Husk Power Systems (HPS) won a 2011 Ashden Award because of its success in providing electricity to villages using gasified rice–husk as the fuel.

India has a serious shortage of electricity, and people living in villages suffer the most. This is particularly acute in the state of Bihar, where even for those that are connected, the supply is very unreliable. Most households have to use kerosene for lighting, and businesses turn to diesel generators for power. The founders of HPS looked for affordable ways to address this shortage of electricity, and identified the potential for making gas from rice husk – a plentiful local resource – and using this for power generation at village level.

Key information
- HPS builds plants where there is local demand for electricity, and a source of rice husk or other agricultural residues within 10 km.
- Plant consists of rice husk gasifier, series of filters to clean the gas, gas engine, 35 kW generator and 240 V ac electricity distribution system to connect customers within a 2 km range of plant.
- Plants run each evening for up to eight hours.
- Basic connection supplies two 15 W CFL lights and phone charging. Costs US$2.20 per month. Customers can pay more for a higher power connection.
- HPS trains a local operator, electrician, fuel handler and fee collector to run each plant, with specialised regional staff available to help with problems. All customers are trained in safe use of electricity.
- High availability of power (over 93% of scheduled time) due to design of equipment, and the rigorous maintenance, safety and monitoring procedures instituted by HPS.
- By March 2011, 65 plants in operation, supplying electricity to about 32,500 households and businesses.
- Household kerosene use cut by 6 to 7 litres/month, saving about US$4.40 per month or twice the cost of a basic connection.
- Overall kerosene saving of 2.7 million litres/year cuts greenhouse gas emissions by 8,100 tonnes/year CO2. Further CO2 saving from reduced use of diesel.
- Reliable electricity makes families feel settled and part of the wider world.
- Good quality lighting enables children to study properly and families to relax in the evening, as well as reducing snake- and dog bites and petty crime.
- Shops and businesses have lower costs and can work more easily without the need for diesel generators, and some new businesses have started.
- Phone charging at home enables families to keep in touch with relatives who work elsewhere in India or abroad.
- HPS is starting businesses that use the char left over from rice husk gasification, including the manufacture of incense sticks.
- 270 people trained and employed by HPS, most of them at village level. Additional temporary work created during plant construction.

Future plans
- HPS has a target of over 2,000 plants in operation by the end of 2014.

Husk Power Systems is a for-profit company, registered in 2008. It has a mission to provide renewable and affordable electricity to rural people in a financially sustainable way. Most of its income comes from electricity sales.
Case study

Husk Power Systems

India

Background
India has a serious shortage of electricity, and people living in villages suffer the most. 125,000 villages lack grid power altogether, and even where the grid extends the supply is unreliable and does not reach all households. When grid rationing takes place, villages often receive power only after midnight when ‘priority’ demand from cities and industry is low. This is of little use to rural households and businesses.

The state of Bihar in North-East India has a very low rate of grid electrification and acute power shortages. It is estimated that the grid can meet only 10% of demand. The founders of Husk Power looked for affordable ways to address this shortage of electricity, and identified the potential for making producer gas from rice husk – a plentiful local resource – and using the gas for power generation at village level.

The organisation
The first power plant that ran on 100% producer gas was commissioned in 2007. In 2008 Husk Power Systems (HPS) was registered as a for-profit company with a mission to provide renewable and affordable electricity to the rural population around the world in a financially sustainable way. Three of its founders (Gyanesh Pandey, Ratnesh Yadav and Manoj Sinha) come from Bihar, and Charles Ransler comes from the USA. Most have had education and professional careers in the USA.

The growth of HPS has been helped by substantial grant-funding from the Shell Foundation, which has supported R&D, strategy and training. US$1.65 million investment from six social investors (Acumen Fund, Bamboo Finance, International Finance Corp, Draper Fisher Jurvetson, LGT Philanthropy and CISCO) was secured in December 2009. In 2010/11 HPS had 270 employees. About 80% of its income comes from sales (mostly electricity, but also char products) and 20% from Government subsidies to new power plants.

The programme
Power plants are installed in places where there is a reliable source of rice husk and other biomass residues within a distance of 10 km. HPS staff visit a village, at the invitation of village representatives, to assess its suitability for a plant and explain how the scheme works. If 400 or more households commit to paying a monthly fee for electricity, HPS will install a plant (rice-husk gasifier, gas engine, generator and 240 V electricity distribution system) and connect the homes and small businesses that have signed up. A village operating team maintains and runs the system, which supplies electricity each evening for up to eight hours.

