BIOMASS STATUS & TRENDS IN INDIA

K. KRISHAN
THE CASE FOR RENEWABLE ENERGY – IN INDIA
With 8 to 10% GDP growth, India will need significant capacity addition in Electricity Generation capacity, which is currently Coal centric.

However, apart from the environmental as well as ecological considerations, following factors could impede growth of fossil fuel power generation in India:

– Availability of Coal
– Cost of imported fossil fuels
– Social & Climate Change factors
Coal availability is an issue → Power shortages

Coal supplies running on empty

GAP WIDENS

Coal production has been unable to keep pace with rising demand, leading to higher imports.

<table>
<thead>
<tr>
<th>Production</th>
<th>Imports vs exports</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(in million tonnes)</em></td>
<td><em>(in million tonnes)</em></td>
</tr>
<tr>
<td>2000-01: 313.7</td>
<td>2000-01: 1.29</td>
</tr>
<tr>
<td>2009-10: 532.1</td>
<td>2009-10: 67.74</td>
</tr>
</tbody>
</table>

< 5% annual growth in Coal production as unexploited coal mines are in forest areas with large tribal population – consequent environmental & social issues
International Coal Price Spikes likely with increased purchases by China & India

### Top Coal Exporters (2009e)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total of which MT</th>
<th>Steam (MT)</th>
<th>Coking (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>259</td>
<td>134</td>
<td>125</td>
</tr>
<tr>
<td>Indonesia</td>
<td>230</td>
<td>200</td>
<td>30</td>
</tr>
<tr>
<td>Russia</td>
<td>116</td>
<td>105</td>
<td>11</td>
</tr>
<tr>
<td>Colombia</td>
<td>69</td>
<td>69</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>67</td>
<td>66</td>
<td>1</td>
</tr>
<tr>
<td>USA</td>
<td>53</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>Canada</td>
<td>28</td>
<td>7</td>
<td>21</td>
</tr>
</tbody>
</table>

Source: IEA 2010

### Top Coal Importers (2009e)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total of which MT</th>
<th>Steam (MT)</th>
<th>Coking (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>165</td>
<td>113</td>
<td>52</td>
</tr>
<tr>
<td>PR China</td>
<td>137</td>
<td>102</td>
<td>35</td>
</tr>
<tr>
<td>South Korea</td>
<td>103</td>
<td>82</td>
<td>21</td>
</tr>
<tr>
<td>India</td>
<td>67</td>
<td>44</td>
<td>23</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>60</td>
<td>57</td>
<td>3</td>
</tr>
<tr>
<td>Germany</td>
<td>38</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>UK</td>
<td>38</td>
<td>33</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: IEA 2010
Rising trends in Australian Coal Prices

![Coal, Australia price chart](https://www.mongabay.com)

Source: www.mongabay.com
International Coal Price rise also impacting domestic Coal prices in India

Sell Coal at Global, Local Price Average: Plan Panel

DEVNIKA BANERJ
NEW DELHI

The planning commission has mooted the need for pooling imported coal with domestic supply to average out costs and supply it to all users at uniform prices.

This will help lower cost for companies that rely on import to meet their coal needs.

Imported coal is about 50% costlier than Indian coal despite the recent price increase by Coal India Ltd, the state-run coal miner.

“We have to develop a system of pool pricing of coal so that imported coal plants don’t become uneconomic.” Planning Commission member SK Chaturvedi told ET.

The commission has forecast coal shortage in India will soar to 200 million tonnes by the end of the 12th Plan (2012-17), with a demand of 1,000 million tonnes against a production of 800 million tonnes.

Next year, the shortage is expected to be around 142 million tonnes, with availability of 554 million tonnes against a requirement of 696 million tonnes.

At a meeting with the prime minister last week, the commission had stressed on pooling and the need to expand the role of Coal India to that of a supplier.

The panel’s proposal on Coal India was in line with the Central Electricity Authority’s suggestion earlier that the state-run miner should act as a nodal agency for importing, pooling and supplying coal.

