

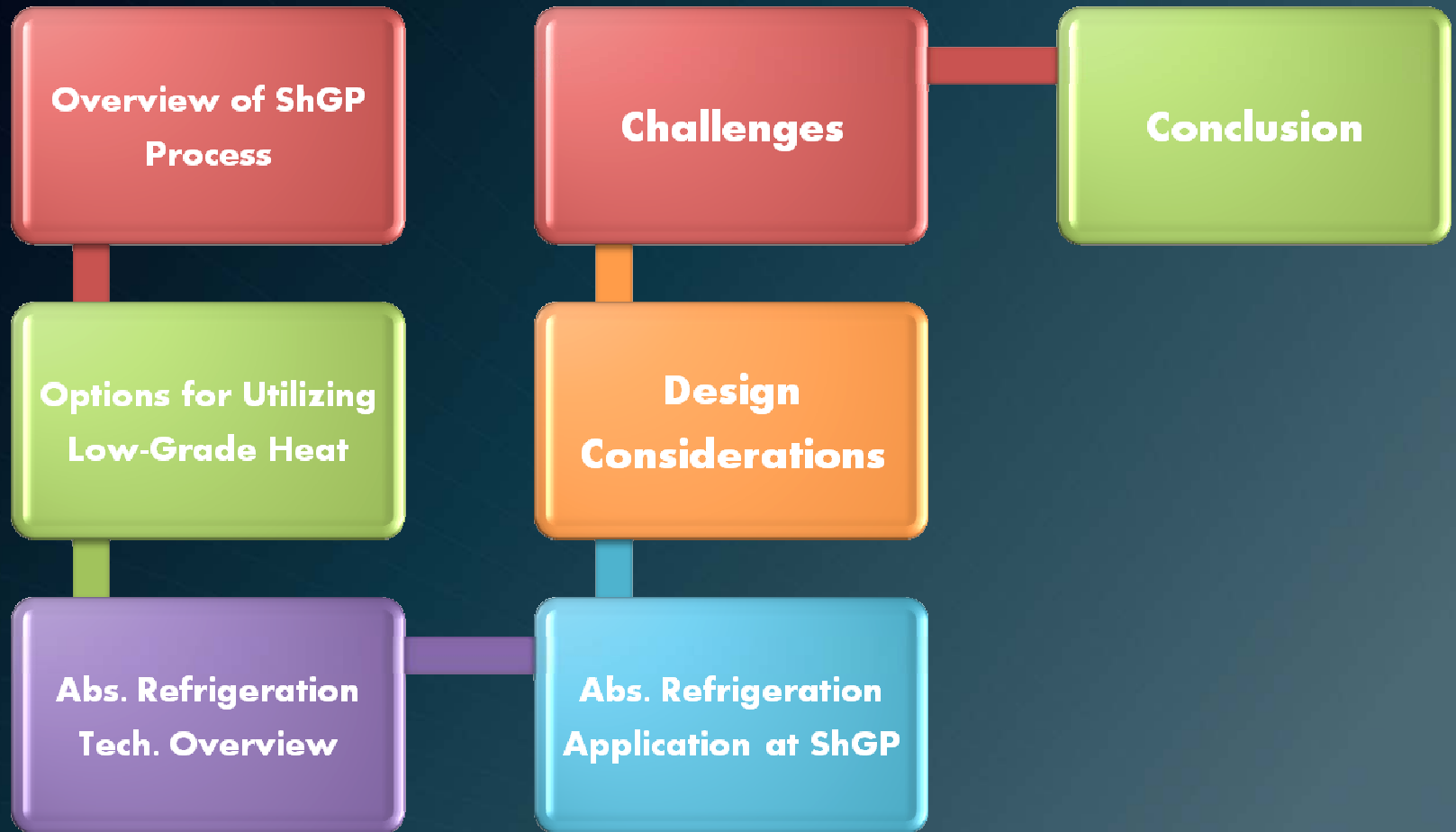
# PROCESS COOLING THROUGH ABSORPTION REFRIGERATION

BY:

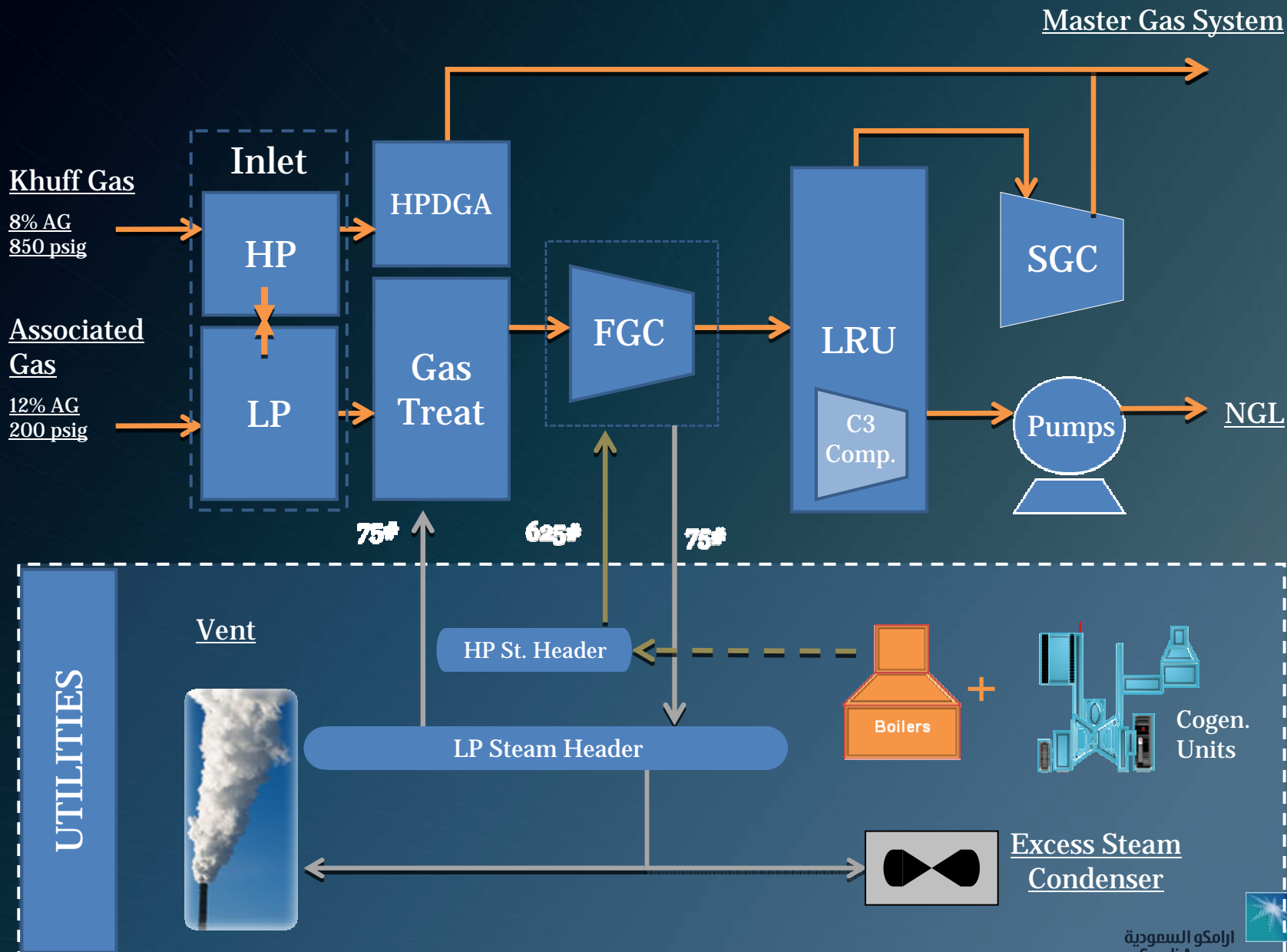
HASSAN BAAQEEL



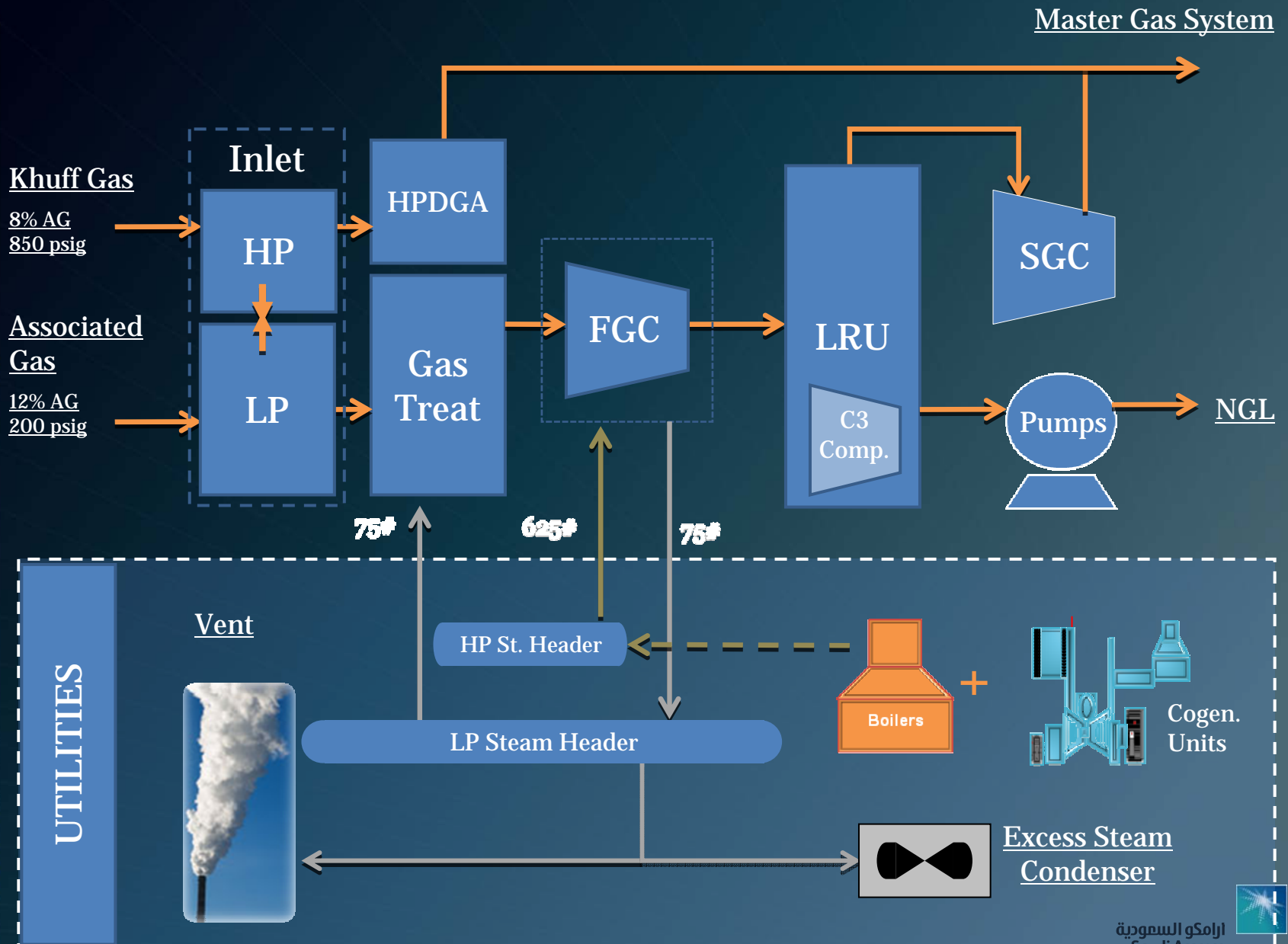
# OUTLINES



# PROCESS OVERVIEW

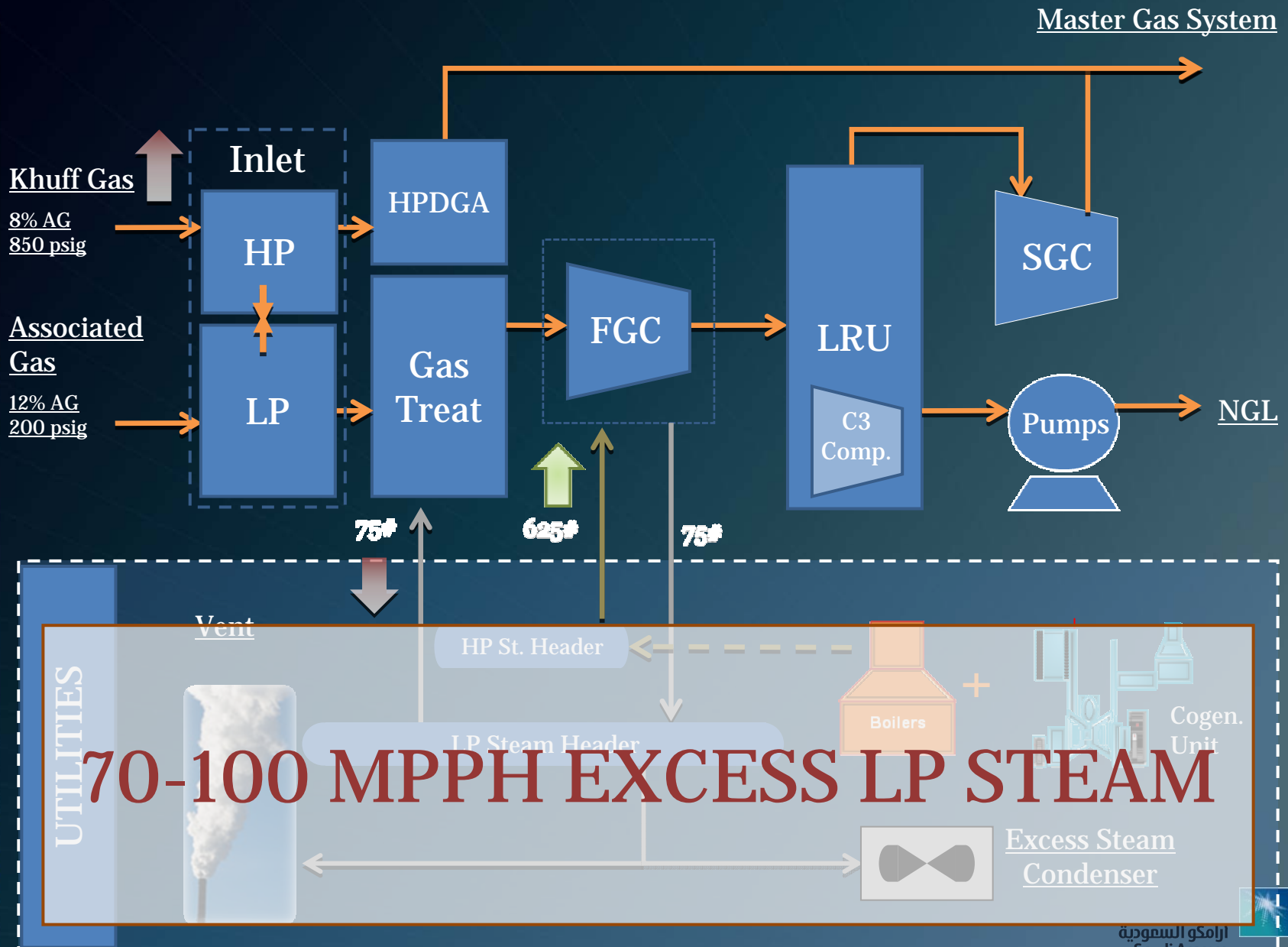


# CURRENT STATUS

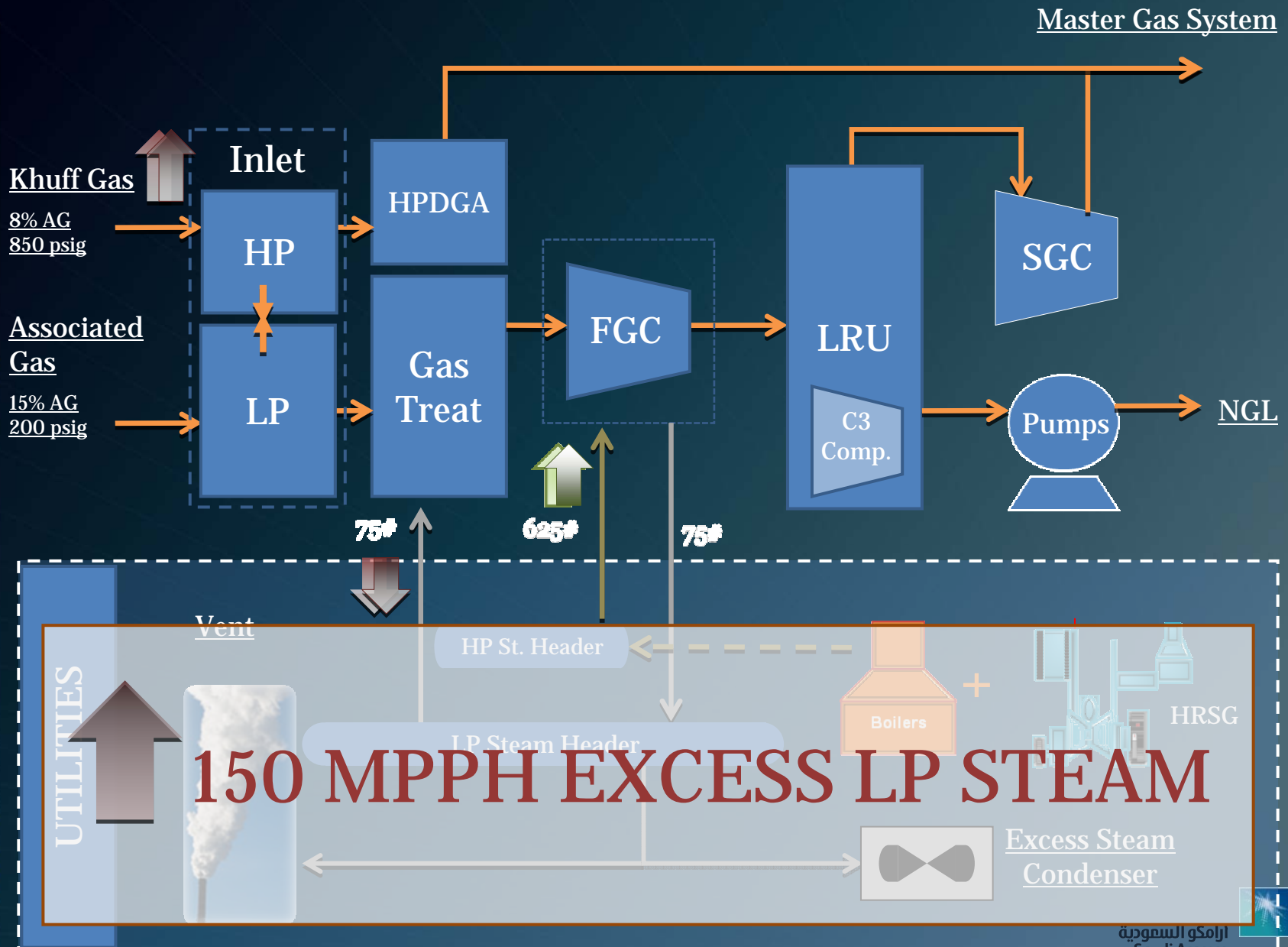




# CURRENT STATUS



# CURRENT STATUS

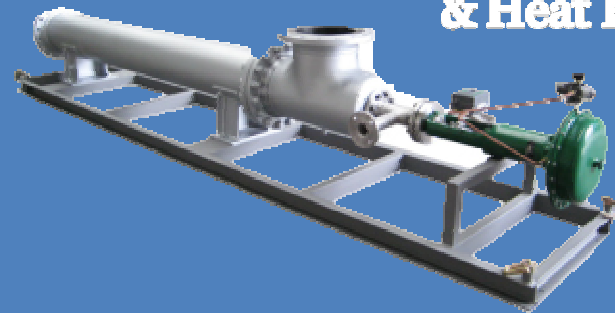


# OPTIONS FOR UTILIZING EXCESS LOW-GRADE HEAT

**Condensing Turbines**



**Thermo Compressors  
& Heat Pumps**



