GLOBAL FORUM

On Flaring and Venting Reduction and Natural Gas Utilisation

"UTILISATION OF HIGH CO2-CONTENT FLARE GAS FOR STEAM AND ELECTRICITY GENERATION"

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PETROBRAS

1. Palo Azul Power Plant Project
2. B18 Field - CDM PROJECT: Incorporate Additional Gas Supply

1.- Palo Azul Power Plant Project

Topics

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1. Location
2. Background
3. Technology and Operation
4. Environmental Issues
5. Location
6. Economic Issues
7. Video
8. Conclusions

1. Location

Location...

- Petrobras operates the Pata and Palo Azul fields in Block 18, located 300 Km. from Quito, the capital of Ecuador.
- Concession area: approximately 110,000 hectares.
- Location: Northeast section of the Ecuadorian Amazon Region, in the Province of Orellana.

Location...

Panoramic View
of the Palo Azul CPF

2. Background

Background ...

- In 2006, the Central Processing Facilities (CPF) were built with a capacity to process 40,000 BOPD (28° API), 75,000 BWPD and 12 MMSCF with 77% CO2.
- A power generation demand of 12 MW, with a 17.38 MW installed capacity, powered by provisional, portable diesel-fuelled reciprocal engines at a high fuel cost. Ecuador imports its diesel.

Background ...

- GOR wells = 400; 12 MMSCFD/ (77% CO2)
- Technological alternatives were analyzed for the use and disposal of the gas from flares for generating electricity and optimizing operating costs.

Background...

- Analyzed alternatives :
  - Combustible gas in Internal Combustion Engines.
  - Gas in Gas Turbines.
  - Flare Gas and/or crude oil in electricity generation with steam cycle.

Background...

- Technical-economic analyses determined that the combined steam cycle system is the best option for achieving:
  - Reduction of environmental emissions and noise pollution
  - Better use of flare gases
  - Minimum gas treatment
  - Substantial reduction of operating costs

Background...

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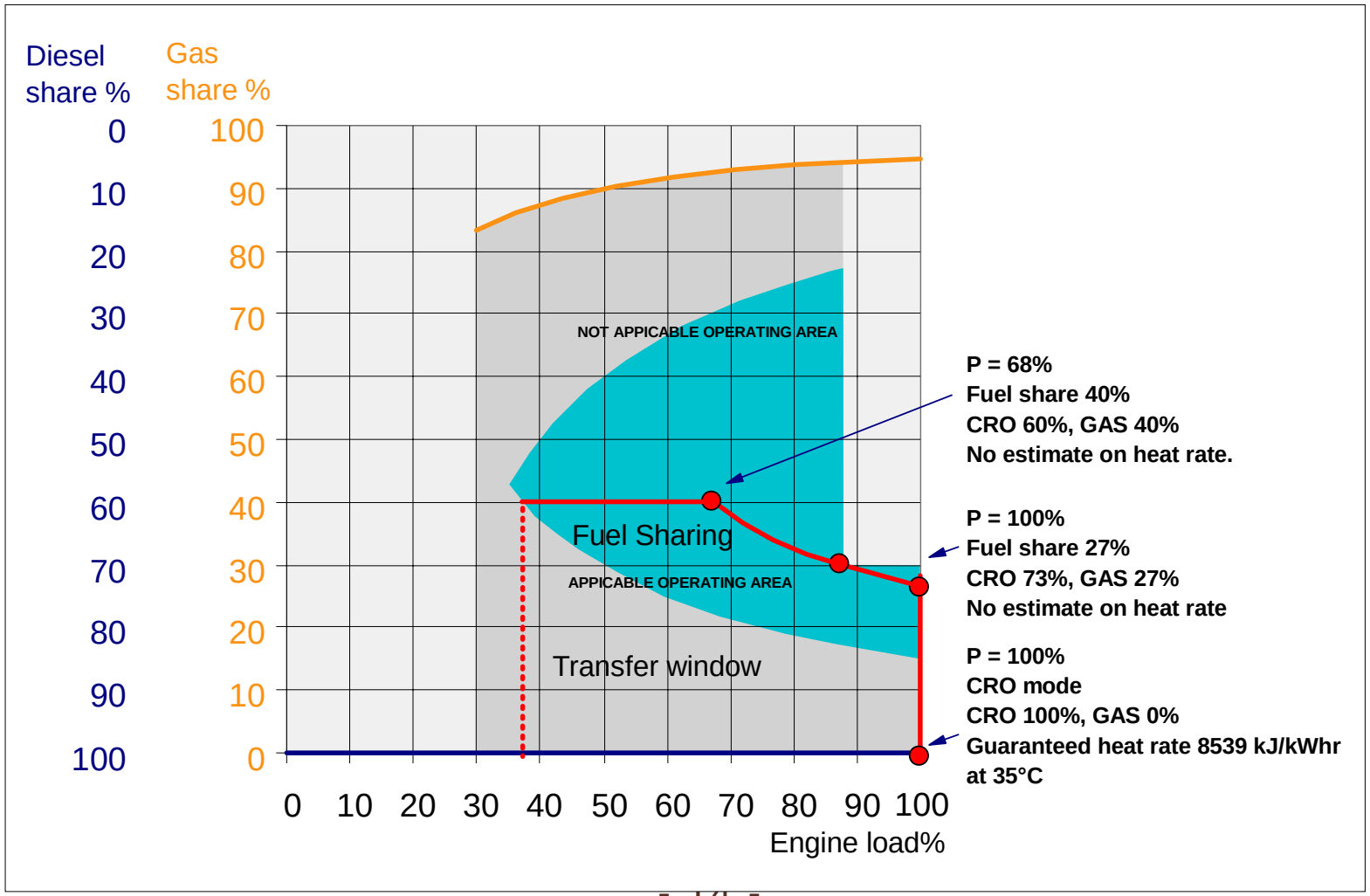
Alternative of a dual combustion engine implied:

- Limited operating window when gas quality decreases
- With full Load: 100%
  - Maximum gas utilization: 30%
  - Requires other fuel (diesel o crude oil): 70%
- More environmental emissions, particularly CO2