“If we have to meet energy requirements, we need to have large amount of power from coal and gas. Large amount of imports have to done,” Chaturvedi said.

The Plan panel member said the idea of pool pricing of coal came from a gas pooling policy that helped revive power projects like the Dabhol plant, owned by Ratnagiri Gas and Power.

“We had a system of pool pricing for LNG, and plants like Ratnagiri became viable along with others. This is the intention of pool pricing. And we are looking into the possibilities of formulating the policy,” Chaturvedi said.

If implemented, the pricing policy will benefit companies such as Adani Power that invest heavily in imported coal. “In my view, pooling prices of coal will rationalise the transportation of coal, reduce congestion and increase efficiency,” said Adani Power vice-president Kandarp Patel.

But it could impact other players differently he added.

For other stakeholders, such as National Thermal Power Corporation, the largest consumer of coal in the country, coal prices will rise because the company meets most of its needs through domestic output.

“It will depend on how the government formulates the pricing policy. We rely heavily on domestic coal, so for us prices will increase,” an NTPC official said.

The electricity authority had also suggested a coal pooling pricing formula based on average price of imported coal after transportation and insurance charges, and taking into consideration coal produced by Coal India and Singareni Collieries Company.

However, the proposal has received few takers and will be worked on by the coal ministry after it gets feedback from all users.

Source: The Economic Times, April 28th 2011
Indian Natural Gas – Growing Demand & Price

Current, producer tariff of Rs 7.5/cu m (based of $ 4.2/MMBTU + Royalty).
Current bulk consumer price of Rs 10/cu m (including transport + taxes)

Current GSPL retail price of Rs 18 to 20/cu m – CNG @ Rs 35/kg

Projected, 2015, consumer gate price (from regasified LNG) of Rs 20-22/cu m
India Offers $12.67/Unit for Turkmenistan Gas

RAJEEV JAYASWAL
NEW DELHI

India is willing to pay about $12.67 per unit for natural gas supplied from Turkmenistan through a transnational pipeline while the central Asian nation wants the gas price to be linked with market rate of liquefied natural gas (LNG).

"We can't pay market rates which could be $14-15 per mbtu (million British thermal unit). We want the rate at par with Petronet LNG's long-term contract with Ras Gas," an Indian government official with direct knowledge of the matter said. India is hosting a meeting of oil ministers of Turkmenistan, Afghanistan and Pakistan in New Delhi to negotiate construction of $7.6 billion transnational gas pipeline.

India will not invest money in constructing 1,680 kilometre pipeline to bring gas from central Asia, provided it is cheaper than LNG, the official said requesting anonymity. "Why to invest in infrastructure, if we can import relatively cheaper LNG," the official said. The price negotiation is being done keeping gas supply in the next 4-5 years.

"India's participation in the TAPI pipeline will depend on the price at which Turkmenistan gives us gas," a senior official in the oil ministry said. The name TAPI pipeline is based on initials of the four partners; Turkmenistan, Afghanistan, Pakistan and India.

Officials said Turkmenistan currently supplies gas to China at $7.5 per unit exclusive of transportation charges and the rate seems reasonable for consumers in the northern India, suffering from acute power shortage. This rate would also go up in the next five years, the expected time to commission the transnational pipeline.

While signing agreements for construction of $7.6 billion transnational natural gas pipeline in December last year, former oil minister Murli Deora had said that Turkmenistan should provide gas at competitive rates and that all the countries involved in the project should share the risks involved in the transit of gas through volatile regions.

Other gas-consuming countries along the 1,680 km pipeline — Afghanistan and Pakistan will also negotiate the gas price with Turkmenistan separately as Turkmenistan wants to sign separate commercial terms with the three gas consuming nations, officials involved in negotiation, said.

The entire process of finalising gas prices with different consumers and signing of separate GSPAs would expected to take 6-7 months time, they said.
International Price of LNG is rising.

