Breaking Energy

GENERATION, TECHNOLOGY

CCS Breakthrough: sCO2 Power Cycles Offer Improved Efficiency and Integrated Carbon Capture

By EDWARD DODGE
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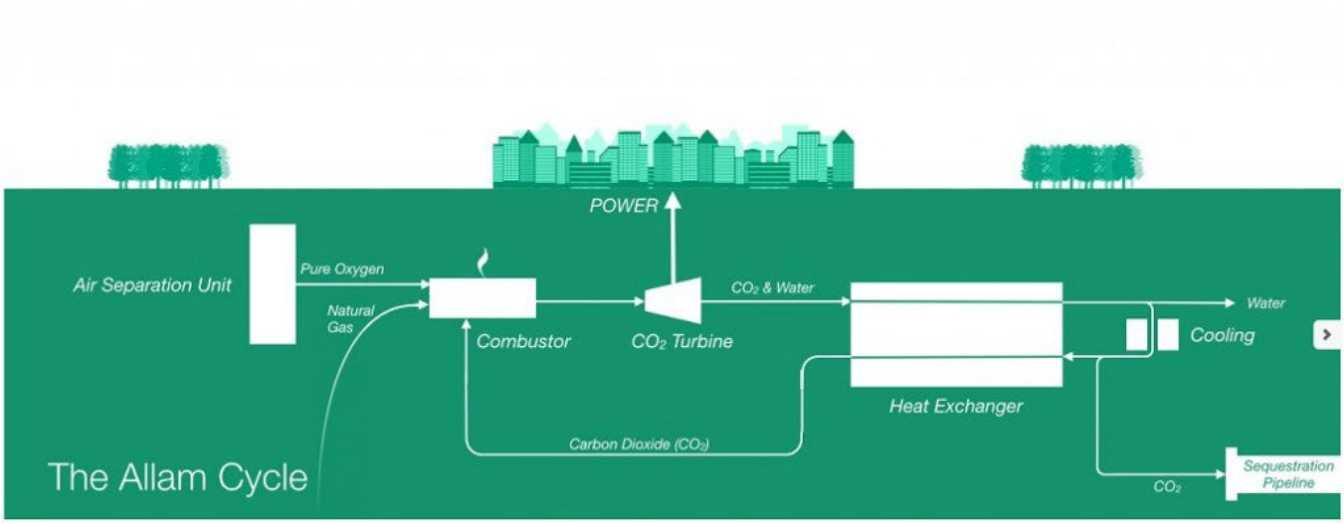
NET Power, a young company from Durham, NC recently announced they will construct the first of a kind natural gas fueled power generation system with zero air emissions and complete carbon capture. NET Power's Allam Cycle technology combines oxy-fuel combustion with a supercritical CO_2 turbine to create power generation at better efficiencies than natural gas combined cycle plants (without carbon capture). The NET Power plant comes in a smaller package at lower cost than NGCC while generating pipeline-quality pressurized CO_2 as a free output.

NET Power has completed all the partnership agreements for a $50MW_{th}$ demonstration plant that will

be built in Texas and commissioned in 2016. The $140 million project is a collaboration with CB&I, one of the world's leading energy infrastructure providers, Exelon Corporation who is a major power utility, and Toshiba Corporation who is providing the sCO_2 turbines, 8 Rivers Capital is the project developer and owner of the Allam Cycle technology. The project is funded by the partners who are all major industrial players and demonstrates that the technology has great promise.

The most efficient fossil fuel power plants today – natural gas combined cycle, integrated gasification combined cycle (IGCC) for coal, and supercritical coal – all rely on turbines and steam cycles for power generation. Using supercritical CO_2 as a working fluid in turbines is a breakthrough in power engineering, the high fluid density of sCO_2 enables much smaller hardware packages and efficiencies above 50%. The Allam Cycle also integrates high pressure carbon capture into the system without penalty, while carbon capture in conventional power plants is an expensive add-on that reduces system efficiency.

