THE PHOENIX

Wankel Energy Systems

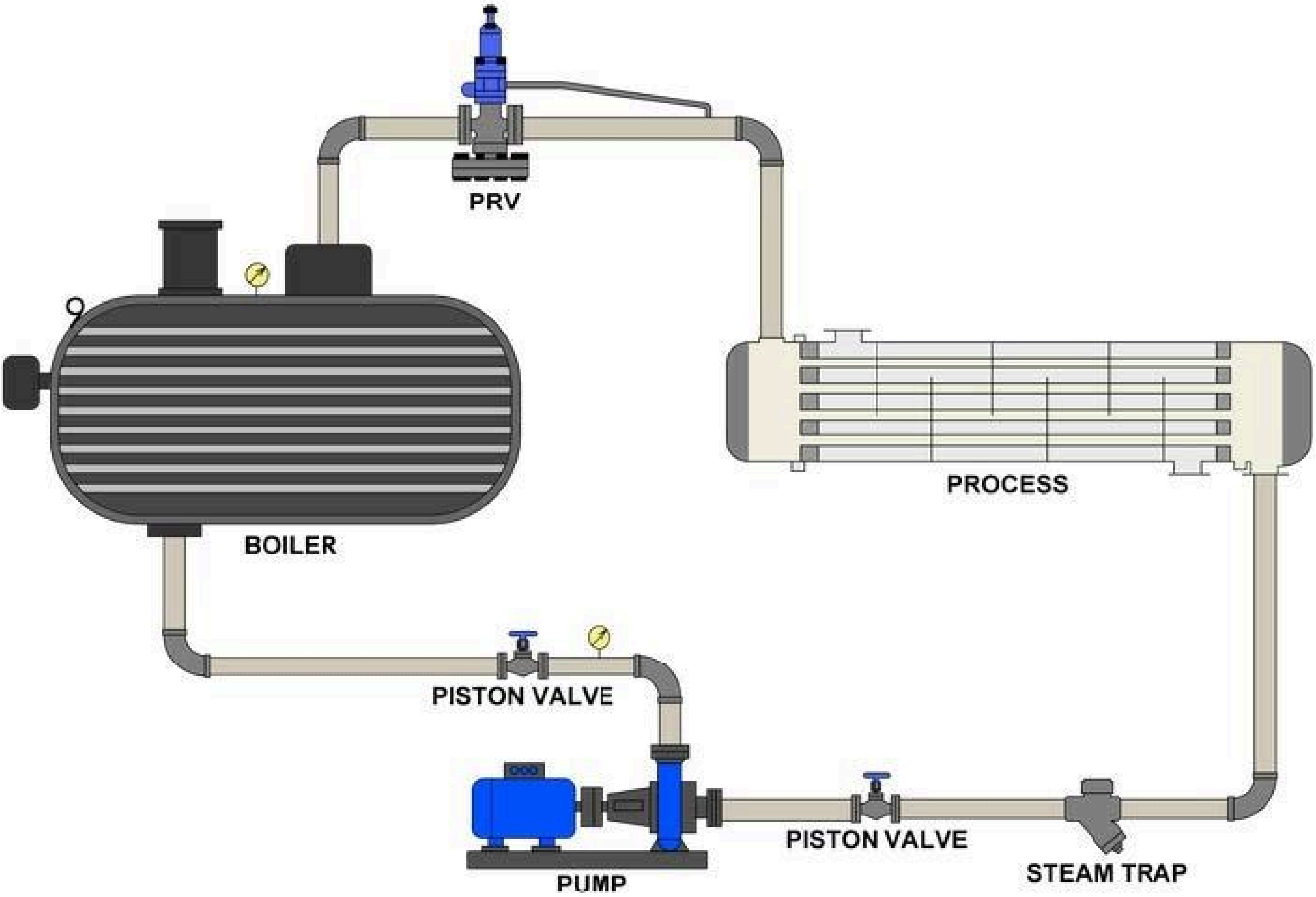
ABOUT US

At Wankel Energy Systems (WES), we challenge traditional energy methods with innovative technology rooted in first principles. Our mission is to help our customers achieve maximum efficiency and sustainability. With our flagship product, **the Phoenix** Expander, we turn wasted steam exergy into electricity, reducing grid dependence and significantly cutting carbon emissions using existing resources. As a deep-tech energy startup, we are dedicated to precision engineering and creating revolutionary products that pave the way for a more sustainable future, driven by our commitment to protecting the environment.