Projected, Indian demand of LNG is 80 mscmd (out of total 350 mscmd for Gas)
High delivered cost of Power from imported LNG.

Plan for uninterrupted power to industries

But only if they are ready to shell out Rs. 7 per unit

Staff Reporter

BANGALORE: Industries in Bengaluru can hope to get uninterrupted power supply in the next two years after the completion of the proposed Bidadri Gas Project. However, they should be ready to buy it at Rs. 7 per unit as against Rs 3.60 they are paying now.

Revealing this at an interaction with members of Bengaluru Chamber of Industry and Commerce (BCIC) on Tuesday, Bangalore Electricity Supply Company (Bescom) Managing Director P. Manivannan said the Bidadi project (the first gas-based power project in the State) would be able to produce 700 megawatts of power.

“The Government has made it clear that if we are able to sell the power at Rs. 7 per unit, the gas-based plant would be expedited as that would be the cost of production,” he said.

Power would be supplied to industrial estates through separate feeder lines and in case of interruptions in the supply, the supply company would be penalised.

Domestic consumers too

Domestic consumers too can hope of uninterrupted power supply in the next two years when Bescom’s projects on Smart Grid and Distribution Automation would be ready. Mr. Manivannan said he was personally interested in introducing franchise system in Bescom, where a portion of work would be given to private companies. “However, there should be proper checks and balances in this system.”

Smart grid

The pilot smart grid project to be introduced in Electronics City will be completed in another two years. Bescom has roped in Infosys to provide an automated system that would help inform the public about power outages. Apart from this, Infosys and Reliance have also been roped in to introduce automated billing system.
THE SOCIAL FACTOR - CENTRALISED POWER GENERATION and CLASSICAL T&D SYSTEMS - UNABLE TO SERVICE RURAL INDIA

55% of Rural Households lack electricity access & poor availability/quality of grid power inhibits non agricultural economic activity

Ultra Mega Power Plant (Coal fired)

765 KV

400 KV

132 KV

33 KV

765/400 KV Transformer

400/132 KV Transformer

132/33 KV Transformer

33/11 KV Transformer

11 KV RURAL ELECTRIC FEEDERS

INVESTMENTS + T&D LOSSES, UPTO 11 KV FEEDERS, ARE HIGH & RETURNS TOO LOW TO SERVICE ASSOCIATED INVESTMENTS
Bangalore: Karnataka’s temperature is likely to soar by 2 degrees Celsius by 2030. It’s not all. The climate change will have disastrous impact on the state’s water resources, rainfall and forest cover, besides enhancing the occurrence of drought. The worst affected will be Uttara Kannada, Shimoga, Chikmagalur and north Karnataka districts.

These are some of the predictions by the Bangalore Climate Change Initiative - Karnataka (BCCI-K). BCCI-K chairman B K Chandrashekar submitted the interim report on the climate change in Karnataka to chief secretary S V Ranganath and chairman of legislative council D H Shankaramurthy.

Explaining the report, Chandrashekar said: “The annual average rainfall in the state has decreased by 6% between 1951 and 2004. The decrease is higher in the coastal and northern parts. The state is projected to experience a warming of 1.8 to 2.2 degrees Celsius by 2030 and the impact is more in the north-eastern parts of the state.”
By 2021 India’s Electricity Demand will be over 2025 TWh, even at a low per capita consumption of 1500 KWh/year.

For Energy Security, as well as GHG mitigation, the share of Renewable Energy could be targeted as 20% i.e. 405 TWh.

Wind & Small Hydro + grid interactive Solar PV/CSP will add to the grid pool … albeit with “infirm” power.

Solar PV/CSP “off grid” solutions with batteries can meet “life line” needs. Peak loads (6 to 10 pm) could be met by CSP + Biomass “hybrids”.

