CONCEPT NOTE

COVER PAGE

Project Title:

An integrated program to reduce child mortality and provide social and economic empowerment of women in the target area at Village Ullon, 24 Parganas (S), West Bengal.

Location: Ullon, 24 Parganas (South), West Bengal.	**Date of preparation:** 19th November, 2010

Project partners:

Project Holder: Vivekananda Sevakendra-O-Sishu Uddyan (VSSU)
Lead Partner: Society for Appropriate Rural Technology for Sustainability (ARTS)
Coalition Partner: Environment Conservation Society (Switch ON)

Full contact details of Project Holder:	**Full contact details of Principal Investigator:**
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Themes addressed in the 'Concept Note':

Overall aim/Innovation: Reduce child mortality by doubling the productivity of Spirulina micro-nutrients as a food supplement to meet the daily nutritional requirements of 540 children in the area;

Expected outcomes for beneficiaries in Sunderbans: Contribute to MDG Goals: (a) Promote gender equality and empower women; and (b) Eradicate extreme poverty and hunger—by creating livelihoods for women for the production of spirulina and aquaculture on the one hand, and biogas and vermicompost on the other, which will double the yield of fish and vegetables production by recycling the waste by-products in a continuous cycle of 'waste-to-wealth'; (d) Ensure environmental sustainability by keeping the environment clean and reducing GHG emissions with M2M approaches for biomethanation; (e) Develop global partnerships through academic networks.

This project is needed to provide food, livelihoods, energy and environmental security to beneficiaries from one, multi-faceted appropriate technology package.

The ***objectives*** of the three-year project will be to develop a participatory approach for empowering the target beneficiaries in the village-based community at Ullon, 24 Parganas (S)—in order to: (a) overcome local barriers to socio-economic development, using biomethanation and spirulina processes as tools for empowerment (see Annex-A for outcomes and expected results); (b) use process oriented and scientific approaches for community building (see Annex-B for project approach).

Project Outline: Three year duration**—**Start date: 1st April 2011 ; End date: 31st March 2014

Year	Plan of Work	Budget
1	Start a participatory program to explain the reasons for initiating the Spirulina project at Ullon; build biomethanation plants and vermibeds;	£ 9,556
2	Develop a sustainable three-tank spirulina project and establish a marketing and distribution program for spirulina "Super Food" products;	£ 9,561
3	Integrate biomethanation and spirulina sub-projects for recycling waste products; promote more community-based SHG's.	£ 9,553
	TOTAL PROJECT	**£ 28,650**

The Logical Framework Analysis of the proposed three-year project is shown in Annex-C.

Concept Note:

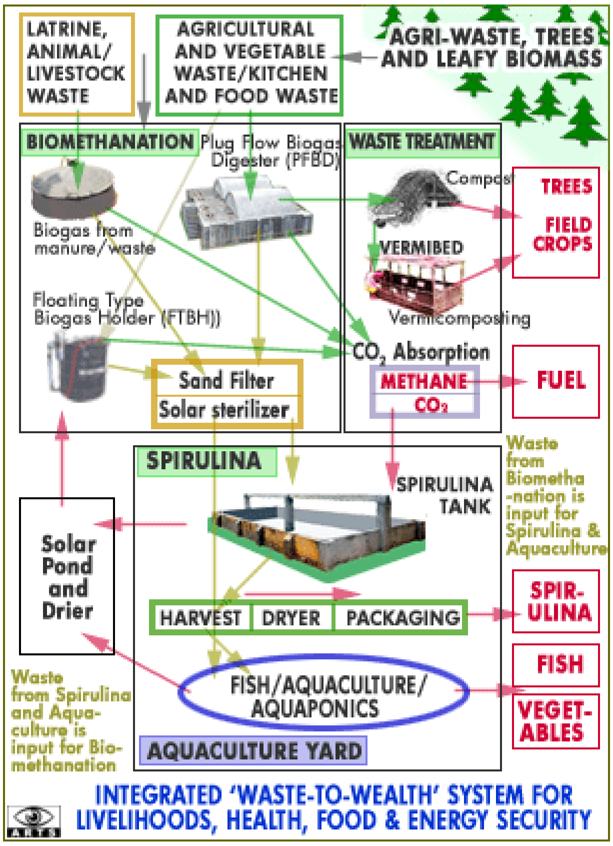
An integrated program to reduce child mortality by doubling the productivity of Spirulina micronutrients as a food supplement to meet the daily nutritional requirements of 540 children; and for social and economic empowerment of women in the target area at Village Ullon, 24 Parganas (S), West Bengal.

Submitted to **Vivekananda Sevakendra-O-Sishu Uddyan (VSSU)**

By

Society for Appropriate Rural Technology for Sustainability (ARTS), Kolkata, India
(A member of the Sankalpa Trust Group)

1 Description of the project



The conjoint processes of (a) biomethanation of agricultural and human/livestock waste; and (b) the cultivation of Spirulina—the 'Super Food'—has the potential of becoming the centerpiece of sustainable village and rural development, as it has important links and synergies with other sustainable and appropriate technologies that have already been demonstrated and implemented elsewhere, most notably, at the Sankalpa Research Center at Village Baidyapur, Nadia—which promotes participatory practices and demonstrates appropriate technologies for sustainable rural development.

