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Abstract

What if we can lower the emissions from electricity produced from natural gas to absolutely zero, do this on the seabed, and connect to a power transmission network? Our concept produces much wanted electrical power using natural gas but without emitting any of the CO₂. This could help the energy transition, while ensuring that the world gets affordable, reliable and emission free power.

The concept is ZEUS, a Zero Emission Underwater Power Station, that produces electrical power by burning natural gas and pure oxygen. The combustion is done at 80bar by utilizing the well pressure. The high pressure ensures that when cooled the exhaust is liquified directly into two separate streams: one with water and one with CO₂. The CO₂ can then be re-injected directly into the same reservoir or a nearby aquifer, using a pump and not a compressor. The injected CO₂ prolongs production of existing fields and is permanently stored when the field is shut down, never leaving the seabed. The only thing leaving the seabed is a power cable. ZEUS relies on a robust oxy-fuel process that eliminates the need for costly pre-processing of the feed gas. Further, the high pressure, naturally provided at the wellhead, combined with cooling provided by the cold sea water, eliminates the need for costly post-processing of the flue gas before re-injection. And finally, the short distances from production wells to ZEUS and from ZEUS to injection wells save much on costly piping infrastructure.

ZEUS can produce emission free power from any type of natural gas. The power can then be used for offshore installations and/or be sold to any suitable onshore grid. The liquid CO₂ and water can be injected for permanent storage or utilized for Enhanced Gas Recovery (EGR) or Enhanced Oil Recovery (EOR) before being permanently stored. Note that the oxy-fuel combustion process can take up to 70% CO₂ in the feed gas which makes it especially well-suited for CO₂ rich gas fields as there are no need for costly CO₂ separation. This includes back-produced CO₂ from EGR/EOR.

By requiring only a cable to shore, ZEUS enables production of gas otherwise not economical. Doing so with no emissions makes ZEUS insensitive to increased carbon taxes or restrictions to gas import. Taken together, this makes ZEUS not only an environmentally sustainable solution, but an economical attractive solution as well. Finally, by prolonging the useful life of a field delays any costly abandoning measures. This includes opening a field for commercial CO₂ storage after oil and/or gas production has stopped even creating revenue streams from such services and/or trading in green certificates.