Bio Energy will be a source of “firm” power at tail end of the grid through Distributed Power Generation facilities.
Distributed Generation (DG) – at “Tail End” of Rural Electric Grids
Small plants, whose power is evacuated at 33/11 KV Substation help in improving the voltage of the 11 KV Grid. For instance, Karnataka Power Transmission Corporation Limited (KPTCL) gets a voltage boost of over 100 volts i.e. 1%.

They improve power factor. This is crucial as usually when irrigation pumps are connected the power factor deteriorates.

Grid frequency stabilises

They limit T&D losses to a large extent. For instance, if a 10 MW biomass based plant is connected to a 132 KV grid and the next 33 KV sub-station is about 30 km then losses would be about 4.7 %.

This justifies specific support for “Tail end” Generation.
Distributed Generation (DG) at Tail End of Grid

Distributed Generation (DG) Projects, based on biomass, at “tail end” of rural electric grids, provide following benefits:

- **Energy security**, through optimal utilization of locally available bio resources

- **Grid stability & assured Voltage** reduces need for enhancing the capacity of T&D networks to service low loads.

- **Useful bye products**, residues from Biogas Plants (compost) & Biomass Gasifiers (charcoal), which meet key needs of rural communities.

- **Socio-economic development of rural India**. The symbiotic relationship between electricity availability & economic activity is a well recognized fact. Rural India suffers from lack of “non farm” economic activity due to inadequate power supplies.
BIOGAS POTENTIAL IN INDIA
MNRE - BIOGAS WORKING GROUP FINDINGS POTENTIAL (excluding specific plans linked to cow manure)

- **Rural Electrification: 4000 projects of 8000 MW Capacity**
  - Modular 2 MW unit based on locally generated and sustainably surplus agricultural residues/short cycle cellulosic biomass.

  - 2 MW Plant would require 30,000 tons of such cellulosic biomass, which could be sustainably sourced in around 4000 out of 6000 Blocks in India.

- **Organic Fraction of MSW: 2000 projects of 1000 MW capacity**
  - Based on 30 million MT segregated Organic MSW generation by 2021 (20 % of total MSW)

  - Modular projects of 400/500 kW capacity could be set in all the 423 Class I cities with a number of projects set up in large cities.
Salem & Namakkal Districts, generate significant amount of Bio waste
Sago Mills Effluent (> 13 mill KL/year) & Poultry litter (> 500,000 tons/year)
• Ammonia Emission
• Nitrate Pollution
• Surface Water Contamination
• Ground Water Contamination.
• Breeding ground for flies … health hazard
• Public Nuisance.
• **Ground Water Contamination**: The effluent water, stored in lagoon, leaches in significant quantity & thereby contaminating ground water & decrease in pH

• **Nitrogen Robbing**: The starch mill effluent is rich in carbohydrates but is deficient in Nitrogen. When this carbon rich effluent is used for irrigation, the soil microbes begin to starve for Nitrogen for growth and starts competing with the plant species for Nitrogen. This scenario is called as ‘Nitrogen Robbing’

• **Making Soil Acidic**: Starch effluent is typically in the range of 3.5 to 4, which increases the soil acidity.

• **Loss of Soil Porosity**: The suspended particle in effluent blocks the pores in the soil there by reducing the porosity in soil.

• **Loss of Water Holding capacity**: Adhesion of carbonaceous compounds on the soil surface disrupts the nascent structure of soil and hence reduces the water holding capacity of it.
# Project portfolio developed by PWPL

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWPL Bio Energy Pvt Ltd</td>
<td>2 Nos. 2 x 2 MW</td>
</tr>
<tr>
<td></td>
<td>Salem District</td>
</tr>
<tr>
<td>Namakkal Bio Energy Pvt Ltd</td>
<td>1 No 4.9 MW</td>
</tr>
<tr>
<td></td>
<td>Namakkal District</td>
</tr>
<tr>
<td>ABC Company</td>
<td>1 No 2x2 MW + 1 No 4.9 MW</td>
</tr>
<tr>
<td></td>
<td>Salem District</td>
</tr>
<tr>
<td></td>
<td>Namakkal District</td>
</tr>
</tbody>
</table>

Total capacity of projects available to Portfolio company Investors is 21.8 MW (8 MW + 4.9 MW + 8.9 MW)

*Note: Above capacity excludes 3 Nos 2x400 KW Biogas plants in Salem District, which is anticipated to be retained in PWPL balance sheet*
Dear Sir,

I was quite enthused by the response to the seminar in Salem on 30th January, 2010 organised by TEDA and also by the presence of Chairman, TNEB regarding setting up of Bio Waste to Biogas + Organic Fertiliser Projects in Salem.