The schematic on the right describes a village-based distributed model (VBDM) for implementing a sustainable and integrated health, waste disposal and energy generation system, which can produce:

(a) Methane fuel from biomethanation of agricultural, livestock and domestic waste, with compost and CO2 as by-products;

(b) Spirulina and fish through appropriate technological, production and aquaculture processes, by utilizing the large amounts of CO2 present in biogas and slurries from biogas plants, which in turn produces agricultural waste products that is recycled as input materials for biomethanation, in a mutual recycling loop.

Briefly, the "Logical Frame Analysis" (LFA) of this three-year project is shown in Annex-C, and the three "Output" definitions may be summarized as follows:

#	OUTPUT	Impact	Cost
1	Eliminate malnutrition in 540 children in the target beneficiary community at Village Ullon.	40% weight	£ 11,460
2	Double the productivity of 'sun-dried' spirulina by maximizing the absorp-tion of biogas CO2 in spirulina production tanks	30% weight	£ 8,595
3	Empower 120 women in the target beneficiary community at Village Ullon, by providing self-employment opportunities in 10 Self Help Groups.	30% weight	£ 8,595
	TOTAL PROJECT COST (3 year duration)		£ 28,650

2 Phase 1: Biomethanation

The process of trapping methane, a significant greenhouse gas, and using it for a productive purpose—such as (a) generation of electricity; (b) fuel for industrial processes and (c) domestic applications in homes for cooking—will not only help to stimulate economic development with resulting social benefits, it will also have a significantly positive impact on the local and global environment. The current high prices of conventional fuels, such as petroleum and natural gas have made it possible for non-conventional energy projects such as biogas energy to attain significantly positive and high benefit-to-cost ratios, even without resorting to shadowy contingent valuation techniques.

2.1 Biogas from leafy biomass

Biogas based power plants are a reliable decentralized source of power generation option, globally, and especially in a place like Auroville with its large source of leafy biomass. The ‘Plug-Flow’ digestion approach is particularly suitable for biomethanation from leafy biomass and agricultural waste and enables the integration of pre-treatment steps into the design of the biogas plant, as shown in the figure below:

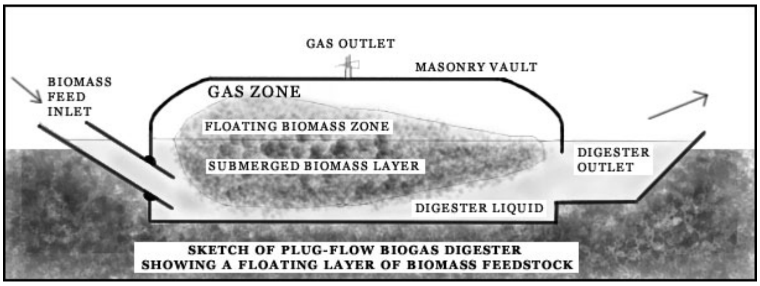
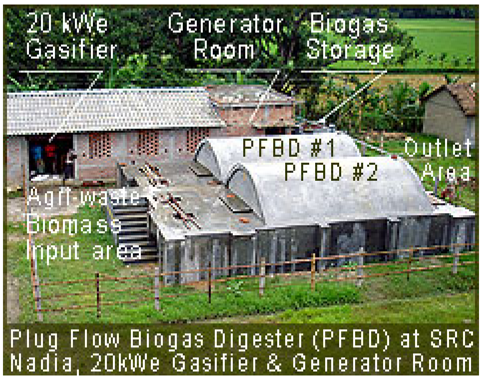


Figure 2: A sketch of the PFBD system

The feedstock acquires a higher density by using the forces of buoyancy rather than gravity-assisted methods of compaction. R&D trials coupled with design modifications and better insights of ‘dry/solid-state stratified bed (SSB)’ fermentation in the ‘plug-flow’ process has greatly reduced the problems related to volatile fatty acids (VFA) overproduction at the early stages of biomass decomposition.

2.1.1 Prototype of PFBD



A prototype of the PFBD with a capacity of about one ton green biomass input daily to produce 60 Nm^3 of methane-rich, biogas output per day, to use as a clean energy source has been built by Sankalpa Trust at Village Baidyapur, District Nadia, West Bengal—in technical collaboration with the Center for Science & Technology (formerly known as ASTRA), IISc Bangalore, as shown in the image on the right.

The biogas energy may be used in domestic and commercial applications to (a) generate electrical power using a gas/diesel mixture as fuel in diesel generators or in a 100% gas engine-alternator; (b) distribute/disseminate biogas fuel for domestic cooking and home lighting systems; (c) provide energy services such as domestic water supply and (d) provide energy security for the village community. 1 Nm^3 of biogas is about 1.2 kg at STP (or ~1kg at room temp); it is equivalent to 5,000 kcal/m3. Considering that 2 Nm^3 of biogas is equivalent to 1 kg of LPG and that there is about 14.2 kg of LPG per cylinder, the 60 Nm^3 PFBD is capable of producing the energy equivalent of about two cylinders of conventional LPG gas, per day.

2.2 Biogas from Animal waste

The technology to convert animal manure to biogas is well established, and will not be repeated here.

