KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

Combined Heat and Power (CHP)

COGENERATION at PETRONAS' Gas Processing Plant

By: Fairos Roslan, Head of Business Development, PGB

Date: 5 June 2012

Venue: Room 403/404, KL Convention Center

Patron

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Objective

- To share a case study example of Combined Heat and Power (CHP) on PETRONAS Gas Berhad (PGB)'s Cogeneration Plant installation project at Gas Processing Plant (GPP) A and B Complex, in Terengganu, Malaysia

Presentation outline

- **INTRODUCTION TO PETRONAS GAS BERHAD (PGB)**

- **BACKGROUND**
  - Current process operation and utilities at GPP A and GPP B

- **PGB'S PROPOSAL FOR COGENERATION SYSTEM**
  - Process operation and utilities with cogeneration system

- **JUSTIFICATION FOR COGENERATION SYSTEM**
  - Improved reliability of sales gas supply to the country
  - Sales gas saving to the country
  - Energy efficiency
  - Attractive economics

- **CONCLUSION**

Corporate Profile of PETRONAS GAS BERHAD (PGB)

- Private Limited Company
  - 23 May 1983

- Public Limited Company
  - 28 March 1995

- Listed on KLSE Main Board
  - 4 September 1995

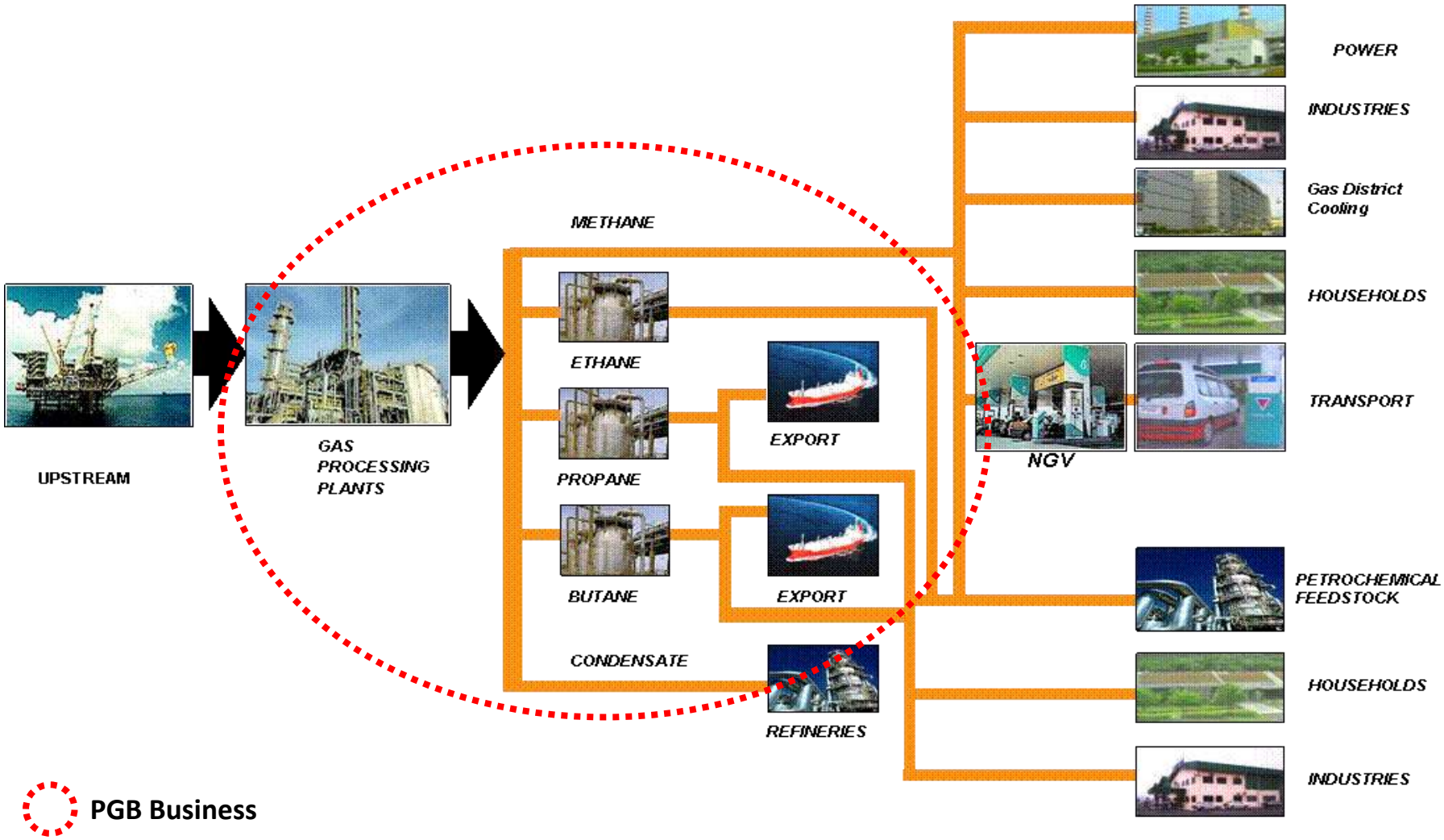
- PETRONAS owns 60.63% equity

Business Division of PETRONAS GAS BERHAD (PGB)

MD/CEO

Plant Operations Division (POD)	Transmission Operations Division (TOD)	Centralised Utility Facilities (CUF)	Re-Gasification Terminal Division (RGTD)	Headquarters (Enablers)
				
Separating natural gas into Sales Gas, Ethane, Propane, Butane & Stabilised Condensate	Transporting and distributing of Sales Gas, Ethane, Propane & Butane via pipelines	Producer of industrial utilities i.e. Power, Steam, Nitrogen, Oxygen, cooling water, etc	Operation of the LNG Regasification Facilities and Jetty	HSE FINANCE HRM COMMERCIAL PROJECT TEAM etc

PETRONAS GAS BERHAD (PGB) plays a major role in adding value to Natural Gas



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Current Process Operation and Utilities setup at the Gas Processing Plant (GPP)-A

GPP A

Feed Gas

- Pretreatment
- Acid Gas Removal
- Dehydration

- Low Temperature Separation Unit
- Product Recovery Unit

Product
- Sales gas (C1)
- Ethane (C2)
- Propane (C3)
- Butane (C4)
- Condensate (C5+)

→ **Customers**

Sales Gas for Internal Gas Consumption (IGC)

Electricity	Other utilities	Steam system	Fuel Gas System
Maximum demand: **21MW** Annual consumption: 178 Mil kWh	E,g, Instrument Air, Nitrogen, Cooling Water	390 degC, 39.5 bar Demand: **279 t/hr**	28 degC, 4.5 bar Gas Turbines, Furnace, Fired boilers

