Optimum Design and Operation of Complex Steam Systems at Oil & Gas Industries Through Combined Heat and Power Optimization Model

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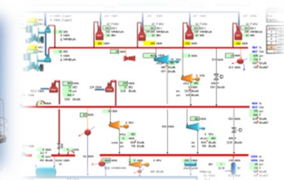

where energy is opportunity

Outline:

- Overview of CHP Models
- Optimum Operation of CHP Systems
- Optimum Design of CHP Systems
- Conclusion

Overview: Combined Heat & Power Optimization Model

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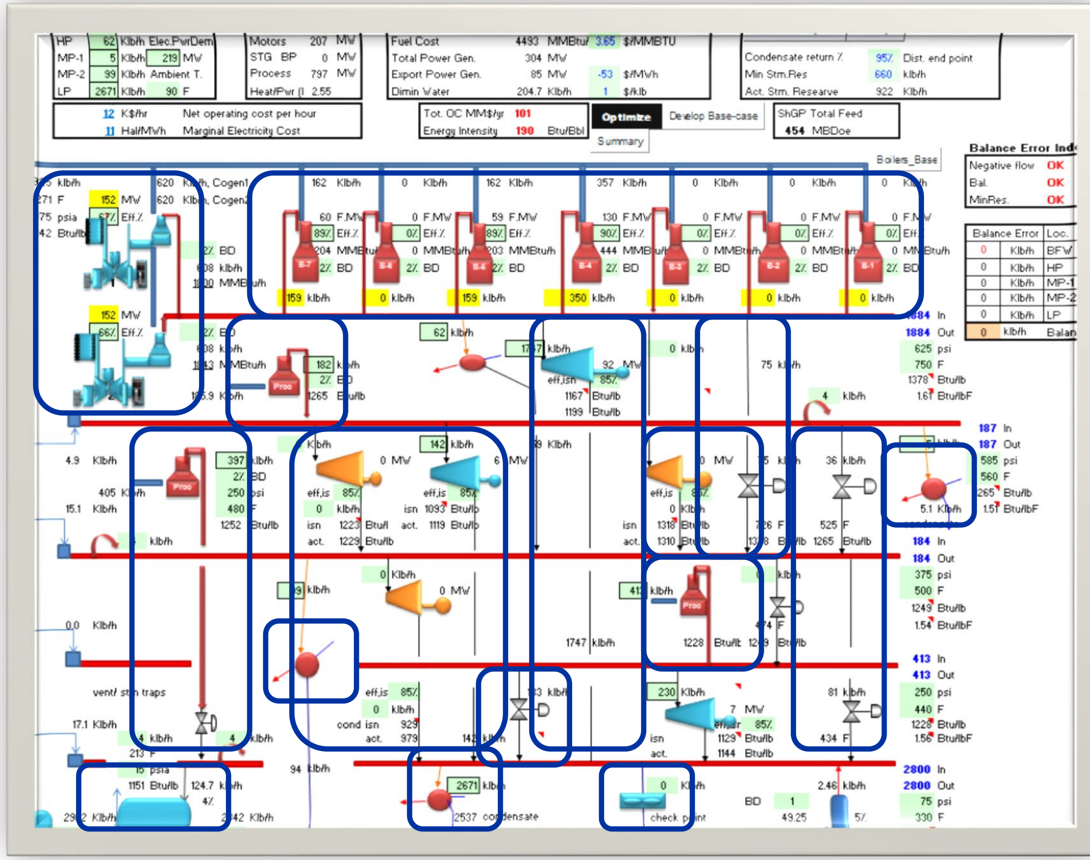
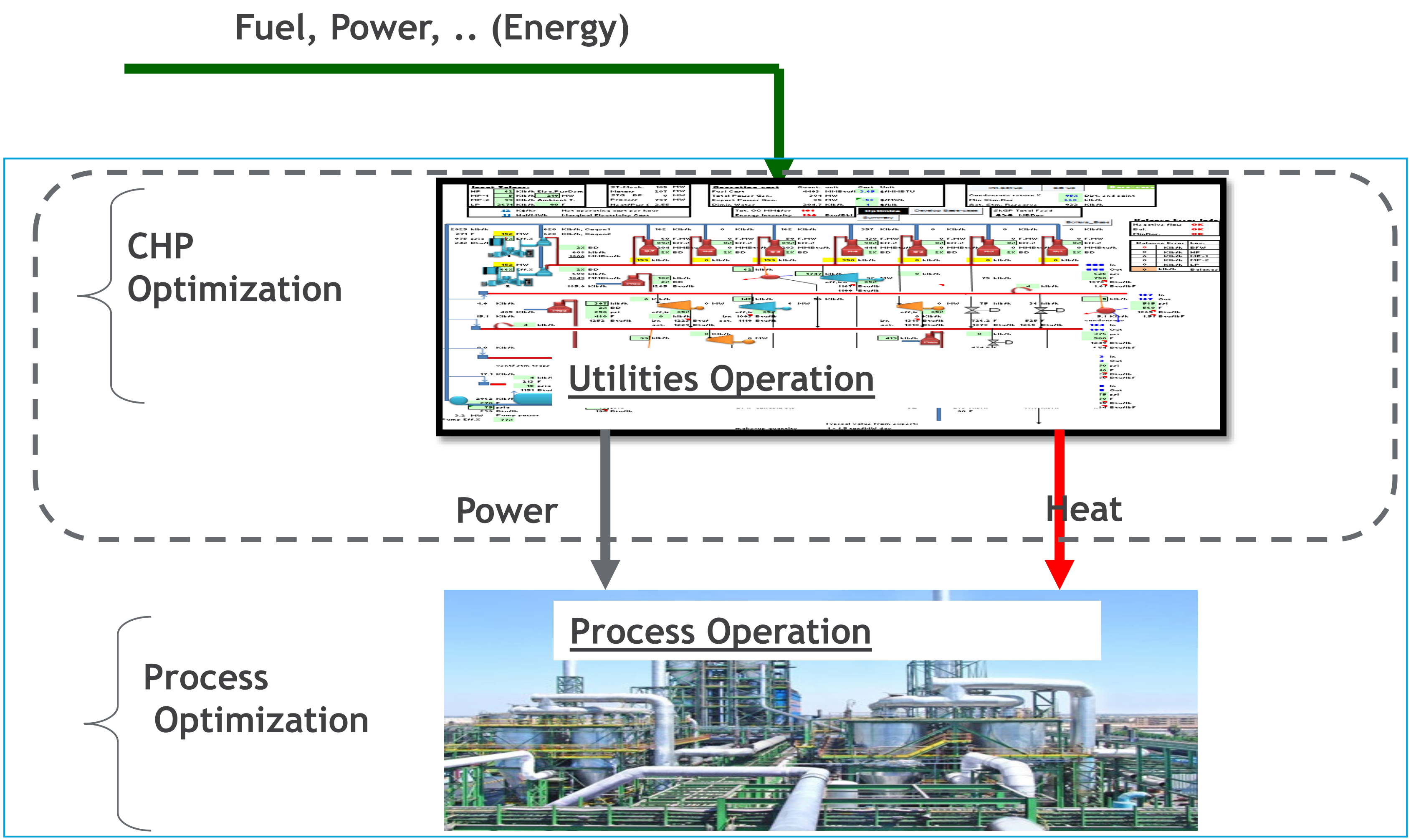
Introduction: Combined Heat & Power Optimization Model