**Absorption  
Refrigeration  
(Chillers)**



**Pre-Heating (i.e. Boiler Feed Water)**



**Off-the-Fence Integration**

# OPTIONS FOR UTILIZING EXCESS LOW-GRADE HEAT

## Condensing Turbines



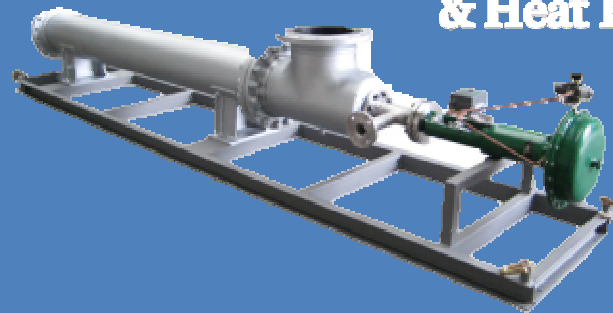
- Generate Power or Drive Equip.
- Exhaust under Vacuum using CW.
- Design Flow Limitation
- Maintainability & Reliability

# OPTIONS FOR UTILIZING EXCESS LOW-GRADE HEAT

## Condensing Turbines



## Thermo Compressors & Heat Pumps



- Use HP Steam as a Motive
- Design Challenge with the High DP Between MP & LP steam.
- Limited Pressure, Flow, & Applications.



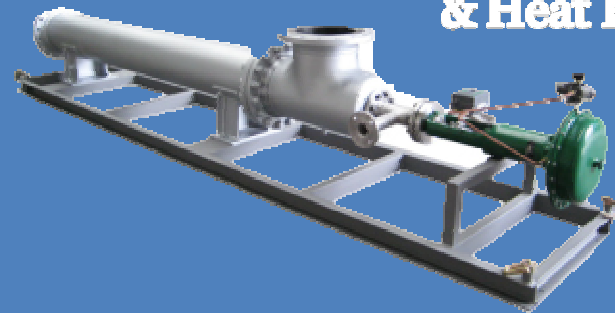
# OPTIONS FOR UTILIZING EXCESS LOW-GRADE HEAT

## Condensing Turbines

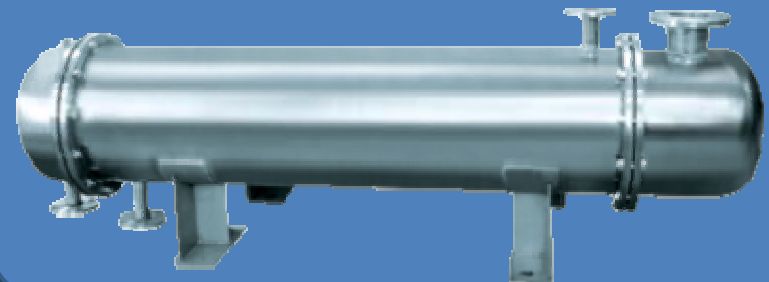


- Boiler Feed Water Heating to Reduce Boiler Fuel Consumption.
- Low Temperature Difference

