Transforming the use of biogas in Pakistan: From household application towards powering small holder irrigation

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Overview

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Note: In April 2014, USD 1= PKR 98,5

1. Summary

Irrigation in Punjab is highly dependent on ground water as a supplement to the supply from irrigation canals. Drawing ground water with the use of electric tube wells or with diesel engines is becoming prohibitively expensive. Particularly the small holders are prone to this problem as both electricity and diesel prices are continuously rising while electricity supply has become very unreliable as well. With its huge population of cattle (60 million heads according to a 2006 Livestock Survey) and a highly favourable climatic condition, production of biogas from manure as a sustainable and affordable alternative to power engines for irrigation is becoming important.

The Pakistan Domestic Biogas Programme (PDBP) implemented through the Rural Support Programmes Network (RSPN) with technical assistance from SNV Netherlands Development Organisation and Winrock International has been facilitating the installation of biogas digesters through local enterprises for household use (mostly cooking).The programme is receiving financial support from the Embassy of the Kingdom of the Netherlands. Since 2013, PDBP has started piloting larger sizes of plants that can generate sufficient biogas to be used in dual fuel diesel engines to operate tube wells for irrigation at small holder farms. From a purely consumptive use, biogas is now moving into more productive applications.

Locally manufactured Petter engines are used. These are hardy engines that do not require much complicated modifications to run on biogas. Running on biogas is saving between 65% and 75% of diesel compared to diesel use only. This translates into substantial financial savings for farmers. The efficiency can further be increased by small modifications in feeding of biogas to the engine, in storage systems and through purification of biogas. Such modifications can locally be carried out by entrepreneurs in the local market after receiving training from the programme.

PDBP is undertaking a client survey on the performance of the biogas-powered irrigation as well as an in-depth financial and economic analysis. Government, non-governmental and private sector collaboration will then be required to up-scale the pilot experience. The potential of biogas as sustainable and practical alternative to power small holder irrigation is dawning upon Pakistan's policy makers, implementers and users alike. The commercial viability of this sector is indicated by the fact that private sector Biogas Construction Companies are actively installing digesters purely on profit basis. This "case" must now be highlighted and much more widely discussed among all stakeholders to develop a workable model for sector sustainability. Some key conditions that need to be met for commercial viability of this sector are: sector cohesion, quality control, favourable financing, capacity building of stakeholders and a smart use of subsidy, if any.

2. Introduction

Pakistan's power sector is currently afflicted by a number of challenges that have led to a crisis; these include a supply-demand gap where the demand for electricity far outstrips the current generation capacity leading to gaps of up to 4,500 – 5,500 MW. The supply-demand gap has continuously grown over the past 5 years and has led to load-shedding schemes of 12-16 hours across the country with rural areas being affected the most. Generation of electricity due to an increased dependence on expensive thermal fuels is highly expensive ranging in price from PKR 12 / unit for mixed (mix of different grades of petroleum); PKR 17 / unit for Furnace Oil, and a tremendously expensive PKR 23 / unit for High Speed Diesel. Dependence on such expensive fuel sources has forced Pakistan to create electricity at rates that are hardly affordable to the nation and its populace. (Power Policy, 2013; http://www.mowp.gov.pk)

Agriculture is the single largest sector of Pakistan's economy. It contributes about 21 percent to the GDP, directly accounts for about 80 percent of the export earnings and employs more than 50 percent of its civilian labour force (Punjab Agriculture Department, 2014). Because of arid

and semi-arid conditions prevailing in most parts of the country, direct rainfall contributes to less than 15 percent of total crop demand. Therefore, irrigated farming is the most economical and remunerative form of agriculture.

Irrigated lands supply more than 90 percent of the agricultural production and are major users of the water resources. There is reduction in surface supplies through capacity losses in the reservoirs due to siltation. The difference between crop water requirements and surface supplies is met through exploitation of groundwater. Therefore, groundwater has gradually acquired a vital role in the development of agricultural and rural economy in Pakistan.

Large-scale exploitation of groundwater for irrigation started during 1960s with the launching of Salinity Control and Reclamation Projects (SCARPs). Thousands of large-capacity tube wells (0.08 to 0.14 m3/sec) were installed to lower groundwater table and supplement irrigation supplies. This demonstration also led to a proliferation of private tube wells with a capacity of up to 0.028 m3/sec by farmers in the 1970s and 1980s. Subsidized power supply and introduction of locally manufactured diesel engines provided an impetus for dramatic increase in the number of private tube wells. It is estimated that investment on the private tube wells is of the order of PKR 25 billion whereas the annual benefits in the form of agricultural production are to the tune of PKR 150 billion (Shah et al., 2003). With the subsidies disappearing, the rise in the price of diesel as well as the diesel engines and load shedding in rural areas, farmers are being hit hard.