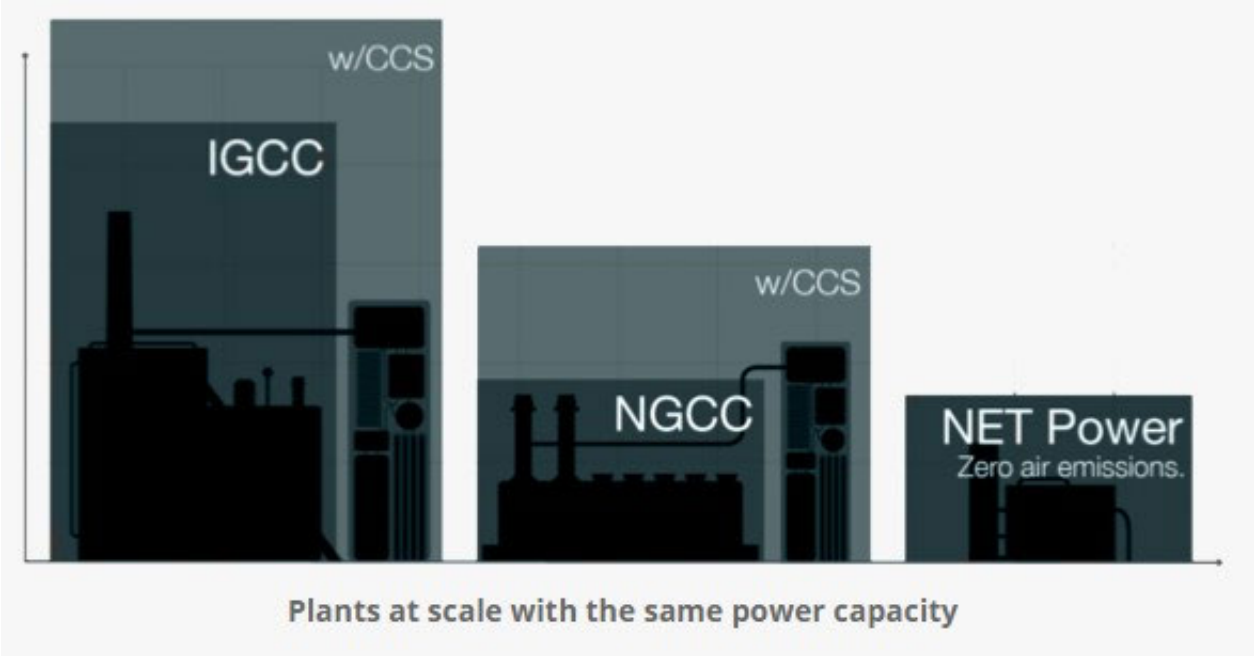


Source: NET Power

NET Power plants using the Allam Cycle are a zero emissions power generation system, there is no smokestack and no water consumption (though water is produced as a product of combustion). The NET Power plant uses oxy-combustion, where fuel is burned with pure oxygen instead of ambient air, this is preferable because air is almost 80% nitrogen and creates harmful NOx pollution when combusted. Oxy-combustion virtually eliminates NOx. Oxygen is produced using an Air Separation Unit (ASU) and combined with fuel and high pressure CO_2 in a combustor and sent through a CO_2 turbine where power is produced. CO_2 and water exit the turbine and go into a heat exchanger where the water is condensed out and some of the CO_2 is looped back to the combustor while the rest exits the system through a high pressure CO_2 pipeline.

NET Power plants are much smaller than conventional power plants and the small footprint translates to lower capital costs. High pressure is used throughout the system and enables higher power densities as smaller components are used. Since the entire steam process is eliminated including the

second turbine and Heat Recovery Steam Generator (HRSG) that gives combined cycle its name, complexity is dramatically reduced.



Source: NET Power

Carbon capture is greatly enhanced in a NET Power plant compared to conventional power plants. Capturing carbon at a conventional steam cycle power plant requires expensive additional equipment such as amine scrubbers and CO_2 compressors that are a drain on power production and result in expensive CO_2. There is enormous demand for pressurized CO_2 for use in enhanced oil recovery but the capture costs thus far have not proven economic and so little progress has been made in commercializing carbon capture.

NET Power plants offer the opportunity to fundamentally reset the economics of carbon capture because it is already built into the system. As long as the LCOE (levelized cost of electricity) produced by the NET Power plant is competitive in the market, then the pressurized CO_2 is effectively free and only requires a pipeline for transport.

Toshiba has taken responsibility for providing the first-of-a-kind combustor and sCO_2 turbine. These components must tolerate high temperature and pressure gas at the turbine inlet. To deal with these conditions Toshiba utilizes specialty materials originally developed for use in high temp steam turbines which Toshiba has extensive experience with. The combustor has been designed to cope with a gas pressure of 300 bars, which is more than 10 times the gas pressure utilized in conventional gas turbines.

NET Power is not limited to natural gas as a fuel. They have designs for coal as well that integrate gasification and removal of all pollutants. NET Power is currently working on feasibility studies for coal that build on the natural gas platform. By combining coal gasification with various stages of

water scrubbing they are able to effectively remove all of the sulfur, nitrogen, particulates and heavy metals found in coal without the use of more expensive acid gas removal technologies. The pollutants are purified and available to be sold as commodities.

Topics: Carbon Capture, Carbon Capture and Sequestration, Carbon Capture and Storage, Carbon Capture Technology, CB&I, CCS, CCS Technology, Chicago Bridge & Iron, Coal, Emissions, Emissions Reduction, Exelon Corp, Natural Gas, Power Engineering, Power Generation, Toshiba