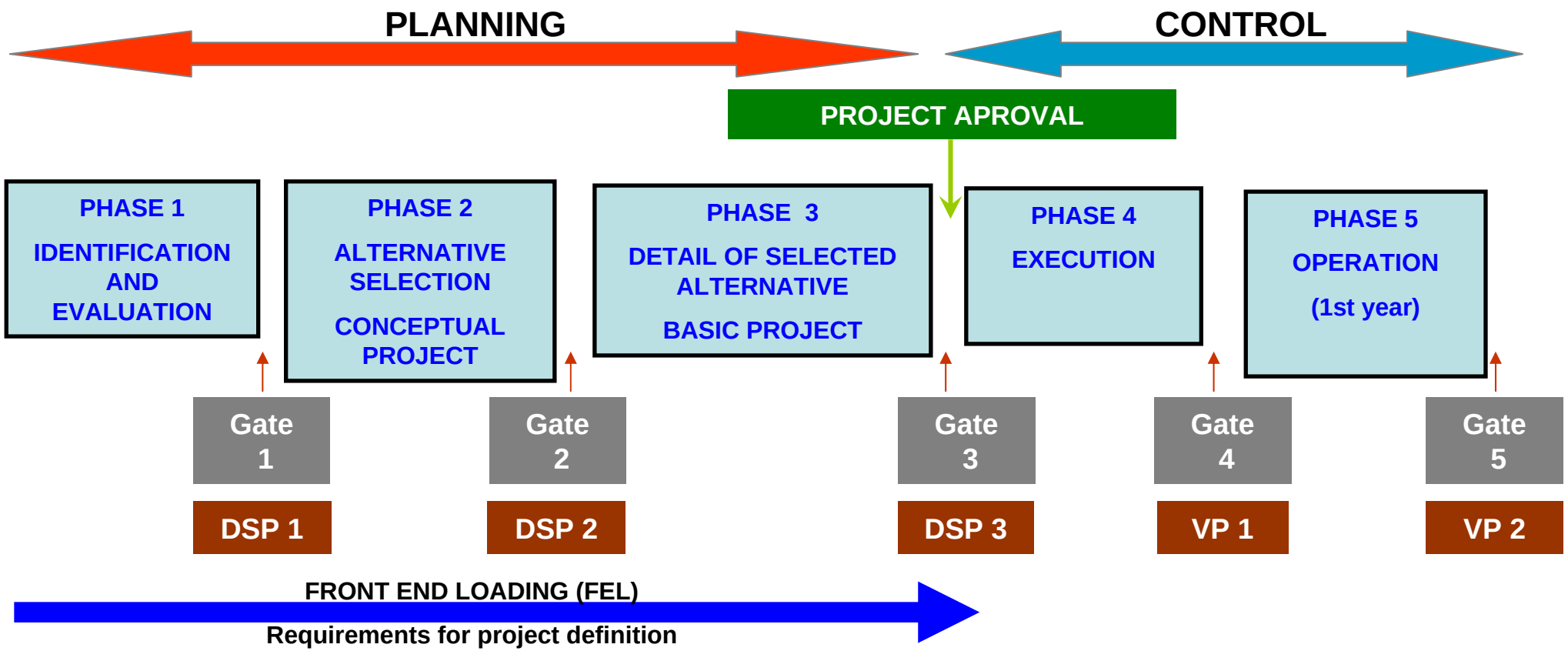
Background...

Poor gas operational window: Dual combustion engine



Background...

- The project was developed using SGPMP-PRODEP (PETROBRAS) methodology



DSP – DECISION SUPPORT PACKAGE VP – VERIFICATION PACKAGE

Background...

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APPLIED LAWS AND REGULATIONS:

- Ecuadorian Hydrocarbons Law, articles 11 and 24.
- Substitute Regulation of the Hydrocarbons Operations Regulation, articles: 11 and 13.
- Ecuadorian Water Act, article 82.
- General Rules for Applying the Water Act, articles: 13, 14 y 15.

Background...

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APPLIED LAWS AND REGULATIONS:

- Environmental Management Law, articles: 19 and 20.
- Environmental Regulation for the Electricity Industry, article 10.
- Electrical Sector Regime Law, articles : 2, 3, 30 and 40.
- Regulation of Concessions, Permits and Licenses for the Provision of Electrical Power Services, articles: 5, 11, 12 , 54, 55 and 95.

Background...

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GOVERNMENTAL APPROVALS:

- Authorization to use gas: DNH (*National Hydrocarbons Office*) resolution #683 of Nov,17th 2006.
- Authorization to use crude oil: DNH resolution #74 of 8/Feb/2008

Background...

GOVERNMENTAL APPROVALS:

- Authorization to use water: CNRH (*National Council of Water Resources*) resolution dated 29/Nov/2005.
- Environmental License: CONELEC (*National Electricity Council*) resolution #DE-06-055 of 6/Nov/2006.
- Authorization Contract for construction, installation and operation: executed with CONELEC on 9/Nov/2007.

3. Technology and Operation

Technology and Operation

- System : 2 steam 6 MW turbogenerators and 1-5.38 MW motor generator.
- 12 MW net generation with gas, 17.38 MW installed capacity.
- Back up motor generator fuelled by crude oil or diesel for start up and auxiliary system.
- Hybrid System using all high CO2-content gas with no prior treatment, depending on required demand.

Technology and Operation

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- Boilers with cutting-edge gas-crude oil dual burners.
- All available gas calorific energy is used. (470 BTU/CF)
- Additional contaminant of gas emissions (CO_2, among others) are avoided by not burning fossil fuels, such as crude oil, diesel or bunker.