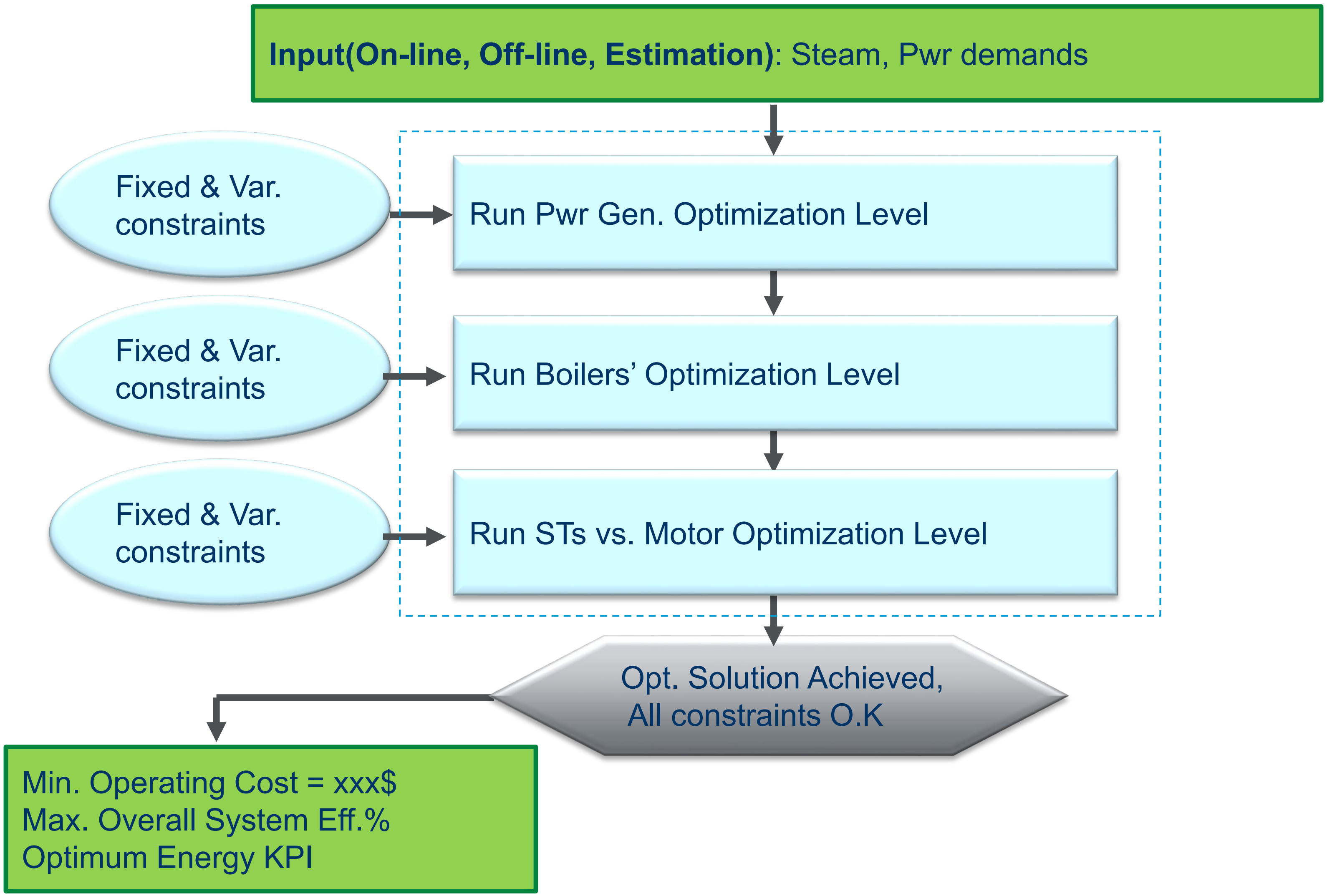
- Boilers
- Cogeneration Units
- Process Steam Generators
- Steam Turbines
- Motors Switchable to STs
- Steam users
- Power users
- Steam System Network
- Letdowns/De-super-heater
- Fin-Fan Condensers
- Deaerator
- Condensate system