Electric tube wells for irrigation are easy to manage and the cost of pumping water is less than that of diesel pumps. However, the installation of these wells was restricted to large land-owners because the small farmers still considered it expensive or, at least, not of potential use due to load shedding. Therefore, they relied more on diesel tube wells, and thus, the number of diesel tube wells in the country kept increasing. Another restricting factor in the installation of electric tube wells was the high capital cost of drawing a cable from the main line to the tube well, the transformer and other accessories. A farmer had to pay for a 25 KV transformer, price per pole and additional charges for the cable, requiring an investment inaccessible to many small farmers. From 1991 onwards when farmers were asked to pay these amounts, the trend towards installing electric tube wells further decreased (Qureshi et al., 2003). For example, before 1991, the ratio of electric motors to diesel pumps was 1:3 whereas it increased to 1:8 in 2000-01 in Punjab (Kazmi and Maurits, 2010). This clearly shows that farmers are less interested in electric tube wells and instead are fast moving towards diesel pumps in Pakistan.
The diesel prices on the other hand are increasing day by day and currently the price of one litre is PKR 118. On an average, a diesel engine consumes 1.5 to 3 litres per hour.

In the current scenario of load shedding and high prices of diesel, biogas can be used to substitute the diesel in the engines as an alternative and cheaper source of energy for small farmers.

3. Pakistan Domestic Biogas Programme and SNV role in technology transfer

In 2007, RSPN in collaboration with Winrock International piloted construction of the fixed dome design biogas plants with technical assistance from the Biogas Support Programme in Nepal in Sialkot Punjab and in Dera Ismail Khan, Khyber Pakhtunkhwa. Subsequently SNV and Winrock carried out a biogas feasibility study and an assessment of existing biogas technology and management in Pakistan. In 2008, a comprehensive Programme Implementation Document (PID) was prepared outlining in detail the technology, technical and socio-economic feasibility as well as management and quality control systems all centred on a market-led and sector-wide approach.

The Pakistan Domestic Biogas Programme (PDBP) was started in January 2009 in Faisalabad District, Punjab Province initially with a start-up funding from SNV and later with funding from the Embassy of the Kingdom of the Netherlands. The start-up was used to set up the project management, train staff on technical aspects and on monitoring and quality control aspects. This

phase was also used to identify and train masons and a first batch of entrepreneurs on biogas construction, marketing, promotion and quality control aspects. In this phase, the programme constructed 36 domestic biogas installations of the modified GGC 2047 design. PDBP has so far facilitated the installation of 4,400 biogas plants by April 2014 and has built the capacity of 36 entrepreneurs as Biogas Construction Companies (BCCs). Emphasis on a market approach in which priority was given to capacity building of the entrepreneurs as well as the users, quality control and most of all an innovative way of linking a small subsidy directly to quality control ensured that above 95% of the plants were operating well and the clients were satisfied with its performance. This was confirmed by third-party client satisfaction surveys successively carried out in 2010, 2011, 2012, and 2013.

SNV played a key role in the promotion of the technology as well as in the design of an innovative implementation approach in Pakistan. SNV has amassed great deal of know-how and experience in the development as well as refinement of quality biogas plant construction in many Asian and African countries.

The key areas of focus in the SNV approach have been:

- Sound and appropriate technology emphasizing a balance between cost and efficiency,
- No compromise on quality and quality control process for the installations as well as the process implementations,
- Capacity building of all stakeholders private, public and client households on technology, construction, marketing, promotion, operation and maintenance,
- Avoiding market disturbance due to disproportionate disbursement of subsidies to any party involved,
- Promotion of coordination and cohesion among all stakeholders involved in the biogas sector.

