The emergence of factory pre-engineered and packaged CHP systems is improving the return on investment for customers and accelerating the take-up of small-scale CHP in the US, write Owen Duffy and Uday Purani.

Plug and play units expand US market for small-scale CHP

Despite all the promise and excitement about CHP and distributed generation (DG) in past years, the industry has moved with great uncertainty, after certain obstacles gave it a black eye. These difficulties included: improperly designed systems; high construction costs; long construction periods; regulatory issues; and firms folding their tents after bad projects and filing for bankruptcy. Meanwhile, it had long been recognised that a 150 kW system needs the same engineering as a 1 MW system. Engineering costs, therefore, used to rule out a good ROI for smaller installations without an output to gain enough off-grid savings to make up for their total cost. What has changed is the development and full-scale deployment of reliable and efficient smaller systems that are not only pre-engineered by their manufacturer, but are also pre-packaged and pre-tested (although only a few manufacturers actually build specifically designed units at their factories).

These units come complete with a prime mover, a generator mounted on a base rail with pumps, heat exchangers, and emission control devices, along with robust digital, on-board controllers capable of many functions and protective features. Thus, both engineering and installation costs are greatly reduced, while total system cost is far less than the energy saving provided, especially when applications feature favourable conditions. Moreover, the gains in reliability from avoiding site building – combined with new opportunities for quality control – further enhance ROI by allowing for lengthier hours of operation and long-term service intervals, with consequent further reduction in grid dependence.

While much of the manufacturing, installation and operation for smaller systems have been standardised to cut costs, each application remains custom-engineered, with know-how and experience from application selection, through start-up and continued operation.

SYSTEM APPLICATION SELECTION AND ROI

While realising return on investment from smaller CHP systems hinges on proper sizing, design, manufacturing and operation, good application selection is still essential. For example, where electricity rates are high relative to fuel costs, good ‘spark spread’ results. Meanwhile, the larger the size of the facility the unit is serving, the lower will be the first cost per kW. Moreover, the longer the length of its operating hours, the more use is made of the energy savings the investment is providing. Where a need to replace or upgrade a facility’s heating, ventilation and air conditioning (HVAC) system is already acknowledged, a capital cost credit may apply. Further credits may be available from the Leadership in Energy...
Packaged CHP in the US


When a facility has a mission requirement for additional power capacity and/or more reliable supply, system value will be further enhanced. A central heating and/or cooling plant provides for thermal load, and good coincidence between electric and thermal loads allows for the use of all available energy products.

INFLUENCE OF CHP SYSTEM ON ROI

The opportunity to realise proper sizing for a small-scale CHP has been enhanced by the development and availability of a range of modular, standard sizes, and their capability of being ‘stacked’ to extend the standard range. The basic standard range is 55–400 kWe for natural gas systems and 60–350 kWe for biogas types.

Smaller-scale CHP systems are now providing a good return on investment opportunities, thanks to the development and deployment of customised, reliable and efficient smaller systems that are not only pre-engineered by their manufacturer, but are also pre-packaged and pre-tested.

Very reliable and robust engines, the prime movers for CHP modules, are now available to provide better fuel efficiency as well as extended hours of operation between overhauls. They can also feature low emissions of NOx and CO, the technology for which continues to advance.

Pre-engineering allows for an interface carefully customised to the end user’s facility and application, including automated full digital control for the CHP unit(s) as well as for other plant equipment, such as pumps and heat exchangers. This customised interface, which may also cover proper utility interconnection and the integration of related infrastructure improvements, can provide multiple benefits, such as more efficient serviceability.

Pre-engineering may also help maximise heat recovery, which can significantly mitigate the impact of natural gas prices on project costs. Similarly, maximising savings on electricity costs can often easily cancel out any increases in fuel cost. In this area, careful consideration of the load levels the CHP unit will be connected to, both for electricity and heat recovery, can pay great dividends.