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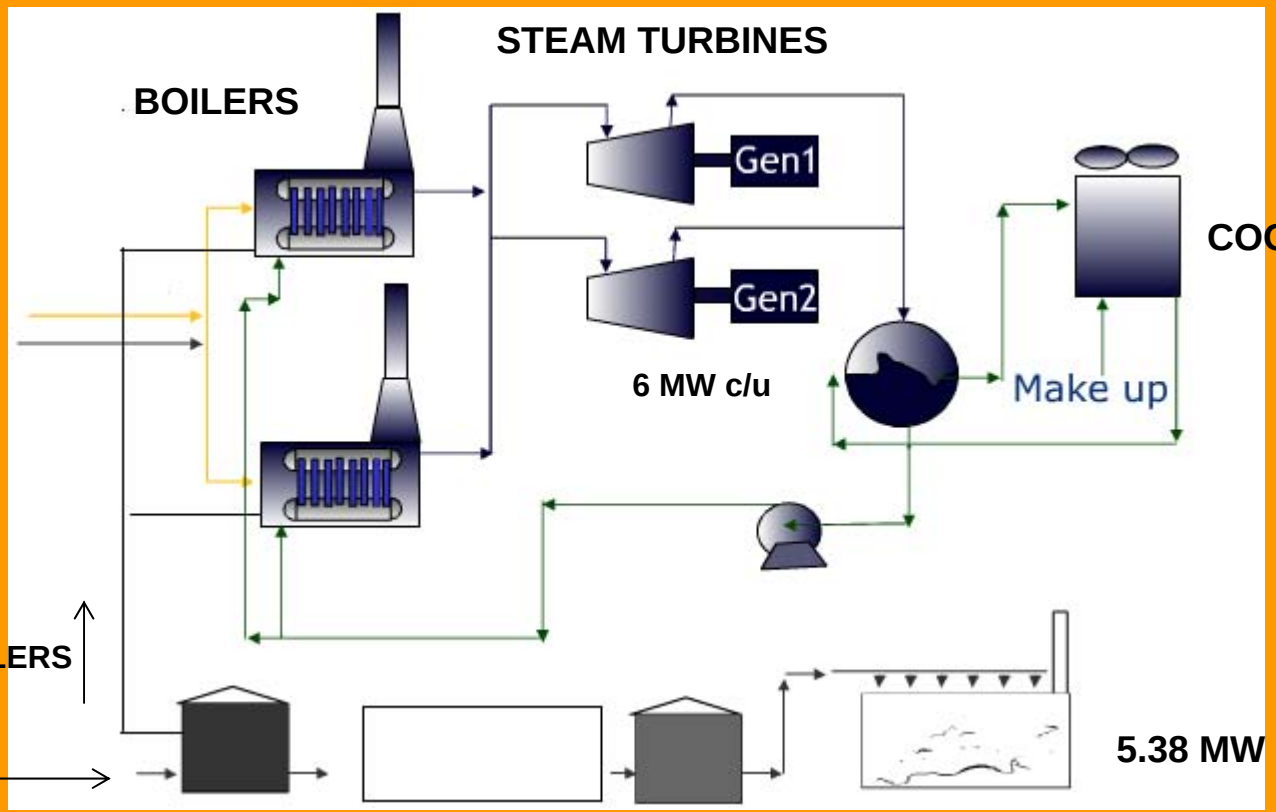
Power Generation Plant Layout