PDBP focused on providing a sustainable solution to replace the use of firewood, dung cake and LPG from the rural kitchen. The project offered four sizes at first – 4, 6, 8 and 10 m^3 biogas digesters and later 15 m^3 depending on the cattle holding, family size and the cooking needs and to small extent lighting. During the life of the programme, the energy scenario in Pakistan, especially in rural areas kept deteriorating. The project increasingly encountered demand from rural farming household for a sustainable and affordable solution for irrigation purposes. Here is an extreme but interesting example of what farming household had to say: *"I can use my chairs and table to burn in the kitchen and cook food if necessary, but if I am not able to irrigate my land and not produce, what can I cook on biogas? What we urgently need now is also the possibility to use biogas for irrigation".*

4. Technology

Many farmers are looking for cheaper and sustainable alternatives to electricity and diesel. Biogas seems to provide such an opportunity. These farmers possess enough cattle heads, space for plant construction and are willing to put up the investment. This motivated the PDBP to design 20 and 25 m^3 biogas installations that could produce enough biogas to run the diesel engine for a reasonable number of hours.

In its simplest form, the system consists of biogas used as a fuel to operate an internal combustion engine which in turn operates the water pump (known as tube well locally) to draw water for irrigation. Biogas is generated through the anaerobic digestion of animal manure in biogas installations. All the installations constructed under the PDBP are the underground, fixed dome GGC 2047 modified plants (Fig. 1). There are some floating drum plants installed by other operators as well. So far, cattle dung is the major raw material for producing biogas. A 20 and 25 m^3 biogas plant is most often used while many farmers who can spare gas from cooking also use 15 m^3 plants.

Fig. 1

By the end of January 2014, PDBP has installed two hundred 25 m^3 and seventy five 20 m^3 plants. Most of these plants are being used to pump water for irrigation, and most of the pumping sites are located near the bio-digesters. The use of a "T" junction allows for the connection of an extra pipe or hose to the diesel engine. As irrigation is not a daily activity and is limited to 4 – 6 hours per day, the household has enough left for use in the kitchen. Some BCCs under PDBP have installed more than 250 biogas plants for irrigation purposes outside the programme area in various districts of Punjab. PDBP has also recently started installation of 50 and 100 m^3 plants as part of its research and development programme.

The most common type of diesel engines used in irrigation is the Petter engines (Fig. 2) which are versatile engines running on diesel and applied in various tasks such as ploughing, running the fodder chopper, operating mills and even used for transportation. They come in several brands and are available in capacities from 8 to 36 horse power locally manufactured/assembled in Pakistan, mainly in the city of Lahore. In a few cases the tractors running on diesel and biogas are also used for pumping water.

Fig. 2

For dual-fuel operation on biogas, the engine is first started with diesel and let idle by keeping the accelerator to its minimum. Biogas is then directly supplied to its air filter using the supply pipe from the biogas plant. In many cases a gas injection kit similar to those used in gas generators is also used. Once biogas is supplied, the engine speed picks up. The engine speed

(rpm) is then set at a desirable level using the manual gas valve/adjuster. The fly wheel is connected to the wheel of the pump of the tube well by a "V" or flat-belt which is turned by the engine and water is drawn up (Fig. 3 and 4). In this situation the consumption of diesel is reduced by 65 to 75% compared to diesel-use only. This means a huge direct saving for farmers. A biogas plant of 20 or 25 m^3 can produce on an average 5-6 m^3 of biogas in 24 hours which is sufficient to run the engine for 6 to 8 hours during day time. The timing can be more than 8 hours if the water table is less than 2-3 meters (high water table) and can be less if the water table is more than 10 meters deep (low water table)[3]. The diameter of bore pipe also affects the consumption of biogas. Larger diameter used for drawing larger volumes of water uses more biogas while smaller diameter of the bore pipe will draw less water and will therefore require lesser consumption of gas.

Fig. 3

Fig. 4

[3] In actual practice, none of the farmers surveyed were running their engine for irrigation for more than 4 – 6 hours each day.

5. Cost involved and benefits accrued

- **Cost of biogas installations of sizes commonly used for irrigation**

Plant size (m^3)	Cost in PKR*	Subsidy PKR	Net cost for farmers
15	107,290	40,000	67,290
20	146,860	40,000	106,860
25	169,455	40,000	129,455
50	352,752	0	492,752
100	514,979	0	784,979

*Source: PDBP (cost is of civil structure only; excluding additional storage tank, filters or engine.