2.3 Biogas from kitchen waste

Substantial quantities of kitchen waste are available throughout the target beneficiary area. Assuming that:

1 Nm³/day drum-type 'Shakti Surabhi' bio-digester from Vivekananda Kendra, Kanyakumari

- There are 1,000 inhabitants who generate ~ 200 gm of vegetable and kitchen waste (feed material)/ day, which leads to the generation of ~ (0.2 x 1,000) kg = 200 kg of kitchen waste products/day;
- Five kg of vegetable and kitchen waste may produce 1 Nm^3 of biogas; this translates to the potential of generating (200 ÷ 5) Nm^3 = 40 Nm^3 of biogas;
- 1 Nm3 of biogas from kitchen waste may generate 1.25 kWh of electrical energy, which means that we may generate (40 x 1.25) kWh = 50 kWh of energy;
- Therefore, an average total availability of 200 kg/day of kitchen waste products throughout the year—at one location—may produce 40 Nm^3 of biogas per day, which in turn is equivalent to running a:
  - 2 kWe electricity generator at 100% PLF, or a
  - 2.6 kWe electricity generator at 80% PLF.

Therefore, in the case of kitchen waste, it would be operationally easier and cost effective to treat this as a distributed energy paradigm, and instead of a central facility, we could procure small 1 Nm^3 biodigesters, of the type shown on the right, for distribution to individual users, which requires approximately 5 kg of vegetable/kitchen waste (feed material) per day; the quantity for smaller or larger units can be determined by linear interpolation; i.e. 10 and 15 kg for 2 and 3 Nm^3 biogas digesters, respectively.

We have procured one 1 Nm^3 biodigester at the Sankalpa Research Center, Nadia, from Vivekanada Kendra, Kanyakumari. This simple device is very convenient to use, handle and maintain, and is possibly the most cost-effective solution for treating domestic kitchen waste and waste vegetable products in a distributed paradigm. So far, the gas has been used for cooking applications. However, the biogas output from this device may also be used to operate electric gensets to produce electricity, and we hope to use it also in hybrid solar/biogas-based fruit and vegetable drying machines.

2.4 Biogas applications and Use Cases

A major objective of producing methane through the PFBD or FTBH biomethanation strategies is to use methane as a valuable clean energy source.

2.4.1 Biogas Lamps

The biogas lamp directly uses biogas produced in a biogas digester, and is an invaluable component of the biogas industry, especially in villages. A sample product made in China and presented to us by Mr. Shamsul Haque, Executive Director, SDI—our partner in Bangladesh, is shown in the image on the right.

However, this valuable product is not commercially produced in India and domestic lighting using biogas lamps, for children's education at night and for general domestic use, is unavailable to the vast majority of biogas users and operators, in the countryside.

To obtain domestic lighting from biogas, operators have to use expensive, inefficient and complicated diesel gensets to convert the biogas energy into electricity first, before being used—again highly inefficiently—in incandescent lights (as the more efficient CFL lamps are prohibitively expensive for poor villagers). In our social studies, it has emerged that the most important reason that villagers want electricity in their homes is for their children to study at night. Use of electricity for all other domestic use comes second. This biogas lamp, in conjunction with the 1 Nm3/day drum-type bio-methanation plant, will therefore help to solve the most important social need in the villages of India, and help to increase primary education—the most important national need identified by Dr. Amartya Sen, the Nobel Laureate—to eliminate poverty in India.

Rated Output Power (kW)	0.8	0.9
Rated Output Voltage (V)	230	240/120
Frequency (Hz)	50	60
Maximam Output Power (kW)	1.0	1.1

Engine Type	Cylinder, 4-stroke, OHV, Forced Air-cooled
BorexStroke (mm)	52x38
Displacement (mm)	81
Ignition System	TCI
Starting Method	Recoil Starter
Type of Fuel	LPG
Fuel Consumption	0.35kg/kw.hr
Rated Output Power KW (r/min)	1.3/3600

2.4.2 Generate electricity from biogas

LPG gensets (made in China) with rated output power of 0.8kW and 1.3 kW (shown above) can be imported from Bangladesh for ~ Rs. 40,000 and 60,000, respectively (prices quoted at an exhibition in Dhaka in November 2008). A special adapter costing about BD Taka 5,000 needs to be fitted, to enable operation with biogas.

Details are available on request.

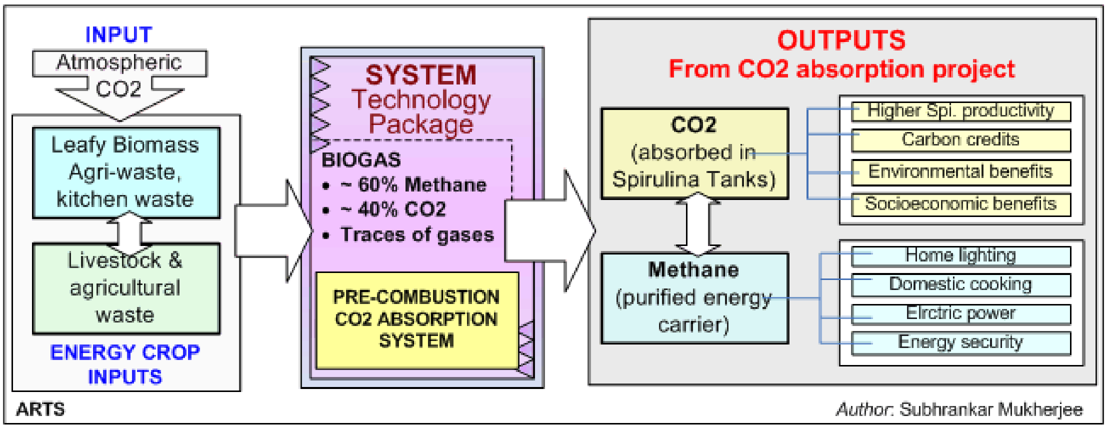
2.4.3 Biogas stoves for cooking

A variety of biogas stoves are available for use. Ordinary burners for LPG stoves may be used, with the aperture enlarged to meet the lower pressure of biogas from biodigesters. The image shown on the right relates to burners acquired from Vivekananda Kendra.