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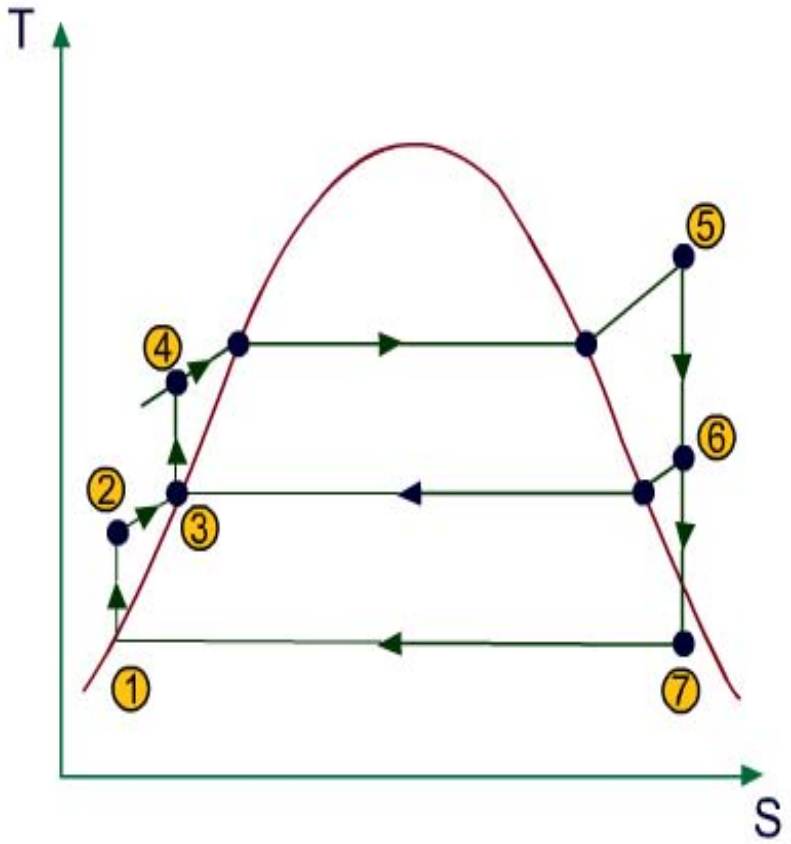
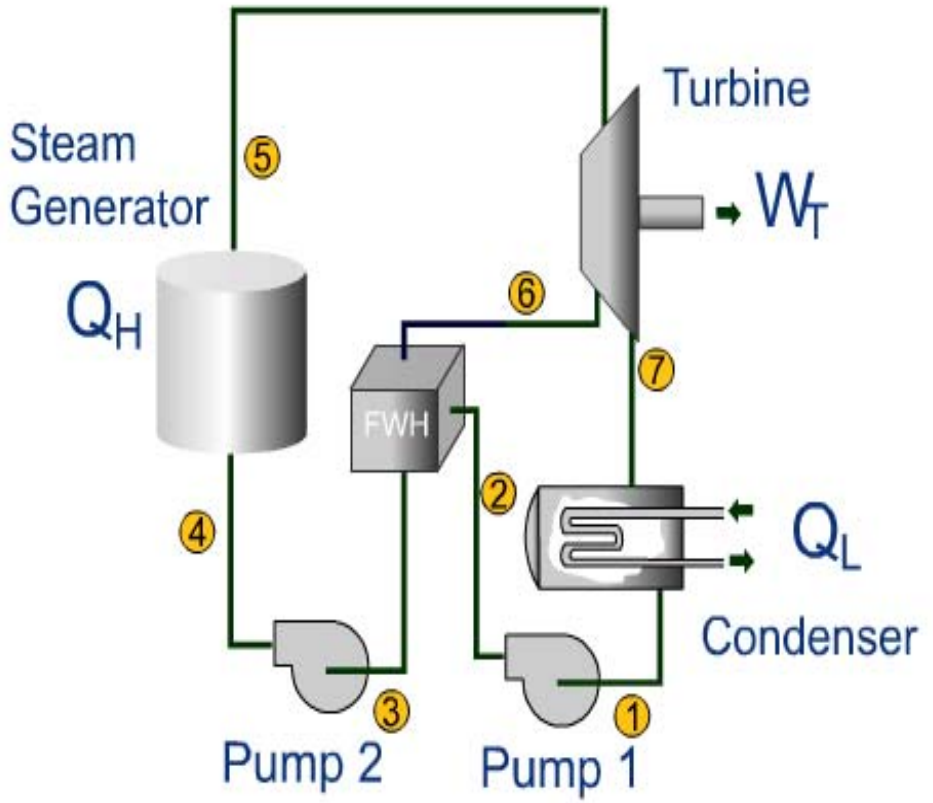
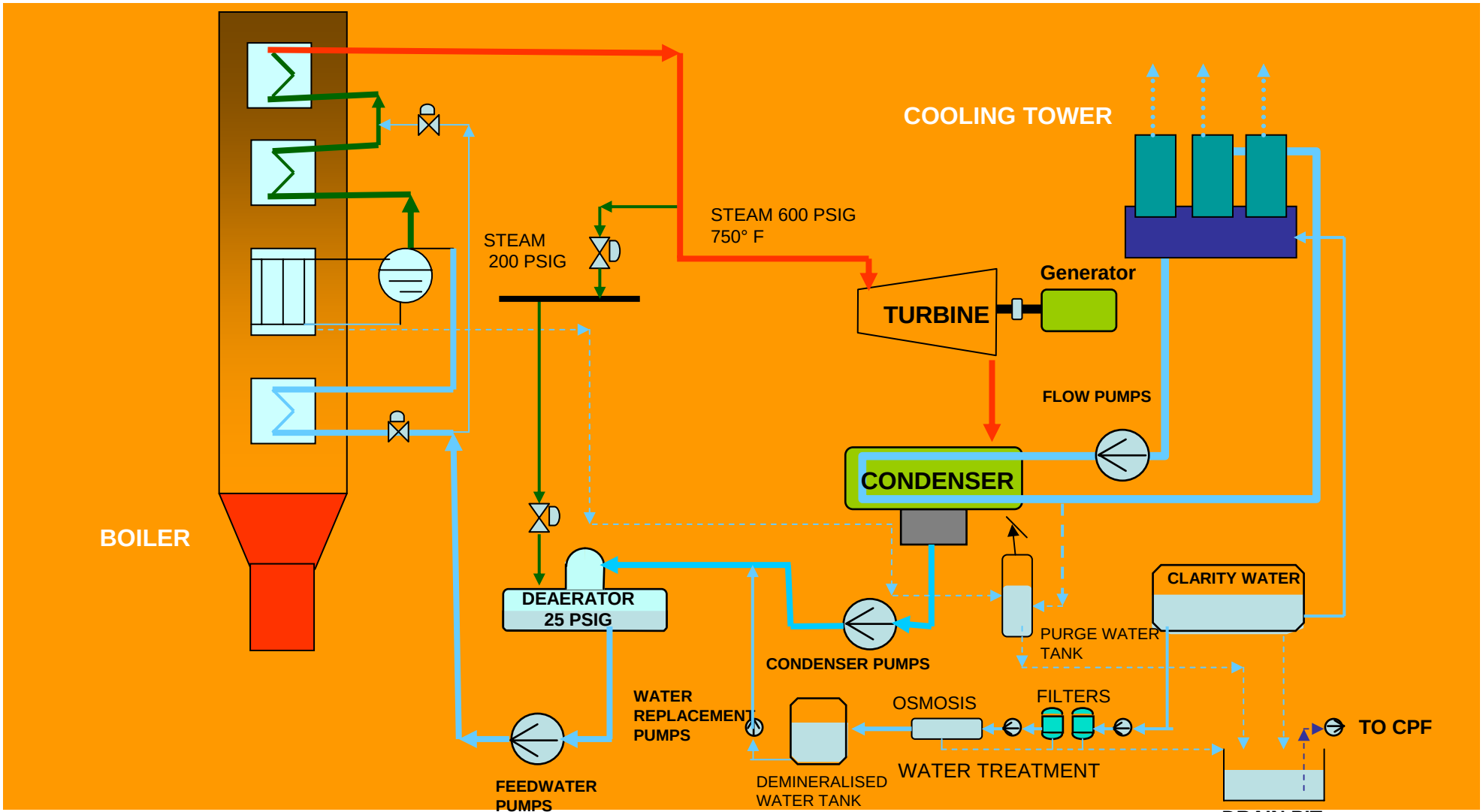
Water-Steam Cycle (Rankine Cycle)