- **Cost of Petter engine and its operation and maintenance**

HP	Market price (PKR)	Diesel ltr/hr	Diesel ltr/hr with biogas*	Diesel saved Litres**	Savings in PKR per day***
16	37,000	1.5	0.5	1x6 = 6	708
18	42,000	2	0.7	1.3 x 6 = 7.8	920
20	44,000	2-2.5	0.7-0.8	1.3-1.7 x 6 = 7.8-10.2	920-1,204
25	46,000	2.5	0.8	1.7 x 6 = 10.2	1,204
27	48,000	2.75	0.92	1.83 x 6 = 10.98	1,296
30	30,000	3	1	2 x 6 = 12	1,416
32	52,000	3-3.25	1-1.1	2-2.15 x 6 = 12-12.9	1,416-1,522
34	62,000	3-3.5	1-1.2	2-2.3 x 6 = 12-13.8	1,416-1,628
36	70,000	3-3.5	1-1.2	2-2.3 x 6 = 12-13.8	1,416-1,628

*1/3 diesel and 2/3 biogas
**If Petter engine runs for 6 average hours per day on biogas
***Rate of diesel is PKR 118 per litres
Information based on PDBP survey of Petter engine manufacturers, 2013.

Following from the above table, operating on dual fuel, PKR 920 is saved each day for an 18 HP engine. The current cost for a bio-digester of 25 m3 is PKR 129,455 and that of an 18 HP engine is PKR 42,000. The total investment of PKR 171,455 as well as if expenses for oil change (5 litres in 100 days) and other costs are added, the payback is within a year which is extremely attractive. This is assuming that a farmer already has invested in his tube well infrastructure and pumps. Of course a more refined study and analysis need to be made for the cost and benefits of this system.

- **Construction cost for installation of tube well such as the digging of well and the bore well including civil works.**

Particulars	RCC Pipe tube well cost in PKR	PVC Pipe tube well cost in PKR	GI Pipe tube well cost in PKR
Pipe Used in Bore 5" diameter*	80 per ft	150 per ft	475 per ft
Filter at bottom of bore	10,000	10,000	10,000
Shaft and wheel	20,000	20,000	20,000
Belts	12,000	12,000	12,000
Centrifugal pump	35,000	35,000	35,000
Digging+ Civil Work costs	120,000	120,000	120,000
Boring	300 per ft	300 per ft	300 per ft
Petter Engine	65,000	65,000	65,000
Annual maintenance costs estimated	20,000	20,000	20,000

* Bore diameter is kept 5 inch if the delivery pipe's diameter is 4 inch (based on PDBP market survey 2013)

- **Cost of filtration and storage equipment**

Equipment	Capacity	Costs in PKR **50 – 100 m^3 plant**	Replacement period
Storage tank	1000 litres	45000 – 80000	5 years
Compressor	0-150 psi max	15000 – 25000	5 years
H_2S filter		30000 – 40000	5 years
Water filter			
CO_2 filter			
Gauges		2500	5 years

6. Optional refinements for improved performance and efficiency

Gas is mostly directly injected to the Petter engine without any filtration of moisture, CO_2 or H_2S as the engine is claimed to be sturdy enough to withstand the impurities. As replacement parts are locally available and relatively cheap, farmers do not go for modifications. Some refinements are however possible to improve the efficiency mainly through purification of biogas and on adjustment of the Petter engine and storage of biogas.

- **Purification of biogas:**

Biogas is a mixture of 60-70% methane (the fuel) and rest carbon dioxide, nitrogen, hydrogen sulphide and moisture vapours. Increased proportion of methane in biogas would result in increased calorific value. The project is yet to try and test this methodology but several households have applied a simple technology in which biogas is passed successively through a column of water to scrub carbon dioxide, a column of iron filing to scrub hydrogen sulphide and a third column of silica desiccant to scrub moisture. This equipment can be locally manufactured and installed. It is however not documented as to what levels of purification of methane in terms of its content and removal of hydrogen sulphide and moisture is achieved (Fig. 5). This is an area which PDBP will take up in future.

Fig. 5

- **Adjustment of Petter engine:**

Farmers commonly just let biogas through the air filter of the engine from where it is sucked with air and burnt in the engine. This is simple but results in loss of biogas to the atmosphere. A simple technique to improve on this is to install gas kit being used for gasoline engines to run the gasoline engine on natural gas, after minor adjustments in the kit. In such case, the same amount of biogas would result in more hours of operation as reported by users. Local engine manufacturers also indicate that just regular oil change and maintenance would not only improve efficiency but also increase the life of the engine. Moreover, they claimed that an additional nozzle for biogas along with other nozzles of diesel can make maximum usage of biogas for engine running without any wastage, which means more hours of operation.