Introduction: Combined Heat & Power Optimization Model



Overview: Combined Heat & Power Optimization Model



Optimum Operation of CHP Systems

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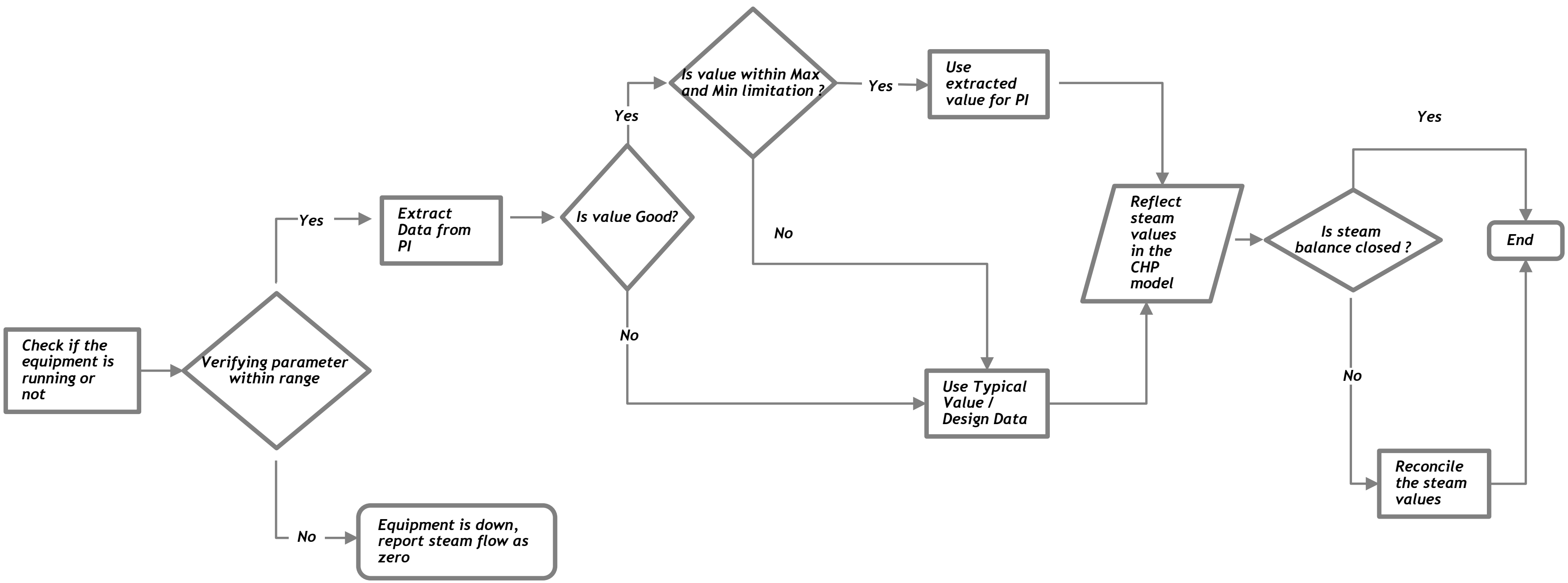
Optimum Operation of Steam and Power Systems

The real time (online) CHP model is taking real time data from the PI system to advise improvement in energy system operation

- Simulating actual CHP operation of the facilities
- Providing real-time advisory recommendations to reduce operating cost and improve system efficiency through:
  - Maximize Cogeneration units.
  - Boiler Load Management
  - Steam Turbine & Motor Switching
  - Minimize Excess Steam
- A tool that helps the user to proactively monitor and optimize operations

Optimum Operation of Steam and Power Systems



Case Study: Optimum Operation of Steam and Power Systems

- Start time: 7/16/2019 11:00:00 AM
- End Time: 7/16/2019 12:00:00 PM

Maximize Cogeneration units

Cogen Units	Actual load %	Optimized Load %
Unit 1	96	100
Unit 2	91	100
Unit 3	96	100
Unit 4	98	100

Boiler Load Management

Boiler #	Actual stm (klb/h)	Optimized stm (klb/h)
Boiler # 1	0	0
Boiler # 2	260	188
Boiler # 3	255	188

Steam Turbine & Motor Switching

Service	Equipment	Type	Actual Status	Optimized Status
SRU-100 Air Blowers	KT-101A	Turbine	ON	ON
	KT-101B	Turbine	ON	ON
	KT-101C	Motor	OFF	OFF
SRU-200 Air Blowers	KT-201A	Turbine	ON	ON
	KT-201B	Turbine	ON	ON
	KT-201C	Motor	OFF	OFF
SRU-300 Air Blowers	KT-301A	Turbine	ON	ON
	KT-301B	Turbine	ON	ON
	KT-301C	Motor	OFF	OFF
SRU-400 Air Blowers	KT-401A	Turbine	ON	ON
	KT-401B	Turbine	ON	ON
	KT-401C	Motor	OFF	OFF

Optimum Operation of Steam and Power Systems

Design Mode | Active Mode

Online Utility Advisory Tool

16-Jul-19

Model Updateing Steps

1- Update PI readings to Live reading

2- Reflect the PI readings to the CHP model

3- Close the balance of the CHP model

4- Optimize the operation

Actual Operating Cost (MM$/Year)	Optimized Operating Cost (MM$/Year)	Potential Saving (MM$/Year)
44.67	43.45	1.22

Co2 Emissions (K Ton/yr)

Actual	1535
Optimized	1473

Excess Stm (Klb/h)