## Thermo Compressors & Heat Pumps



## Pre-Heating (i.e. Boiler Feed Water)



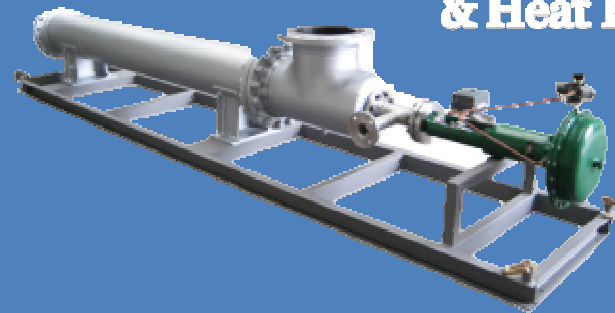


# OPTIONS FOR UTILIZING EXCESS LOW- GRADE HEAT

**Condensing Turbines**



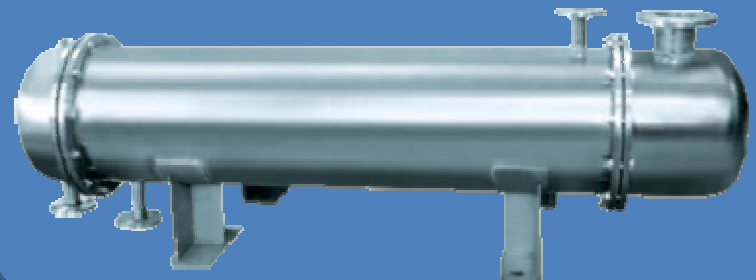
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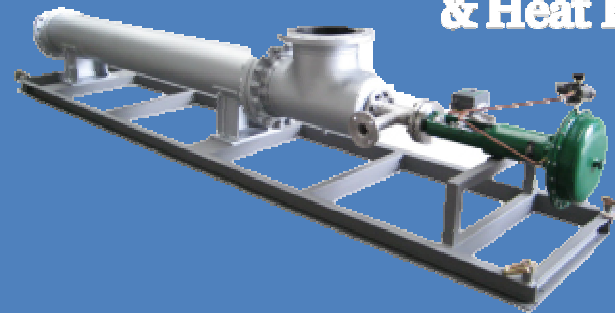


# OPTIONS FOR UTILIZING EXCESS LOW-GRADE HEAT

**Condensing Turbines**



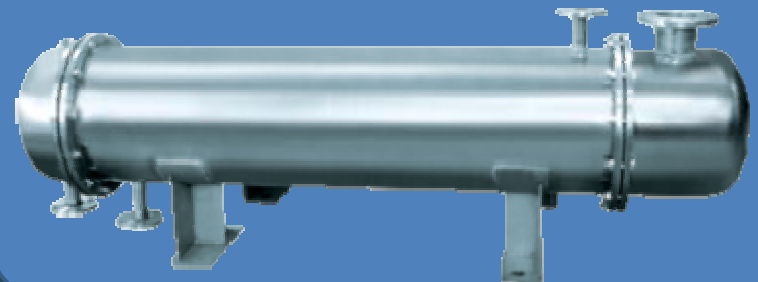
**Thermo Compressors  
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**Pre-Heating (i.e. Boiler Feed Water)**



