MITR PHOL GROUP

Biomass Power: High Efficiency Boiler Technology for Sugar Industry

Seminar on Renewable Energy Technology Implementation in Thailand

October 4, 2012

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What is Biomass?

Biomass is organic matter which can be converted into energy. Common examples of biomass include crops for energy, crop residues, wood waste and animal manure.

Rice Husk

from rice mills

Bagasse

from sugar mills

Wood Waste

From wood converting

Empty Fruit Brunch

From CPO Plant

Animal Manure

From farm

Corn Cob

From corn mill

Energy Crop

Biomass = Clean Energy Source

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Carbon Life Cycle for Biomass Power Plant

Electricity from Biomass = Neutral Carbon Emission

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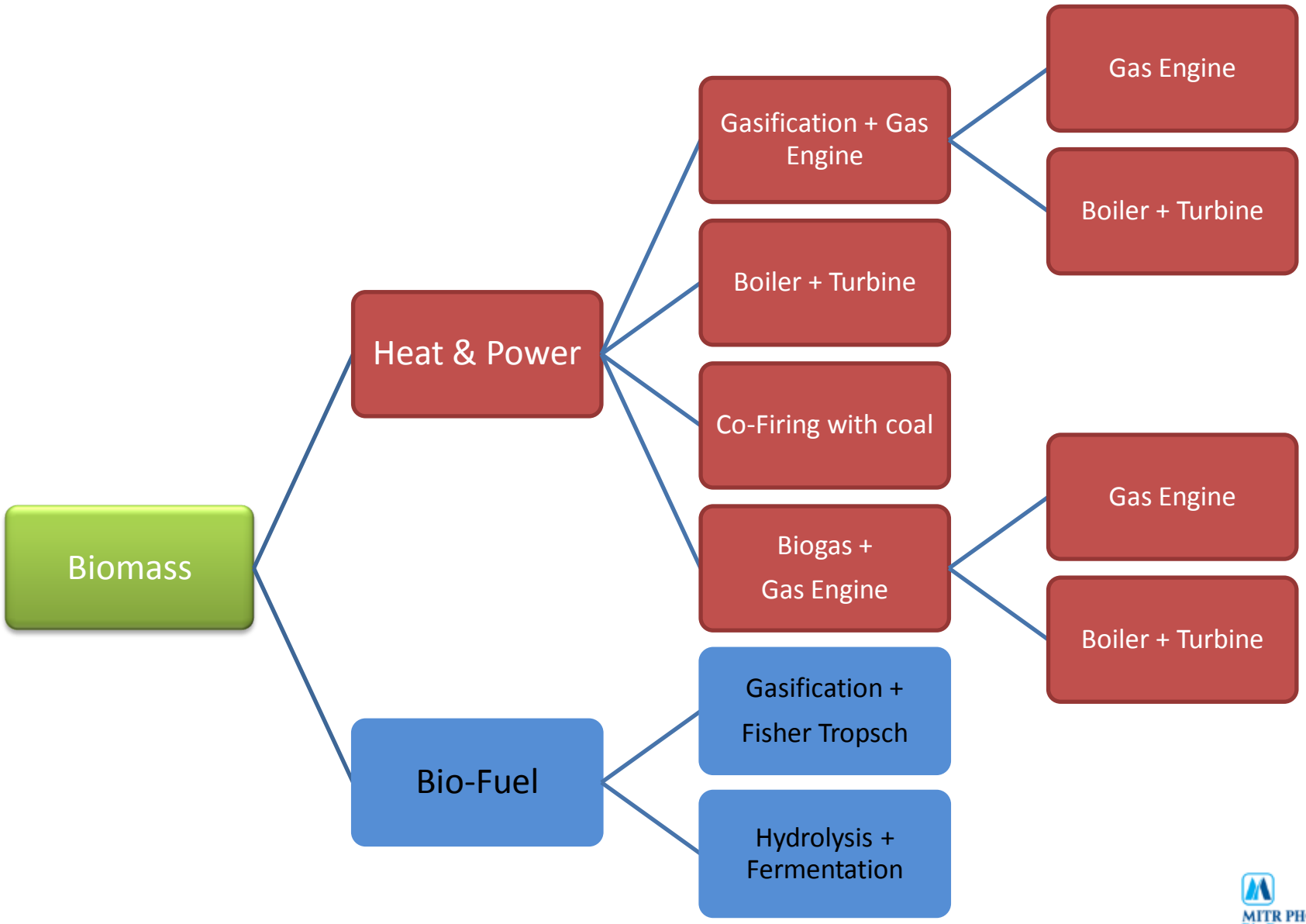
Technologies Converting Biomass to Energy



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Biomass Boiler Turbine Generator