- **Storage of gas:**

Storage of biogas would immensely help to improve the utility of biogas. A local technology applied by some farms is the construction of a gas storage tank out of iron sheets. A small compressor compresses biogas into the tank via a one way valve monitored by a pressure gauge installed atop the storage tank (Fig. 5). Gas is supplied to its end use whenever required and not

only when the biogas plant is producing gas. Storage of gas at a certain pressure, usually 40-70 PSI can easily be passed to engine through a regulator which also allows for the gas to be supplied to engines and generators at constant pressure which would not have been possible with the direct supply from the biogas plant (fixed dome models which are most prevalent in Pakistan).

7. Opportunities and constraints in the productive application of biogas

Know-how of biogas technology has existed in Pakistan since the sixties. In the last decades the technology remained on pilot mode never being up scaled enough to generate desired impact. The sector remained fragmented with some national level agencies, provincial authorities, NGOs and even donors embarking upon their own pilots. Different designs and differing implementation models were used. One aspect strikingly common among all the initiatives was the use of varying but heavy subsidy rates never considering the fact that this was one major factor that hampered massive uptake by farmers. Heavy subsidy meant low ownership resulting on lack of proper maintenance and rapid malfunction of the system (Bikash Panday and Sundar Bajgain, 2007). Technology was easier to be blamed rather than the implementation and management aspects. PDBP with a completely new market-based approach building capacity of multiple-stakeholders with strong emphasis on quality control and less on subsidy has proven to be successful with more than 4,400 biogas plants built by April 2014 and 97% operating successfully.

The scenario may now be changing especially with the realisation that biogas can be effectively used as a fuel to operate tube wells substituting expensive and unreliable supply of electricity and diesel. PDBP's move into productive use of biogas in addition to the household use and the recent interest being shown by the provincial government into commissioning of biogas digesters solely for the purpose of facilitating irrigation will create a positive environment in the sector. Opportunities and constraints as relevant to the sector are explained below.

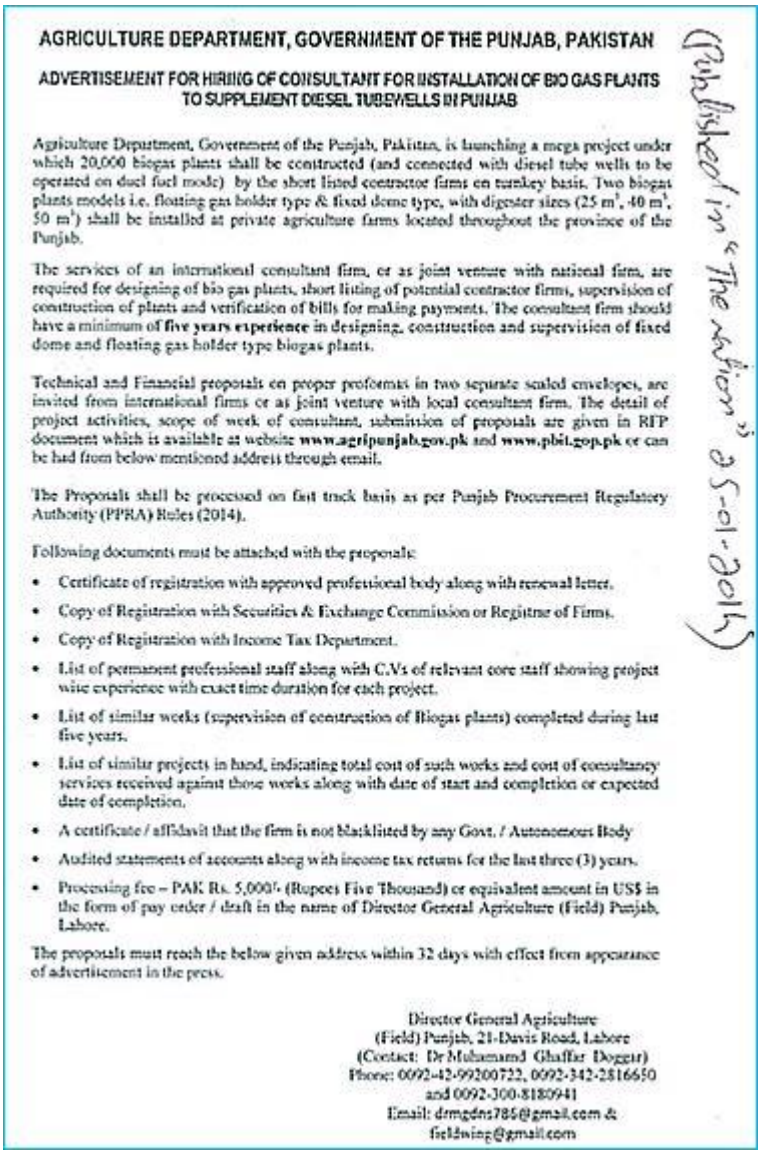
Opportunities:

There are many opportunities that can be utilized to ensure a vibrant biogas sector not only in the "traditional" domestic biogas subsector but also the newly arising opportunities in the area for productive application of biogas with more direct relation to household and enterprise level financial benefits. These areas are utilization of biogas as a reliable energy source for agri-based enterprises such as irrigation, dairy enterprises and small scale agri-processing.

- Worsening situation of supply of conventional energy sources such as electricity and petroleum products as well as progressing increase in their price has definitely raised red flags in front of policy makers. A realization is growing for the need to develop an array of reliable sources of renewable energy including biogas.
- At national level an apex body in the form of Alternative Energy Development Board (AEDB) already exists. The need of the day is for relevant ministries and departments at federal and provincial level to help AEDB to devise a policy and strategy that may act as a cohesive force to bring all actors – public, non-governmental and private sector to promote a sustainable RE sector including that for biogas.
- Pakistan is among the few countries in the world where the population of livestock is increasing. Already with the current population of 60 million livestock heads the potential for biogas is tremendous. Over 40,000 households have more than 50 cows and buffaloes and many more own 10 to 50 cattle indicating a huge technical potential. Combine with it the favourable ambient conditions, availability of necessary materials locally and the relative ease of its transportation. A detailed market study will however be required to derive socio-economic data.
- Experience in PDBP shows that a huge base does exist for capacity strengthening in service delivery of biogas. Skilled masons are available and willing to be trained on biogas construction; enterprises are available and willing to take on biogas construction as a viable enterprise. Some of whom as indicated in section 4 have already started to provide services

in the supply side. Similarly, NGOs interested in promotion of RE are available mainly at national level but occasionally also at district level.

- Financing agencies exist in Pakistan with resources as well as interest to invest in innovative technologies as long as it is a profitable business. The challenge for organizations like RSPN/PDBP, other NGOs and government agencies is to ensure a level playing field and provide policy support.
- Increasing realization within provincial governments about the importance of RE especially biogas due to the availability of cattle and dung and the potential benefits of bio-slurry in improving land productivity is a favourable opportunity of this sector. The recent example is of the Punjab Government calling for bids from the private sector to construct 20,000 biogas digesters of 25, 40 and 50 m3, both fixed dome and floating drum designs to be connected to tube wells operating dual fuel engines (Fig. 6). Inclusion of fixed dome design is purely due to the reason that PDBP has proved it to be a successful, and cheap technology.



AGRICULTURE DEPARTMENT, GOVERNMENT OF THE PUNJAB, PAKISTAN

ADVERTISEMENT FOR HIRING OF CONSULTANT FOR INSTALLATION OF BIO GAS PLANTS TO SUPPLEMENT DIESEL TUBEWELLS IN PUNJAB

Agriculture Department, Government of the Punjab, Pakistan, is launching a mega project under which 20,000 biogas plants shall be constructed (and connected with diesel tube wells to be operated on duel fuel mode) by the short listed contractor firms on turnkey basis. Two biogas plants models i.e. floating gas holder type & fixed dome type, with digester sizes (25 m^3, 40 m^3, 50 m^3) shall be installed at private agriculture farms located throughout the province of the Punjab.

The services of an international consultant firm, or as joint venture with national firm, are required for designing of bio gas plants, short listing of potential contractor firms, supervision of construction of plants and verification of bills for making payments. The consultant firm should have a minimum of **five years experience** in designing, construction and supervision of fixed dome and floating gas holder type biogas plants.

Technical and Financial proposals on proper proformas in two separate sealed envelopes, are invited from international firms or as joint venture with local consultant firm. The detail of project activities, scope of work of consultant, submission of proposals are given in RFP document which is available at website **www.agripunjab.gov.pk** and **www.pbit.gop.pk** or can be had from below mentioned address through email.

The Proposals shall be processed on fast track basis as per Punjab Procurement Regulatory Authority (PPRA) Rules (2014).

