Can Combined Power Plants Maintain their Foothold?

As national energy markets transition more renewables into the mix, and phase out nuclear power plants and coal power plants, the need for pioneering energy systems like CCPPs is growing in intensity. CCPP looks to fill the gap until a full transition is made, but are there enough market incentives and financial profitability to make combined cycle power viable in the near future?[i]

Market Factors Influencing the Development of CCPPs

There are many factors influencing the level of interest in cogeneration power plants around the world. For instance, in markets such as America's where renewables aren't on the same fast track and where gas supplies are high, the combined cycle gas turbine is extremely attractive. In fact, the ability to generate gas-based electricity more cheaply and with 50% less carbon dioxide compared to coal has been one of the biggest advances in the US energy market of late. Gas, which occupied only 16% of the energy mix form the 1960s through the 1990s is now reaching past 21% and rising.[ii]

In the current US energy market, CCPPs are cheaper than both nuclear and renewables in terms of capital costs. The limiting factor for further growth in this sector is the high cost of gas. And because gas development is regional and pipelines are expensive to build, gas is generally extracted and sold locally to keep costs of developing it down, so expansion to the entire country is likely to be curtailed until alternative fuel sources can be more profitably developed.[iii]

CCPP installations are also growing in number in regions such as Asia, though for different reasons. At this stage, the availability of natural gas in the region and the fast-growing demand for electricity has spurred growth in gas fired power generation. Not only that, but much of Asia is somewhat limited in terms of solar

and wind development capacity by geographic and climatic conditions. As a result, at this stage, gas will provide a much larger share of the base load of many Asian countries. In Malaysia, it's currently 35%; Thailand 65%; and Singapore 78%. As environmental awareness and concern over global warming increases in these countries, people are demanding cleaner gas-fired technologies, and so many utilities in the region are turning to combined cycle options.[iv]

However, in Spain, the growth of both wind and solar installations in the country combined with sufficient existing low-load capacity has negated the need for new combined cycle power plants investments – for the next 10 to 15 years and perhaps beyond. In fact, some are saying that the growth of wind in the region will reduce the market share of these types of power plants to zero.[v] Likewise in Germany where the internal rate of return on CCPPs has nearly reached zero, making them less financially viable.[vi]

Cleary the challenges for CCPP technology throughout the globe are different. Regardless of the current factors impacting the level of interest in CCGTs, one thing is likely – with its quick ramp-up times and low carbon emissions, CCPPs are likely to continue to play a large role in national grids as renewable energy portfolios increase. Even in countries like Spain and Germany with rapidly expanding solar and wind installations, combined power plants are likely to be a necessity to fill the void when renewable supply is low – at last until sufficient storage capacity can be developed. As such, there is a need to make CCPPs more financially viable on a larger scale.

Achieving Greater Cost Effectiveness with Alternative CCPP Configurations

Combined cycle power plant technology is not a niche market, generally speaking. In fact, the turbines required for building a new combined cycle power plant are based on existing technological philosophies and are commercially available from a variety of suppliers around the world. In general, the capital costs of building a CCPP are about 66% of the costs of building a new, comparable coal power plant. [vii]

Despite the fact that CCPP technology is widely available and affordable compared to conventional power plants, many are looking for ways to achieve even greater profitability. CCGTs are extremely legislation sensitive in the energy market, and therefore require either extremely good profit margins or a very stable, predictable environment.[viii] Because of factors already mentioned, in many markets CCGT margins are slim if next to nothing, and carbon legislations are having a volatility impact on the environment as well. This has created many challenges for those working to make CCPP installations viable.

One way German combined cycle gas power plants are finding profitability is to sell heat for district heating. For this purpose, RheinEnergie has commissioned Alstom to construct a 450 MW CCPP in Cologne Niehl. This power plant will be run at part-load in order to achieve profitability. By decreasing electricity output, the system will produce excess heat which is in higher demand and can be sold at a higher profit.[ix]

A similar Siemens project at Stadtwerke Dusseldorf will achieve an efficiency of 85%, in part because it will generate 300 MWth of district heat running in the combined cycle mode. At 595 MW of power, the system will satisfy most of Dusseldorf's power demand.

Retrofitting combined cycle power plants with new technologies is another way of achieving greater profitability. A recent study of an existing CCPP configured with two combustion turbines and one steam turbine with a generating capacity of 531 MW looked at whether adding heat transformers to the gas turbines would improve efficiencies and reduce costs. The two natural gas combustion turbines generate 336 MW, while the steam turbine generates the remainder through a heat recovery steam generator (HRSG) through heat exchange between the combustion gases and water.

The study was designed to test whether heat transformers using low grade calorific energy such as waste heat from solar, industry, or geothermal could be used for industrial applications. The test was designed to see the impact of advanced absorption heat transformers such as two-stage heat transformers and double absorption heat transformers (consisting of a generator, condenser, evaporator, absorber, absorbers/evaporator, and economizer).