2.5 By products from biomethanation

2.5.1 CO_2 absorption in Spirulina culture

Depending on the feedstocks and the production process, biogas contains between 35 and 45% of CO_2. The remainder is methane (CH4), with some trace gases and elements. This large CO_2 fraction makes pre-combustion CO_2 absorption technologies commercially viable.



The absorption of the waste CO_2 in biogas in spirulina culture[1] is a major innovation in this project, as this has never been tried before. Dr. S. Mukherjee has reviewed this novel technology with: (a) Dr.

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[1] Carbon dioxide (CO_2) is one of the major inputs required for spirulina growth. Just as plants absorb CO2 through its leaves, spirulina needs CO_2 in the water. However, spirulina grows so quickly, that atmospheric CO_2 cannot penetrate into the water body quickly enough to replenish the supply of CO_2 to sustain growth. Hence, if CO_2 can be bubbled into the culture, then a high rate of spirulina production can be achieved.

Richard D. Noble, Professor, University of Colorado at Boulder; who is a global expert in CO_2 separation technologies; and with (b) Dr. Bryan Willson, Professor, Colorado State University, Fort Collins, who has worked with a similar project for algae in glass tubing. The consensus view involves pumping biogas through the spirulina culture, in specially fabricated concentric tubes, such that the CO_2 is absorbed by the spirulina culture, whereas methane, which is insoluble in the spirulina culture suspension, will pass through and be collected for use as an energy carrier. This will additionally reduce CO_2 emissions from the biomethanation process.

As the spirulina and biogas units are in remote areas without electricity, we will need solar photovoltaic power to operate this process. This will further reduce the carbon footprint of this project. A major contribution to science would be the experimental determination of mini-mum power required to obtain the optimum size of gas bubbles for maximizing absorption of CO2.

2.5.2 Compost

The solid residue from biomethanation facilities may be fed to a vermibed—an 100% organic fertilizer and a natural process in which earthworms consume various type of organic waste like cattle manure, dried leaves, agriculture and kitchen waste, garden cuttings—all of which are inputs into the biomethanation plants—and convert them into a high quality organic compost.

3 Phase 2: Spirulina ‘Super Food’

Spirulina, which can be grown in brackish water and on non-fertile land, is a low-fat, low-calorie, cholesterol-free source of easily-digestible vegetable protein containing all the essential amino acids that cannot be produced by the body but are needed to synthesize the non-essential amino acids. Spirulina is comprised of at least 60% all-vegetable protein, **essential vitamins** and **phytonutrients** such as the rare essential **fatty acid GLA, sulfolipids, glycolipids and polysaccharides**. It is called a ‘super food’ because its nutrient content is more potent than any other food. One gram of Spirulina per day (a) can correct malnutrition in a small child in a few weeks, and (b) is less costly than the 50 or 100 grams of carrots or spinach, respectively, that would provide roughly the same nutrition.

Another compelling feature of Spirulina is that it improves not only the physical strength of the body but also the **cognitive development** of the child.

Spirulina is also highly relevant for people affected by HIV/AIDS: improved and more balanced nutrition can ease their life considerably although it cannot, of course, cure their disease. In West and Central Africa, it has been reported that HIV/AIDS patients buy Spirulina every day as a dietary supplement. A recent study with children in Burkina Faso has shown that HIV/AIDS-infected children put on weight and grow if rehabilitated with Spirulina.

The benefits of the use and local production of Spirulina from three complementary angles are:

1. Spirulina as a natural product provides a comprehensive solution to malnutrition. It contains most critical micronutrients although, it must be noted, not all and it is by no means a miracle solution. However, **with just one gram per day being enough to correct a malnutrition of a child in a few weeks, it is an effective solution**;
2. Spirulina is a relatively **cost-effective solution**, compared to the prices of artificial vitamins, minerals and other food fortification additives;

3. Local Spirulina production can become a **viable business for a group of entrepreneurial women and can thus create sustainable employment**, income and also establish a profitable supply chain for feeding programs…if the same women who are producing also get involved in the distribution operations.

3.1 Plan of work—Phase 2

The *objective* of Phase 2 is to develop the institutional capacity for growing and selling Spirulina as a marketable commodity that can establish the economic sustainability of not only the Spirulina project, but other rural and tribal community development initiatives. A ‘Needs-Outcome Model’ that graphically depicts the ‘Holistic Community Building/Livelihoods Generation Model’ to achieve the desired outcomes over the project lifetime is shown in Annex-A.

We propose to build four regular brick-work Spirulina Tanks measuring 10 meters long x 3 meters wide over the six month ‘Phase 2’ project duration; it is the breakeven point established by our technology partners, Simplicity farm at Auroville, Tamil Nadu. The highlights of Phase 2 are:

(a) It is believed that this level of operations will be sufficient to provide the needed scales of operation for economic sustainability of Phase 2;

(b) An appropriate spirulina marketing and dissemination program will be developed;

(c) The proceeds from the Spirulina project can be used to initiate the community building programs focused on handicraft projects and knowledge-based, holistic initiatives in Phase 3.