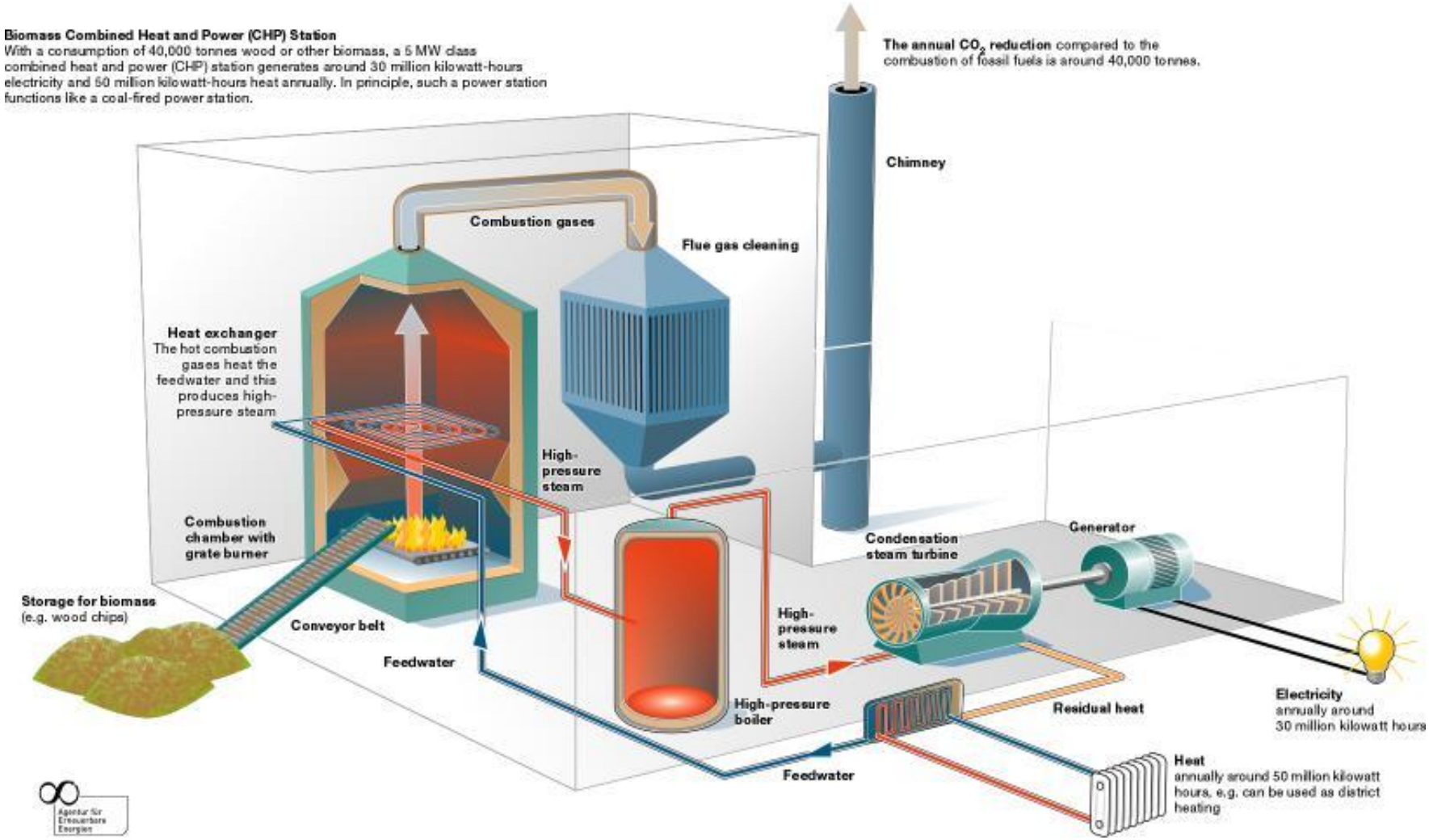

Image source : http://www.unendlich-viel-energie.de/en/electricity/details/article/111/functioning-principles-of-a-biomass-combined-heat-and-power-chp-station.html

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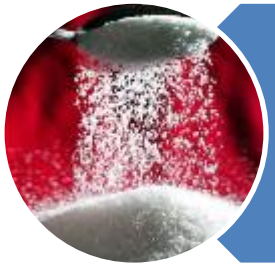
Mitr Phol Group and Renewable Energy



Sugar: Mitr Phol is the largest sugar producer in Thailand crushing about 18 million tons cane per year from 5 sugar mills.

Bio Power: Bagasse from sugar production is used in biomass power plants with total capacity of 307 MW in which 177 MW is fed to national grid around 1,000 GWH annually.

Bio Fuel: Molasses from sugar production is used to produce ethanol approximately 250 million liters annually.

World's Sugar Cane Production 2011

COUNTRY	AREA HARVESTED (Ha)	PRODUCTION RANKING	YIELD (tonnes/ha)	PRODUCTION (tonnes)	Source
BRAZIL	8,490,000	1	73.03	620,000,000	GAIN Report
INDIA	4,810,000	2	70.80	340,540,000	GAIN Report
CHINA	1,780,000	3	69.66	124,000,000	GAIN Report
THAILAND	1,200,000	4	79.75	95,700,000	GAIN Report
PAKISTAN	1,011,000	6	53.41	54,000,000	GAIN Report
MEXICO	675,000	5	67.33	45,450,000	GAIN Report
AUSTRALIA	353,000	8	77.76	27,450,000	GAIN Report
PHILIPPINES	390,000	7	66.41	25,900,000	GAIN Report
USA	359,766	9	64.71	23,281,082	USDA
COLOMBIA*	171,633	10	118.12	20,272,800	FAO Database
CUBA*	431,400	11	26.19	11,300,000	FAO Database