Actual	149
Optimized	156

Cogens' Load

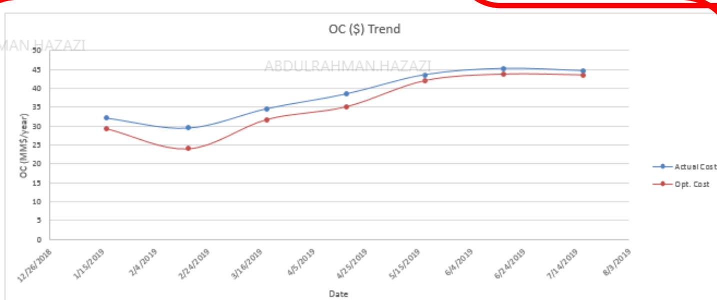
Boiler #	Optimized Load	Actual Load
Cogen #1	100%	95%
Cogen #2	100%	91%
Cogen #3	100%	95%
Cogen #4	100%	98%

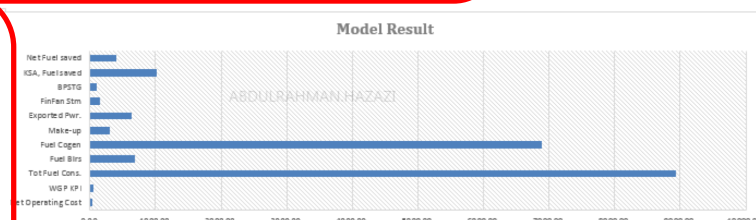
Boilers' Load

Boiler #	Optimized Load	Actual Load
Boiler #1	0	0
Boiler #2	188	260
Boiler #3	188	255
Fuel saving	186	MSCFH

Swtichability Summary

Service	Equipment	Type	OptimizedStatus	Actual Status
SRU-100 Air Blowers	KT-101A	T	ON	ON
	KT-101B	T	ON	ON
	KT-101C	M	OFF	OFF
SRU-200 Air Blowers	KT-201A	T	ON	ON
	KT-201B	T	ON	ON
	KT-201C	M	OFF	OFF
SRU-300 Air Blowers	KT-301A	T	ON	ON
	KT-301B	T	ON	ON
	KT-301C	M	OFF	OFF
SRU-400 Air Blowers	KT-401A	T	ON	ON
	KT-401B	T	ON	ON
	KT-401C	M	OFF	OFF





	Net Operating Cost	WGP KPI	Tot Fuel Cons.	Fuel Blrs	Fuel Cogen	Make-up	Exported Pwr.	FinFan Stm	BPSTG	KSA, Fuel saved	Net Fuel saved
Model Result	43.45	59.70	8933.28	683.15	6893.94	294.51	626.53	155.72	98.47	1011.84	397.26

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Optimum Design of Steam and Power Systems

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Capital Modifications

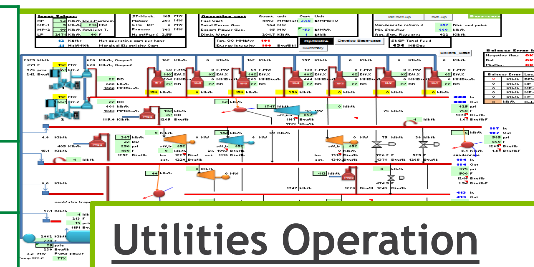
Optimum Design- Grassroot

1. Identify the best configuration of steam system network (number of headers)
2. Identify the optimum number and sizes of boilers, cogeneration units
3. Identify the optimum number and sizes of steam turbines and motors drivers
4. Consider key reliability constraints (design /operation)
5. Evaluate key alternatives based on efficiency and economics

Case Study: Optimum Design of Combined Heat & Power System

Facility Energy Demand		Value	Unit
Power Demand		200	MW
Steam Demand		1200	Klb/h
Steam Reserve Available	>=	One Unit	
Overall System Eff%	>=	70%	

Utility Design Configuration:
1. Boilers and Steam Turbines
2. Cogen and Steam Turbines
3. Cogen and Boilers and Steam Turbines