THE PROCESS

Process industries use pressure-reducing valves (PRV) to reduce steam pressure from its generation pressure in the boiler to usage pressure near process application.

The process in PRV is thermodynamically irreversible throttling which generates entropy leading to a reduction in the exergy of steam, i.e., a reduction in the work potential of steam due to the throttling process. This lost exergy can be recovered if expansion is done instead of throttling.

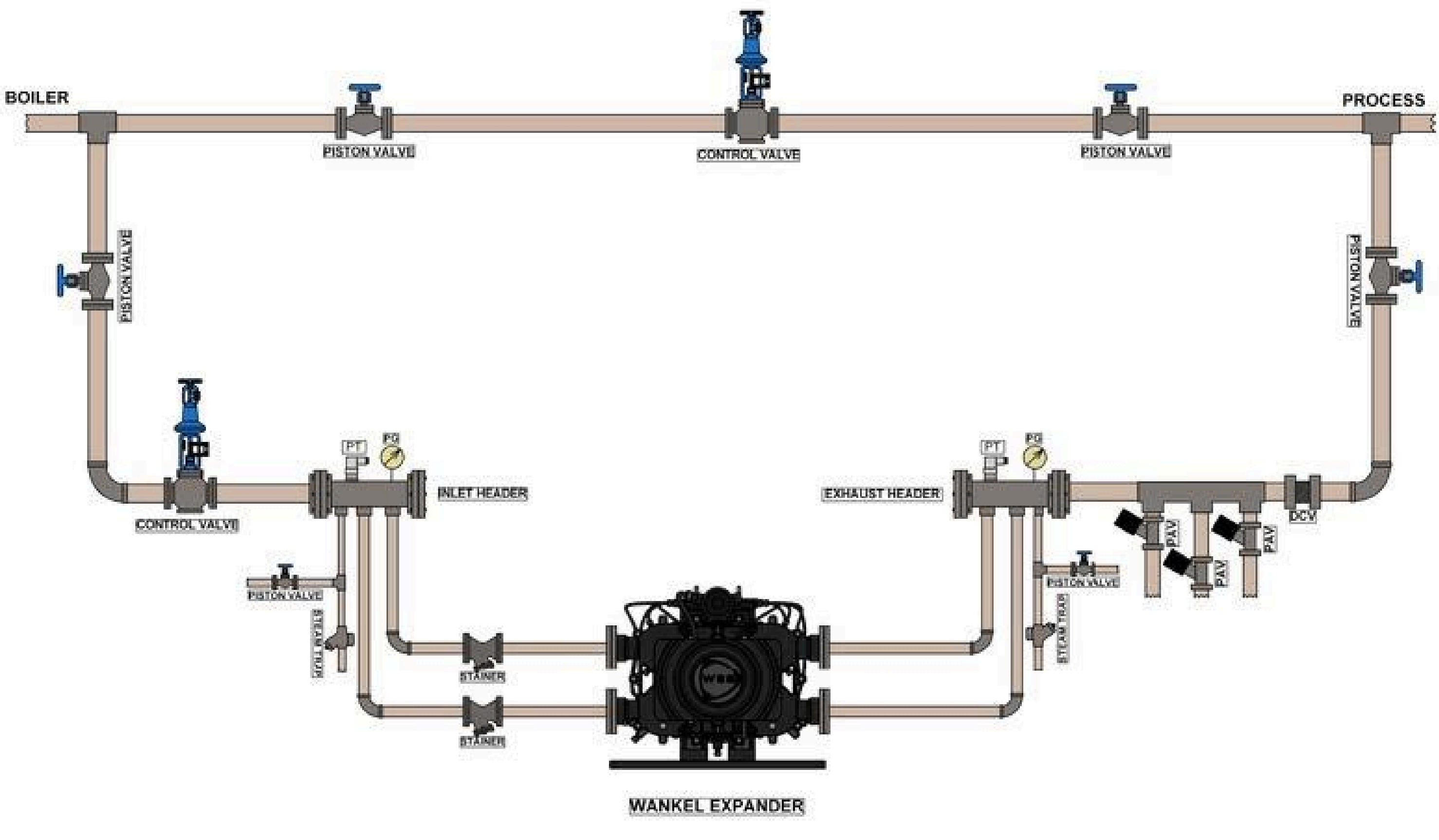


WHY DO YOU NEED AN EXPANDER?

Using turbines, especially impulse turbines, in process industries can be problematic due to erosion and poor efficiency. Commercial turbines often have compromised designs to handle erosion, leading to low peak efficiency (around 45%) and poor performance under variable loads. Process industries with saturated steam and fluctuating steam demand need part-loading capabilities, where turbines fall short.

Positive displacement expanders, like reciprocating and screw expanders, handle wet steam better due to low inlet velocity. However, while reciprocating expanders have good efficiency, they suffer from reliability issues. Screw expanders, though reliable, also struggle with poor part-load efficiency.

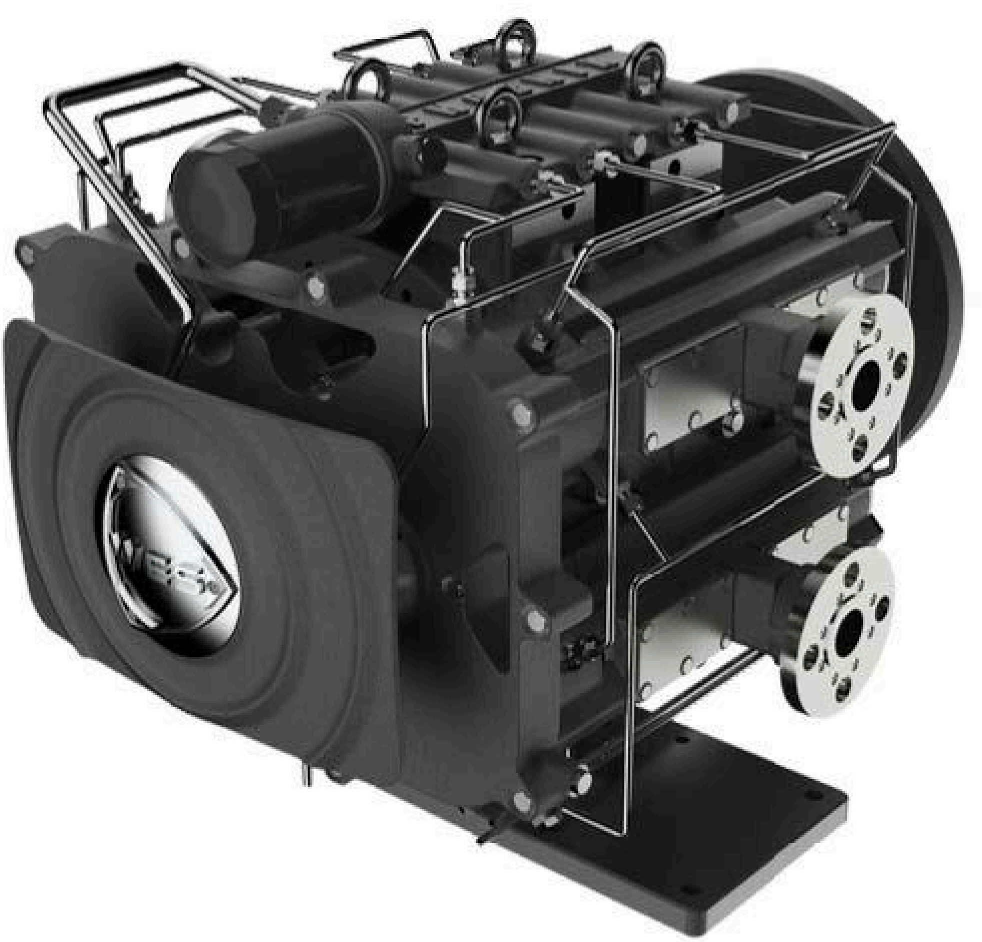
Therefore, a new expander technology is needed that offers peak efficiency, handles moisture in saturated steam, performs efficiently under part-loading conditions, is reliable, and integrates easily into existing infrastructure.



