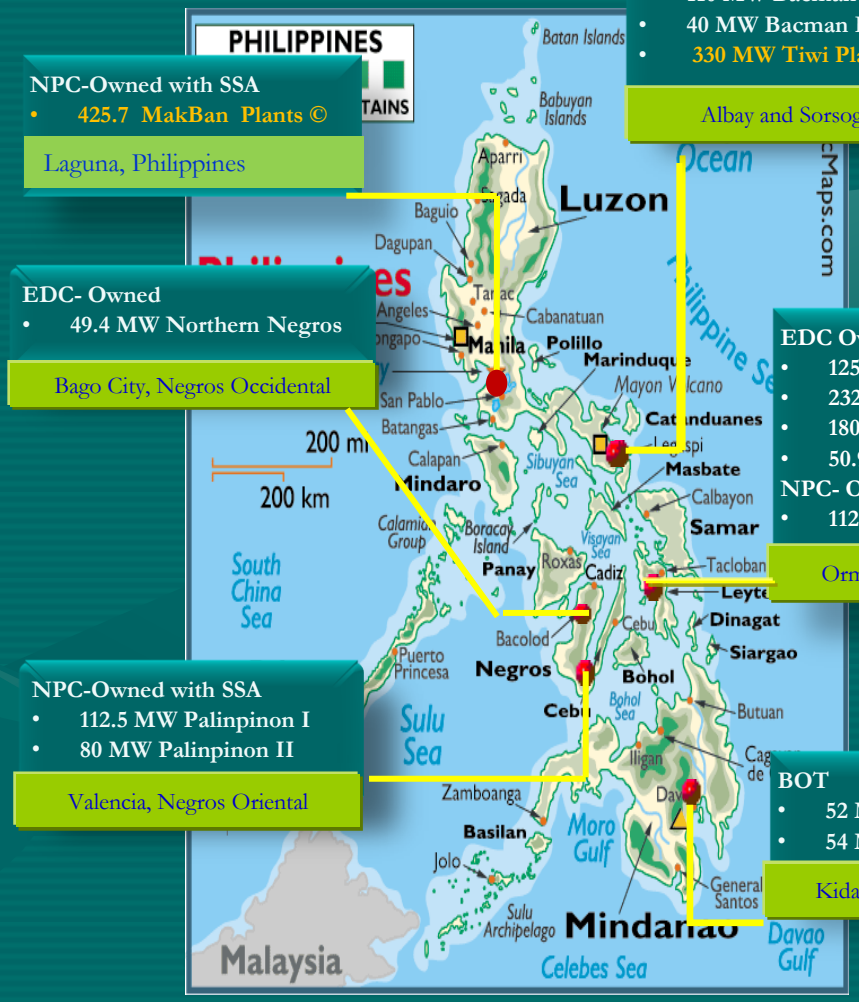
GEOTHERMAL ENERGY DEVELOPMENT IN THE PHILIPPINES WITH THE ENERGY DEVELOPMENT CORPORATION EMBARKING INTO POWER GENERATION

By:

Danilo C. Catigtig
Energy Development Corporation
Merritt Road, Fort Bonifacio, Taguig City, Philippines
catigtig@energy.com.ph, catigtig.danc@gmail.com