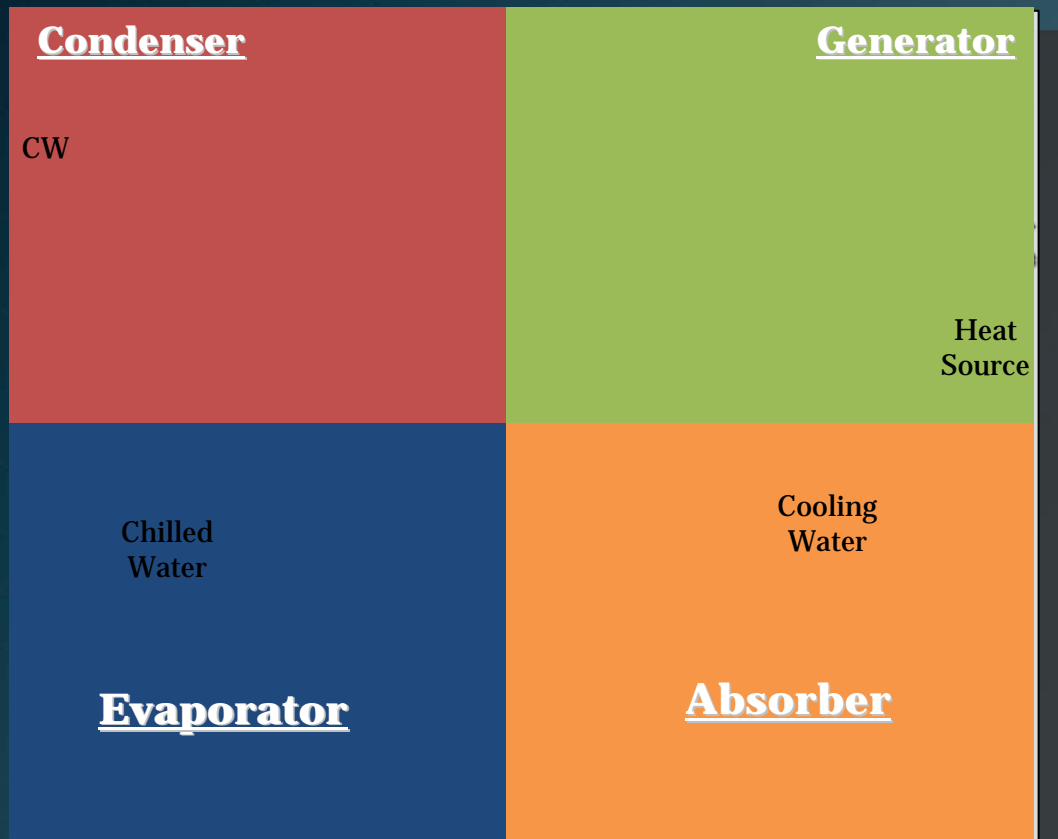
**Off-the-Fence Integration**

# ABSORPTION CHILLER TECH. OVERVIEW

THE CONCEPT

ADVANTAGES

APPLICATIONS



# ABSORPTION CHILLER TECH. OVERVIEW

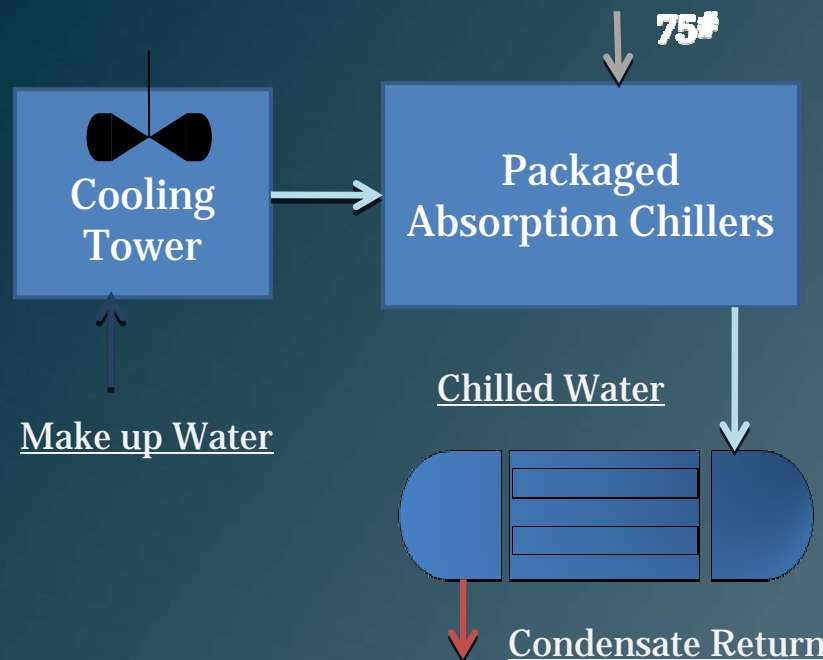
## THE CONCEPT

## ADVANTAGES

## APPLICATIONS

### System Components:

- Heat Rejection Unit (CT, HX, Aerial Cooler)
- Packaged Absorption Chillers
- Process Heat Exchangers



# ABSORPTION CHILLER TECH. OVERVIEW

## THE CONCEPT

## ADVANTAGES

## APPLICATIONS

### COMPARED TO COMPRESSION REFRIGERATION:

More Reliable with More Stationary Equipment

Little Maintenance with Less Moving Parts

Generally Cheaper Especially When Utilizing Wasted Heat

Environmental Advantages (Less Carbon Footprint)

Not Sensitive to Load Variations



# ABSORPTION CHILLER TECH. OVERVIEW

## THE CONCEPT

## ADVANTAGES

## APPLICATIONS

### Applications:

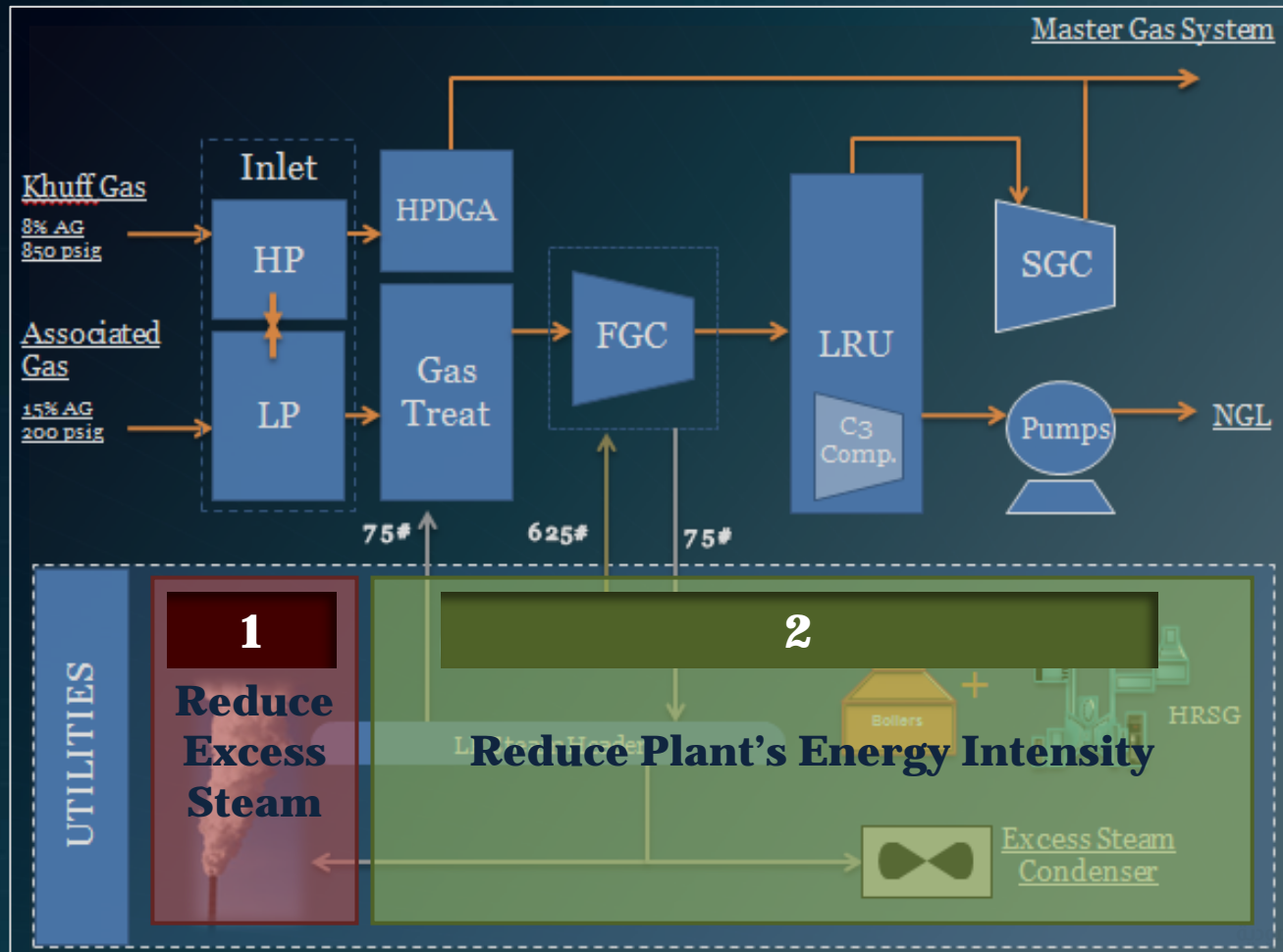
- 1.Utilization of Wasted Heat
- 2.High Power Cost Compared to Fuel
- 3.Robust & Unreliable Electrical Supply
- 4.Tri-Generation
- 5.Capturing Environmental Advantages