From TNB*
21 MW

Location	Maximum Demand (MW)
GPP 1	4.5
GPP 2	5.5
GPP 3	5.5
GPP 4	5.5
	21

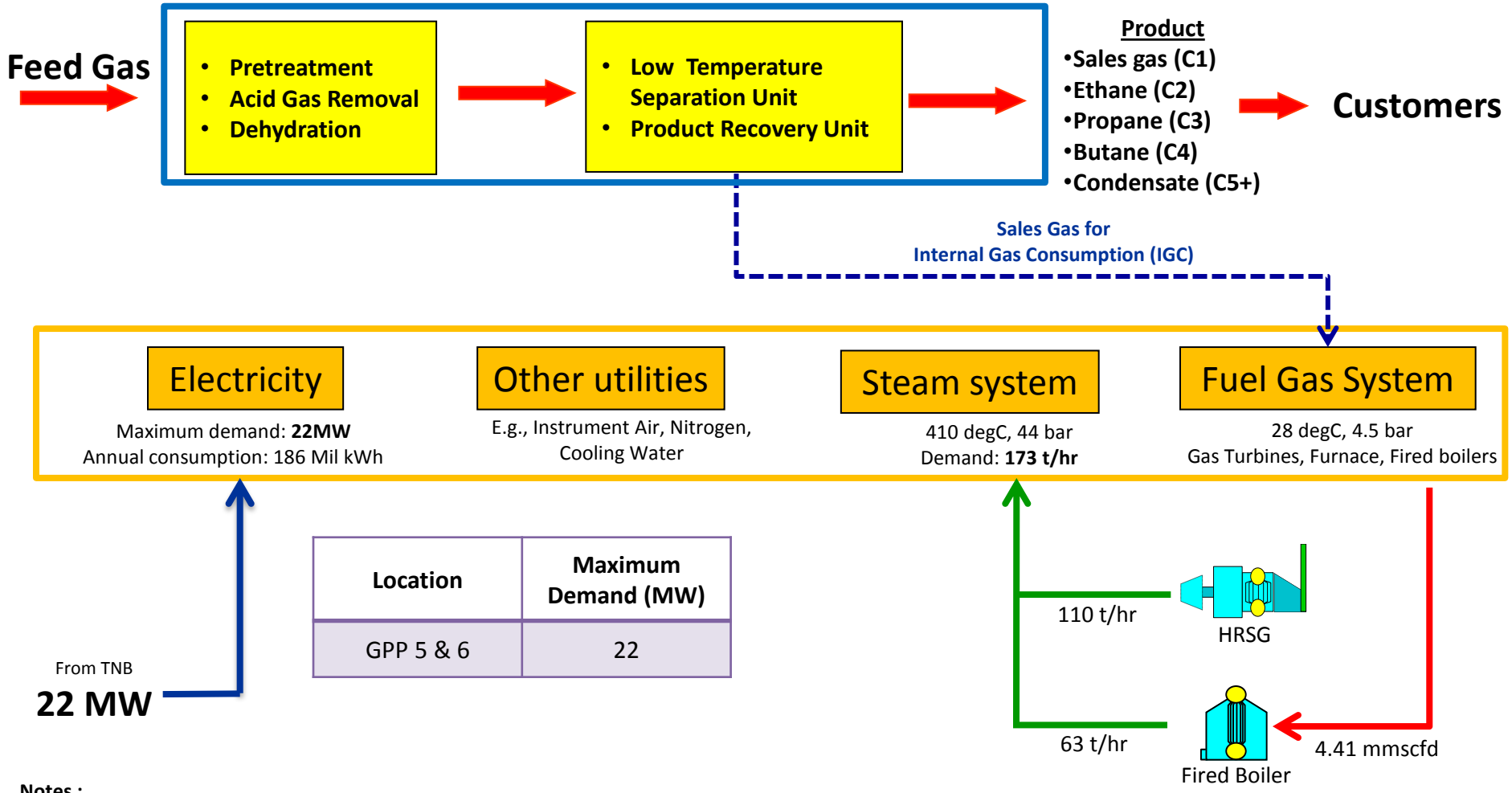
201 t/hr
HRSG
(Supp.firing)
4.23 mmscfd
78 t/hr
Fired Boiler
5.15 mmscfd

Notes :
* TNB : Tenaga Nasional Berhad i.e. national electricity grid/supplier

Notes :
HRSG : Heat Recovery Steam Generator
IGC : Internal Gas Combustion

Current Process Operation and Utilities setup at the Gas Processing Plant (GPP)-B

GPP B



Location	Maximum Demand (MW)
GPP 5 & 6	22

Notes :
* TNB : Tenaga Nasional Berhad i.e. national electricity grid/supplier

Notes :
HRSG : Heat Recovery Steam Generator

Summary of GPP utilities

UTILITY	SUPPLY CONDITION	DESCRIPTION	CURRENT DEMAND
GPP A			
Electricity	11 kV	Maximum Demand	21,000 kW
		Annual Electricity Consumption	178 million kWh
HP Steam	Pressure: 39.5 bar (abs) Temperature: 390 DegC	Total HP Steam Demand	279 T/hr
		Steam generation from Fired Boilers	78 T/hr
		Steam generation from Waste Heat Boilers	201 T/hr
Fuel Gas	Pressure: 4.5 barg Temperature: 28 degC	Total Consumption	36.6 mmscfd
		Consumption at gas turbines, furnace and other users	27.22 mmscfd
		Consumption at steam system	Supp. Firing at HRSG: 4.23 mmscfd Fired boiler: 5.15 mmscfd
GPP B			
Electricity	132 kV / 33 kV/ 6.6kV	Maximum Demand	22,000 kW
		Annual Electricity Consumption	186 million kWh
HP Steam	Pressure: 44 bar (abs) Temperature: 410 DegC	Total HP Steam Demand	173 T/hr
		Steam generation from Fired Boilers	63 T/hr
		Steam generation from Waste Heat Boilers	110 T/hr
Fuel Gas	Pressure: 4.5 barg Temperature: 28 degC	Total Consumption	31.5 mmscfd
		Consumption at gas turbines, furnace and other users	27.09 mmscfd
		Consumption at steam system	Fired boiler: 4.41 mmscd