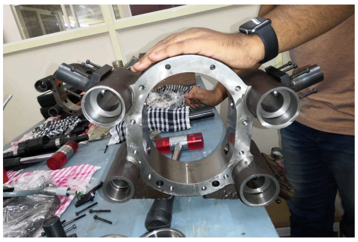
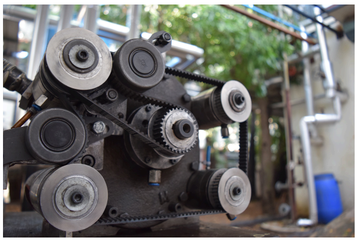
WHY DO YOU NEED "THE PHOENIX"?

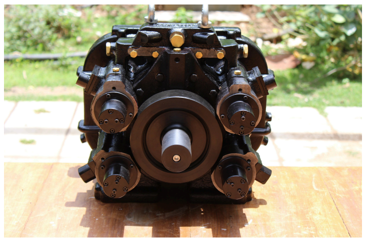
Wankel Energy Systems (WES), with the support of the EnERG (Energy & Emissions Research Group) lab at the Indian Institute of Technology Madras (IITM) and funding from the Department of Science & Technology (DST), Govt. of India, has developed "The Phoenix" expander to tackle the previously mentioned challenges.

The Phoenix features a unique innovation that enables it to achieve an average isentropic efficiency of 80% in both full-load and part-loading conditions. Compared to reciprocating expanders, the Phoenix offers enhanced reliability due to its lower number of components. Moreover, the Phoenix is roughly half the size and weight of reciprocating expanders with similar power output, making it a more efficient and compact solution. It effectively handles wet steam, has the world's best peak and part loading efficiency, and can be easily deployed into existing infrastructure with minimal cost and hassle.



OUR JOURNEY



Testing Phoenix (1st Gen)

Fabrication of modified 1st gen Phoenix
Testing of Modified 1st gen Phoenix

2016

Ideation

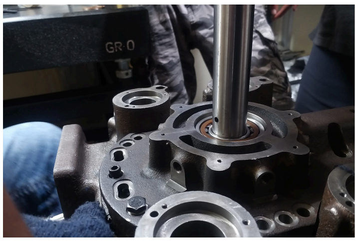
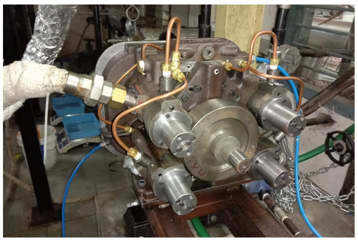
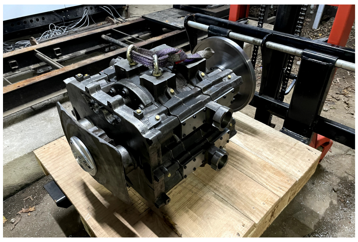
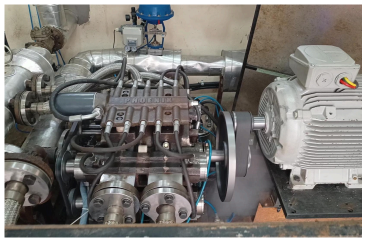
2017

1. DST Grant for POC
2. Proof of concept
3. Phoenix 1st Gen

2020

2021

DST Grant for further development & field deployment

Extensive Lab Tests of 2nd gen Phoenix

Extensive Lab Tests of field deployable Phoenix

2022

1. Start-up Incorporation
2. Multiple site visits across various sectors

2023

1. NIDHI Prayas Grant
2. Evaluation of potential deployment sites

2024

Early commercial deployments

2025

Testing of modified 3rd Gen expander and power production

OUR INNOVATION

As a deep tech energy startup, we approach problem-solving from first principles, focusing on understanding the root causes and creating simple yet effective solutions. Our Dynamic Volumetric Control™ is a prime example of this philosophy. Imagine a system that can sense variations in steam load and gather data from both the boiler and the application. This advanced technology self-adjusts to ensure maximum power output, regardless of changing conditions. Visualise the expander dynamically adapting in real-time, optimising performance and efficiency. This innovative and precise solution allows us to serve process industries globally, ensuring they achieve optimal energy efficiency and output, irrespective of their specific needs or location.