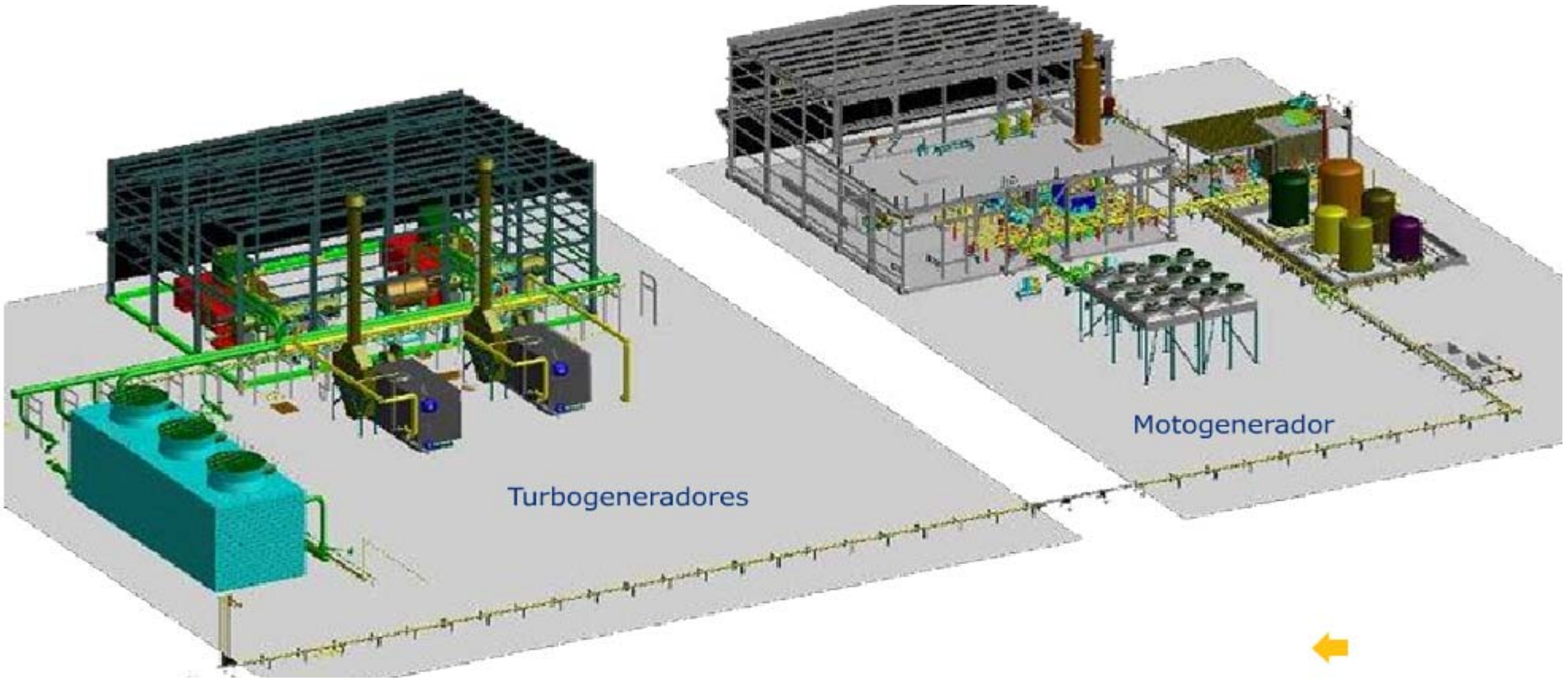




Steam Circuit Layout



3-D View of Plant



Panoramic View of Boilers Area

Boiler Unit

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Crude Oil Generator Unit

4. Environmental Issues

Environmental Issues...

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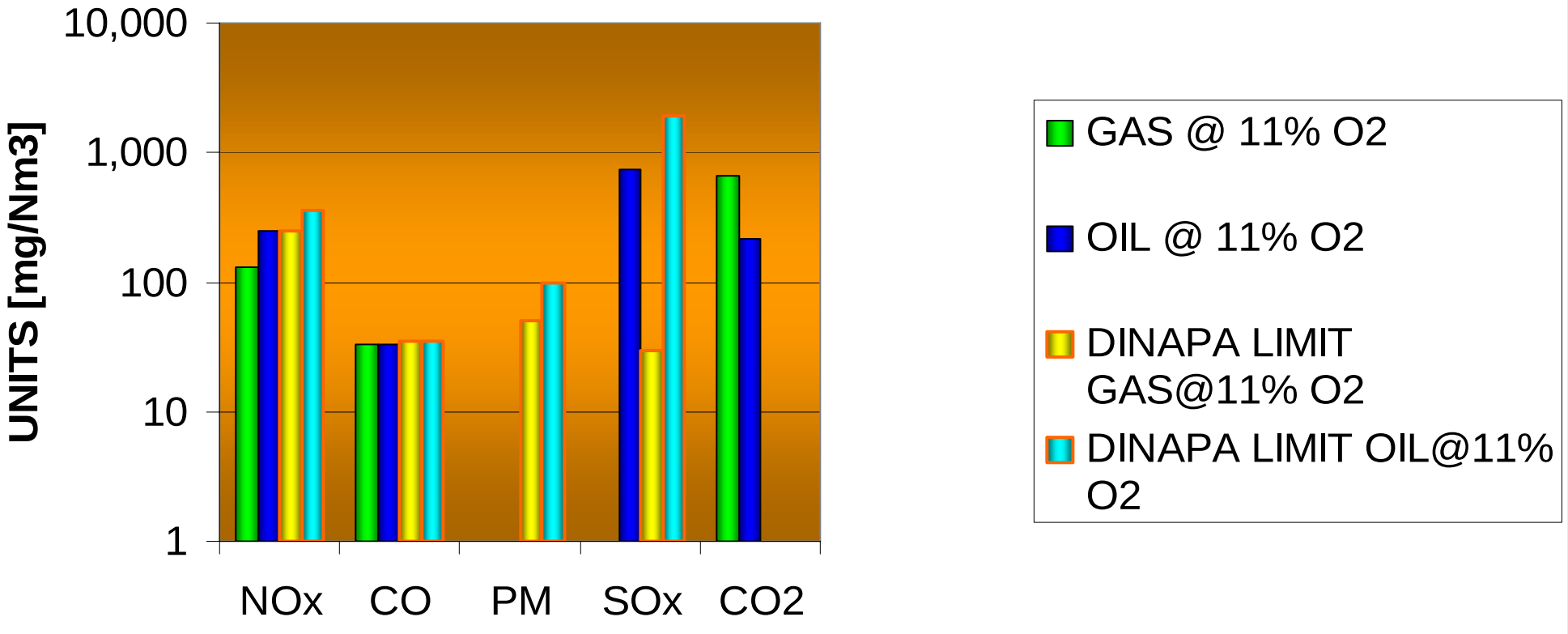
EMISSIONS OF THE BOILERS vs REQUIREMENTS DINAPA[a]

DINAPA: GOVERNMENT ENVIRONMENTAL OFFICE



5. Economic Issues

Economic Issues

- Project allows the use of 100% of flare gas for the steam cycle as thermal energy.
- The achieved results consist of a 90% reduction in equivalent energy expenses, 37% savings (OPEX).