In Phase 2, we will engage (a) a ‘Production/Marketing Supervisor’ to operationalize the workplan; (b) an ‘Administrative Assistant’ to assist in the commercial operations; (c) four women ‘field’ workers and one ‘packaging/distribution’ worker; and (d) a support staff member for the operations.

4 Phase 3: Integration and institutionalization

The *primary objective* of Phase 3 is to integrate the functioning of Phases 1 & 2 in such a way, that a substantial portion of the waste output of (a) the biomethanation processes become the input raw materials for the spirulina growing and aquaculture processes; and (b) the spirulina and pisciculture processes provide a significant amount of the biomass inputs required for biomthanation.

A secondary goal is to institutionalize the project by developing (a) commercial capabilities for the spirulina and biomethanation facilities; and (b) developing appropriate community building programs focused on handicraft projects and knowledge-based, holistic initiatives. This will lead to long-term and sustainable development of the target beneficiaries.

A graphical depiction of the proposed project approach that will help us to achieve both of these goals is briefly described in Annex-B.

4.1 Aquaculture & Pisciculture

Although cow dung is commonly used as a fertilizer for fishponds in India, the yield of fish can be more than doubled if the digested slurry obtained from a biogas plant is used instead of the raw dung. We intend to validate this conjecture in this project. The aim is to efficiently recycle the slurried nutrients from the biomethanation and spirulina facilities into aquatic biomass reservoirs and tanks, and test their suitabilty for producing ornamental plants, fish, phyto- and zooplankton, which can be marketed commercially.

Such aquculture facilities operated close to the biomethanation site could potentially provide energy for infrastructure and also nutrition for lower quality fish that could in turn be used to produce fish meal for higher quality fish or terrestial livestock, thereby providing a high benefit-to-cost ratio.

We shall also investigate the effectiveness of the fluidic and solid waste products obtained from drying the liquid emissions from the Spirulina tanks, as a fertilizer for food crops and growing trees.

5 Logical Framework Analysis

The "Logical Framework Analysis" for the project is shown in Annex-C

6 Budgetary estimates

The budgetary cost estimates of this three-year integrated Biomethanation-Spirulina project may be summarized as follows: (*Details will be made available on request*)

#	Budget Line	Year 1 Apr 2011 – Mar 2012 (£)	Year 2 Apr 2012 – Mar 2013 (£)	Year 3 Apr 2013 – Mar 2014 (£)	Total Budget Line (£)	%
1	Capital expenditure	3,165	1,238	688	**5,091**	18%
2	Project activities	522	1,769	2,019	**4,310**	15%
3	All staff costs	3,396	4,885	5,078	**13,360**	47%
4	Other administrative costs	938	953	1,024	**2,916**	10%
5	Monitoring & Evaluation/Learning	1,534	716	743	**2,993**	10%
	TOTAL	**9,556**	**9,561**	**9,553**	**28,670**	**100%**

Notes:

1. 'Other administrative costs' include (a) travel and subsistence cost; (b) rents, maintenance, office overheads; and (c) ~ 5% 'Institutional overhead cost'.

2. The exchange conversion rate for £/Indian Rs. is **72.6740**; as on 19th Nov 2010; on [http://www.oanda.com/currency/converter/]