Pre-packaging modules eliminates the need to challenge general contractors with the task of procuring and site assembling 150–200 loose pieces. Greater availability of pre-packaged and assembled systems also means end users no longer need to install systems that are, essentially, just prime movers that were modified elsewhere before delivery.

Cost-effective noise reducing enclosures have also been standardised, helping to extend application diversity, while modules without enclosures remain available for indoor installation. Increased concern for noise control in a variety of equipment sectors has made such control for CHP systems more easily attainable.

Higher levels of uptime, which bring direct savings through

For more information, enter 19 at COSPP.hotims.com
Packaged CHP in the US

lower grid dependence, can now be enhanced by the availability of long-term maintenance agreements. Such contracts may provide a fund for scheduled overhauls, and/or replacement of major components. Pre-engineering can also help to further increase uptime, by allowing for more efficient serviceability. Fully digital and automatic design can provide for full remote access and monitoring.

PRE-MANUFACTURING OPENS OPTIONS

Pre-manufacturing of small-scale CHP systems allows selection from a variety of stock engines and generators, as well as a manufacturing process that includes: engine generator base frame; engine generator assembly; exhaust heat exchanger; mechanical system piping and flanges; assembly and wiring of control and breaker cabinets; in-house controller programming and enclosure assembly; and complete pre-shipping system testing.

The integrated controls included in this pre-manufacturing capability include a paralleling breaker that allows for single unit base load to a utility, or to a multi-unit parallel with load add, load share and load shed features. These controls also offer end users an opportunity for engine start/stop sequencing and engine monitoring, among general control functions such as those to help determine the degree of reliance on the grid at any moment. Moreover, utility inter-tie controls have now been standardised, and switchgear and genset can be pre-integrated at the factory.

These fully designed and tested, plug-and-play CHP systems can include automated, pre-programmed preventive maintenance notification, including spark plug change, oil filter change, and belt/filters change.

At a multiple-building, public institution facility, a 250 kWe unit, stacked with a 150 kWe unit, has been operating at full load, 24/7, since 2008. The pre-packaged unit includes supplying hot water as a vehicle for BTU recovery.

For more information, enter 21 at COSPP.hotims.com
Factory-trained and certified service technicians, when available 365 days per year, have also helped maximise run time, especially when they are fully equipped to perform field testing, and can facilitate testing, repairs and/or overhauls in-house or in-frame. Similarly, when manufacturers have large stocking facilities, staffed by factory-trained and certified parts specialists, run time can be extended further.

Manufacturers with well-trained service technicians and parts specialists may also provide good end-user training, towards further maximising system run time.

APPLICATION CASE HISTORIES

Examples of cost-effective installations of small CHP systems installed by Kraft Power include the following:

Public institution, multiple buildings
A 250 kWe unit, stacked with a 150 kWe unit, has been operating at full load, 24/7, since 2008. Full utilisation of combined electricity and thermal contribution potential is being realised, as the CHP system is also providing a domestic hot water service in addition to grid relief. The pre-packaged unit includes supplying hot water as a vehicle for BTU recovery. A second pre-packaged CHP system was installed at a similar facility nearby. The system consists of two 150 kWe units, with hot water recovery.

Municipal wastewater treatment plant, Northeast
Two 180 kWe synchronous units, equipped with external heat dump radiation add-ons, have been operating since early 2011. Biogas from the plant’s anaerobic digester is collected, cleaned and fed to the engines, with heat recovered from the engine used for heating the digester, and also providing for the plant’s domestic hot water needs.

State office building
A 500 kWe unit, with synchronous generator, has been operating since early 2010. The system includes the supply of hot water as a vehicle for use of by-product heat.