The technology

How does it work?
Sackloads of rice husk or other biomass residues are poured into the gasifier hopper every 30 to 45 minutes. The biomass burns in a restricted supply of air to give energy-rich producer gas. The gas passes through a series of filters which clean it, and it is then used as the fuel for an engine that drives the electricity generator. Electricity is distributed to customers via insulated overhead cables.

The basic connection provides a household with two 15 W compact fluorescent lights and mobile phone charging throughout the period each day that the plant runs (up to eight hours in the evening). Sometimes poorer households share a basic connection and get one light each. If a household or business wants to pay more for a higher power connection, then this can be provided. A fuse blows if the customer attempts to use more than their agreed power. Each plant serves about 500 customers, and has sufficient capacity to allow for demand to increase. About 70% of homes within the distribution area get connected.
How much does it cost and how do users pay?
US$1 = INR 45 (Indian Rupees) [April 2011]

Electricity fees start at INR 100 (US$2.2) per month for a basic connection. One month’s deposit is required when a customer signs the supply contract with HPS. The local HPS collector goes from house to house to collect the fee each month in advance, and checks that everything is working well. All complaints are logged and followed up. Under the terms of the contract, HPS agrees to provide service for at least 27 days every month, and pro-rates the fees if this level is not met. However, average provision is now over 28 days per month (93% availability).

The total landed cost of a 35 kW plant, including distribution system, is less than US$1,000 per kW. HPS is paid a subsidy of up to INR 320,000 (US$7,100) for each plant, by the Ministry of New and Renewable Energy. The remainder of the capital comes from investment and sales revenue. HPS loses only about 4% of revenue through default on payment or electricity theft, considerably lower than most power suppliers in India, who often lose 30%.

How is it manufactured, managed and maintained?
The gasifiers were originally made by Ganesh Engineering. HPS improved the design considerably and now does much of the manufacturing itself. Gasifiers are optimised for rice husk (a difficult material to gasify) but can also work with other types of agricultural residue or with wood. The engines are manufactured by a local partner who worked with HPS to develop an engine that could run on rice husk gas alone (rather than dual-fuel operation with diesel fuel). This is a technical challenge because of the amount of tar in the rice husk gas.

Promotion of the plants is largely by word-of-mouth and also through local press and media, and their benefits are now well known in Bihar. HPS receives several hundred enquiries about installations each year.

HPS’s value proposition lies in making the plants so simple to operate and maintain that high-school educated people from the village can be trained to manage and run them. Tars and other particulates in the producer gas can damage equipment, in particular engines so a key factor for successful operation is the rigorous HPS maintenance programme. This schedules cleaning and maintenance tasks on a daily, weekly, monthly and quarterly basis. HPS also requires high safety standards and detailed monitoring, with individual plant managers sending a daily report to the manager of their local ‘cluster’ of four or five plants, and the cluster manager relaying data to the regional level and onwards. It is through this attention to maintenance and monitoring that HPS plants achieve over 93% availability.

Benefits
By the end of March 2011, HPS had 65 fully operational plants, and a further ten under construction or starting operation. 48 plants are wholly owned and operated by HPS, and the other 17 run under some type of franchise or partnership.

Plants have 500 customers on average, so about 32,500 households are supplied. With five or six members in a household, this means that about 180,000 people benefit from HPS electricity.

Environmental benefits
Surveys show that households stop using kerosene lamps when they get HPS electricity, and save 6 – 7 litres/month of kerosene on average. The total kerosene saving for the 32,500 households supplied at the end of March 2011 is therefore about 2.7 million litres per year.

Kerosene savings cut greenhouse gas emissions by an estimated 125 tonnes/year CO₂ equivalent per plant (assessed as part of CDM certification). Thus the total saving for the 65 plants in operation at the end of March 2011 is about 8,100 tonnes/year of CO₂e.

Further CO₂ savings come from the reduced use of diesel generators to supply small businesses: these savings vary from plant to plant because they depend on the type of customers served.

The technology in more detail
The gasifier has a cylindrical combustion chamber with a hopper above it. To start up the plant, rice husk is poured into the hopper, and flows into the combustion chamber where it is set alight. Air is drawn downwards through the husk, which burns in a restricted supply of oxygen to give energy-rich producer gas, a mixture that includes hydrogen, carbon monoxide and methane. The char that remains drops to the bottom of the gasifier and is removed.

The gas is cooled and cleaned by water, and is then drawn through three or more filter beds made of charcoal or rice husk, to remove tars. A final cloth filter removes particulates, before the gas is burned in an engine that drives a generator to produce about 35 kW of ac electrical power at 240 V. The engine is monitored all the time by the plant electrician, and both operator and automated controls ensure that electricity supply matches demand.