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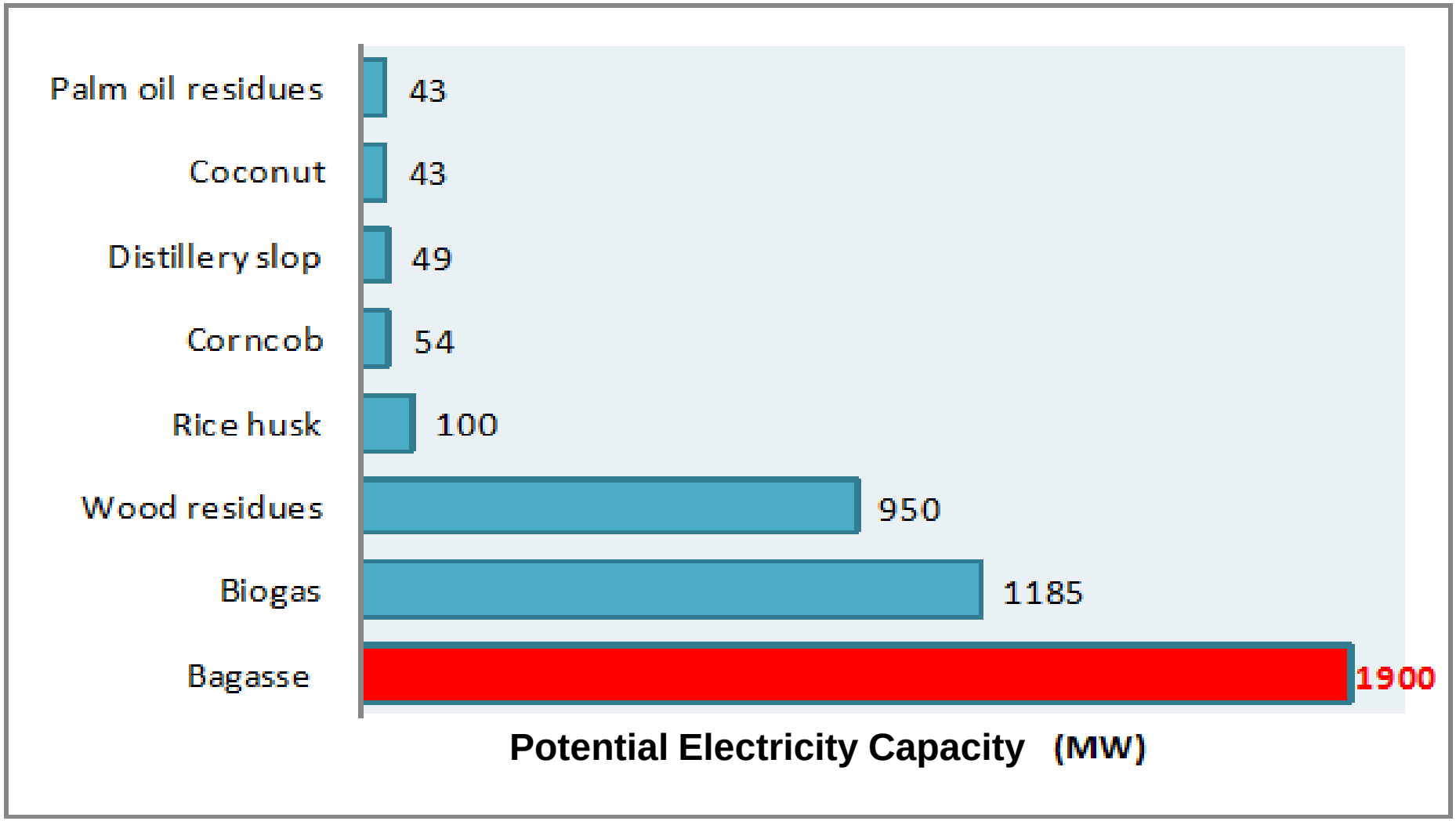
Thailand Biomass-Based Power Generation Potential



Source : Black and Veatch (2000). Final Report

Advantages of High Pressure Boiler

90% of sugar mill boilers in Thailand are below this category

Parameters	Unit	45 Kg/cm²(a)		66 Kg/cm² (a)		87 Kg/cm² (a)		105 Kg/cm² (a) / 540 °C
		440°C	515 °C	485 °C	515°C	515°C	540°C	
Feed Water temp to boiler	°C	105 (without HP Heater)		150 (with 1 HP Heater)		170 (with 1 HP Heater)		220 (with 2 HP Heater)
Bagasse Quantity	TPH	43.51	46.18	41.78	42.89	41.2	42.2	38.6
Steam /Fuel ratio	-	2.29	2.16	2.39	2.33	2.42	2.36	2.59
Gross Power output	MW	24.8	28.8	26.5	28.9	28.5	29.4	29.4
Net Power Output	MW	22	25.2	23.4	25.3	25.1	25.7	25.9
Specific Steam consumption	Kg/KW-hr	4.03	3.46	3.77	3.46	3.51	3.40	3.40
Power Generation per ton of Bagasse	KW/Ton	Base	+9.5%	+ 11.4%	+18.3%	+ 21.4%	+ 22.3%	+ 33%
Heat Rate	Kcals/KW-hr	3983	3640	3579	3370	3281	3258	2980

(Calculations shown above are based on a 100 TPH Travelling Grate boiler with 69% efficiency (on GCV 2270 Kcal/Kg Basis) and Turbine exhaust at 0.1 Kg/Cm2 (a)