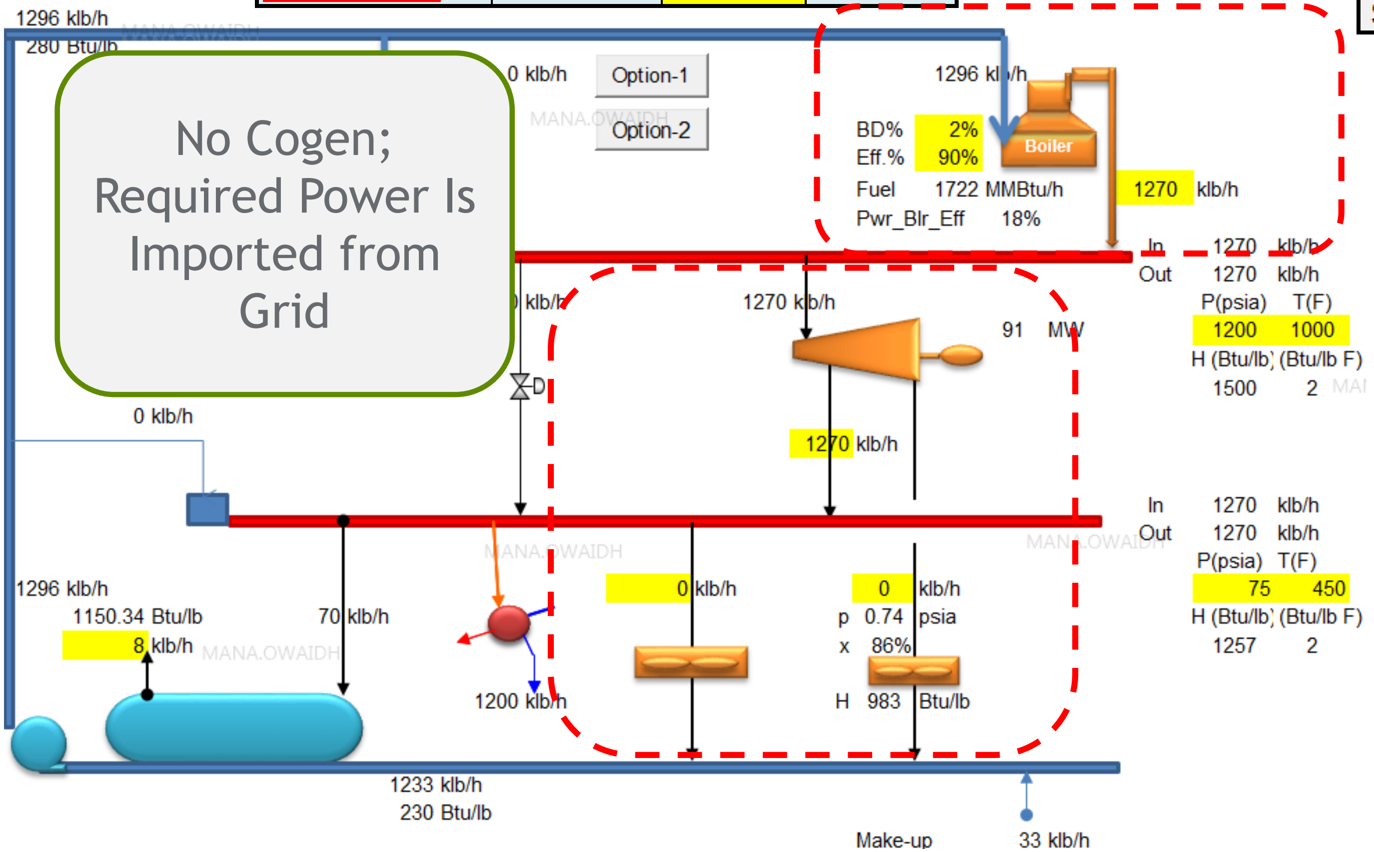
CHP System Thermal Efficiency- “Boilers Configuration”

** Input

Steam Demand	LP	1200	Klb/h
Required Pwr	MW	200	MW

Net Pwr	MW	91
Fuel	(MMBtu/h)	1722
SEC Fuel	(MMBtu/h)	691
Systm	Eff.%	64%
	Cogen %	Boilers
Scenario	0%	100%

