtake of the electricity generated from renewable sources like solar, wind or biomass. There is currently no such quota or obligation in case of upgraded biogas and fertilizer. Similar to bio-ethanol, India can explore the possibility of mixing a certain percentage of biogas into compressed natural gas or even the gas grid. This policy, can give incentive to developers who wish to produce gas instead of power.

In case of organic fertilizers, state owned fertilizers companies can purchase the byproduct and market it to both local and international markets. There is a growing market for organic fertilizer across the world and this could be a good business opportunity for government as well as private firms. There is a need to create standards for organic and mineral content for such fertilizers.

Key Takeaways

- *Hedging the price volatility of input feedstock is the most critical success factor for developer owned biogas plants*
- *Enabling mechanisms for offtake of biogas power (such as NTPC or SECI) and biogas (such as gas companies) would create demand*
- *Government needs to de-risk investments and enhance bankability*

Overall Market Challenge

India's biogas market has been stuck far too long in the Government Driven Phase (see figure below). There is a dire need for the market to transition to an incentive driven phase where the Government plays an active role in de-risking investments.

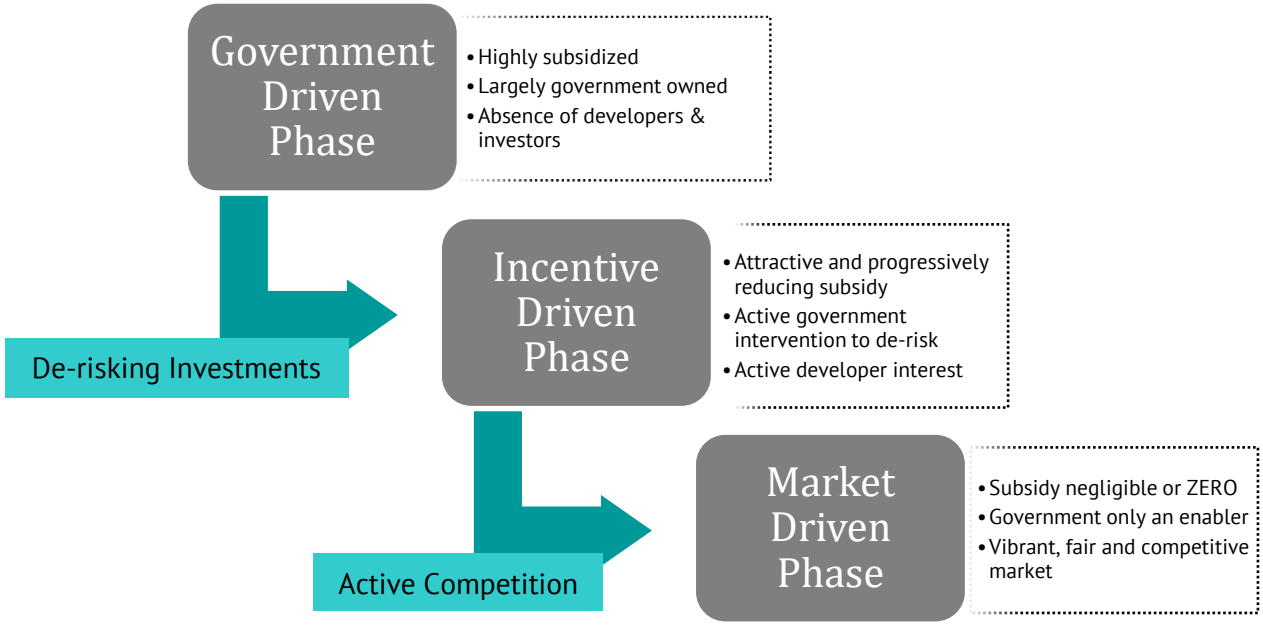

Figure 3: Typical phases in any developing market

De-risking involves feedstock supply security, offtake of products and mechanisms for guaranteed power (discussed in earlier sections). This ensures a favourable environment for the industry to invest in biogas and expand. Eventually this attractiveness attracts competition and moves the sector to a market driven phase. India's policymakers need to urgently start recognizing biogas as a technology that can seriously contribute to curbing greenhouse gas emissions, secure energy supplies by reducing imports, create jobs especially at the rural hinterland, reduce deforestation and improve cleanliness in India.

About GERMI

Gujarat Energy Research & Management Institute (GERMI) is a center of excellence in the energy sector that seeks to provide research based consulting and advisory services in the field of renewable energy and petroleum to policy makers and to the industry.

The institute also provides professional and vocational training across these sectors to an audience that includes government officials, industry leaders. GERMI is based in the capital city of Gujarat in Gandhinagar, India.

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About Indian Biogas Association

Indian Biogas Association (IBA) is the first nationwide and professional biogas association of operators, manufacturers, and planners of biogas plants, representatives from public policy, science and research in India, and all other stakeholders of biogas ecosystem. The motto of the association is **''propagating biogas in a sustainable way''**.

The Indian Biogas Association has members from across the biogas community and related fields of biogas. Members represent industry, academia, institutes, governmental and non-governmental organizations. The association received the Global Green Award for its holistic contribution.

The Biogas App is an indigenously developed mobile application by the Indian Biogas Association that is currently available for free on Google Play Store. The app can determine the biogas potential of more than 200 substrate, helps locate feedstock aggregators, enlists government policies and provides other useful information to consumers.

Notes:

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