HIGHER THE CYCLE PARAMETERS- HIGHER THE OUTPUT

More power output with same input quantity of fuel

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Power Cogeneration in Sugar Mills

Sugar Cane

Sugar Mill

Juice
73%

Sugar

Bagasse 27%

Power and Steam

Fuel

Excess
Power

Bagasse Storage

New Power House

National Grid

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Cogeneration by Sugar Mills in Thailand

Before Year 2006	After Year 2006
• Mostly low-pressure boilers (< 25 bar) and are very old (> 30 years)	• Use of medium-pressure boilers and high efficiency turbine
• Mostly within the sugar mill.	• Excess electricity export to the grid.
• Boilers have been designed deliberately with low efficiency.	• Professional approach in project development.
• Purchase of used equipment are common.	• Use of special purpose company

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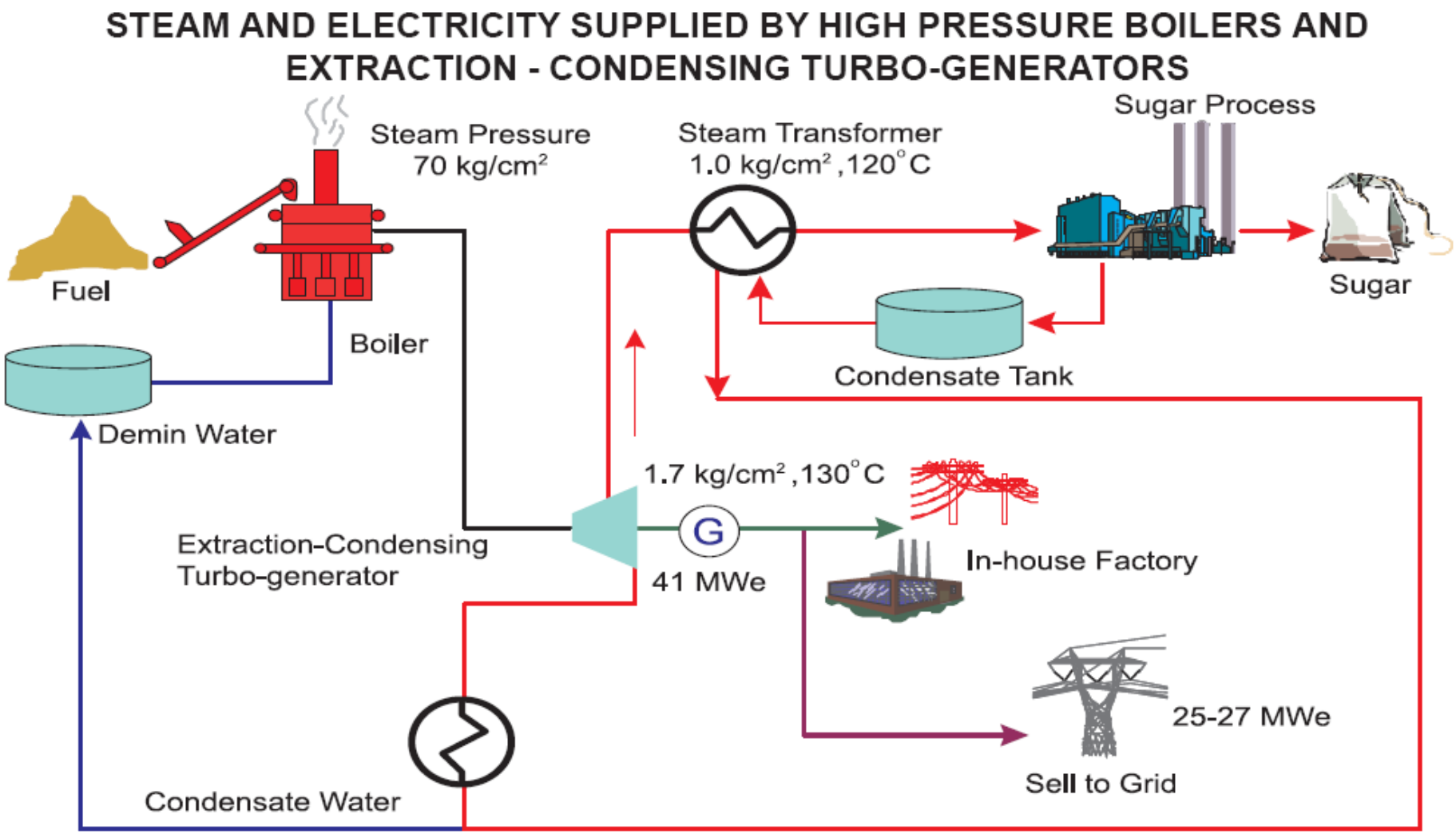
Process Diagram for New Plant



