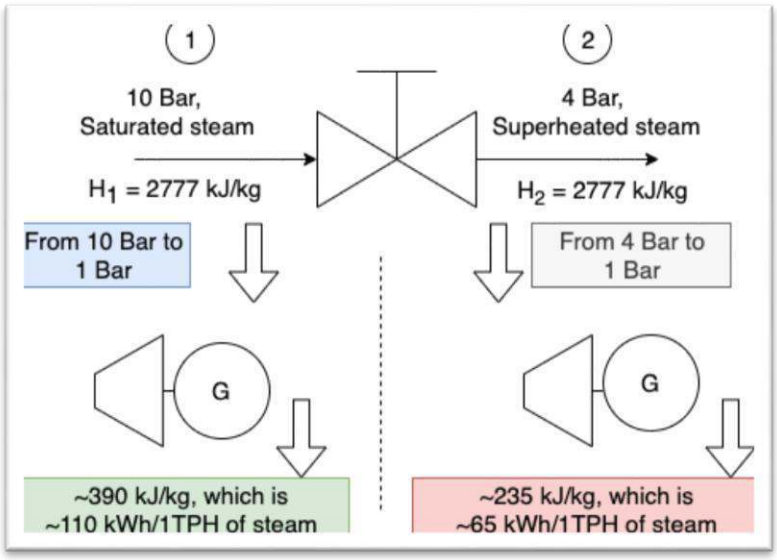
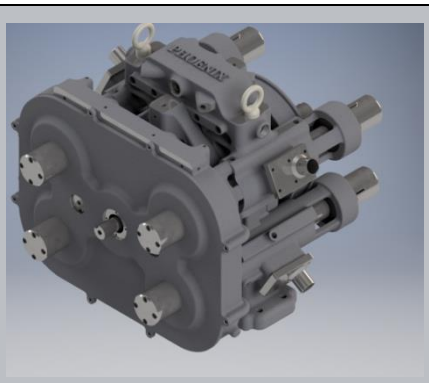
Pressure to Power (P2P) using Phoenix Steam Expander for Process Energy Efficiency

Steam generation is akin to power generation in large power plants, where the generated power is transmitted at high-voltage and stepped down at the point of use. The nature of electric power is such that the quality or ability to perform useful work like running a motor remain the same even after step-down. In the case of steam for heating applications, it is generated and transmitted at higher pressure to improve generation efficiency and to reduce the cost of transmission (pipeline cost). At the point of use, it is stepped down using a Pressure Reducing Valve (PRV). The PRV, unlike a transformer, reduces the ability of steam to do mechanical work, such as moving a turbine. For example, a 10 Bar saturated steam could produce about 110 units. But the 4 Bar steam after the PRV can only produce 65 units as the PRV has destroyed the ability of steam to produce power. Hence instead of the PRV, an energy recovery system could be used to improve efficiency of the process.



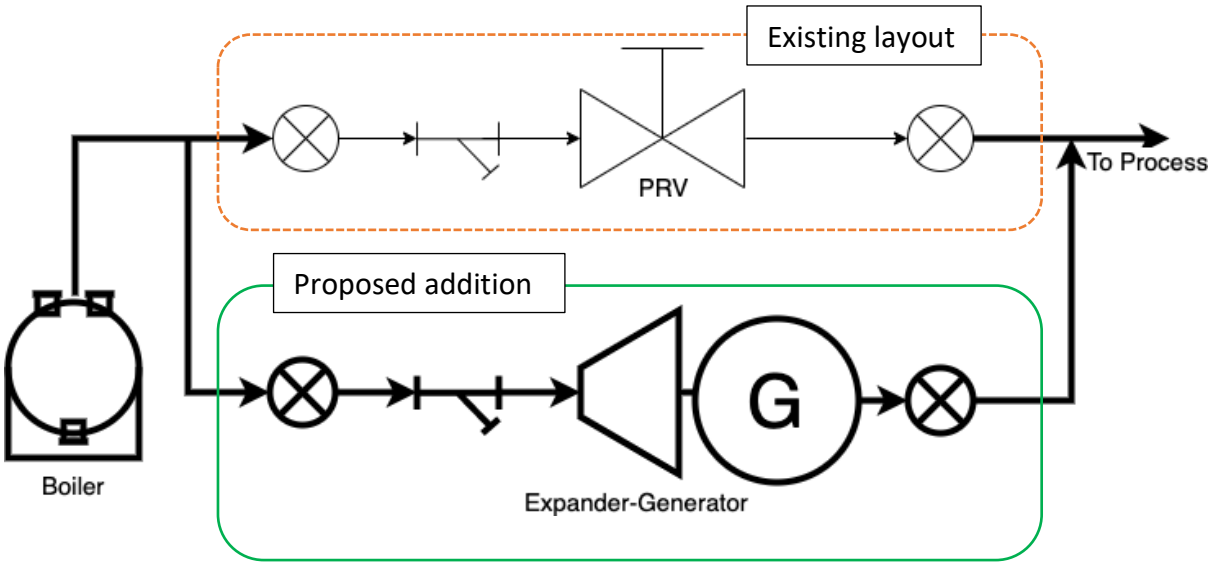
A back-pressure turbo-generator or a steam expansion to power device could be considered to recover this lost work and produce nearly free power. Turbine based generators available in the market (also known as energy conservation turbines – ECT) are available when steam flow rate through the PRV is typically over 1.5 TPH, where the power produced is about 50 kW. Though their efficiencies are typically less than 50% in smaller sizes like these. However, more than 80% of the PRV installation in India are with ratings < 2 TPH. In these situations, a turbine-based system has some difficulties in adapting to the low loads and changing loads. The following table presents a comparison between the Phoenix and other technologies available for P2P.

PARAMETERS	100% LOAD 1 TPH		75% LOAD 0.75 TPH		50% LOAD 500 KG/HR		35%LOAD 350 KG/HR	
	Phoenix	Alt. Tech	Phoenix	Alt. Tech	Phoenix	Alt. Tech	Phoenix	Alt. Tech
ADMISSION PRESSURE (BARG)	10	10	10	7.25	10	4.5	10	2.85
PROCESS PRESSURE (BARG)	3	3	3	3	3	3	3	3
POWER OUTPUT (KW)	34	21	25	12	16	3.3	10.5	-

	**Phoenix Field Trial – Pilot batch: Specifications** Rated power: 18.5 kW Pressure range: 10.5 Barg to 3 Barg Flow rate: up to 0.6 TPH RPM: 3000 Cost of pilot ~ 15 to 18 Lakhs Typical payback: < 18 months, depends on cost of electricity saved

Phoenix is the first of its kind steam expander, capable of dynamically controlling admission of steam and exhaust to ensure that process variability can be accommodated. To cater to varying loads, alternate technologies, such as turbines or screw expanders, throttle steam (as seen from first row in the table) prior to admission to expander. It helps to reduce the mass flow rate, but also reduces the available pressure difference for expansion and hence the power generation potential as well. Phoenix, however, can vary the mass flow through it without reducing the admission pressure, leading to significant performance gains.

The Phoenix expander can be integrated with minimal interruption to the process as shown in the schematic below.



Phoenix 1.0: Lab trial – Outcomes Rated power: up to 10 kW Pressure ratio: 1.2 to 4.2 Flow rate: up to 0.2 TPH RPM: 750 to 2000	

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