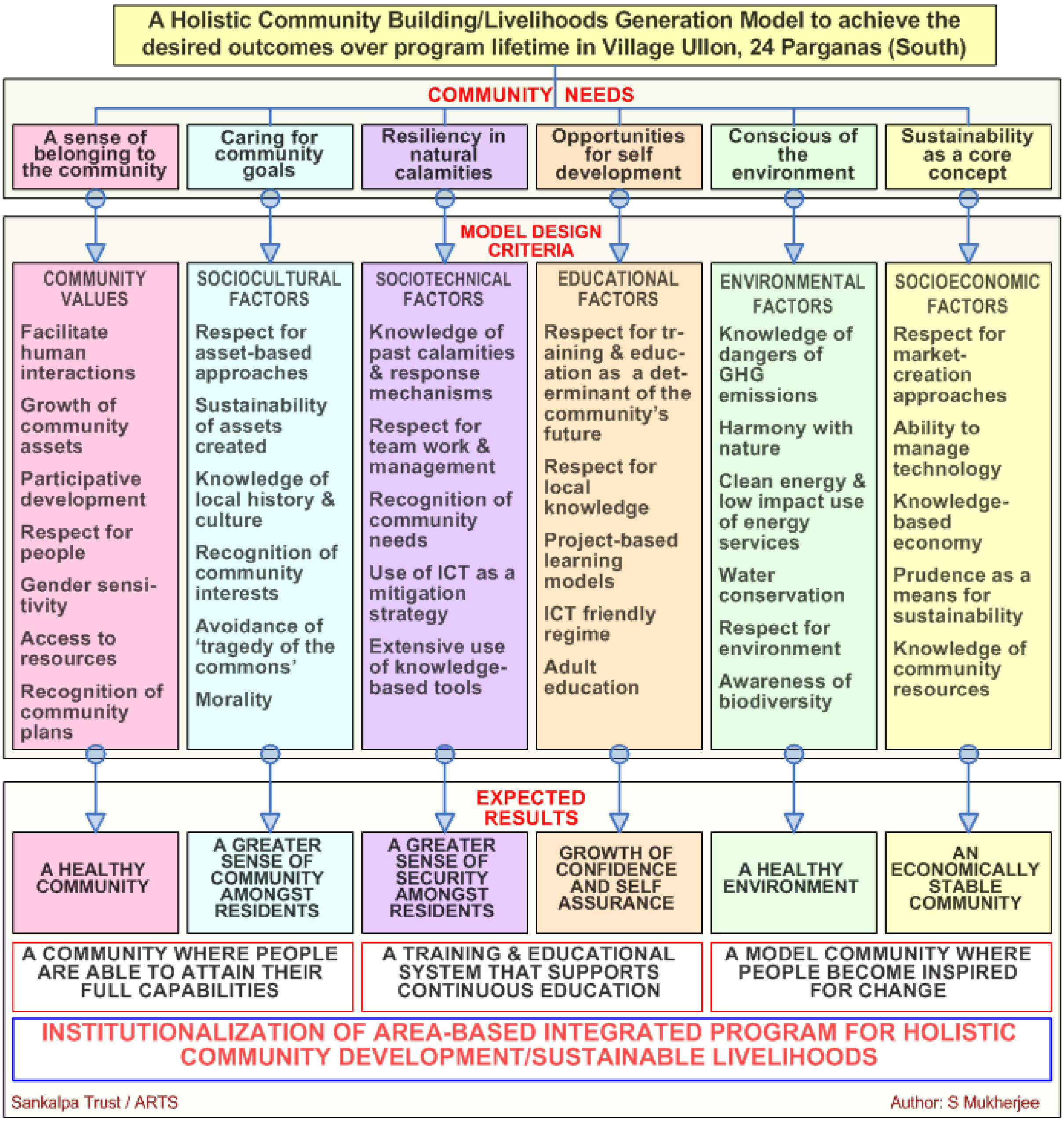
7 Conclusion

Most of the proposed technologies have already been tried and tested in the field, and hence there is very little risk of project failure. The CO2 separation technology is nascent, and will require extensive trials.

This two-year project will develop a framework for sustainable development based on (a) biomethanation of animal/agricultural biomass waste into 'biogas'; (b) grow Spirulina micronutrient 'Super Food' for distribution to needy communities, especially women and children; and (c) integrate the two into a self-contained loop for holistic development, effective waste management and reduce GHG emissions.

The budget is estimated to be £ 59,026, and is expected to benefit about 5,000 households, or about 25,000 people. This translates to about £ 1.18 per beneficiary per year—a small price to pay for so large a benefit.

Annex-A: Needs-Outcome Model



A Holistic Community Building/Livelihoods Generation Model to achieve the desired outcomes over program lifetime in Village Ullon, 24 Parganas (South)

COMMUNITY NEEDS	A sense of belonging to the community	Caring for community goals	Resiliency in natural calamities	Opportunities for self development	Conscious of the environment	Sustainability as a core concept
MODEL DESIGN CRITERIA	COMMUNITY VALUES	SOCIOCULTURAL FACTORS	SOCIOTECHNICAL FACTORS	EDUCATIONAL FACTORS	ENVIRONMENTAL FACTORS	SOCIOECONOMIC FACTORS
	Facilitate human interactions Growth of community assets Participative development Respect for people Gender sensitivity Access to resources Recognition of community plans	Respect for asset-based approaches Sustainability of assets created Knowledge of local history & culture Recognition of community interests Avoidance of 'tragedy of the commons' Morality	Knowledge of past calamities & response mechanisms Respect for team work & management Recognition of community needs Use of ICT as a mitigation strategy Extensive use of knowledge-based tools	Respect for training & education as a determinant of the community's future Respect for local knowledge Project-based learning models ICT friendly regime Adult education	Knowledge of dangers of GHG emissions Harmony with nature Clean energy & low impact use of energy services Water conservation Respect for environment Awareness of biodiversity	Respect for market-creation approaches Ability to manage technology Knowledge-based economy Prudence as a means for sustainability Knowledge of community resources
EXPECTED RESULTS	A HEALTHY COMMUNITY	A GREATER SENSE OF COMMUNITY AMONGST RESIDENTS	A GREATER SENSE OF SECURITY AMONGST RESIDENTS	GROWTH OF CONFIDENCE AND SELF ASSURANCE	A HEALTHY ENVIRONMENT	AN ECONOMICALLY STABLE COMMUNITY