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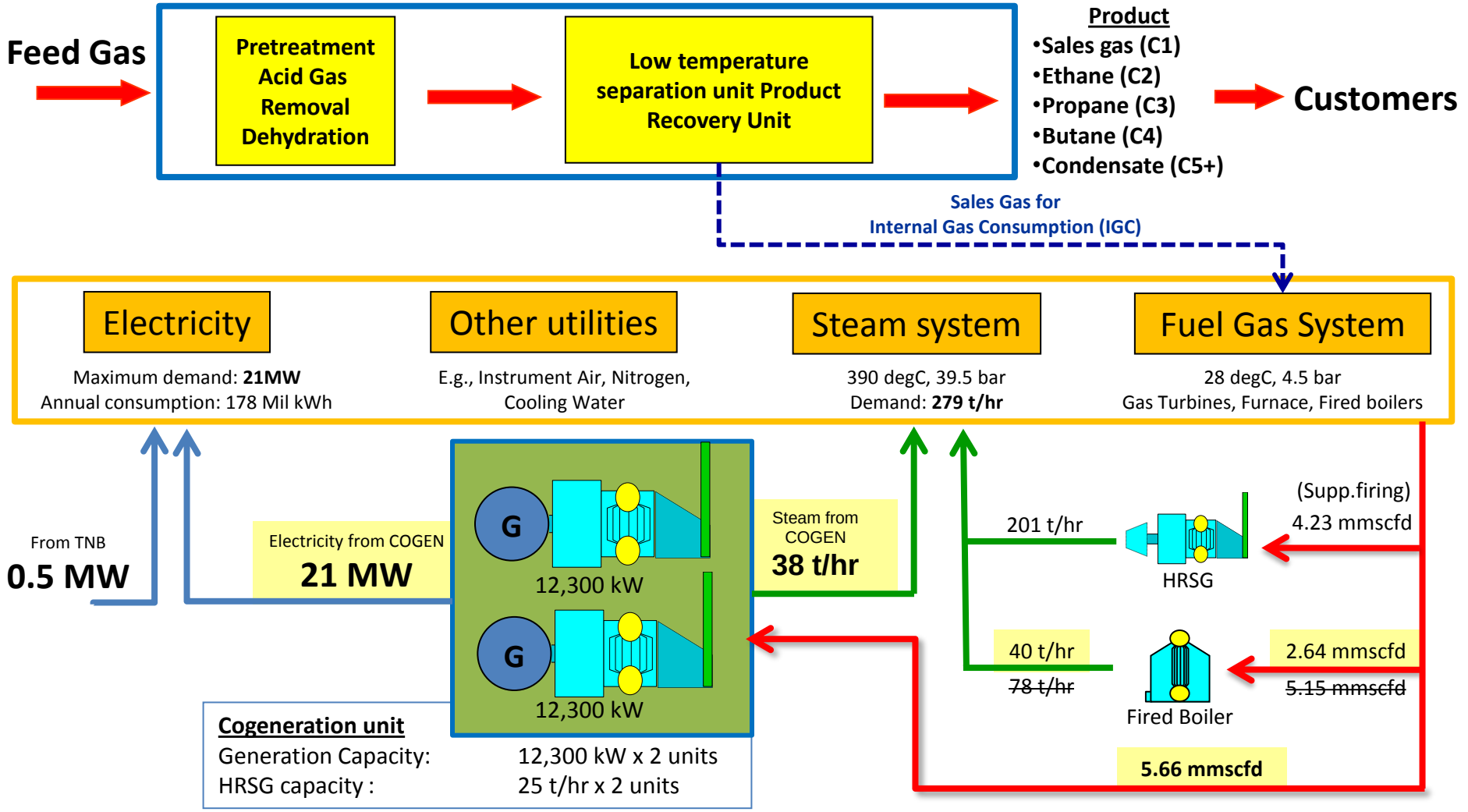
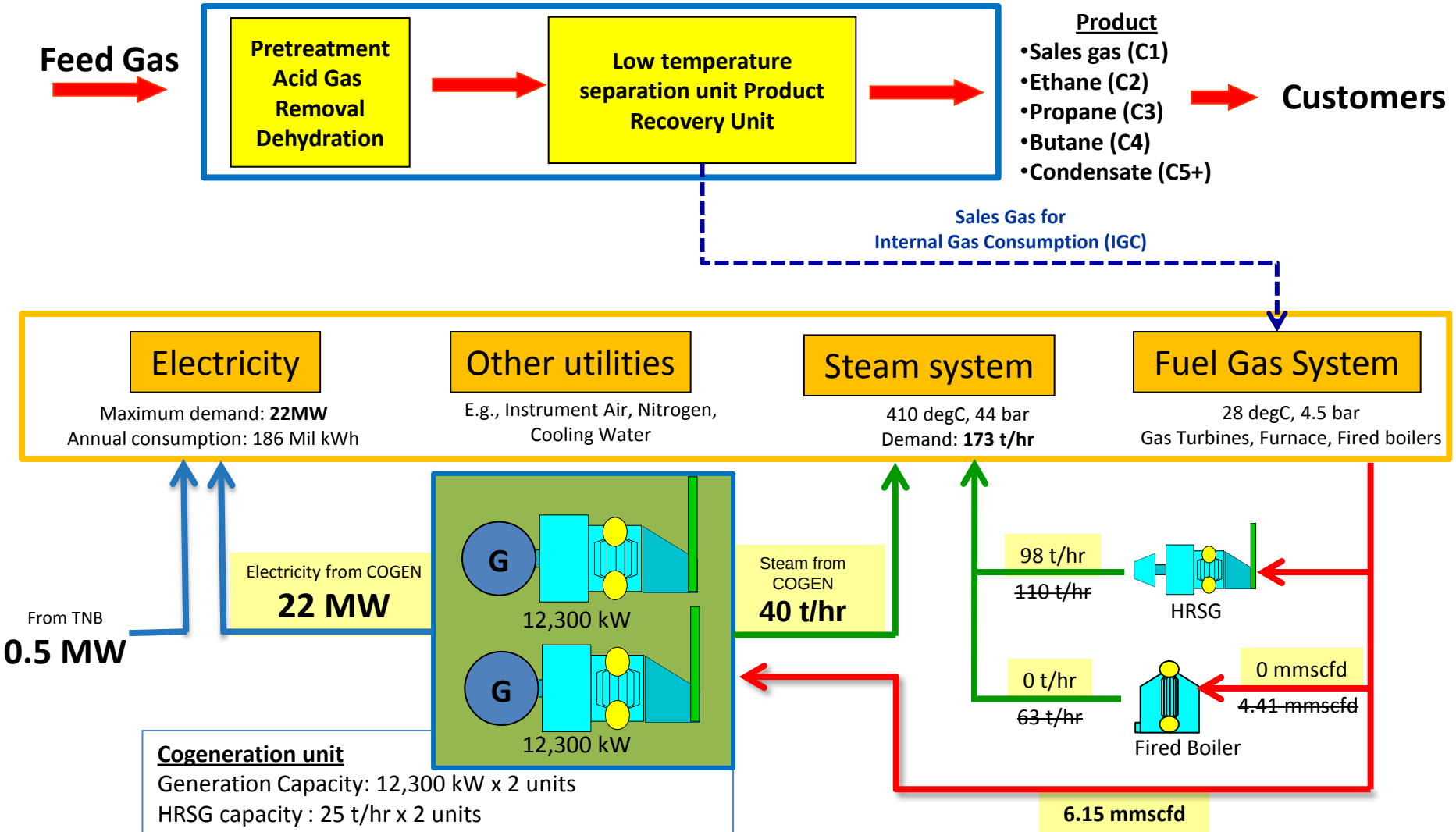
GPP-A installation of new COGEN unit will enable us to shutdown 2 fired-boilers while satisfying the steam demand

GPP A



GPP-B installation of new COGEN unit will enable us to totally shutdown the operation of fired-boilers

GPP B



Summary of GPP utilities after installation of Cogeneration plant

UTILITY	SUPPLY CONDITION	DESCRIPTION	WITHOUT COGENERATION	WITH COGENERATION
GPP A				
Electricity	11 kV	Maximum Demand	21,000 kW	21,000 kW
		Annual Electricity Consumption	178 million kWh	178 million kWh
HP Steam	Pressure: 39.5 bar (abs) Temperature: 390 DegC	Total HP Steam Demand	279 T/hr	279 T/hr
		Steam generation from Fired Boilers	78 T/hr	40 T/hr
		Steam generation from Waste Heat Boilers	201 T/hr	200 T/hr
Fuel Gas	Pressure: 4.5 barg Temperature: 28 degC	Total Consumption	36.6 mmscfd	39.75 mmscfd
		Consumption at gas turbines, furnace and other users	27.22 mmscfd	27.22 mmscfd
		Consumption at steam system	Supp. Firing at HRSG: 4.23 mmscfd Fired boiler: 5.15 mmscfd	Supp. Firing at HRSG: 4.23 mmscfd Fired boiler: 2.64 mmscfd
		COGEN	-nil-	5.66 mmscfd
GPP B				
Electricity	66 kV	Maximum Demand	22,000 kW	22,000 kW
		Annual Electricity Consumption	186 million kWh	186 million kWh
HP Steam	Pressure: 39.5 bar (abs) Temperature: 390 DegC	Total HP Steam Demand	173 T/hr	173 T/hr
		Steam generation from Fired Boilers	63 T/hr	0 T/hr
		Steam generation from Waste Heat Boilers	110 T/hr	110 T/hr
Fuel Gas	Pressure: 4.5 barg Temperature: 28 degC	Total Consumption	31.5 mmscfd	33.31 mmscfd
		Consumption at gas turbines, furnace and other users	27.09 mmscfd	27.09 mmscfd
		Consumption at steam system	Fired boiler: 4.41 mmscd	Fired boiler: 0 mmscd
		COGEN	-nil-	6.15 mmscfd