Following documents must be attached with the proposals:

- Certificate of registration with approved professional body along with renewal letter.
- Copy of Registration with Securities & Exchange Commission or Registrar of Firms.
- Copy of Registration with Income Tax Department.
- List of permanent professional staff along with C.Vs of relevant core staff showing project wise experience with exact time duration for each project.
- List of similar works (supervision of construction of Biogas plants) completed during last five years.
- List of similar projects in hand, indicating total cost of such works and cost of consultancy services received against those works along with date of start and completion or expected date of completion.
- A certificate / affidavit that the firm is not blacklisted by any Govt. / Autonomous Body
- Audited statements of accounts along with income tax returns for the last three (3) years.
- Processing fee – PAK Rs. 5,000/- (Rupees Five Thousand) or equivalent amount in US$ in the form of pay order / draft in the name of Director General Agriculture (Field) Punjab, Lahore.

The proposals must reach the below given address within 32 days with effect from appearance of advertisement in the press.

Director General Agriculture
(Field) Punjab, 21-Davis Road, Lahore
(Contact: Dr Muhammad Ghaffar Doggar)
Phone: 0092-42-99200722, 0092-342-2816650
and 0092-300-8180941
Email: drmgdrs786@gmail.com &
fieldwing@gmail.com

(Published in "The Nation" on 5-10-2014)

Fig. 6

Constraints:

Constraints more or less mirrors the opportunities described above. Constraints faced for mass scale dissemination of domestic biogas also mirrors constraints that productive use of biogas will face.

- **Wider acceptance of technology:** Even biogas as domestic energy alternative, despite of the soundness of the technology, is still facing constraints in Pakistan as the technology is yet to reach a threshold level of awareness that would accelerate its wider acceptance and adoption. Productive use of biogas is a very new area altogether and is still in a test phase where only few initiatives are underway. A proper system for financing, construction, management, service delivery and quality control are yet to be in place. Success of these new initiatives piloted by PDBP and few other agencies and collaboration among these agencies in developing a workable market will determine how it will fare in future in terms of acceptance and performance.

- **Financing bottlenecks**: Financing will be required for promotion of the technology, capacity building and quality control activity and some smart subsidies will be required in the initial years before the programme picks up and confidence in the technology is built for wider adoption. Household and enterprise financing will be necessary as installation of biogas plants and other equipment requires a significant financial outlay. Unlike domestic biogas which is perceived as not generating a direct financial return, the productive use of biogas for irrigation can be directly linked to financial return in terms of crop productivity and will be attractive for financing/micro-financing institute to invest on.
  Financing programme development, capacity building and quality control activity requires significant resources and the traditional donors for such initiatives are the bilateral, multilateral, government agencies and some international NGOs. In the present context of Pakistan and over a short to medium term, donor priority has veered towards improving security situation and rehabilitation of internally displaced due to insurgency and natural calamities. EKN which was a key player in the environmental sector in general including RE technologies has also scaled down its activities in Pakistan to a minimum. At present the government is still stalled in a welfare mentality and rather than making or promoting sustainable market facilitation it is choosing to achieve political mileage by selecting free or highly subsidized programmes in off and on fashion in very limited localities. This has time and again proven to be very harmful for other agencies like PDBP/RSPN who are promoting a market based and quality led approach.

- **Welfare approach as compared to a market led approach**: In the psyche of the policy and decision makers especially at the government side RE, biogas is still considered as a technology for the poor and a welfare approach such as granting an installation free or on a highly subsidized basis is favoured. Such an approach and a lack of awareness raising of the technology, needs assessment, capacity building, quality control and dearth of after sales services meant the technology did not perform as it should. Few studies are available documenting this but the results have not been widely shared to be internalized by those who should. The concept of "zakat" or free donations of cash or kind to the poor is an integral part of Islam and it is difficult to take this opportunity for a good deed away in favour of a more market led approach where needs, benefits and profit is the driving force for technology innovation, delivery and utilization.

- **Inability to rise above pilot mode and a delivery of a cohesive approach:** Different NGOs, several federal, provincial and district level government agencies are still trying out biogas plants mainly for domestic kitchen energy purposes. All such pilots are implemented with varying but heavy amount of subsidy without any emphasis on quality control and efficiency. Moreover, no one shares their experience with each other and thus no lessons learnt are exchanged and resources are duplicated in trying to invent the wheel many times

over. Neither the government nor its designated body the AEDB has so far taken any initiative to bring all these actors together to work for a cohesive approach so as to generate a real impact.

Addressing lack of capacity for the operation and maintenance of the digester equipment and the irrigation paraphernalia is an additional concern. In this regard, a capacity strengthening system can be established, based on previous systems laid out by the domestic biogas programme.