The following is a description of the modifications made to the system:

"By using of pinch technology, the chimney exit was selected as the best site for the implementation of a double absorption Heat Transformer (HT) to improve the plant efficiency, where the HT will use the residual energy of the CG at the chimneys exit (90 °C), preheating 91.5% of the total water fed by the condenser from 40 °C to 120 °C, being the CG output at 40°C."

Through predictive mathematical modeling, the study was able to predict the CCPP irreversibility costs of introducing heat transformers to gas turbines with the use of high quality natural gas and while observing the corrosive effects inside the HRSGs. Their conclusion was that, by upgrading an existent CCPP in this way, the heat transformer was able to save $14 million per year through improved efficiencies and decreased costs and irreversibility.

Another way to reduce costs of combined cycle power plants is to go simple: choose a single shaft configuration over a multi shaft configuration. In a single shaft configuration, only one gas turbine, one generator, one steam turbine, and one heat recovery steam generator (HRSG) are required. In this system, the steam turbine and gas turbine are coupled into one generator on a single shaft. This type of system is much simpler and therefore also more reliable.

A multi shaft system, on the other hand, is a more complex installation and requires the installation of multiple gas turbine generators and HRSGs that together supply steam through a shared header. The steam is then fed into a separate steam turbine generator. This type of combined cycle power plant requires a larger number of components – cooling towers, circulating water systems, steam turbines, condensate systems, condensers, and so on. As a result, additional gas turbines are also required. Together, these extra components can increase the costs of a power plant installation or modification.

That said, the overall upfront investment for a multi shaft system is only about 5% higher than a single shaft system. The size of a particular power plant, therefore, can often be determined on power requirements instead of upfront costs. [x] Researchers will no doubt continue looking for new and better ways like these to increase the profitability of CCGT technologies to prolong the life of natural gas as the sweetheart of the energy industry.

CCPPs Likely to Play Large Role in Future Grid, Despite Financial Trials

CCPPs are becoming increasingly popular in many regions of the world as natural gas prices fall, dislike of coal and nuclear rises, the need for more flexible grid configurations increases, and countries look for low carbon ways of fueling their economies. As a result, until we are able to make a complete switch to renewables, combined cycle power is likely to play a larger role. As utilities work out the financial kinks through better efficiencies and alternative ways to configure their installations and sell their power, many of the struggles that current face these systems will fade.

Maryruth Belsey Priebe

A student of all things green, Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

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Sources

[i] Blackaby, N. (2012, February 16). *The new power mix in Germany - What does it mean for the rest of Europe?* . Retrieved from Power Engineering: http://www.powerengineeringint.com/articles/2012/02/the-new-power-mix-in-germany-what-does-it-mean-for-the-rest-of-europe.html

[ii] *An unconventional bonanza: New sources of gas could transform the world's energy markets, says Simon Wright—but it won't be quick or easy*. (2012, July 14). Retrieved from The Economist: http://www.economist.com/node/21558432

[iii] *An unconventional bonanza: New sources of gas could transform the world's energy markets, says Simon Wright—but it won't be quick or easy*. (2012, July 14). Retrieved from The Economist: http://www.economist.com/node/21558432

[iv] *The role of CCPP in the Asian power market – Providing the power for a prosperous future*. (2012, September 12). Retrieved from AsiaPOwer: http://asian-power.com/project/commentary/role-ccpp-in-asian-power-market-%E2%80%93-providing-power-prosperous-future

[v] *Spain: "Profitability of CCGTs has not reached the bottom yet" - Poery*. (2012, May 17). Retrieved from Gas to Power Journal: http://gastopowerjournal.com/markets/item/493-spain-%E2%80%9Cprofitability-of-ccgts-may-not-have-reached-the-bottom-yet%E2%80%9D-poery

[vi] *Return on CCGT investments in Germany is "close to zero" - PwC*. (2012, April 19). Retrieved from Gas to Power Journal: http://gastopowerjournal.com/projectsafinance/item/397-internal-rate-of-return-on-ccgt-investments-in-germany-is-close-to-zero-pwc

[vii] Rimireddy, V. (2012, August 25). *An Overview of Combined Cycle Power Plant*. Retrieved from Electrical Engineering Portal: http://electrical-engineering-portal.com/an-overview-of-combined-cycle-power-plant

[viii] *Development Of Future Combined-Cycle Power Plants Fuelled By Low Investment Costs*. (2012, February 27). Retrieved from Oil & Gas IQ: http://www.oilandgasiq.com/gas-oil-production-and-operations/articles/development-of-future-combined-cycle-power-plants/

[ix] *Selling heat makes German gas power plants profitable*. (2012, December 5). Retrieved from Gas to Power Journal: http://gastopowerjournal.com/projectsafinance/item/1193-selling-heat-renders-german-gas-power-plants-profitable

[x] Rimireddy, V. (2012, August 25). *An Overview of Combined Cycle Power Plant*. Retrieved from Electrical Engineering Portal: http://electrical-engineering-portal.com/an-overview-of-combined-cycle-power-plant