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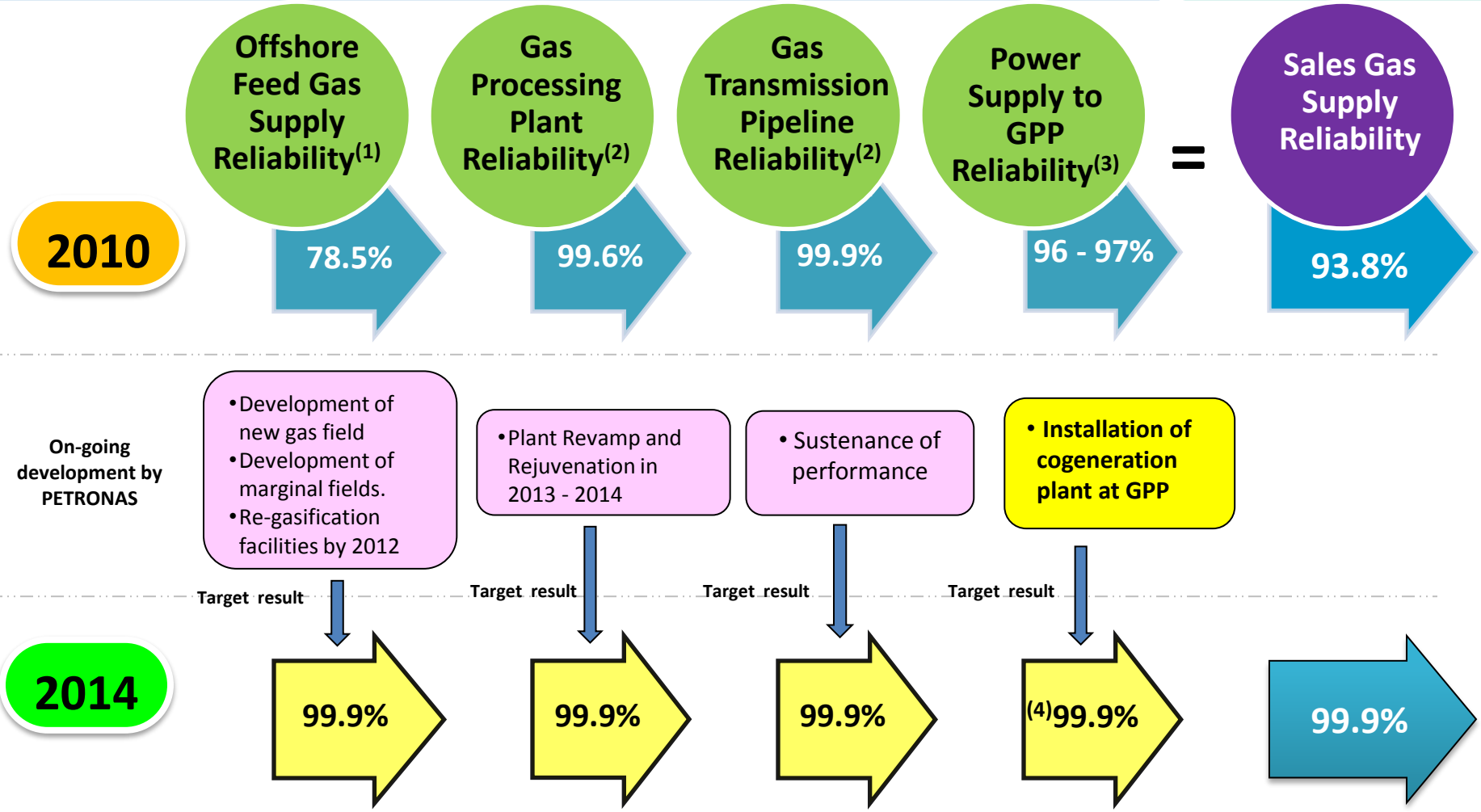
- **CONCLUSION**

Sales Gas supply reliability to the country will improve from 93.8% to 99.9%



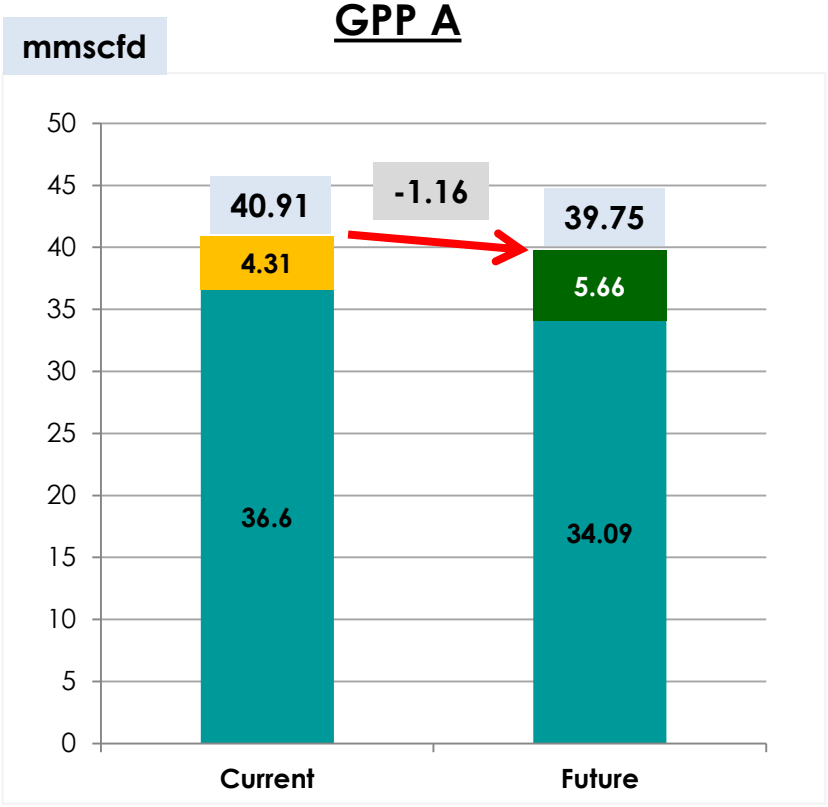
(1) Source data: POD Production Planning department

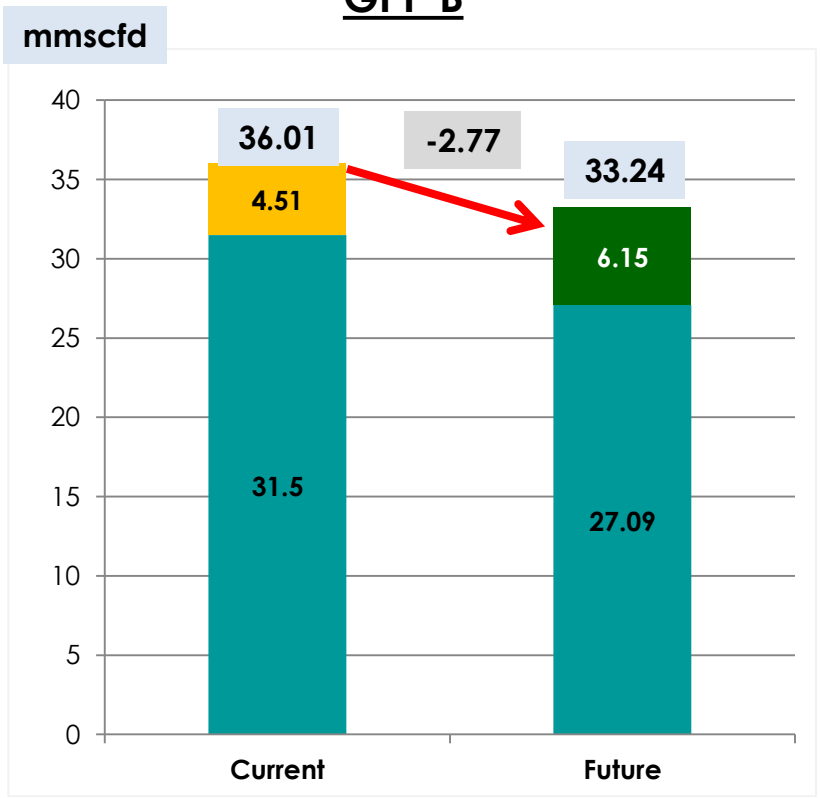
(2) Source data: Petronas Gas Berhad, Annual Report (2008 – 2010)