OUR PERFORMANCE

Wankel Energy Systems (WES) has developed three expanders to handle standard pressure letdown scenarios in process industries. These expanders cater to flow capacities of 1 TPH, 2 TPH, and 3 TPH, respectively. They operate with admission pressures ranging from 8.5 bar to 17.5 bar and can manage a maximum exhaust pressure of up to 6 bar. Under these conditions, the power output ranges from 20 kWe to 120 kWe.

Steam Turbines or expanders are used in process industry to capture the work potential or Exergy lost during the throttling process in pressure reducing valve (PRV).

PRV operating Conditions:

1. Inlet pressure - 10 bar(g)
2. Process pressure – 3 bar(g)
3. Steam flow variation – 0.5–4 TPH

Since there is no time series data of flow variation over a day in the PRV, let us consider a duty cycle as per the below table 1.

***Table 1**. Duty Cycle of steam flow across PRV for a day*

Steam Flow (TPH)	Duty Cycle (%)
1	15%
1.5	20%
2	25%
3	40%

Based on the above operating conditions, we arrive at the power generation capacity of turbine, other positive displacement expanders and Phoenix expander as shown in table 2. The table also shows the advantage of having a phoenix expander compared to other solutions as per the annual savings that the customer is provided.

***Table 2**. Power Generation capacity of Turbine and other expanders with throttle governing and Phoenix expander*

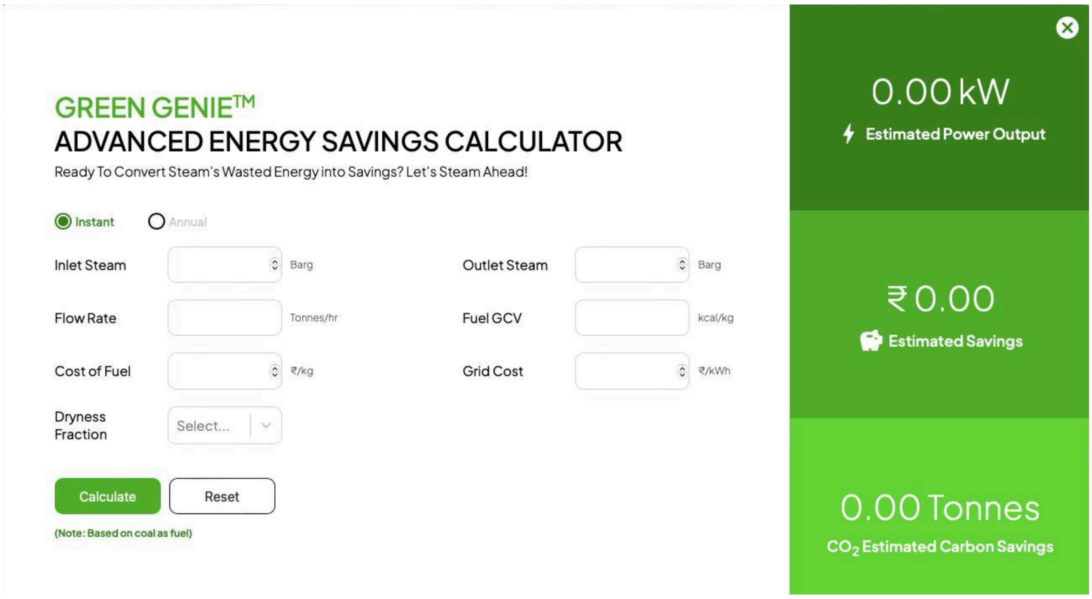
Steam Flow (TPH)	Duty Cycle (%)	Power Generated (kW)	
		Turbine With Throttle Governing	Phoenix Expander
1	15%	0	35
1.5	20%	12	52
2	25%	30	70
3	40%	83	105
Hourly Savings (kWh)		43.1	75.15
Annual Savings (kWh)		2,84,460	4,95,990
Annual Savings (Rs.)		₹ 22,75,680	₹ 39,67,920