Economic Issues

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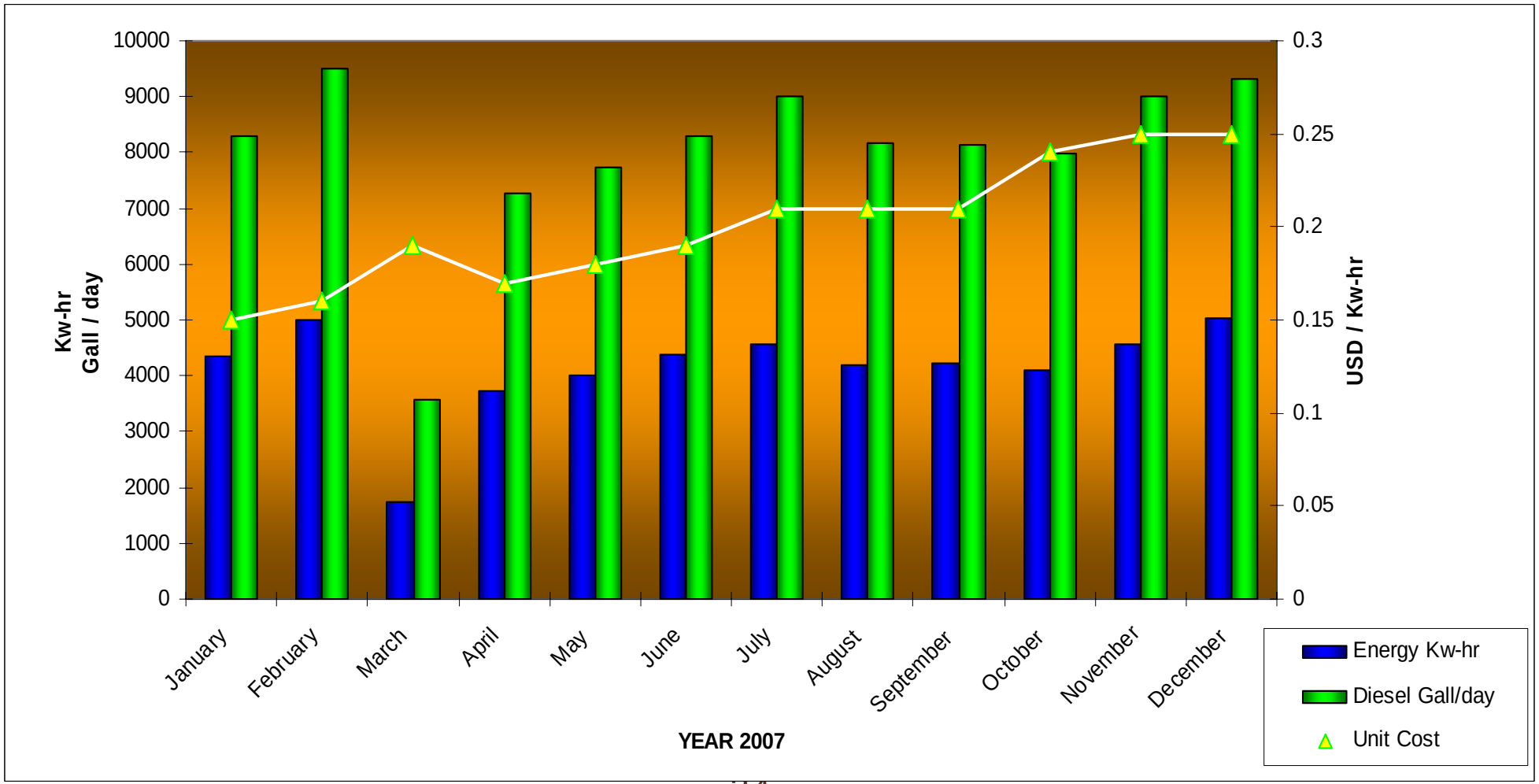
Year 2007: Power Generation with Diesel # 2