(3) Calculated based on GPP

(4) High reliability of power supply to GPP due to parallel operation with TNB. Cogen reliability is at 97.6% as per PGB project proposal

Sales Gas savings to the country is 3.93 mmscfd





Fuel requirement

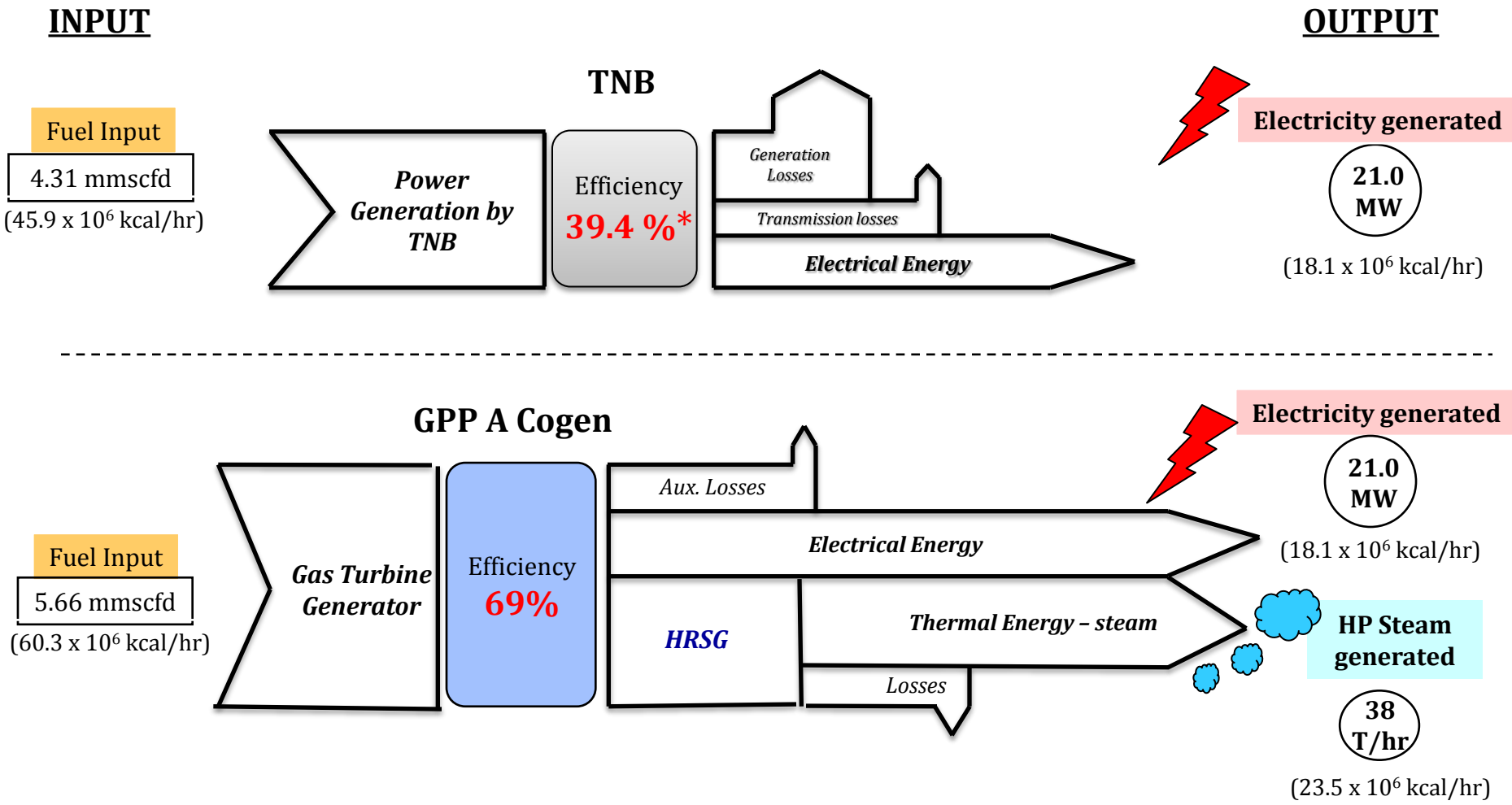
- TNB
- PGB
- COGEN

Total savings to the country: 3.93 mmscfd

3.93 mmscfd = 19 MW electricity can be generated

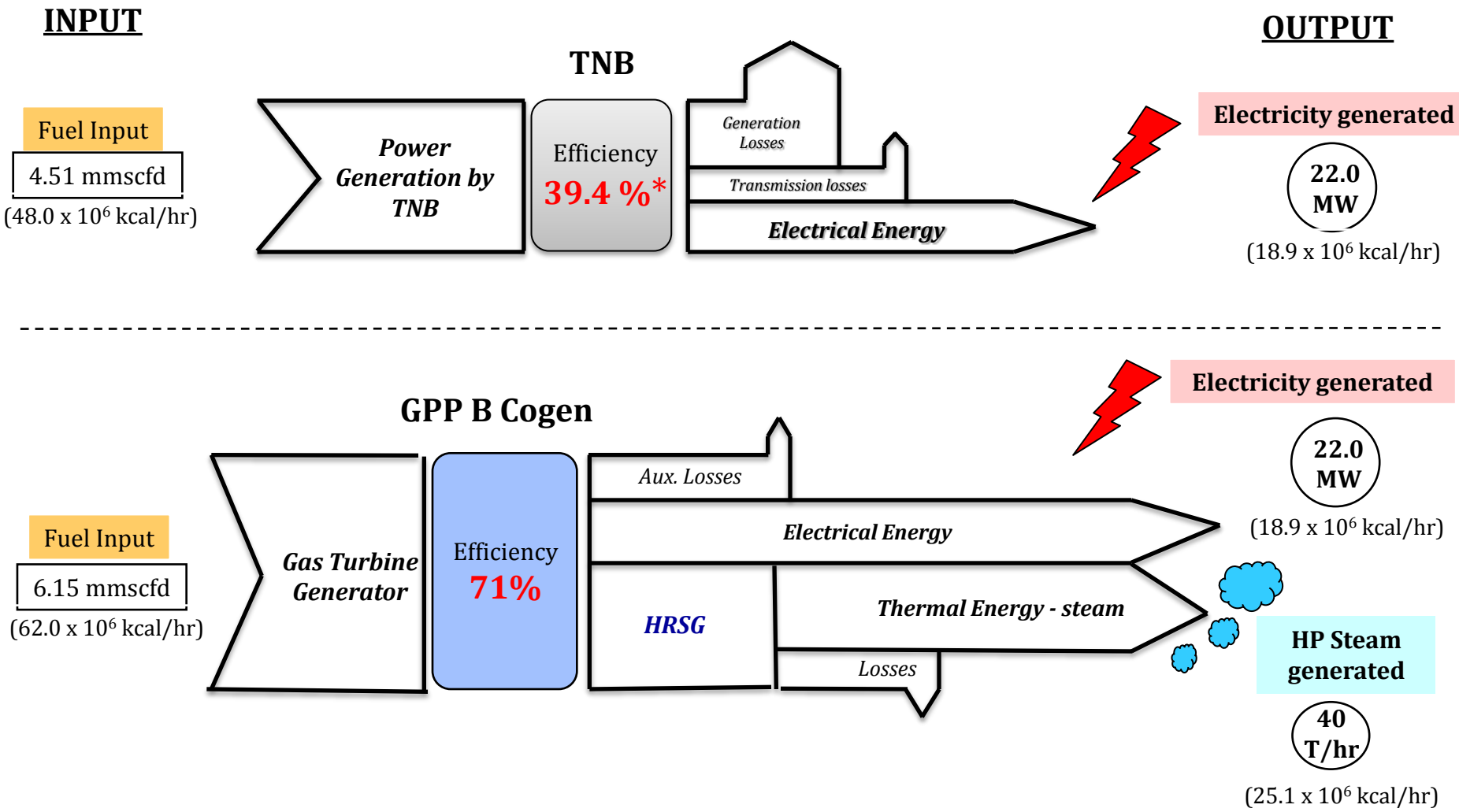
3.93 mmscfd = RM 59.5 million/year @ Gas price = RM 38.00/mmbtu