Hospital, New York City
A 250 kWe CHP unit in a soundproof container was recently delivered to a private hospital to displace its high-cost electricity. Due to stringent interconnect requirements by the local utility company, the unit was manufactured utilising an

For more information, enter 22 at COSPP.hotims.com
Packaged CHP in the US

induction generator. The module also includes a hot water heat recovery system to supplement the hospital’s hot water requirements. Since this is a pre-packaged, fully automated, plug and play system, it will be installed on the roof of the hospital, where the installing contractor will only have to make gas, water and electrical connections.

Hospital, Massachusetts

A 250 kWe CHP unit was installed for a Massachusetts hospital. The indoor installation has a state-of-the-art digital control system for hot water heat recovery. The module and its components are housed in a soundproof enclosure.

Wastewater treatment plants, Wisconsin & Illinois

In spite of low electricity costs, incentives have led to projects in the state of Wisconsin and Illinois, where 180 kWe sized CHP modules will be supplied by early this year. A few more biogas CHP projects, in the range of 180–350 kWe, will also roll out by spring this year.

Airport energy centre

Here, a larger system was available from a manufacturer that specialised primarily in smaller systems, in order to gain the benefits of standardised design and pre-engineering and pre-assembly. It was not supplied as a separately housed unit, since the airport already had a building to house it. Four units provide a total of 5.66 MW of electricity, in addition to 96°C hot water.

The installation began operation in 2002, and has provided complete outsourcing of total energy requirements. Airport heating and cooling is now assisted by reclaimed heat from the units’ engine jacket coolants. Meanwhile,

At a northeastern wastewater treatment plant, two 180 kWe synchronous units, with each module equipped with an external heat dump radiation add-on, have been operating since early 2011. Biogas is fed to the engines, with heat recovered from the engine used for heating the digester.

For more information, enter 23 at COSPP.hotims.com
the project has benefited from incentives from the local electric power utility that encourage on-site generation.

MARKET POTENTIAL

Industrial applications for smaller CHP systems that have been identified so far include food processing, textiles, wood, pulp and paper, petroleum, and chemicals. According to data acquired from the Mid-Atlantic CHP Application Center, US application potential also includes:

- hospitals, 8000 sites;
- convention hotels, 7000 sites;
- high-rise residential complexes, 12,000 MW;
- office buildings, 25,000 MW;
- restaurants, 1000 MW and 20,000 sites;
- shopping centres or malls, 12,000 MW and 8000 sites;
- schools and colleges, 2600 MW and 13,000 sites;
- supermarkets, 8400 MW and 28,000 sites;
- casinos.

Currently, about 95% of CHP projects are electric-driven. Thermal load profile is also matched to facility thermal demand, thereby optimising system performance. Applications include space heat, dryer operations, boiler preheating, absorption air conditioning, process heat, sludge digestion, domestic hot water, laundry operations and washing operations. However, in some cases, projects are driven by thermal loads, and not by electricity demand.

GENERAL OUTLOOK

A few years ago, there was great uncertainty about the outlook for CHP in the US. Today, many industry analysts are envisioning some strong trends in the direction of CHP/DG. Environmentally sensitive and energy intensive customers in the Northeast and Midwest, as well as on the West Coast, are recognising the advantages and benefits of pre-manufactured, plug and play-type, efficient, modular CHP plants.

Experience has shown that smaller CHP systems, when acknowledged by their end users as reliable and beneficial, will continue to operate for a long time. Use for 20 years and longer is increasingly common. This longevity, coupled with continuing advances by smaller CHP system manufacturers in pre-engineering, pre-packaging, manufacturing technology, system integration, and ongoing service and maintenance capability – and combined with incentives from grid operators that encourage on-site power generation – strongly suggest a good opportunity for electricity generation project developers and general contractors, working either with energy supply companies or independently.

Owen Duffy is President and Uday Purani is Sales and Marketing Director for CHP systems for Kraft Energy Systems, the manufacturing division for Kraft Power, New Jersey, US. Email: oduffy@kraftpower.com; upurani@kraftpower.com

www.kraftpower.com

This article is available on-line. Please visit www.cospp.com