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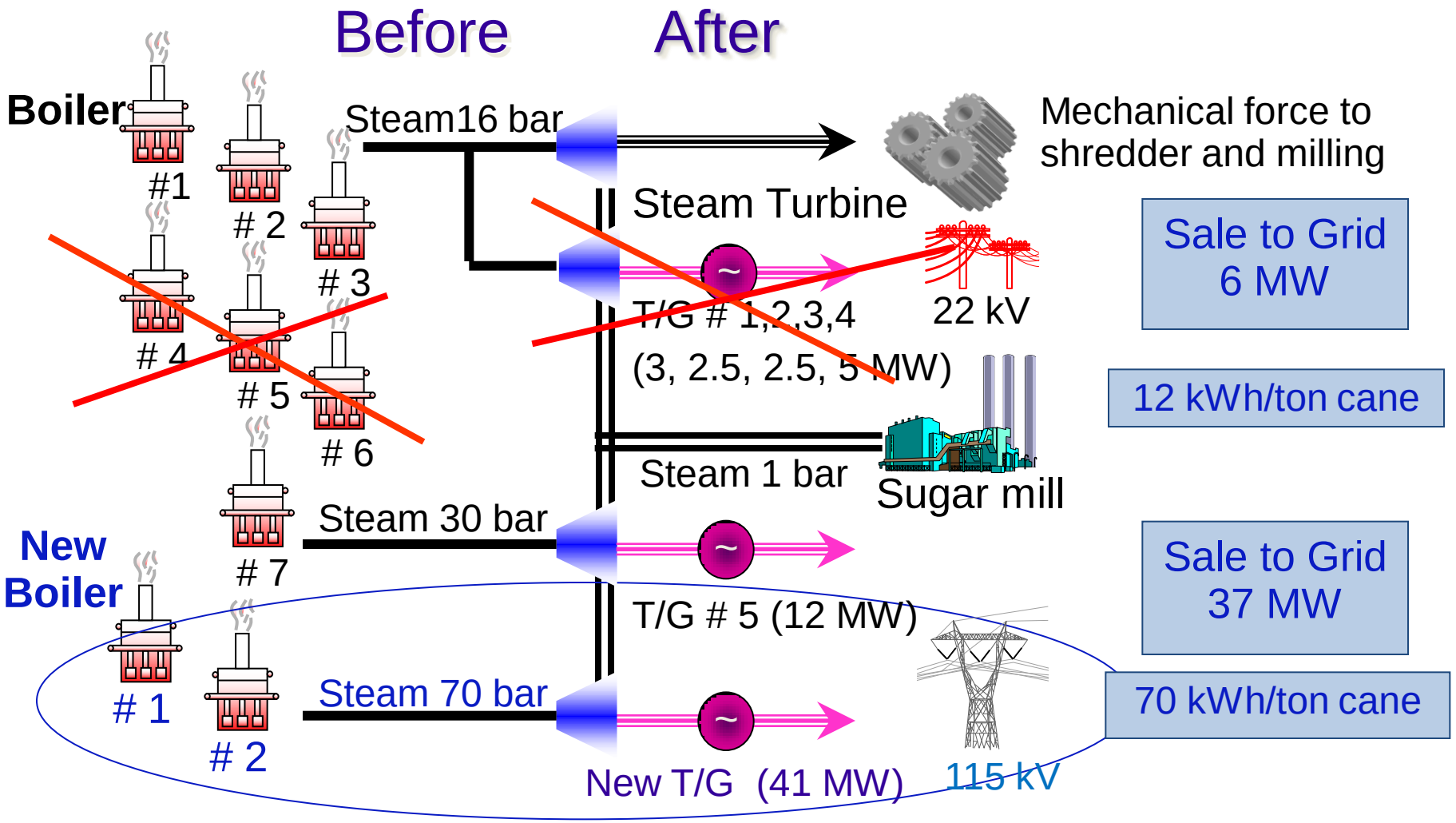
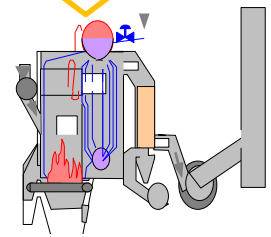
Major Technical Development

Aspects	Previous	Current
Equipment Pressure Level	16-30 bar 380 °C	70-100 bar 520 °C
Boiler Efficiency	< 80%	> 90%
Plant Thermal Efficiency	< 60%	> 70%
Flexibility in load change	low	High
Multi Fuel Firing	no	Yes
Control System	Manual or Semi Auto	Full Computerized
Operators' Skill	Fair	Trained & Skilled
Project Management	Unorganized	Professional

Transformation from Sugar Power House to Biomass Power plant

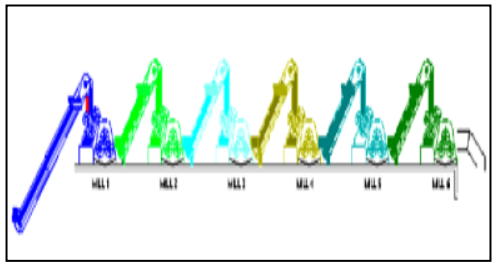


How does a High Pressure System Work?