Power generation efficiency comparison between TNB and PGB Cogeneration for GPP-A



* Overall TNB Net thermal efficiency was taken from TNB 2010 Annual Report

Power generation efficiency comparison between TNB and PGB Cogeneration for GPP-B

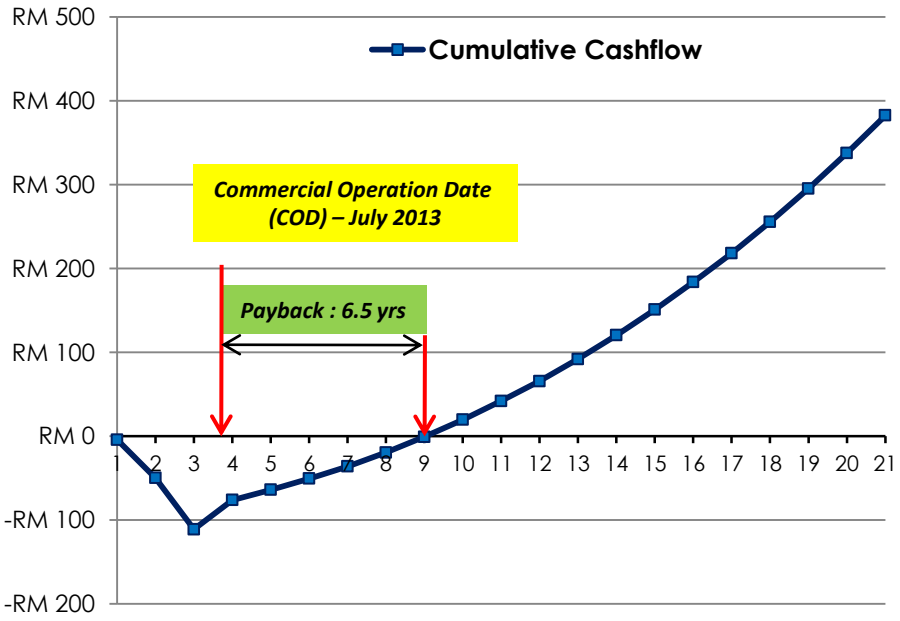


* Overall TNB Net thermal efficiency was taken from TNB 2010 Annual Report

New Cogeneration plant is economically feasible

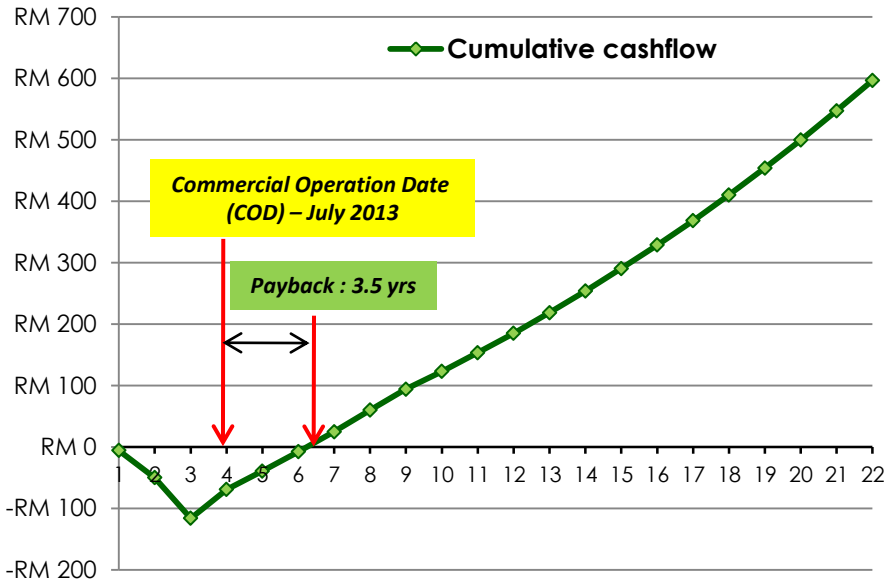
RM (Million)

COGEN GPP A (Kertih) - Cumulative cashflow



RM (Million)

COGEN GPP B (Paka) - Cumulative cashflow



Economics results for 20 years (from Year 2011-2032)

Item	Cost (RM)
ROI	17.8 %
NPV@ 10%	RM 71.9 million
Payback period	6.5 years

Item	Cost (RM)
ROI	26.7%
NPV@ 10%	RM 147.6 million
Payback period	3.5 years

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This COGENERATION Project will benefit the country in the aspect of…

- **Transfer of operational risk from TNB to PGB** for the security of supply for sales gas to the country
- **Improved reliability of sales gas supply** to the nation from 93.8% to 99.9%, above world class reliability standard.
- **Net reduction of sales gas volume** available to the nation by 3.93 mmscfd
- **Improved overall thermal efficiency** from 39.4% to 69% at GPP A and 71% at GPP B.
- **Economically feasible** with Internal Rate of Return (IRR) of 17.8% and 26.7% at GPP A and GPP B respectively.

Thank You

BACKUP SLIDES

Calculation

Upstream reliability = $\frac{\text{Actual supplied volume}}{\text{Plant capacity}}$

2007 $\frac{2321}{2512} = 92.4\%$

2010 $\frac{1972}{2512} = 78.5\%$

2014 $\frac{2437}{2512} = 97.0\%$

* Calculated based on KPBI yr 2014
* Figures are calculated based on actual data

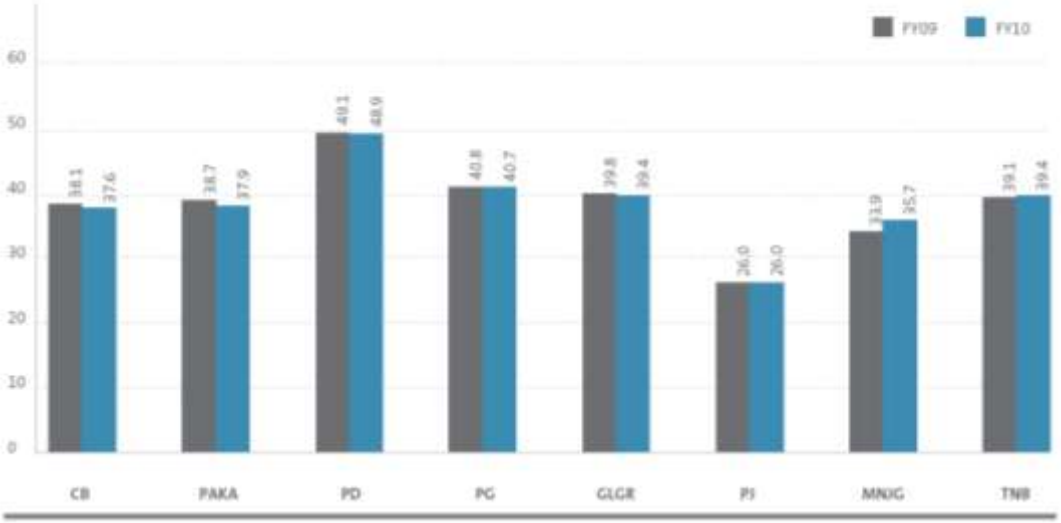
2015 $\frac{2470}{2512} = 98.3\%$

Power supply reliability to GPP (based on 4 years data)