No Cogen; Required Power Is Imported from Grid



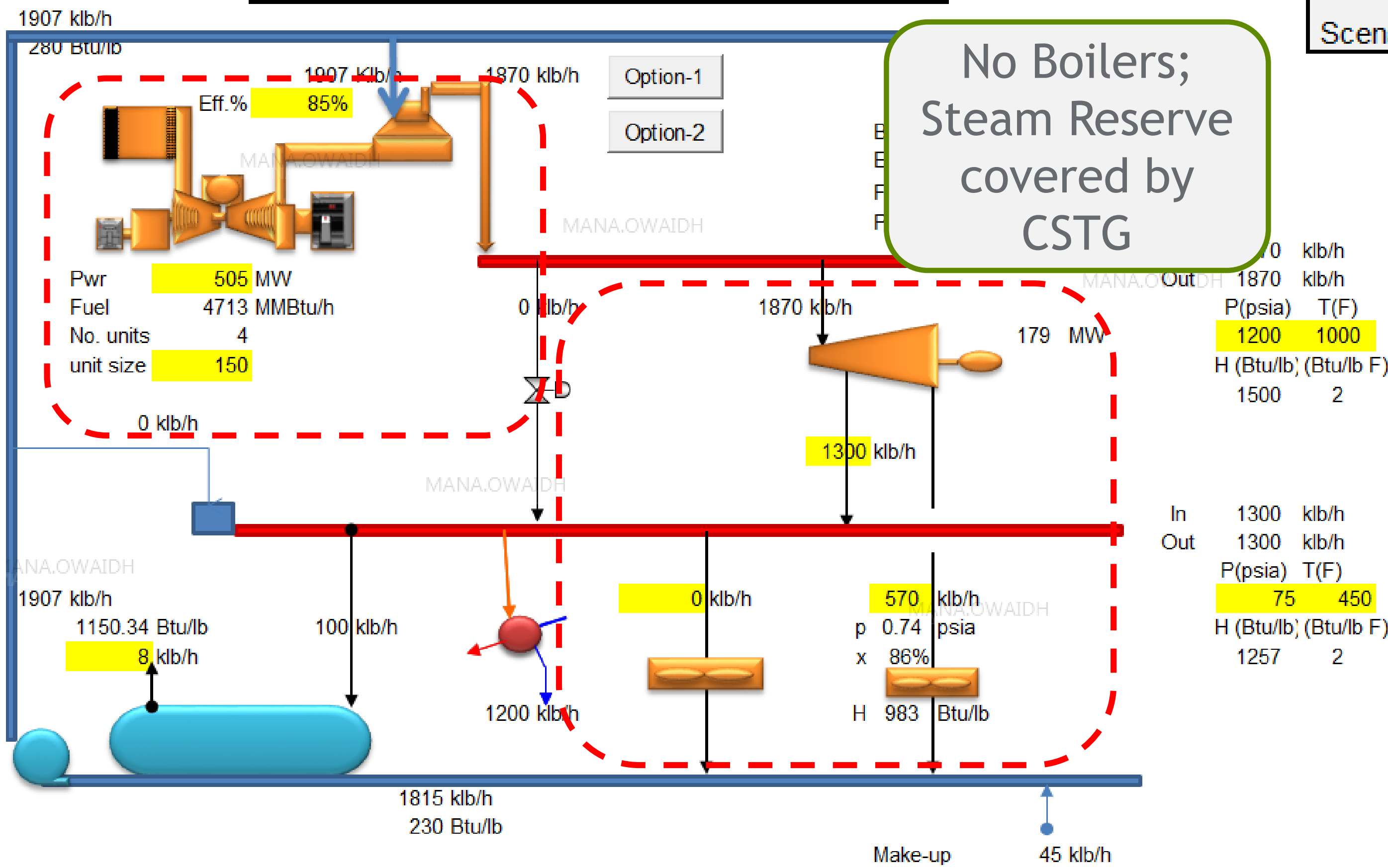
CHP System Thermal Efficiency- "Cogen Configuration"

**** Input**

Steam Demand	LP	1200	Klb/h
Required Pwr	MW	200	MW

Net Pwr	MW	684
Fuel	(MMBtu/h)	4713
SEC Fuel	(MMBtu/h)	-3061
Systm	Eff.%	76%
	Cogen %	Boilers
Scenario	100%	0%