Economic Issues

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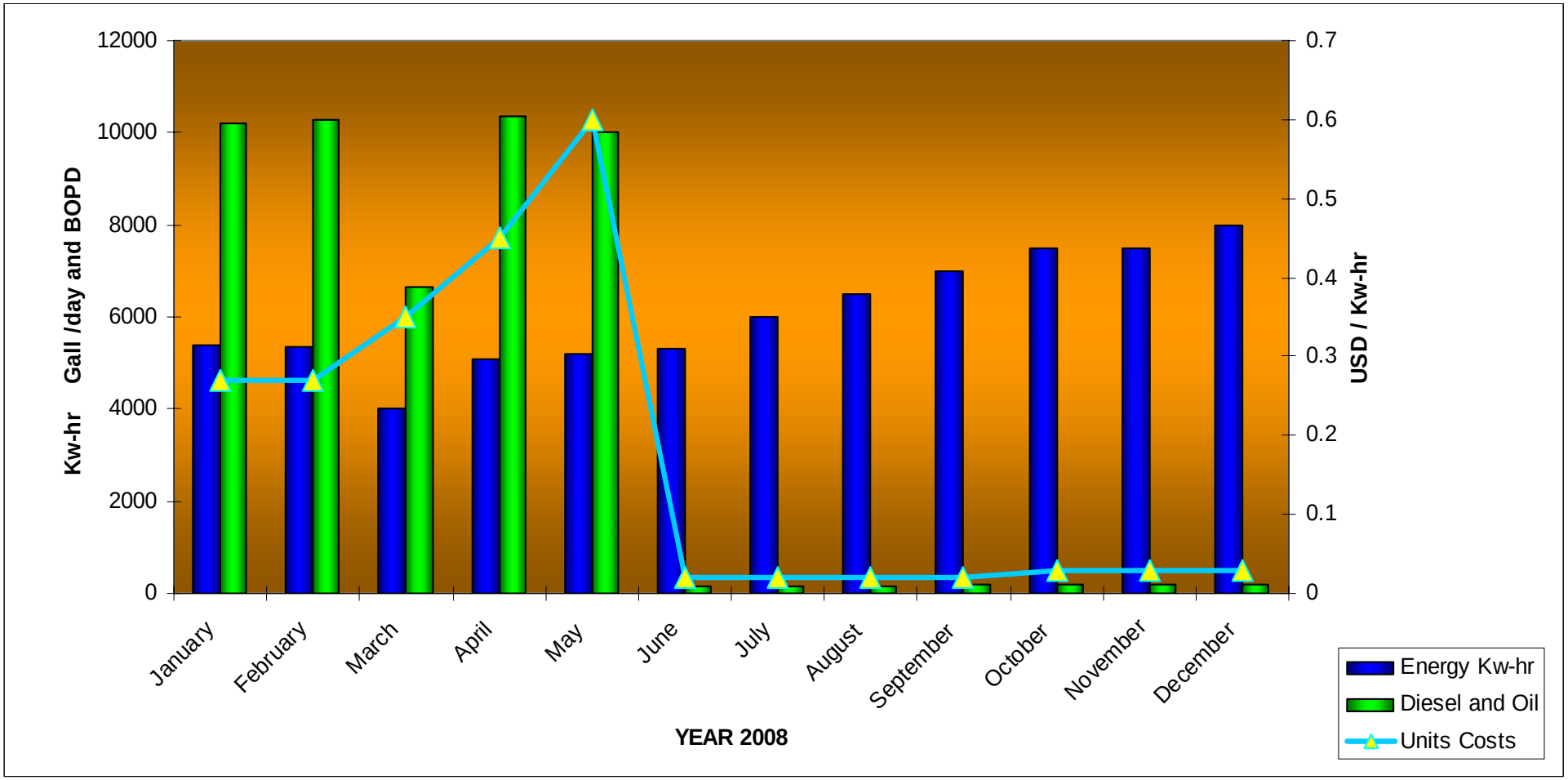
Year 2008: Power Generation with Flare Gas



6. VIDEO

Existing Plant

Video

7. Conclusions

Conclusions

- Flexible system, poor gas options, poor and rich gas or crude oil blends.
- Use of flare gas, no prior treatment required, only removal of liquids.
- Reduction of 60 MTCDE/year.
- Possibility to use 100% of available gas (12 MMSCFD). Current use is 50%.
- Flexibility for adapting to future field requirements, depending on oil and formation water production.

Conclusions

- Reduction of emissions compared to those of previous plant

EQUIP.	SO2 (mg/m3)	NOx (mg/m3)	CO (mg/m3)	MP (mg/m3)
Diesel Gen.	301	2,085	142	24
Gas Boiler	< 5	17	< 5	< 5

- Reduction of noise from 115 to 88dB in turbines area.
- Immediate effects consisting of a 90% of energy savings and 37% of OPEX, approximately

2.- B18 Field - CDM PROJECT: Incorporate Additional Gas Supply

Gas avalability vs Power Demand

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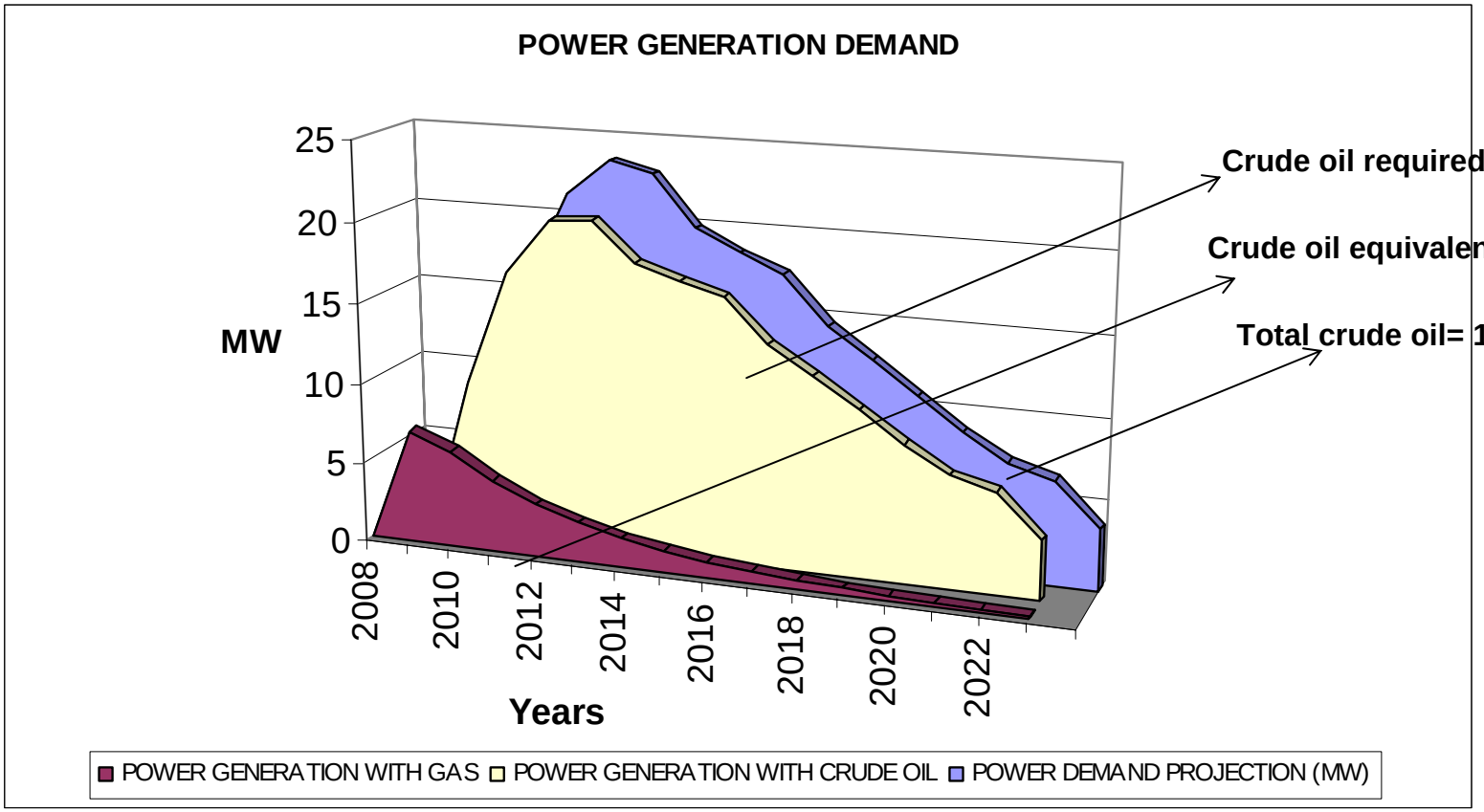
- Gas projection indicates continuing decrease in quantity:

  - Current 12 MMSCF vs.0.1MMSCF (2022)

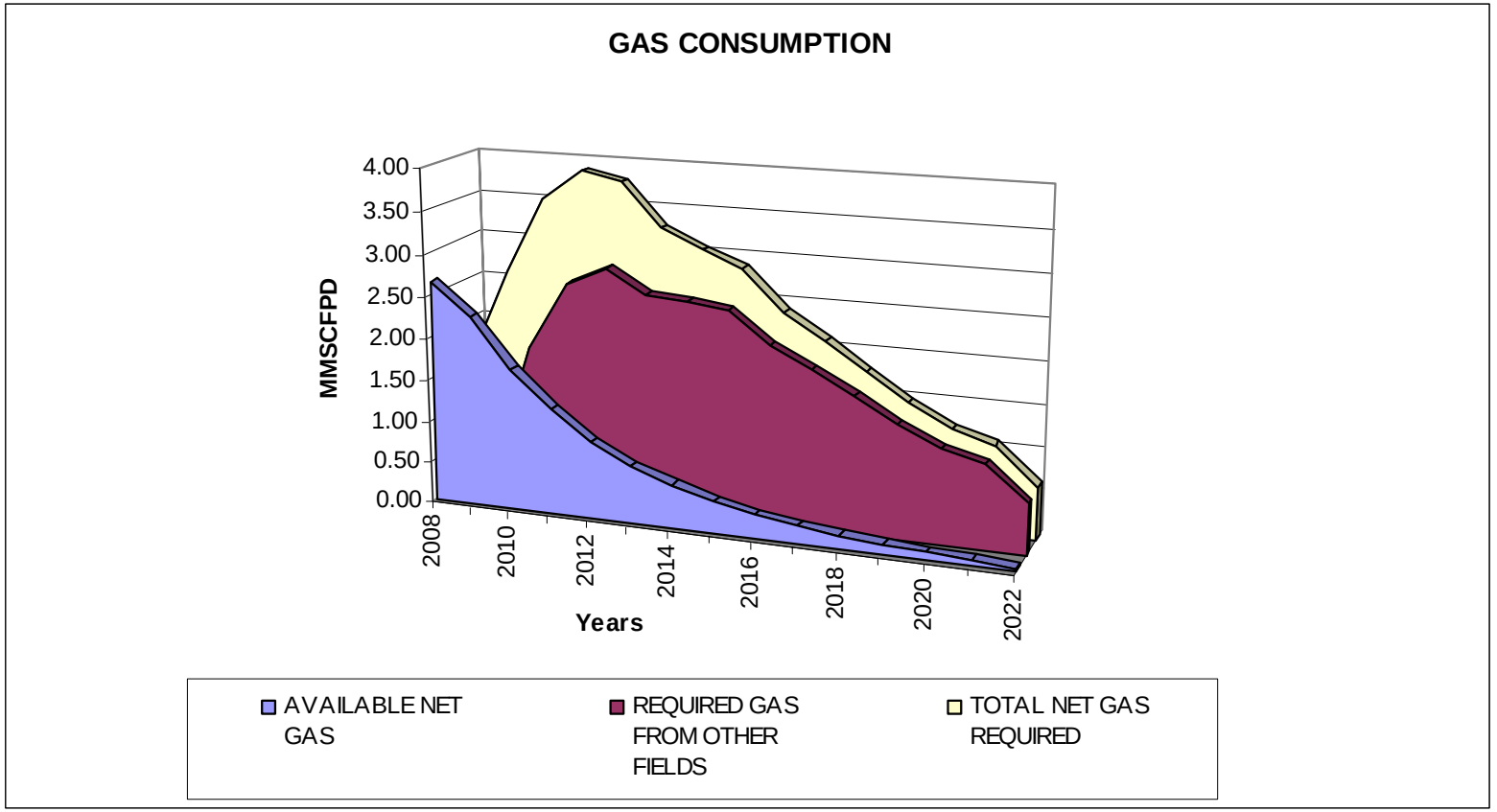
- Power demand increasing, expected peak of 23 MW in 2011

- Future flare gas deficit in power demand peak: 3 MMSCFPD

Project Generation Demand



Gas consumption



Objectives…

- Gas purchase from nearby oil fields.
- Near future: Replace crude oil burning with gas burning.
- Expected savings aprox. 1.6 million barrels of crude oil in 14 years for the Block 18 oil field.
- Project development, currently status at Identification & Evaluation phase.

Objectives…

- Expected total savings of aprox. of 1.3 MMTCDE (not burning crude oil) during 14 years.
- Project meets CDM requirements
- Bonuses CER´s are expected
- Project could be part of the Programatic CDM activities of Petrobras-PESA

Thank You