8. Future roles for RSPN and SNV

- RSPN has become the leading organisation in Pakistan not only in the numbers of digesters installed but also a pioneer on promoting successfully a market based approach. The market is further developing and the provincial government is becoming increasingly open to the technology of utilising biogas for irrigation. They are also open for proposals from local organisations in partnership with international organisation or firms (Fig. 6). RSPN and SNV could continue partnering also at such fund raising opportunities locally.

- SNV invested significantly in the biogas sector development in Pakistan through technical assistance on technology development, support in appropriate implementation mechanism based on market demand and quality control and capacity building of the implementation organization RSPN as well as the biogas entrepreneurs. SNV was also successful in resourcing funds from EKN for the project for five years. SNV had also developed proposal and submitted to several potential donors. The security situation in Pakistan and the recent natural calamities and internal displacement of population necessitated donors to change their priorities more towards welfare and rehabilitation and less attention was being paid towards renewable energy. RSPN and SNV with their local partners can still pursue the donors once the situation alters and take advantage of the successful base that has already been created in the field.

- During this phase of the programme, SNV assisted RSPN to concentrate more on field where technology, methodology was perfected for domestic biogas and capacity of the entrepreneurs were built. A sound basis and infrastructure has been created ready for further up scaling and generating real impact. RSPN can continue this trend while SNV can now shift its focus towards awareness raising and capacity building of district, provincial and national level government, semi-government and private sector actors that have stake in renewable energy. This will also help promote the setting up a RE and within it biogas policies and strategies which is being felt as very necessary in Pakistan and ultimately in resourcing government level funding towards biogas within such a framework.

- The project recently initiated productive use of biogas in addition to domestic kitchen use. PDBP has started promoting and marketing biogas installation to power engines for irrigation purposes. The development is still in pilot stage which needs further technical assistance and R&D. SNV can continue to assist RSPN or any other agencies in Pakistan in this subsector through design improvements and use of its extensive knowledge network in resourcing technology and methodologies. SNV can also assist in development of capacity building and quality control mechanisms with its experience from the domestic biogas sub sector.

- With the increased realisation dawning upon policy makers, implementers and the users about the feasibility of using biogas for powering small holder irrigation as well as other practical applications, SNV with its global experience in biogas sector development both at domestic and medium scale level is in a niche position to help strengthen the capacity of all relevant stakeholder – government, non-government and private sector in Pakistan to work together cohesively and to develop sector policies that help ensure the commercial viability of the sector.

- SNV can also help design and carry out a client satisfaction survey as well as an economic analysis of the biogas installations and related peripherals for establishing a sound basis for further up scaling. This is a new and highly potential field for both SNV and Pakistan as the potential for using biogas in powering irrigation for small farms in Pakistan is immense.

9. References

Agriculture in Punjab, 2014 accessed 20 February 2014 (http://www.agripunjab.gov.pk/index.php?agri=detail&r=0)

Bikash Panday and Sundar Bajgain, July 2007. Feasibility Study of Domestic Biogas in Pakistan. SNV, Winrock and UNDP.

Biogas Users Survey 2010, 2011, 2012 and 2013. Pakistan Domestic Biogas Programme, Rural Support Programmes Network.

Felix ter Heegde and Bikash Panday, 2008. Programme Implementation Document for the Dissemination of Domestic Biogas in Pakistan, SNV

Kazmi, Syed, and Maurits, 2010. "Changes in tube wells count in two decades in area under conjunctive irrigation in Pakistan.

PWP. 2001. *Supplement to the framework for action (FFA) for achieving the Pakistan water vision 2025-Civil society response to FFA*. Islamabad, Pakistan: Pakistan Water Partnership.

Productive biogas, current and future developments, April 2014, SNV and FACT Foundation

Rajesh B. Shrestha, Productive use of biogas: Operating Petter engines on biogas for small scale irrigation, PDBP-SNV, 2013

Shah, T.; A. Debroy; A. S. Qureshi; J. Wang. 2003. Sustaining Asia's groundwater boom: An overview of issues and evidences. *Natural Resource Forum,* 2: 130-140. IWMI's contribution to International Conference on *A Key to Sustainable Groundwater Management.* Bonn, Germany. December 6-7*.*

Qureshi, A.S.; M. Akhtar; A. Sarwar. 2003. Effect of electricity pricing policies on groundwater management in Pakistan*. Journal of Drainage and Water Management,* 7(2). (*In press*)
