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EIC Fuel Gas Energy Storage White Paper

1.0 Executive Summary

The phenomenal rise of data center construction and related power demand associated with the evolution of artificial intelligence, combined grid resilience and capacity constraints is driving a massive pivot to behind-the-meter power generation. The fuel of choice is often natural gas and the rapid growth of this source combined with geopolitical and weather-related price fluctuations necessitate economical buffer storage.

EIC has developed and patented technology that permits compression of various gases to high pressures with limited temperature rise, which offers significant reduction in energy usage relative to conventional machines based on the thermodynamics of near-isothermal compression. In addition to natural gas, hydrogen or bio-mass derived fuel gases are similarly suitable for this process with applications around green steel, energy backup, or pipeline injection.

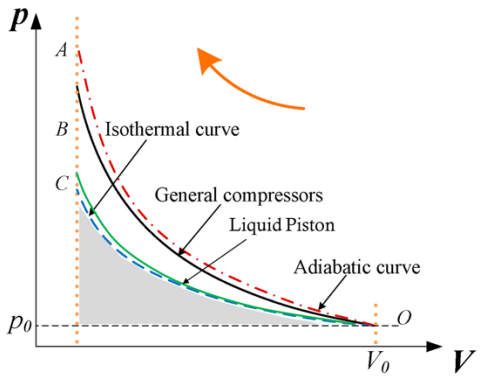
EIC offers the following additional information covering a technical discussion, potential solution sets, and opportunities for collaboration.

2.0 Technology Discussion

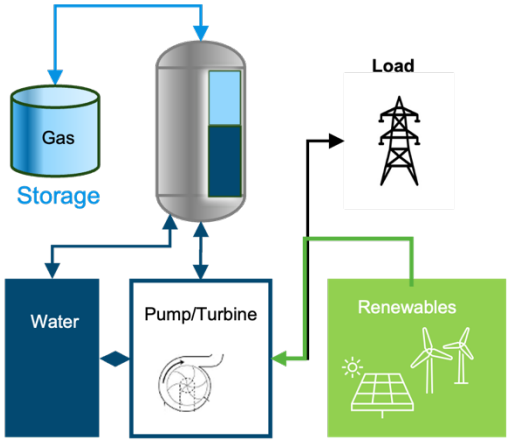
EIC has developed and patented process and equipment for compressing gases with liquid pistons that allows us to approach the theoretical limit of isothermal compression, meaning zero temperature rise from compression. The underlying thermodynamic principles are mature and well understood, and the physical components are variations of common hydromechanical and electric devices in use every day globally. Even liquid pistons have existed for a century, EIC's innovation is around assembling these components to solve a new problem.

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Principle: The essential advantage to near-isothermal compression is that by dissipating the heat of compression real-time as it is being created, more of the input energy goes to raising the gas pressure than if the heat builds up during the cycle. This can be observed in the graph of pressure and volume for isothermal (no temperature rise), near-isothermal, conventional and pure adiabatic (no heat transfer out of system) compression. The area under the P-V curve is the work (energy) that it takes to reach a certain pressure, clearly less as the process approaches isothermality (gray shaded area). This is also captured in the thermodynamic principle of exergy, or the mechanically *useful* energy that can be stored and recovered in a system like this.



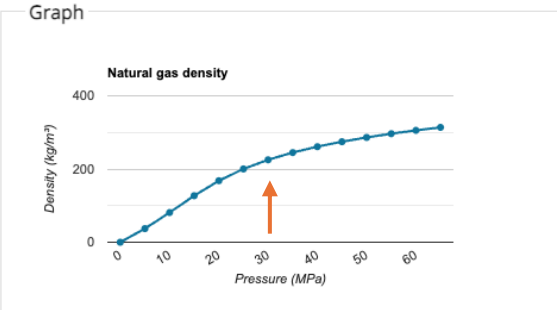
Compression: Conventional compression systems cannot dissipate heat rapidly and can only crudely emulate the process through intercoolers after each stage of compression. The same amount of heat is discarded but only after it has done its damage. Liquid pistons are the key to near-isothermality, as the liquid itself replaces a mechanical piston or rotating blade. The liquid both enables the high surface area-to-volume ratio of the compression chamber, and also helps dissipate the heat. In the liquid piston system, pumps and hydraulic intensifiers flow water at increasing pressure into closed tubular compression vessels, raising the pressure of the trapped gas as its volume reduces. With just this approach, we can perform high pressure gas compression for a variety of applications with a 20-30% energy reduction, depending on the gas, pressure and flow rate.