280 kg. Bagasse

30 bar 380° C



Sugar Mill

1 ton Cane

Low Pressure Boiler and TG

36 kWH

0.45 ton steam @1.2 bar

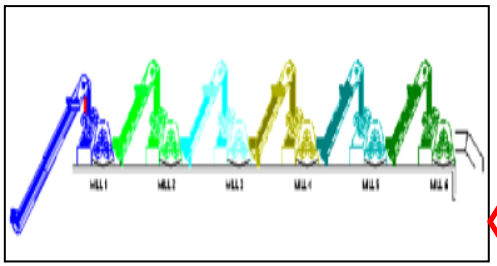
0.65 ton steam @ 30 bar

~

23 kWH

280 kg. Bagasse

100 bar 510° C



Sugar Mill

1 ton Cane

High Pressure Boiler and TG

35 kWH

0.45 ton steam @1.2 bar

0.65 ton steam @ 100 bar

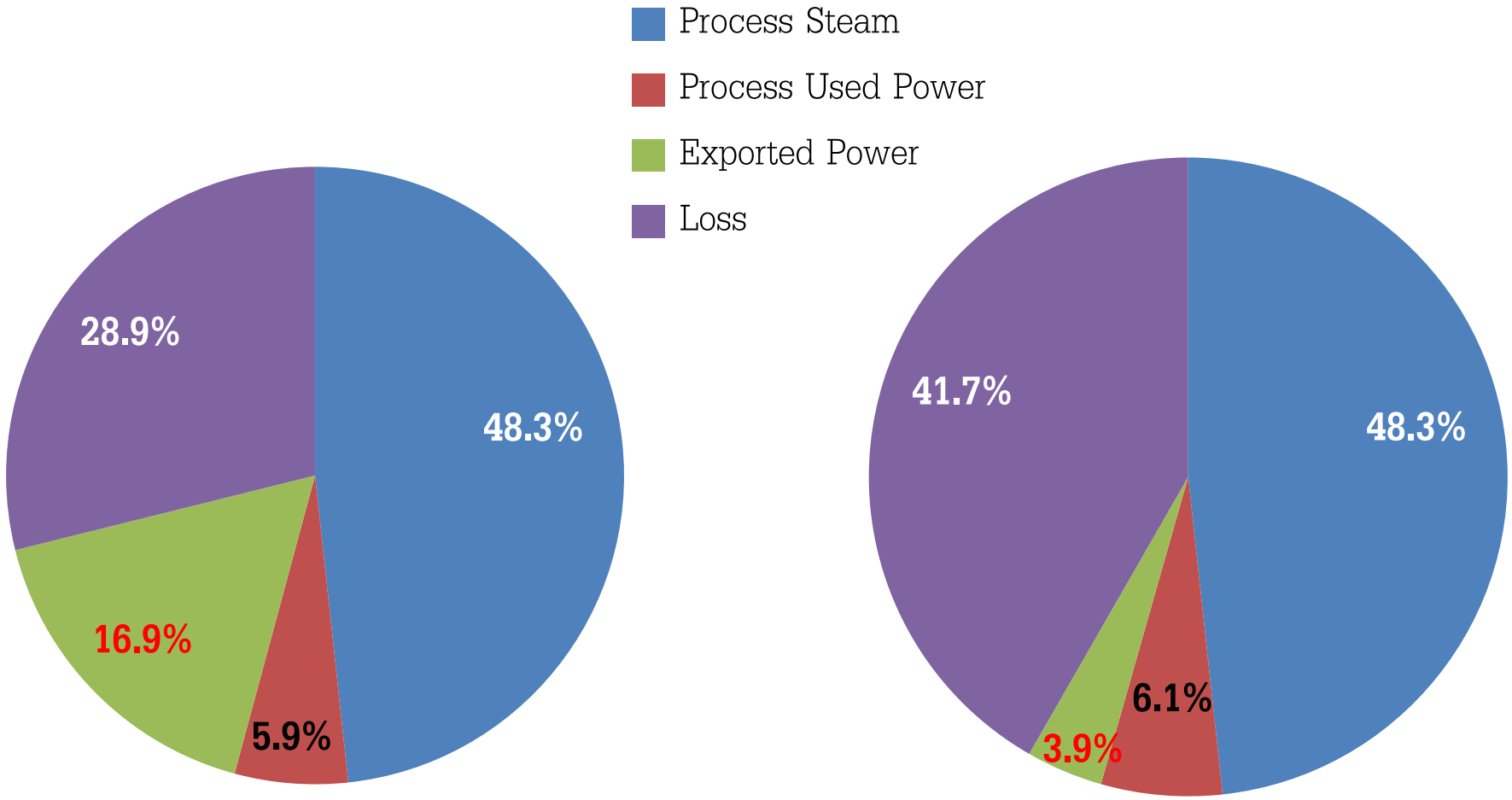
100 kWH

Strictly Confidential, Internal Use Only

Energy Balance Comparison

High Pressure Boiler and TG

Low Pressure Boiler and TG



Current Status of Power Co-Generation of Thailand's Sugar Mills

	Number of mills	Installed Capacity, MW	Exported Power, MW	Exported Unit, GWH	Sugar Cane, million ton	Exported Power, kWH/TC
Total	47	1008	397	1626*	95.35	17
With High Pressure	2	105	76	577	7.99	72
With Medium/low Pressure	45	903	321	1049*	87.36	12

* *Estimated from these assumptions:*
- *SPP firm : 330 day running with 95% Plant Factor*
- *SPP non-firm &VSPP : 150 running day with 80% Plant Factor*
- Countercheck with database from EPPO

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Development of Bagasse Power Plants in Thailand


REQUEST FOR PROPOSAL
POWER PURCHASE AGREEMENT
FOR SOLAR PHOTOVOLTAIC SYSTEMS

Issued By:

CITY OF SANTA ANA
PUBLIC WORKS AGENCY
20 CIVIC CENTER PLAZA, M-21
SANTA ANA, CALIFORNIA 92701

Project Manager:

Project Engineer:

1992

First SPP regulation was announced

1994

First Biomass Power Plant supply to grid 8 MW non-firm by a sugar mill

2001

Start feasibility study of high pressure co-generation

2004

First high pressure (70 bar 510 °C co-generation in biomass power plant

First PPA achieving firm contract with 29 MW

2012

First 105 bar 520 °C co-generation in biomass power plant

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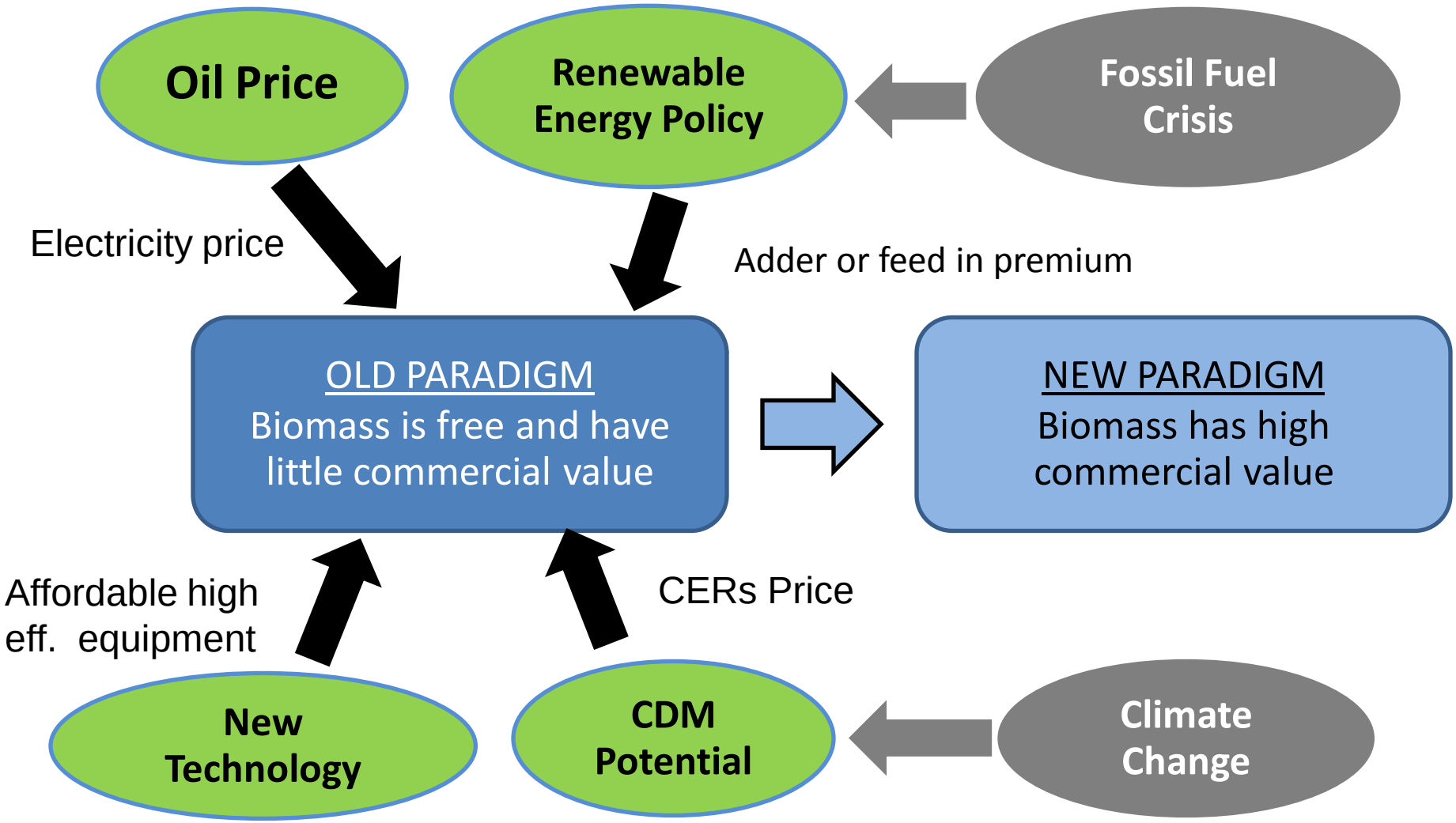
What led to the change?



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Favorable Environmental Impacts

Stack emission: Cleaner air

		(COAL)
• Particulate	20 - 50 ppm	(120)
• NOx	120 - 160 ppm	(350)
• SOx	0 - 8 ppm	(320)

Solid waste: Recycle back to farm

ashes from boiler can be used as soil improvement substance.

Global Warming: Reduce green house gas

- Grid emission factor : 500 kg CO_2/ 1 MWH

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Socio-Economic Benefits

Increased business activities in the local community

More jobs have been created

Created value added to many agricultural waste

New technology transfer to the industry

Reduction of the nation's import of fossil fuel for power generation

Challenges

Technical Challenges

Operational Challenges

Management Challenges

Financial Challenges

Technical Challenges: Seasoning Operation

	Crushing	Remelting
Steam Consumption, ton/hr	550	160
Power Consumption, MW	18	6
Bagasse Production, ton/day	8700	0
Operation Period, months	4 (Dec-Mar)	8 (Apr-Nov)

What capacity should the biomass power plant be ?