OUR MODELS

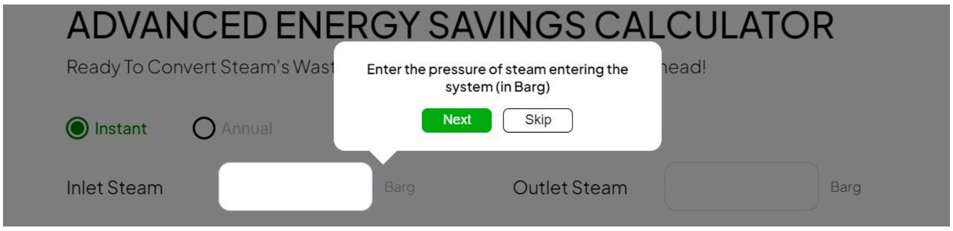
Flange connection ASA 300 BS 10 Control system Controller with HMI Electrical connection output 3 phase IP rated IP 60 Noise Level Equal to or less than 70 dB Test condition It can operate in almost all environments.

	Model 1	Model 2	Model 3
FLOW RATE	**1 TPH**	**2 TPH**	**3 TPH**
PRESSURE	**10/4 Pa**	**10/4 Pa**	**10/4 Pa**
RPM	**1500 RPM**	**1500 RPM**	**1500 RPM**
POWER	**25 KW**	**55 KW**	**100 KW**
PRIME	• Can handle flow rate unlike any other device • Can handle saturated steam • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 20%.** • Superior efficiency	• Can handle flow rate unlike any other device • Can handle saturated steam • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 20%**. • Superior efficiency	• Can handle flow rate unlike any other device • Can handle saturated steam • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 20%**. • Superior efficiency
STEPPED	• Can do exactly whatever "**Prime**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 70%**. • Superior efficiency	• Can do exactly whatever "**Prime**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 70%**. • Superior efficiency	• Can do exactly whatever "**Prime**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 70%**. • Superior efficiency
DYNAMIC	• Can do exactly whatever "**Stepped**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 100%.** • Superior efficiency	• Can do exactly whatever "**Stepped**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 100%.** • Superior efficiency	• Can do exactly whatever "**Stepped**" does • Suggestive to put this device if the established PRV's flow rate variation is between **0% and 100%**. • Superior efficiency