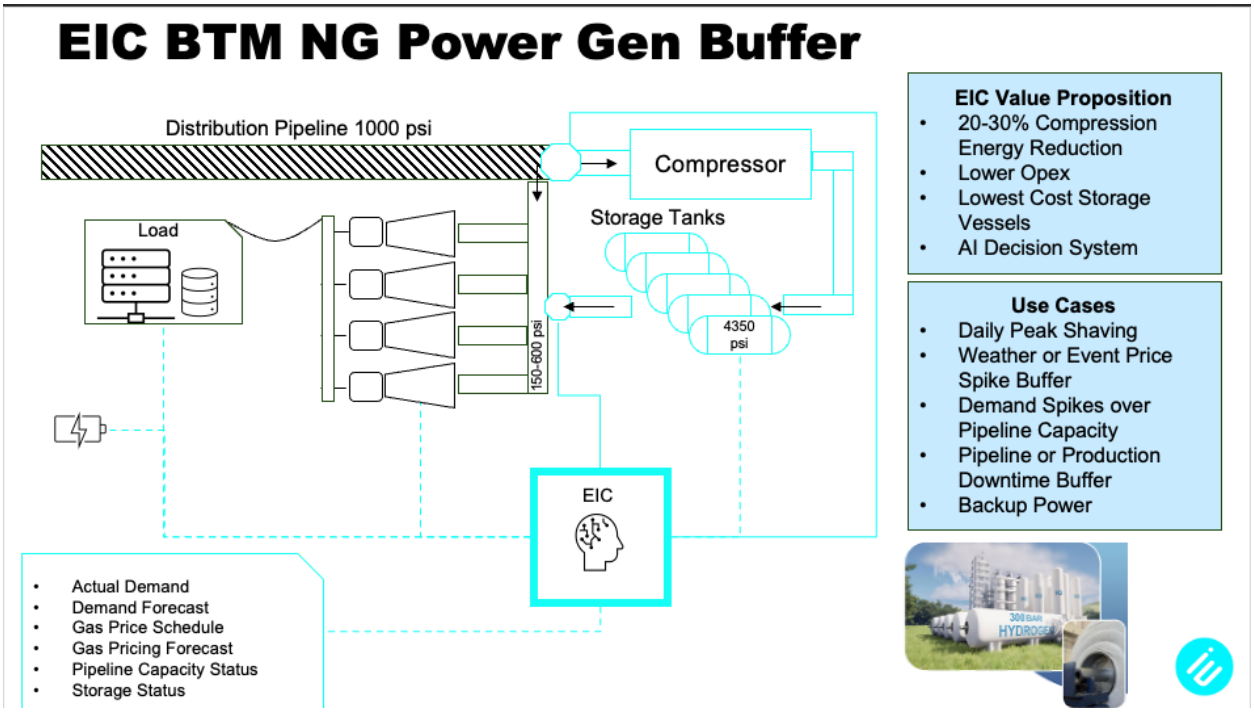
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3.0 Natural gas compression and storage

Natural gas buffer storage is an excellent application for EIC's compression process and for our partner's high-pressure high-volume storage vessels. Whether a virtual or actual pipeline is used, buffer stock will be critical to continued operation. Storing natural gas at 300 bar raises the density to reduce container volume and cost per kilogram, and EIC can provide this compression at a 30% lower energy consumption rate than conventional.