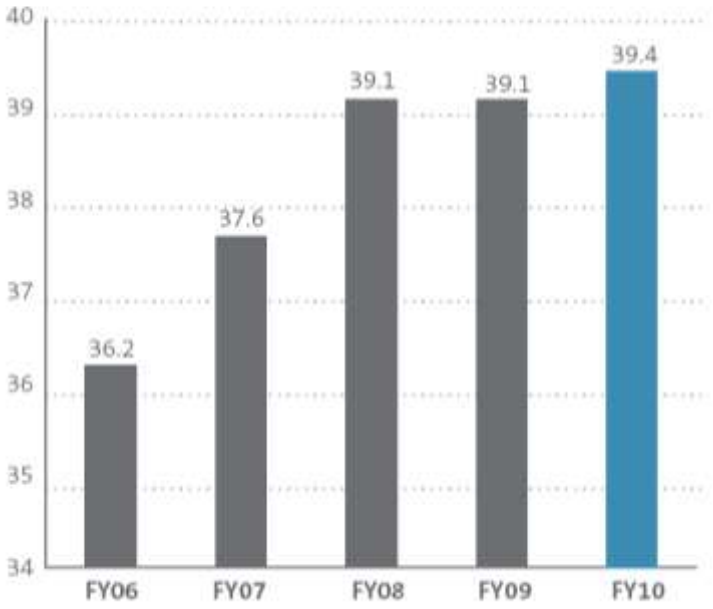
Year	GPP A Outage (hr)	GPP B Outage (hr)	GPP A Reliability (%)	GPP B Reliability (%)
2010	1.2	0	99.99	100
2009	0	0	100	100
2008	48.25	0	99.45	100
2007	0	0	100	100

Power generation thermal efficiency (extracted from TNB 2010 Annual Report, pg 121)

Graph 13: Thermal Efficiency by Station (%)



Graph 14: Trending of TNB Thermal Efficiency (%)



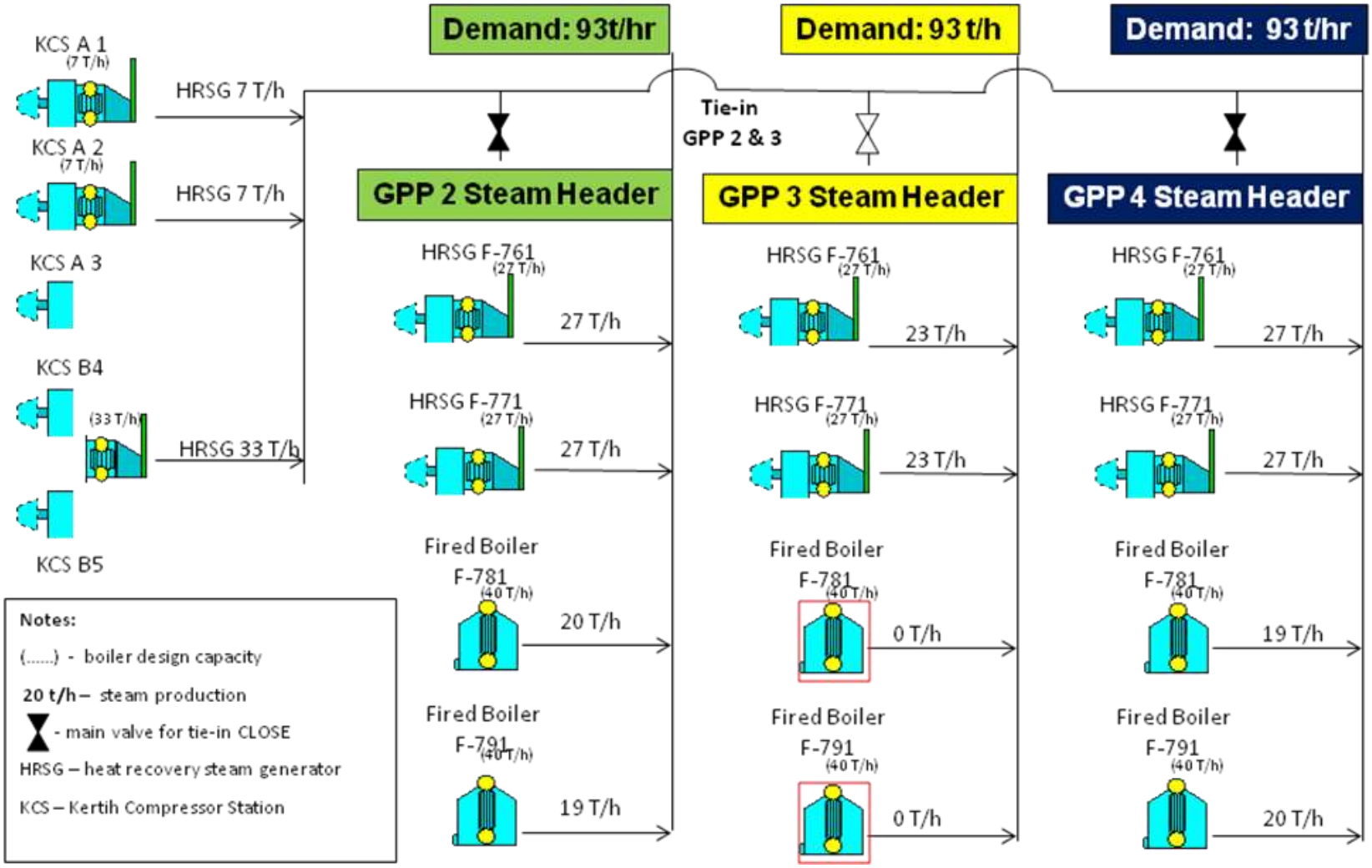
Economic assumptions (1/2)

NO	DESCRIPTION	INFO / VALUE ASSUMPTIONS
1	Maximum Demand During Peak Period	GPP A : 21 MW , GPP B : 22 MW
2	Total power consumption	GPP A : 178 Mil kWh , GPP B : 186 kWh
3	Natural Gas Price	RM 10.70/ mmbtu according to GPTA until 2014. By the year 2015 onwards, RM 38/mmbtu as per PEMANDU guideline
4	Total CAPEX Cost	RM 142.6 mil (per GPP)
5	Project Life	20 Years. Commercial Operation Date (COD) -July 2013
6	Debt : Equity Ratio	100 % Equity
7	Depreciation	Straight line over 20 years
8	Capital Allowance	1st Yr: 34%, 2nd-5th Yr: 14%,6th Yr: 10%
9	Reinvestment Allowance	60 %
10	Corporate Income Tax	25 %
11	TNB Electric Tariff Charge	GPP A : E2 Rate, GPP B : E3 Rate
12	TNB Electricity Annual Increment	3.0% (Based on historical data)
13	Non Firm Stand-by From TNB	GPP A: 9 MW, GPP B : 10 MW

Economic assumptions (2/2)