I am told that, as a rough estimate, the Biogas Power Plants potential in Salem and Namakkal Districts is over 100 MW from the Bio Waste generated by Sago & Starch Mills and Poultry farms. Equally, such Biogas Plants will also address the significant environment pollution being caused by Sago & Starch Mills/Poultry farms waste.

There are also collateral benefits of the by-products from the Biogas Plants such as superior quality Organic Fertilizer and waste heat utilization of biogas engines, either to meet thermal energy needs of Sago Mills or to establish cold storages.

We feel that a focused effort should be made to implement such Biogas Power Plants in Salem and Namakkal Districts. Government of Tamil Nadu’s involvement is necessary in the context of Power Purchase/Open Access facilities to be provided by TNEB. There is also need to involve the Collectors and Taluka/Block level officials of RDPR to ensure that local community is sensitized on the benefits of these projects. MNRE support is available in form of subsidies.

With warm regards,

Yours sincerely,

(Deepak Gupta)

Shri K.S. Sripathi,
Chief Secretary,
Govt of Tamil Nadu,
Secretariat,
Chennai – 600 009.
• 5000 Plants of 1500 MW cumulative capacity
  □ Linked to feedstock of
  
  (a) 60 million MT of cow manure generated at Dairy farms/large Gaushalas (< 5% of total cow dung generated in India) +
  
  (b) 30 million MT of agricultural waste (< 5% of annual waste generated in India).

□ Modular 100/250 KWe or 400/500 KWe or 1000/1200 KWe, to match bio waste availability – as Captive Power Plants at the lower end & IPP’s at the higher end.

□ The waste heat of the biogas engines could be used to meet thermal energy needs of Pasteurizers & Milk Chillers
CASE STUDY – GAUSHALAS IN INDIA

- Shree Krishna Captive Energy Pvt Ltd (SKCEL), which has developed 2 MW portfolio in Haryana (linked to 5 Gaushalas, each having > 2,000 cows)
  Agreements, signed with Gaushalas at Bhiwani, Rohtak, Hisar, Jhajjar and Hansi, for land lease as well as supply of feedstock.

- Permits obtained for 2 Gaushalas and will be obtained, for further 2 Gaushalas, by June 2011. All permits will be in place by Sept 2011.

- HERC (Electricity Regulator) order for Biogas tariff is anticipated within June 2011

- Term sheet signed with DSM for their equity investment in pre construction phase & joint efforts, employing DSM knowhow of enzymes, to enhance biogas yield from substrates
There are 4,000 Gaushalas in India. They are supported by the State & community contributions. SKCEL’s programme is fully supported by Government of India, as is evidenced by the fact that the agreements, with 5 Gaushalas, were signed in the presence of Minister & Secretary of Ministry of New & Renewable Energy, with Minister of Environment & Forest and Chairman of Animal Welfare Board of India (AWBI) also being present.
India has 283 million Cows & Buffaloes (18.5% of global population of bovine animals)

India’s cow belt lies all along the Indo-gangetic plains comprising of Uttar Pradesh and Bihar

Green + Dry Fodder demand of 1.5 billion tons/year & manure (18% DS) production of 1.25 billion tons/year
BIOGAS FROM BIO WASTE & MANURE – TECHNOLOGY & PROJECT DELIVERABLES
Modular Biogas Plant Solutions

Advantages of standardisation

- Low cost deviation and high planning security
- Efficient construction
- High & assured product quality
- Economies of scale via serial production