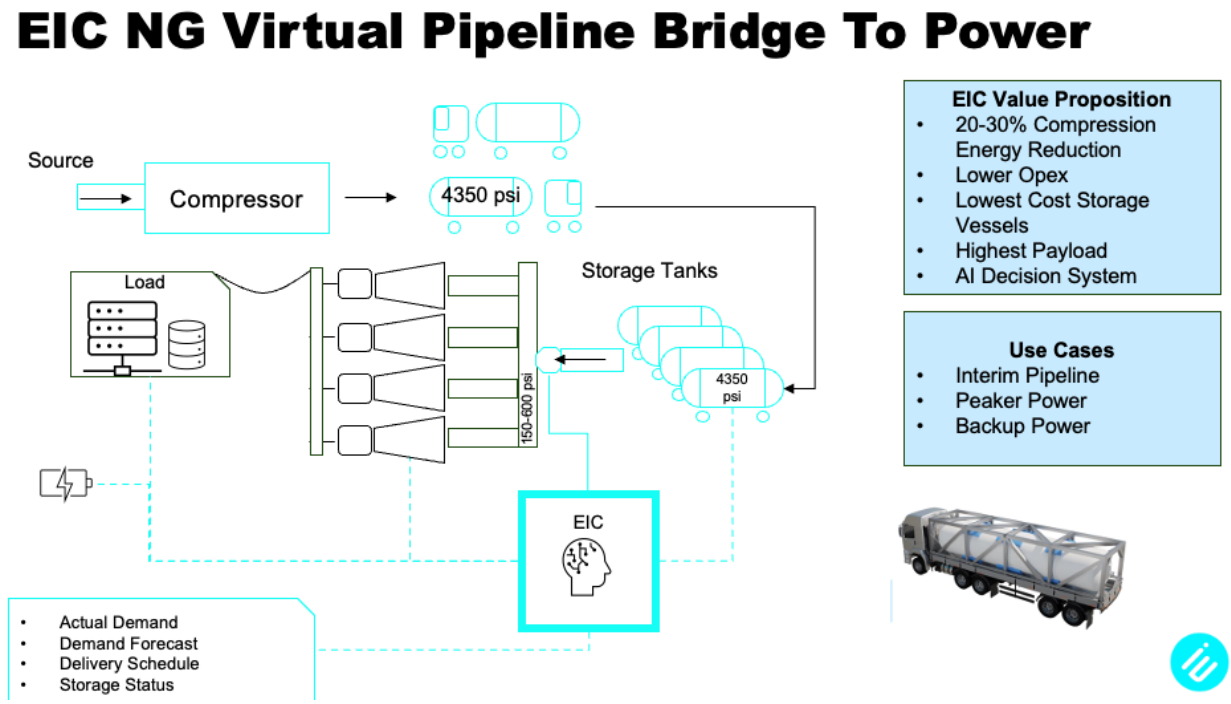


Once the pipeline is installed, the compression equipment and storage tanks can be used to store NG from the pipeline during low demand hours to provide peak buffering when demand spikes outpace pipeline capacity, an area of great interest for BTM generators and utilities alike.



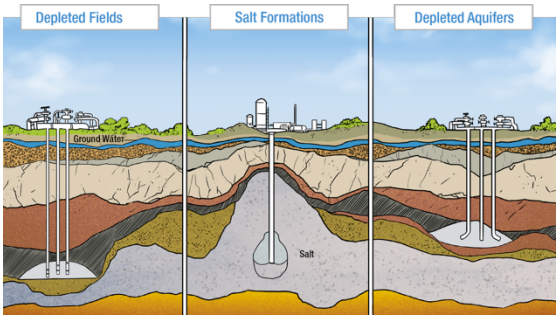
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In some cases, a virtual pipeline may be required for temporary bridging to power. The EIC compression process and our storage vessels address this challenge as well.



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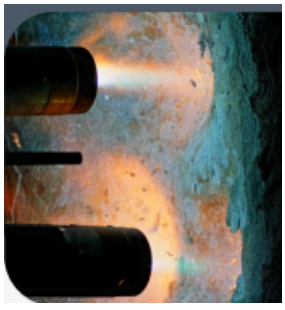
Subsurface Storage:



Because large volumes of gas may be required to store meaningful amounts of energy, storage underground in a naturally occurring feature may be considered. Depleted natural gas fields, aquifers, or other porous rock formations provide vast storage opportunities that can reach weeks of duration but are geographically limited. Depleted natural gas fields are the best candidate in that the geology is well mapped by the previous user, the integrity is proven, and the infrastructure can sometimes be re-purposed to reduce access cost. Access infrastructure cost is driven by depth, permeability, and physical shape, the latter two determining the number of bores required.

Solution mined salt beds are the most commonly used storage mechanism however they incur costs and complexities and may not be available in a specific area.

Hard rock excavations are also possible although more challenging at the depths found at the site and so are included for reference. The recent emergence of technology that uses high temperature plasma (ionized gas) to thermally disassociate any type of rock without contact or concussion provides the speed and cost of subsurface excavation to reduce the cost of these options. EIC has partnered with the IP holders for this technology.



This technique forces high-pressure compressed air through barrels in which plasma is created by high-amperage DC electricity. The exiting gas has temperatures exceeding 20,000 degrees which spalls off small pieces of rock that can be continuously evacuated to the surface for secondary uses as a concrete additive. Almost any kind of rock can be excavated with this technique, and costs are much lower than for traditional drilling as the speed is higher.

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4. Other Use Cases

A range of potential use cases is summarized below:

Compressor Applications and Economics

Applications

- Hydrogen compression for storage
- Hydrogen compression for refueling
- Hydrogen compression for Haber Bosch
- Hydrogen compression for transport

- Bio-derived gas compression for storage
- Bio-derived gas compression for pipeline
- Bio-derived gas compression for upgrade

- Syngas compression for Fischer-Tropsch
- Syngas compression for storage, transport
- Syngas hydrolysis for purification

- NG compression for storage
- NG compression for transport

- CO2 compression for separation
- CO2 compression for sequestration
- CO2 compression for resale

- Refrigeration for data center
- Refrigeration for cold storage

Comparative Economics Example

Total Cost of Ownership on NPV basis for 40-550 bar hydrogen compressor at 45kg/hr

EIC $2,360,505 OEM $3,767,577

Year	EIC				Major OEM			
	Capex	O&M	Energy	Total	Capex	O&M	Energy	Total
1	$ 800,000	$ 80,000	$ 60,000	$ 940,000	$1,100,000	$ 150,000	$ 88,000	$ 1,338,000
2		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000
3		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000
17		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000
18		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000
19		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000
20		$ 80,000	$ 60,000	$ 140,000		$ 150,000	$ 88,000	$ 238,000

37% Lower TCO at 6% WACC