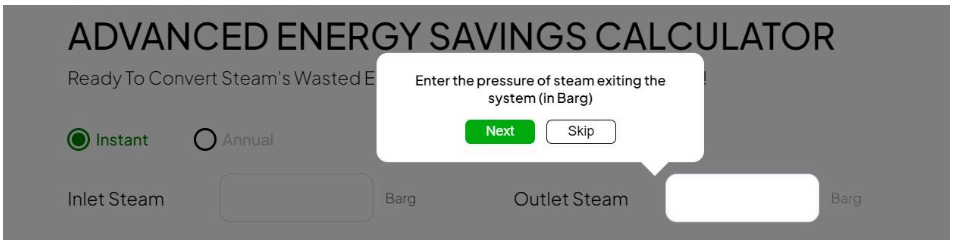
GREEN GENIE™
ADVANCED ENERGY SAVINGS CALCULATOR



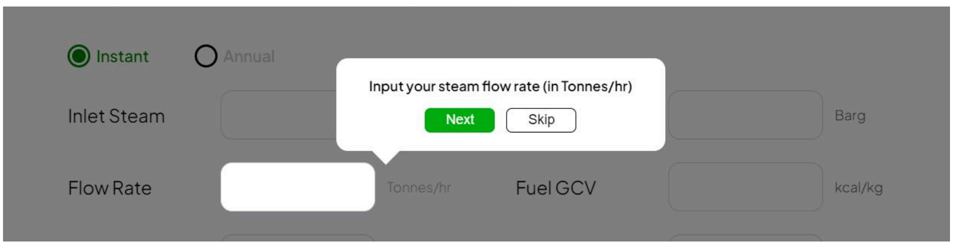
Step 1: Enter the inlet pressure



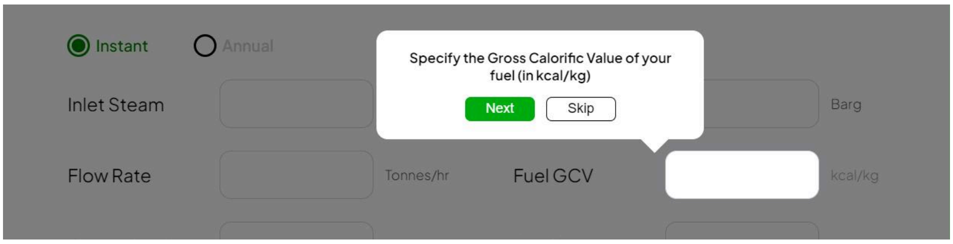
Step 2: Enter the exhaust pressure



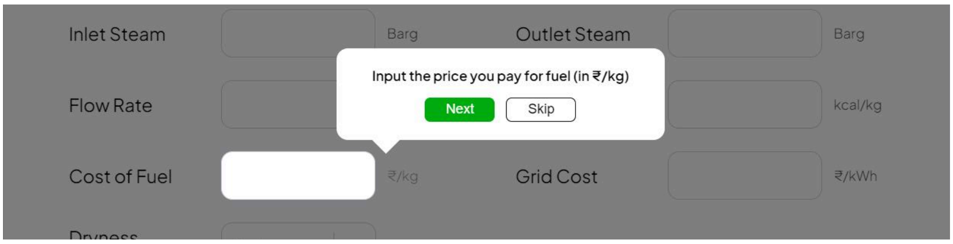
Step 3: Enter the Flow Rate



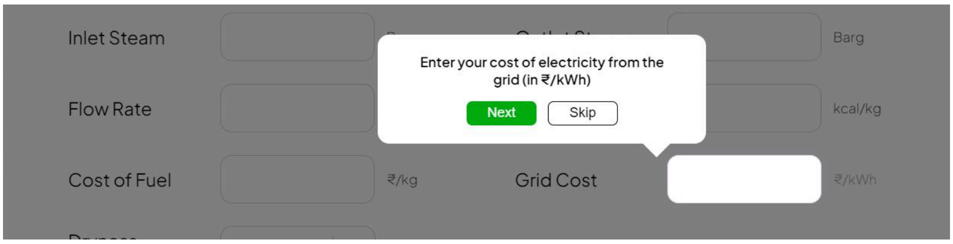
Step 4: Enter the Fuel GC



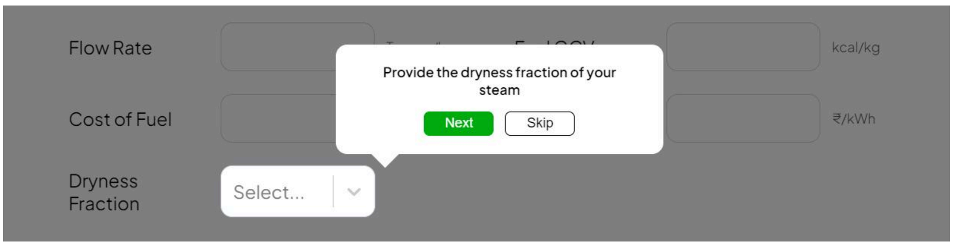
Step 5: Enter the cost of Fuel



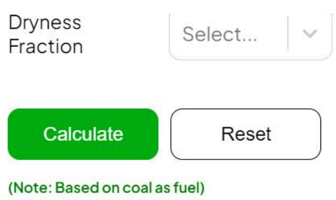
Step 6: Enter the cost of electricity



Step 7: Enter the dryness fraction of steam



Step 8: Hit calculate



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