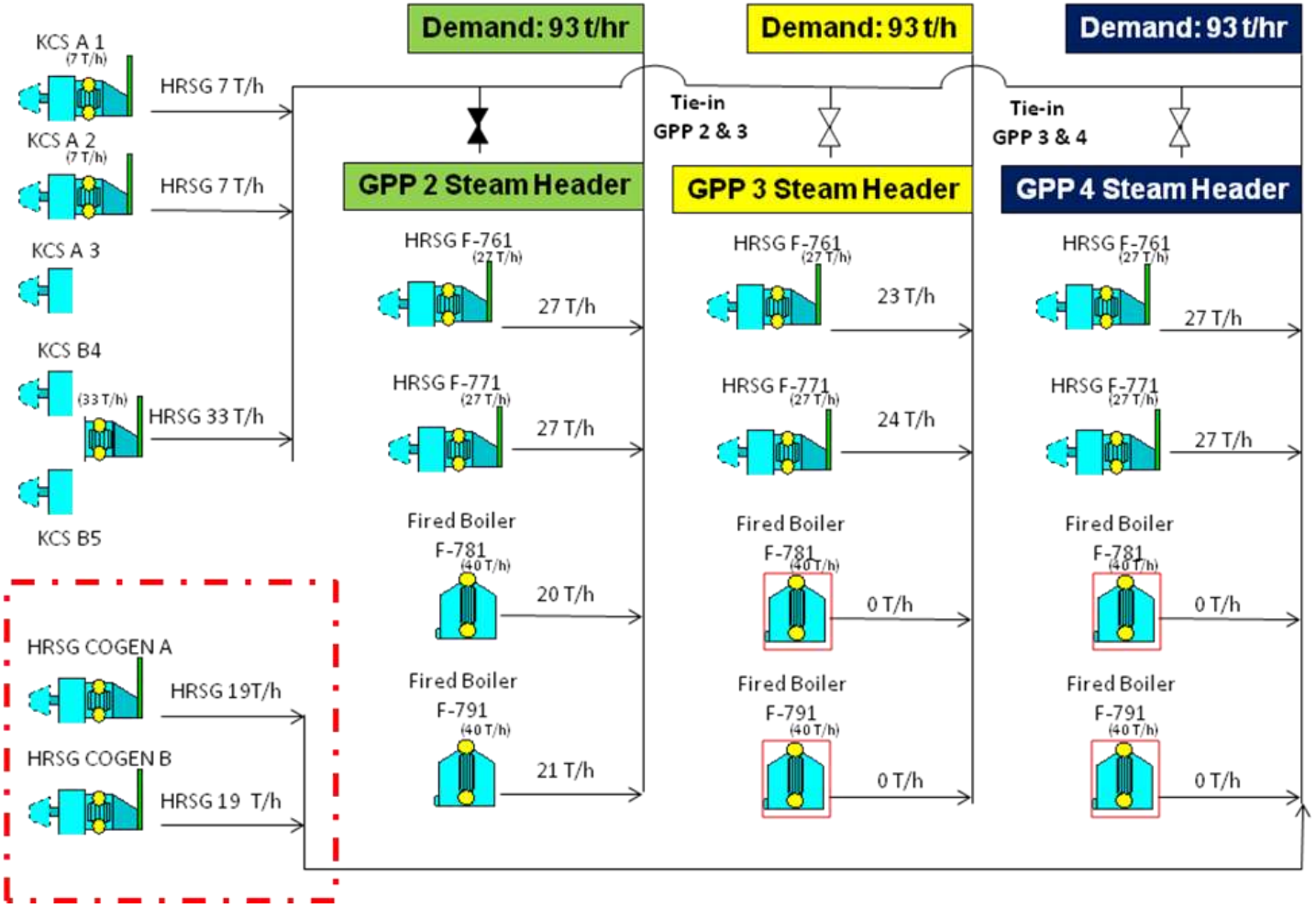
NO	DESCRIPTION	INFO /VALUE ASSUMPTIONS
14	Discount Rate	10%
15	Exchange Rate	1 USD = RM 3.03 as publish by Bank Negara Malaysia on the 22nd Feb 2011
16	GT ,Generator & HRSG Maint	RM 2.3 Million /yr
17	Annual Increment of Gas Turbines & Generator Maintenance Cost	3 % (Based on average US-CPI index)
18	GTG and HRSG Reliability	96%

Existing GPP-A Steam System Overview (GPP Generates 78 t/hr of steam from fired-boilers)

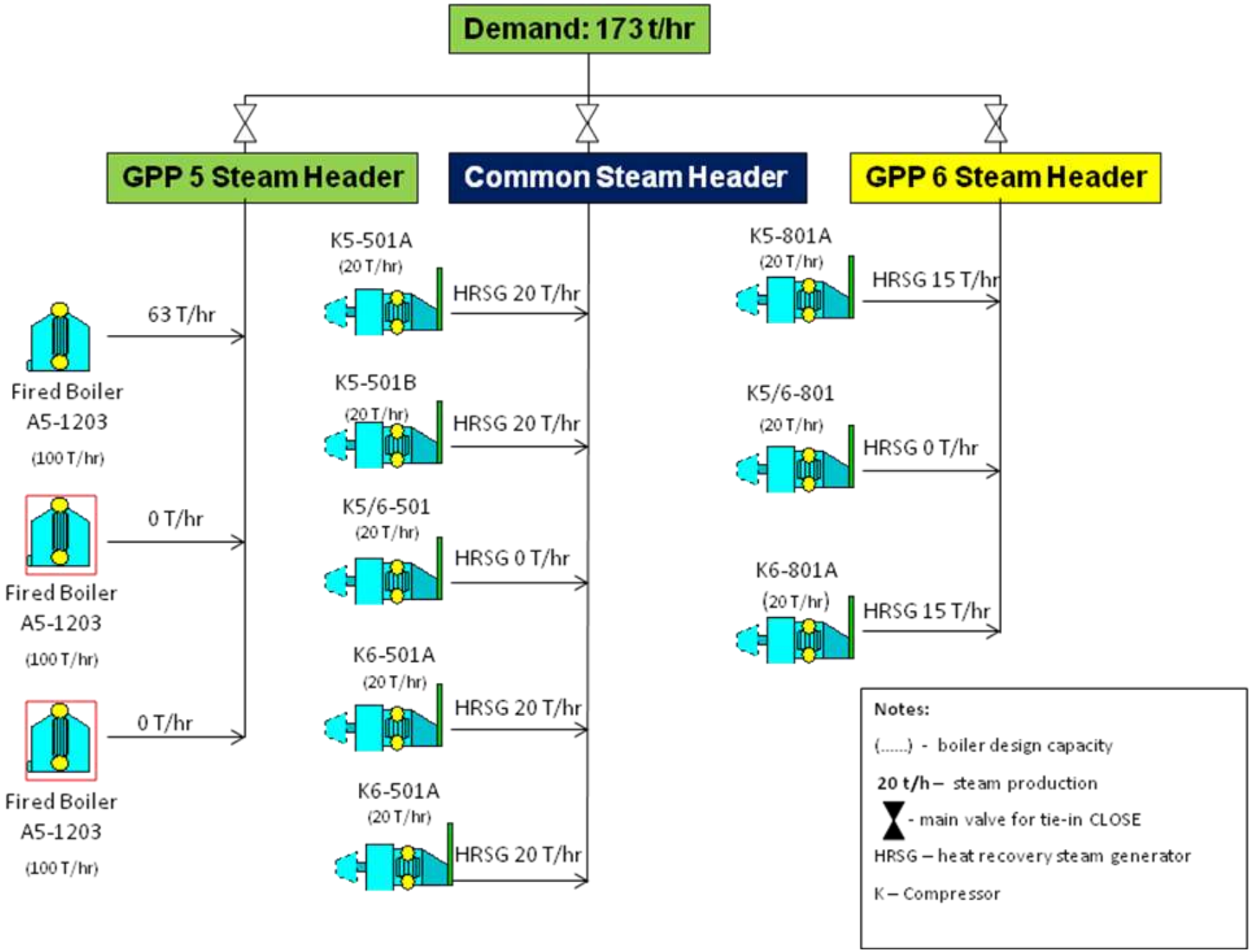


GPP-A Steam System Overview – Post COGEN project i.e. able to shutdown 4/6 fired-boilers

Figure B : GPP A Steam production and distribution with COGEN



Existing GPP-B Steam System Overview (GPP Generates 63 t/hr of steam from fired-boilers)



GPP-B Steam System Overview – Post COGEN project i.e. able to shutdown ALL fired-boilers