A COMMUNITY WHERE PEOPLE ARE ABLE TO ATTAIN THEIR FULL CAPABILITIES

A TRAINING & EDUCATIONAL SYSTEM THAT SUPPORTS CONTINUOUS EDUCATION

A MODEL COMMUNITY WHERE PEOPLE BECOME INSPIRED FOR CHANGE

INSTITUTIONALIZATION OF AREA-BASED INTEGRATED PROGRAM FOR HOLISTIC COMMUNITY DEVELOPMENT/SUSTAINABLE LIVELIHOODS

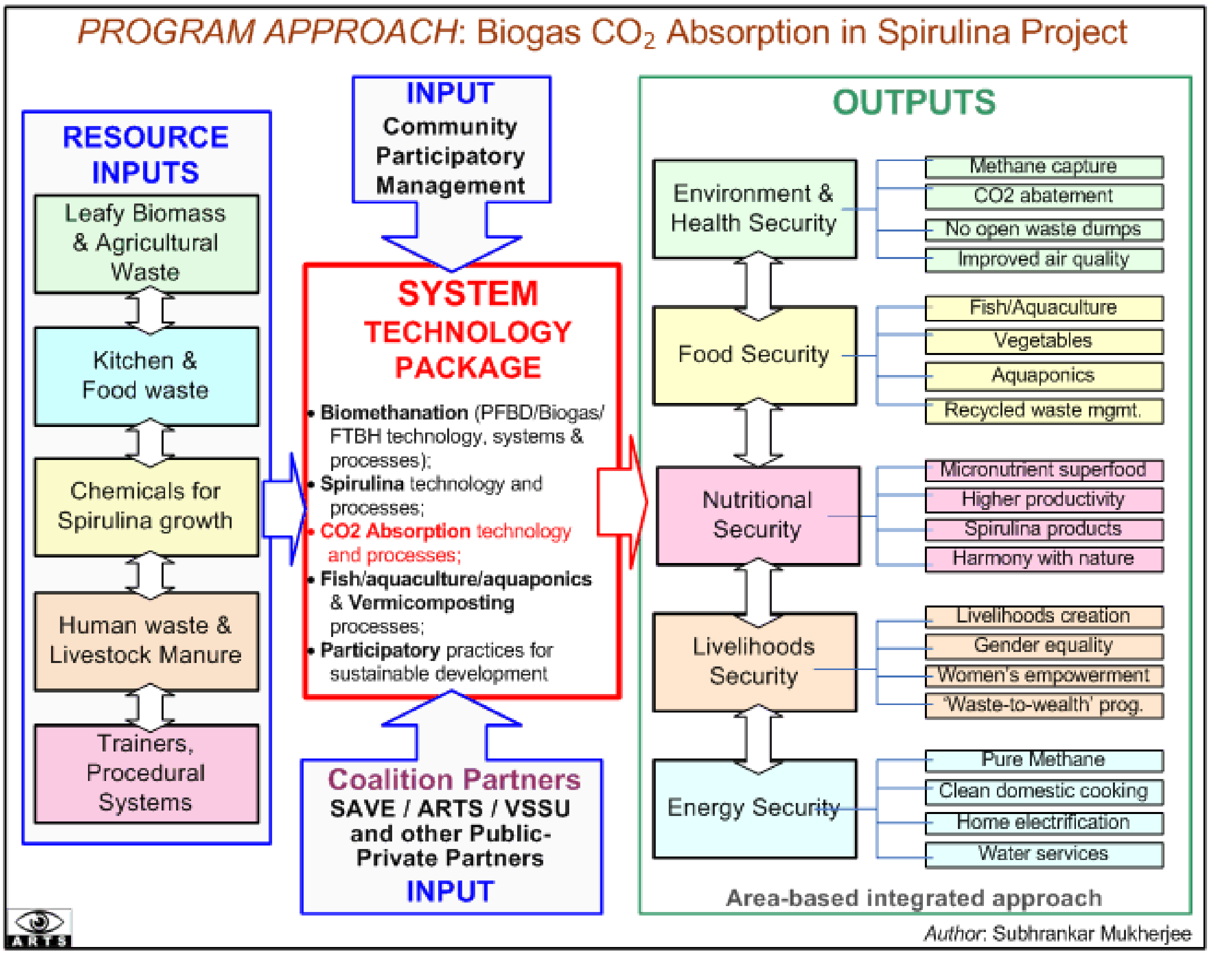
Sankalpa Trust / ARTS

Author: S Mukherjee

Notes:

1. The above community needs assessments, model design criteria and expected results are based on actual studies that have been carried out at Village Baidyapur, Nadia and have been validated in studies conducted at other village-based environments in rural India.
2. Details will be made available on request.

Annex-B: Project Approach



Notes:

Our approach for realizing the program outcomes—and how we propose to design and implement the area-based integrated approach over a five-year period—is graphically depicted in the figure above. The proposed community development processes at Village Ullon are based on the "Total Rural Development" Model[2] for holistic rural development:

- Through PPPs, provide knowledge-based and IT-enabled services to promote sustainable livelihoods and education, using an asset-based and market creation approach that focus on (a) Education and Livelihoods; (b) Health; (c) Agriculture and Environment; (d) Energy; (e) Shelter and (f) Advanced Technologies;
- Adoption of 'process oriented' and 'object oriented' approaches for the delivery mechanism of the change management processes, which are humanistic, grounded in scientific management processes, are reusable and more stable

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[2] Please visit [http://www.sankalpacmfs.org/trd/index.html] for details

Annex-C: Logical Framework Analysis (based on DFID Template)

LOGFRAME	**PROJECT TITLE: An integrated program for livelihoods, energy and health security plus waste management using biomethanation and spirulina cultivation processes**					
GOAL	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
Reduce child mortality by reducing chronic child malnutrition in Village Ullon, near the Sunderbans.	Percentage of stunted children in the target beneficiary community	52% of children stunted in Jan 2011	45% children are stunted	35% children are stunted	Less than 25% are stunted in Dec. 2014	
		Source				
		Institute of Health Management Research, Jan 2010 report				
	Indicator	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
	Percentage of children vulnerable to respiratory ailments during the last two weeks	35.5% in Jan 2011	30% are vulnerable	20% are vulnerable	15% in Dec. 2014	
		Source				
		Institute of Health Management Research, Jan 2010 report				
PURPOSE	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	**Assumptions**
Increase the productivity and distribution of spirulina micronutrients—the “Super Food”—by maximizing the absorption of biogas CO_2 in spirulina cultures, to increase spirulina productivity—to feed more children suffering from malnutrition.	Productivity of ‘sun-dried’, spirulina micronutrient “Super Food”.	No production in Jan 2011	10 kg sun-dried spirulina/month	15 kg sun-dried spirulina/mth	20 kg /month in Dec. 2014	It is assumed that the productivity of spirulina can be doubled with appropriate quantities of external injections of CO2 into spirulina cultures. *Source*: “*Spirulina: Production & Potential*”, ISBN 2-85744-883-X; EDISUD.
		Source				
		Projections on the production of sun-dried spirulina, based on Auroville’s three-tank spirulina production system.				
	Indicator	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
	Percentage of CO2 in biogas.	40% CO2 in Jan 2011	35% CO2 in Dec. 2012	25% CO2 in Dec. 2013	20% CO2 in Dec. 2014	
		Source				
		Laboratory tests of biogas produced in the field.				
INPUTS (£)	**DFID (£)**	**Govt (£)**	**Other (£)**	**Total (£)**	**DFID SHARE (%)**	
	28,650	0	0	28,650	100%	
INPUTS (HR)	**DFID (FTEs)**					