Modular Biogas Plants (of Envitec design)

- 400/500 KWe, CHP solution
- 1000/1200 KWe CHP solution
- 2000 KWe CHP solution
Envitec technology deliverables – mitigating Construction/O&M risks

Multifunctional

- Generation of heat and electricity (food processing industry needs)
- Organic Fertiliser
- Silage (for animal feed)
- Natural gas substitute (CNG)

Storable and available

- Base load capability
- Peak load capability through the possibility of storage
- Generation of energy from biogas not dependent on weather conditions which is an advantage over solar- and wind-power

Highly efficient

- Highest energy recovery amongst all biomass project types
- The generation of biogas can be based on agriculture residues & short cycle cellulosic biomass (2nd crop when land is normally not utilised)
- Variety of feed-stocks can be processed (e.g. Food industry waste, Manure)

Output

- Biogas production gives a net positive carbon footprint
- Suitable for the development of decentralised energy supply
- Fermentation residues suitable for premium fertilizer
Competitive advantages & technological superiority

Reasons

> Single-stage, mesophilic (35°-38°C), fully mixed process

> Accurate weighing of feedstock

> Daily variance analysis and calibration of gas production

> High quality and standardised construction of components

> Consistent implementation of process requirements

Plant efficiency

<table>
<thead>
<tr>
<th>Year</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>88.9%</td>
</tr>
<tr>
<td>2006</td>
<td>91.0%</td>
</tr>
<tr>
<td>2007</td>
<td>91.9%</td>
</tr>
<tr>
<td>2008</td>
<td>92.0%</td>
</tr>
<tr>
<td>2009</td>
<td>92.7%</td>
</tr>
</tbody>
</table>

Sector average 81.3% as per HY 1 2008

Source: EnviTec, Fachverband Biogas 2009
Biological service – key to Biogas Plant performance

**Trouble-free operation**

> Agro scientific specialists support before and during the commissioning of plant, and train O&M staff

> During operation the biological processes are monitored online daily

> Laboratory testing of substrates and residual effluents is carried out, as well as on-line gas production and the capacity utilization of biogas plant

> Based on this data, feed stock mix is optimised along with suggestions for additives (enzymes) to ensure ongoing optimization of plant performance

**Monitoring and control**

Source: EnviTec

All-round service and security for trouble-free operation
# Technology & Construction Features of EnviTec Biogas plants

<table>
<thead>
<tr>
<th>Description</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mixing</strong></td>
<td></td>
</tr>
<tr>
<td>Blending of feedstock before induction in fermenter</td>
<td>Easy stirring into fermenter through blending</td>
</tr>
<tr>
<td>Inputs are weighed &amp; controlled</td>
<td>Permanent control of inputs</td>
</tr>
<tr>
<td><strong>Tank construction</strong></td>
<td></td>
</tr>
<tr>
<td>Fermenter construction including a system tank</td>
<td>High quality</td>
</tr>
<tr>
<td>Pre-fabricated concrete elements</td>
<td>Flexibility and scalability</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td></td>
</tr>
<tr>
<td>FLEXO-roof</td>
<td>Film coating against corrosion</td>
</tr>
<tr>
<td>Two-ply</td>
<td>Snow and wind pressure; static load certified</td>
</tr>
<tr>
<td>Self-supporting</td>
<td>Execution of a compression test</td>
</tr>
<tr>
<td><strong>Agitator</strong></td>
<td></td>
</tr>
<tr>
<td>Flexible agitators in the fermenter</td>
<td>Guarantees complete stirring</td>
</tr>
<tr>
<td>Not fixed within the fermenter</td>
<td>Cleaning / maintenance through extraction of agitator during operation</td>
</tr>
<tr>
<td><strong>CHP</strong></td>
<td></td>
</tr>
<tr>
<td>Gas engine</td>
<td>Engine specifically created for biogas plants</td>
</tr>
<tr>
<td>Integrative control system</td>
<td>Long-life cycle</td>
</tr>
<tr>
<td><strong>Anaerobic technique</strong></td>
<td></td>
</tr>
<tr>
<td>Mesophilic fermentation (35-38°C)</td>
<td>Lower energy input / higher efficiency</td>
</tr>
<tr>
<td>Wet fermentation</td>
<td>Non-sensitive process</td>
</tr>
</tbody>
</table>