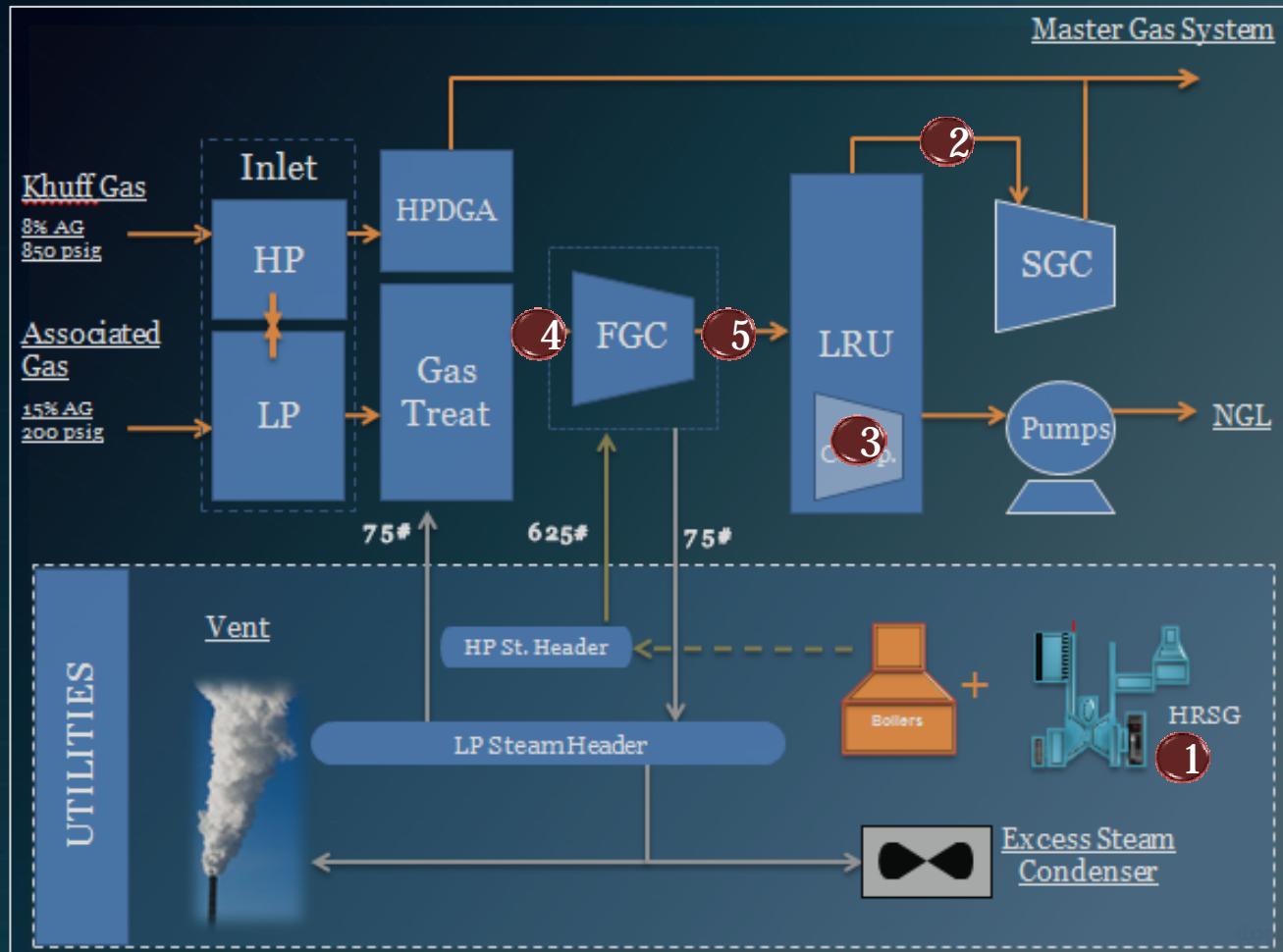
# ABSORPTION REFRIGERATION TECH. APPLICATIONS at ShGP