	1 FTE (Project Mgr) 0.25 FTE (Adviser); 1 FTE (1 Supervisor); 0.1FTE (2 Accounts clerks);1 FTE (3 Workers)					
OUTPUT 1	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	**Assumptions**
Eliminate malnutrition in 540 children in the target beneficiary community at Village Ullon.	Percentage of chronically malnourished children in the target beneficiary community	More than 50% children in Jan 2011	40% children are chronically malnourished	30% children are chronically malnourished	Less than 25% children in Dec 2014	It is assumed that feeding one gram of Spirulina per day can correct malnutrition in a small child in a few weeks. *Source*: *“Sustainable Approaches to combat malnutrition”*, by Urs Heierli, Ph.D, SDC Publication, 1st Edition : March 2007.
		Source				
		Institute of Health Management Research, Jan 2010 report				
	Indicator	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
	Percentage of children vulnerable to fever during the last two weeks	39.2% in Jan 2011	35% are vulnerable	25% are vulnerable	Less than 20% in Dec. 2014	
		Source				
		Institute of Health Management Research, Jan 2010 report				
IMPACT WEIGHTING	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
40%						
		Source				**RISK RATING**
						Low
INPUTS (£)	**DFID (£)**	**Govt (£)**	**Other (£)**	**Total (£)**	**DFID SHARE (%)**	
	11,460	0	0	11,460	100%	
INPUTS (HR)	**DFID (FTEs)**					
	0.4 FTE (Project Mgr); 0.1 FTE (Adviser); 0.4 FTE (1 Supervisor); 0.4 FTE (3 Workers)					
OUTPUT 2	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	**Assumptions**

Double the productivity of ‘sun-dried’ spirulina by maximizing the absorption of biogas CO_2 in spirulina production tanks	Spirulina production rate (per square meter per day)	5 gm/m2/day in Jan 2011	6 gm/m2/day in Dec. 2012	8 gm/m2/day in Dec. 2013	10 gm/m2/day in Dec. 2014	It is assumed that the productivity of spirulina can be doubled with appropriate external injections of CO2 into spirulina cultures. *Source*: “*Spirulina: Production & Potential*”, ISBN 2-85744-883-X; EDISUD.
		Source				
		Productivity records maintained during pilot production of spirulina in Calcutta, between November 2009 and May 2010.				
	Indicator	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
	Purity of methane in biogas, as an indirect measure of the CO2 absorption efficiency in spirulina culture	Sputtering of biogas	35% less sputtering	70% less sputtering	Steady biogas flame	
		Source				
		“Sputtering” tests conducted on-site at biogas production plants.				
IMPACT WEIGHTING	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
30%						
		Source				**RISK RATING**
						Moderate to high
INPUTS (£)	**DFID (£)**	**Govt (£)**	**Other (£)**	**Total (£)**	**DFID SHARE (%)**	
	£ 8,595	0 %	0 %	£ 8,595	100%	
INPUTS (HR)	**DFID (FTEs)**					
	0.3 FTE (Project Mgr); 0.075 FTE (Adviser); 0.3 FTE (1 Supervisor); 0.3 FTE (3 Workers)					
OUTPUT 3	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	**Assumptions**
Empower 120 women in the target beneficiary community at Village Ullon, by providing self-employment opportunities in 10 Self Help Groups (SHGs)	Number of self-employment opportunities created	None--Jan 2011	12 women in the first SHG	60 women in five SHGs	120 women/10 SHGs-Dec 2014	Assuming that the average savings made by a woman is Rs 3.00 per day, this yields annual savings rate projections of Rs.1,095 or £ 15 per year.
		Source				
		Source for baseline data: Occupational Structure (Census 2001 figures)				
	Indicator	**Baseline + year**	**Milestone 1**	**Milestone 2**	**Target + year**	
	Savings rate per woman	Nil—Jan 2011	£ 15 —1st year	£ 30 —2nd year	£ 45—Dec 2014	

		Source				
		Bank statements of SHG savings deposits				
IMPACT WEIGHTING	**Indicator**	**Baseline 2011**	**Milestone 2012**	**Milestone 2013**	**Target Dec 2014**	
30%						
		Source				**RISK RATING**
						Low
INPUTS (£)	**DFID (£)**	**Govt (£)**	**Other (£)**	**Total (£)**	**DFID SHARE (%)**	
	£ 8,595	0 %	0 %	£ 8,595	100%	
INPUTS (HR)	**DFID (FTEs)**					
	0.3 FTE (Project Mgr); 0.075 FTE (Adviser); 0.3 FTE (1 Supervisor) 0.3 FTE (3 Workers)					