High quality and security standards allow CE labeling in combination with high plant efficiency confirmed by TUV certificate
### Plant construction – improved techniques – Envitec Feed Control

#### Performance-controlled feeding

- Variable instead of the usual fixed feeding times
- Adaptation to different substrate qualities
- Software update and a redox probe in the fermenter for measurement and visualization of voltage differences

#### Advantages

- Better utilisation of the CHP
- Prevents overfeeding and therefore an excess production of gas
- Saving substrates
- Insensitive to variations in the quality of input
- Gas storage is used optimally
  - 2-5% more electricity
Collateral benefit - Organic fertilizer (from Digestate)

- Close nutrient cycle, using biogas plant effluent as fertilizer
  - Nutrients in feedstock of biogas plants can be reused after anaerobic digestion
  - Only very few losses of nutrients during storage, transport and biogas process itself

- Improvements on manure quality with anaerobic digestion
  - Degradation of cells, organic acids and long chain organic matter (which helps the young plant)
  - Increase of availability of nutrients (especially nitrogen)
  - Increase of humus on the fields (compared to combustion)

Indian imports 17 million MT Chemical Fertiliser, total demand of 53 million MT. Fertiliser subsidy amounted to Rs 966 billion in FY09 – not sustainable

10,000 MW Biogas Plants will result in 40 million MT stabilised (>75% dry solids) Organic manure – improving soil fertility of about 10 million hectares farm land
India’s current fodder consumption (green + dry) is around 1 billion MT. Cultivating short cycle cellulosic biomass, as 2nd crop in rain fed areas, can enhance availability to 2 billion MT … meeting needs of Animal feed as well as generating surplus for Bio-energy.

Poor quality fodder is a key cause of low milk yields in India … 70 million producers average only 6 to 8 liters/day of milk.

Annual milk production (117 mill tons) targeted as 200 mill tons by 2021 is a key element of farm households nutrition & income (from milk sales).
WHR System - potential for Milk Chiller & Pasteurizer

- **Dairy farm Assumptions**: Gross production of 100,000 Litres per day.

- **Operations cycle assumptions**: in the morning, milk chilling is done for two hours, after that pasteurization process is run for 6-8 hours. In the evening, milk chilling is again done for two hours and pasteurization process is repeated again for 6-8 hours.

- **Process description**: the milk is collected at 25 °C and cooled through a Milk chiller and stored in Raw milk Silo at 4 °C.
  
  The milk is then pasteurized, where it is first heated to 65 °C and then from 65 °C to 72 °C.
  
  The milk is then cooled to 11 °C by passing through a Heat exchanger and then again cooled to 4 °C. The Pasteurized milk is then stored in Processed milk Silo.

- **Waste Heat Recovery System**: from Engine exhaust Ammonia Absorption Chiller which will replace the Ammonia Compressors thereby saving 70 KW of power.

  The jacket water heat of the engine will be used as a heating media for the pasteurizer.
SCHEMATIC OF AGRI COMPANY (linked to Biogas Plant)

AGRICULTURE FIELDS

DAIRY COWS & BUFFALOES

POULTRY FARMS

Liquid fertilizer (integrated with micro irrigation systems)

Stabilised Compost

Crop residues

Leguminous & forage crops

Animal feed

COMPOST YARD

SILAGE YARD

SILAGE YARD

Separated Solids

Silage

DIGESTATE TREATMENT PLANT

BIOGAS PLANT

GAS ENGINE

Electricity

Thermal Energy

Other Bio Waste
Many thanks for your attention!