- Objective of Application:



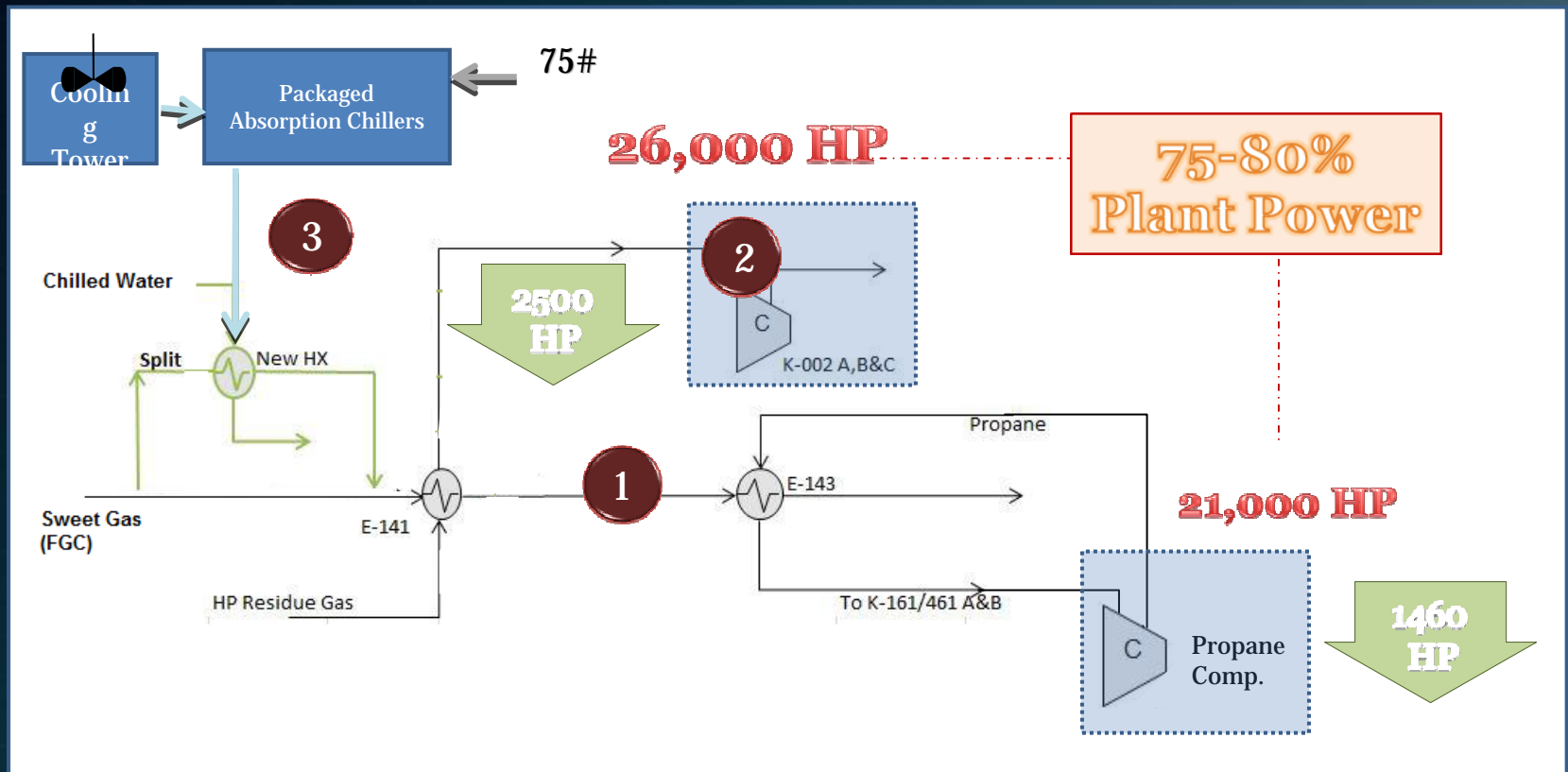
# ABSORPTION REFRIGERATION TECH. APPLICATIONS at ShGP

- 5 Potential Process Applications for Absorption Refrig.



# ABSORPTION REFRIGERATION TECH. APPLICATIONS at ShGP

- Cool Sweet Gas Using Chilled Water
- Bypasses on E-141 For Cooling Sweet Gas to SGC



# ABSORPTION REFRIGERATION DESIGN CONSIDERATIONS

**Process Limitations**

**Impact on  
Compressors**

**Selection of Refrigerant  
& Chiller Type**

- Temperature limited by Hydrate Formation
- Propane Refrigeration System Limitation:
  - High C3 Condenser Temperature

# ABSORPTION REFRIGERATION DESIGN CONSIDERATIONS

**Process Limitations**

**Impact on  
Compressors**

**Selection of Refrigerant  
& Chiller Type**

- Preliminary Evaluation Revealed a Min. Temp of 85 F
- Additional Reduction Requires Major Revamp



# ABSORPTION REFRIGERATION DESIGN CONSIDERATIONS

**Process Limitations**

**Impact on  
Compressors**

**Selection of Refrigerant  
& Chiller Type**

- Double Effect Design is Pressing for the Following:
  - Reduce Heat Rejection requirement
  - Reduce Make Up Water
- LiBr Provides Sufficient Chilled Water Temperature





# ABSORPTION REFRIGERATION CHALLENGES

- Huge Heat Rejection
- Excessive Makeup Water
- Seasonality & Other Limitations
- Humidity & Elevations
- Economically Challenged

# CONCLUSION

- Promising Technology for Facilities with Excess LP Heat Source
- Economically Challenged in Deserted Areas
- Path Forward:
  - Alternative Heat Sinks
  - Further Evaluation of All Applications
  - Value Engineering & Higher Capital Efficiency