No Boilers; Steam Reserve covered by CSTG

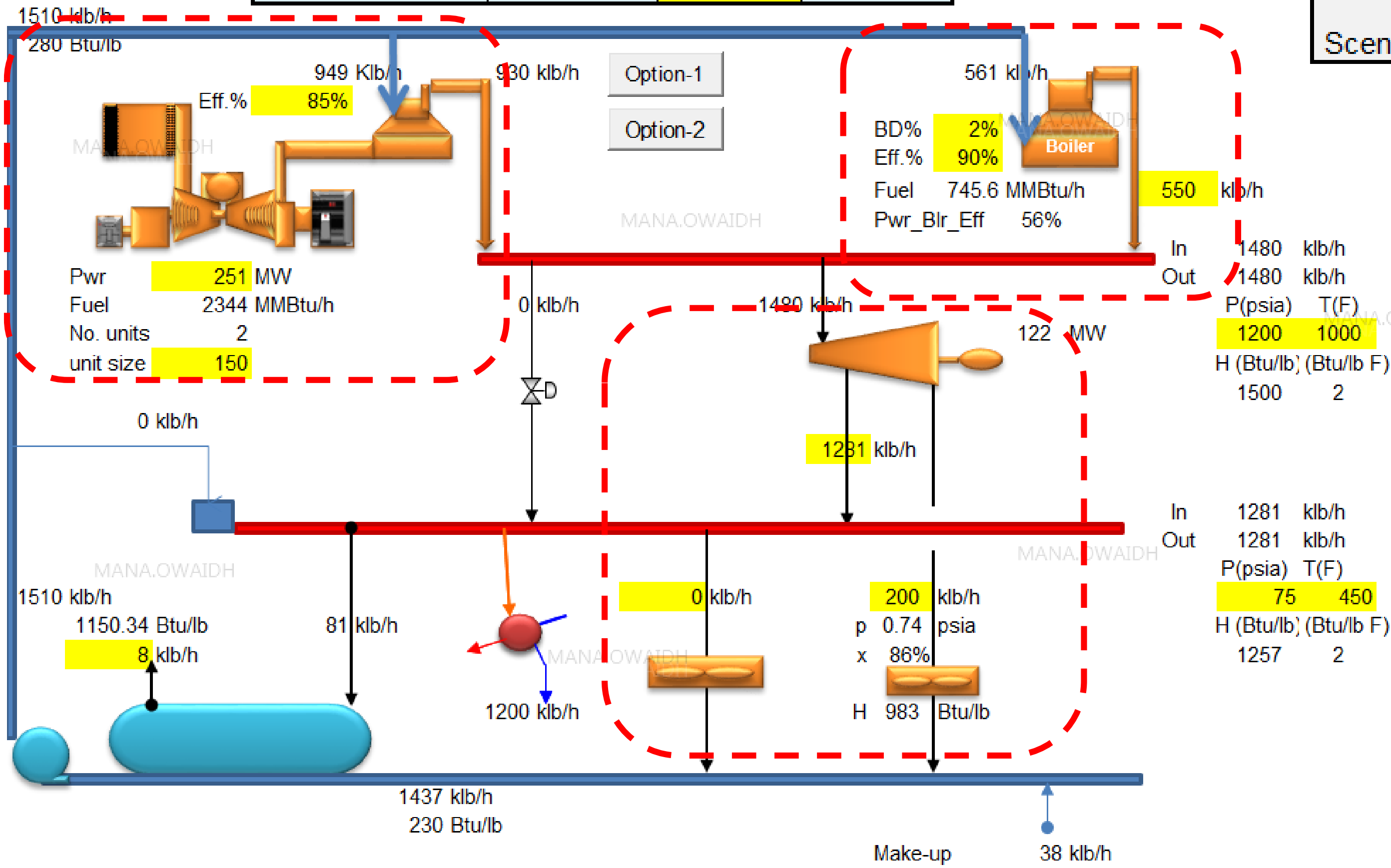


CHP System Thermal Efficiency- “Cogen & Boilers”

**** Input**

Steam Demand	LP	1200	Klb/h
Required Pwr	MW	200	MW

Net Pwr	MW	373
Fuel	(MMBtu/h)	3090
SEC Fuel	(MMBtu/h)	-1093
Systm	Eff.%	81%
	Cogen %	Boilers
Scenario	63%	37%



CHP System Thermal Efficiency- “Cogen & Boilers”

Facility Energy Demand		Value	Unit
Power Demand		200	MW
Steam Demand		1200	Klb/h
Steam Reserve Available	>=	One Unit	
Overall System Eff%	>=	70%	

Option	Fuel (MMBTU/h)	Power Gen MW	Overall Supply Eff. %
Boilers Only	1722	91	62%
Cogen Only	4713	684	76%
Cogen & Boilers	2642	373	81%

Conclusion

- CHP Optimization Models:
  - Provides a Clear Picture of Plant's Utilities Operations
  - Provides high potential energy savings in new design
- Optimum design CHP model is crucial for grassroots Oil & Gas industrial facilities.
- Saudi Aramco Mandated the methodology in the design stage for new facilities

Q&A

Thank You