The 240 V distribution system uses insulated cables for safety and also to reduce electricity theft. Cables are taken on bamboo poles to users up to 2 km from the plant; longer distances are discouraged because they lead to high losses and voltage drops in a low-voltage system. HPS connects the supply to the user, but the household or business must pay for the internal wiring.

A plant uses about 10 tonnes/month of rice husk or other biomass residue. HPS normally keeps one week’s worth of biomass in reserve for each plant, but stocks up before the monsoon period when deliveries may be disrupted.
Note that some CO₂ is produced from the fossil fuels used in the transport of rice husk, but the amount is small (less than 1 tonne/year CO₂ per plant) since HPS plants are sited within 10 km of the rice mill, and some transport is done by bullock cart.

**Social benefits**

Having a reliable electricity supply makes families feel more settled and connected to the wider world. Even in villages with grid power, households and businesses choose to connect to the HPS supply because of its greater reliability and lower cost. HPS makes sure that customers understand how to use electricity safely, and that every member of the household agrees to abide by safety rules.

Good-quality lighting throughout the evening is a huge benefit to households. Children can study properly, housework is easier, and families can relax and socialise. Better lighting deters petty crime, and reduces the frequency of snake-bites and dog-bites – a common reason for emergency hospital admission in Bihar.

Removing kerosene lamps reduces exposure to smoke and fumes, and the risk of fire: many village homes are built from woven bamboo, and house fires are common in rural Bihar.

Mobile phones are important for keeping in touch with the many family members who work elsewhere in India or abroad. In one village mobile phone ownership increased from 10% to 80% of households after the HPS supply was installed, because previously people had to go out of the village to have their phones charged.

**Economic and employment benefits**

Households with HPS power save typically INR 200 per month on kerosene, so their net monthly saving (after paying for their CFLs) is about INR 100 (US$2.2). With household earnings of typically US$75 to 100 per month, this frees up a significant amount of cash.

Businesses benefit from better quality light and electric fans, and some new businesses have started because of the HPS supply, including photocopying shops and mini cinemas.

Rice mills are paid about US$25 per tonne of rice husk, so earn an extra US$3,000 per year by supplying an HPS plant, as well as solving a disposal problem. Some mills have shared this benefit with their customers by cutting the charges that they make for milling.

HPS provides good employment at a local level. Plant assembly provides temporary employment for about 10 local labourers. Each plant then employs four people (plant operator, electrician, fuel handler and fee collector) who have training, income and safe working conditions. The collector is encouraged to earn extra as “travelling salesman”, selling goods that are not usually available in the village at the same time as collecting fees. Further skilled and professional employment is provided in the cluster-level, regional and central operations. HPS provides full medical benefits and retirement contributions for its full time employees, who number about 270.

Rice husk char is produced as a by-product of the gasification process. HPS is investigating ways of using this that will add value and create employment. At five plants, groups of about 15 women work part-time making incense sticks from char, and can earn about INR 80 (US$1.8) per day.

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**“Women aren’t interested in men from our village any more: there will be no more marriages until we get an HPS plant.”**

Farmer from unelectrified village.

- fortunately they got a plant six months later!

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“I like working for HPS, they take notice of what staff suggest. I have a degree from a good university, but I’ve learned a lot more working for HPS.”

Kshitij Khurana (HPS regional manager)
Potential for growth and replication

HPS aims to continue its rapid growth, with a target of 2,014 operating plants by the end of 2014. Recent investment is supporting the immediate expansion, and HPS is also working to obtain carbon finance and expand its franchising operations, to enable further growth.

A key factor in the success of HPS is its emphasis on staff training and strict operating procedures, at village level and right through its organisational structure. The main challenge for achieving growth is providing training to the 9,000 or more people that will be needed to operate over 2,000 plants to the same level of performance. HPS is planning to build a training centre, and also provide some training by distance learning.

The basic technology and plant operation are not expected to change, but the R&D and monitoring that HPS undertake will lead to technical and operational improvement and bring down costs. Current ideas under development and testing include programmable pre-payment meters, char removal systems that cut water use, and automated plant monitoring. Other ways of adding value to char are also under investigation.

Rice husk is a plentiful resource in India and many other countries, since about 25% of the weight of the dried paddy is husk. Bihar alone produces three million tonnes/year of paddy, which could provide sufficient husk to supply electricity to three million households. HPS technology could therefore be used in many other rice-producing areas, as well as places with other biomass residues.

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Disclaimer

This report is based on information provided to the Ashden Awards judges by Husk Power Systems and findings from a visit by a member of the judging team to see its work in India in March 2011.

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