Technical Challenges: Technology Consideration

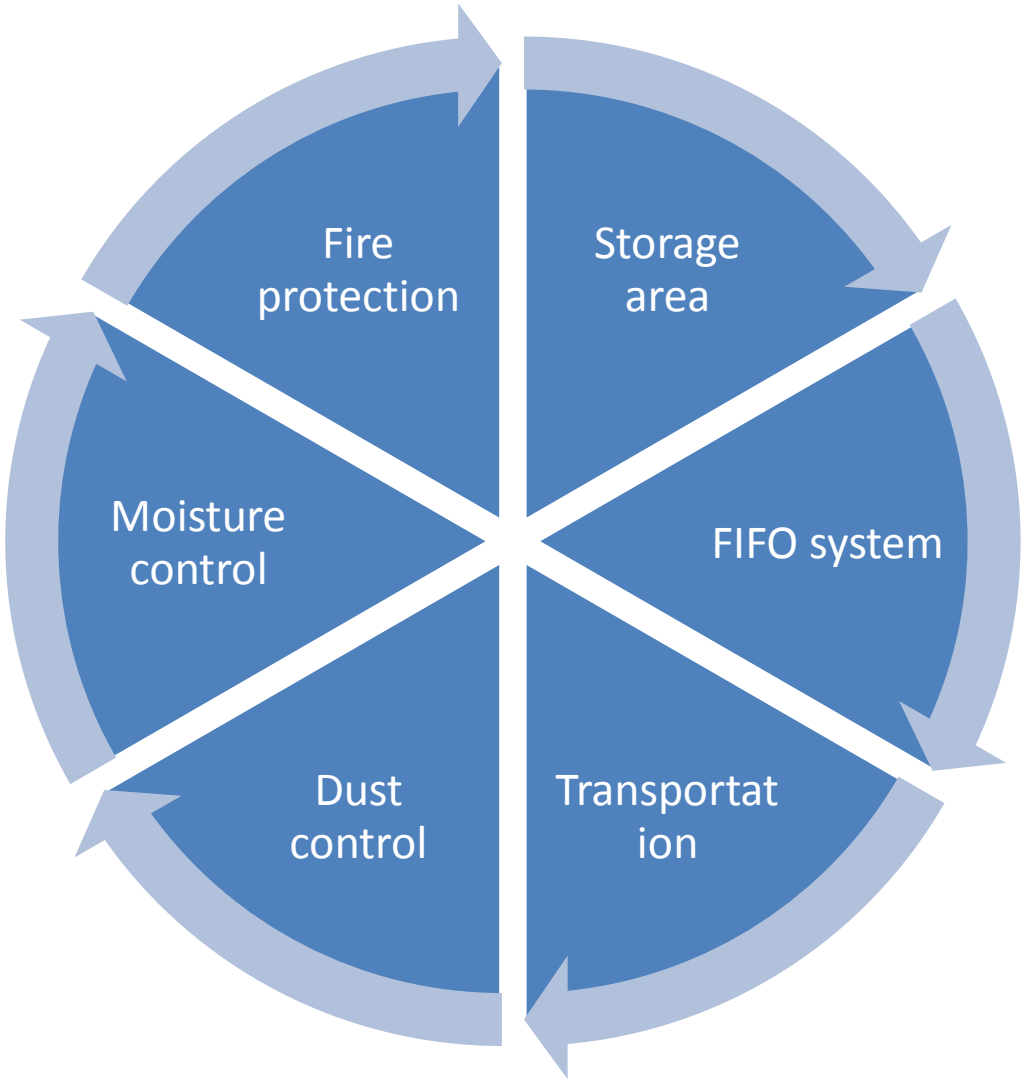
Basic Design	Type of Boiler	Type of Turbine	Water System
• Firm vs Non-firm • Bagasse fuel with or without supplementary fuel	• Heat recovery system • Emission control system: wet scrubber, ESP, bag filter • Supplemental fuel : rice husk, cane leaves, wood chips	• Back pressure + condensing VS extraction condensing • Single shaft or dual casing turbine	• Demineralization: Conventional Resin bed VS Reverse Osmosis • Condensate return : Direct mix or separate water circuit

Operational Challenges: Priority - Internal vs. External

Components	Sugar Mills	National Grid
Process type	Batch + Continuous type	Continuous
Main parameter	Steam pressure and flow	Electrical Power
Load characteristics	High load variation	Stable load
Flexibility	High	Low
Maintenance period	Short	Long
Defaults Event	Negotiable	Penalty

Who should have the priority?

Operational Challenges: Fuel Handling System



Operational Challenges: Supplementary Fuels

Rice husk

- High silica content
- High demand :competition with other rice husk users

Cane leaves

- High chloride content
- Difficult to handle : shredding, fire

Wood chips

- High lignin content
- Limit supply :competition with pulp mills

Management Challenges

	Current	New Scheme
Main Concern	Internal production	External customer
Efficiency	Less priority	Major concern
Engineering	In-house	Out-source
Investment	Low	High
People • Recruitment • Compensations	Sugar industry	Power plant
Communication	Informal	Formal

Need a new management concept !

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