Geothermal Power Development in the Philippines

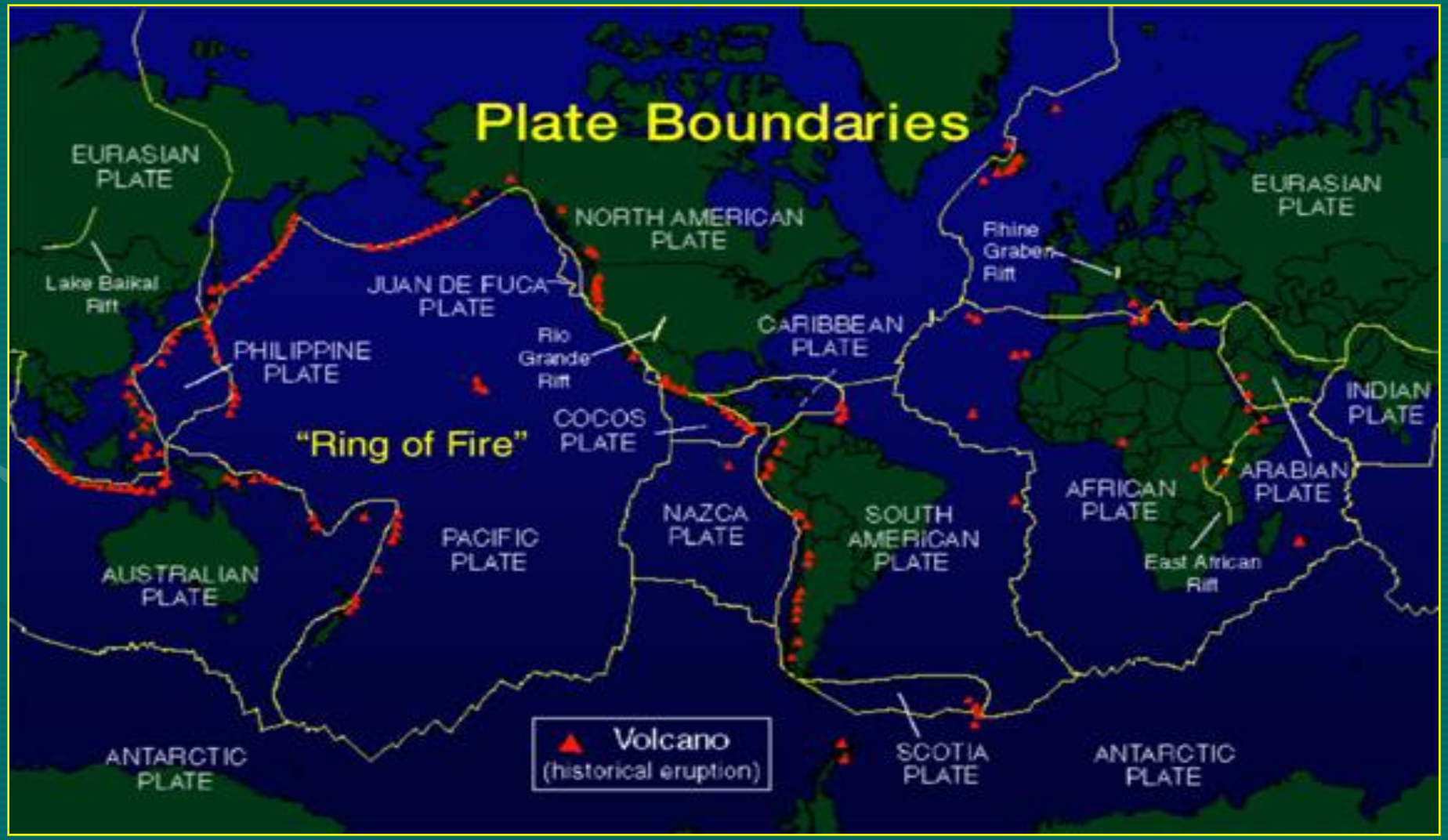
- 1977 : 3 MW pilot plant
- 2008 : 1954 MW, EDC = 61.2 %, 1199 MW.



Geothermal Power Development in the Philippines was largely driven by the following factors:

- the country's Geographical setting
- strong Government support, and
- efficient Resource Management

Geographical Setting- the country is situated in the circum-pacific ring of fire where geothermal resources abounds



Strong Government Support – the government enacted laws and issued decrees and executive orders which provides incentives to would be developers.

Year	Laws, etc	Event
1973	PD 334	Creation of the Philippine National Oil Company (PNOC).
1975	PP 1112 PP 1413 PP 2036-A	• Established the Geothermal Reservation in Tongonan. • Established the Geothermal Reservation in Palinpinon. • Established the Geothermal Reservation of Bacon-Manito.
1976	PD 927	Created the Energy Development Corporation under PNOC.
1978	PD 1442	Enacted the Philippine Geothermal Law.
1987	EO 215	Allowed the private sector to finance, build and construct power plants.
1992	PP 853	Established the Geothermal Reservation of Mt. Apo in Mindanao..
1990	RA 6957	Enacted the Build Operate Transfer Law.
2001	RA 9136	Enacted the Electricity Productivity Industry Reform Act.

Efficient Resource Management - EDC pursued vigorously the acquisition of geothermal technology expertise and applied the same for the efficient and sustainable management of the geothermal resource.

EDC Staff acquired its expertise in Geothermal Technology thru:

- Foreign training at the Geothermal Institute, New Zealand; at the UNU in Iceland and Japan; and short trainings in the USA and Germany, among others.
- On the job and in-house training at the geothermal project sites side by side with consultants and later by senior experienced staff at EDC's Geothermal Laboratory (EDC's 5 Geothermal Project sites).
- Local trainings provided by academes and agencies

EDC developed practices towards sustainable resource management :

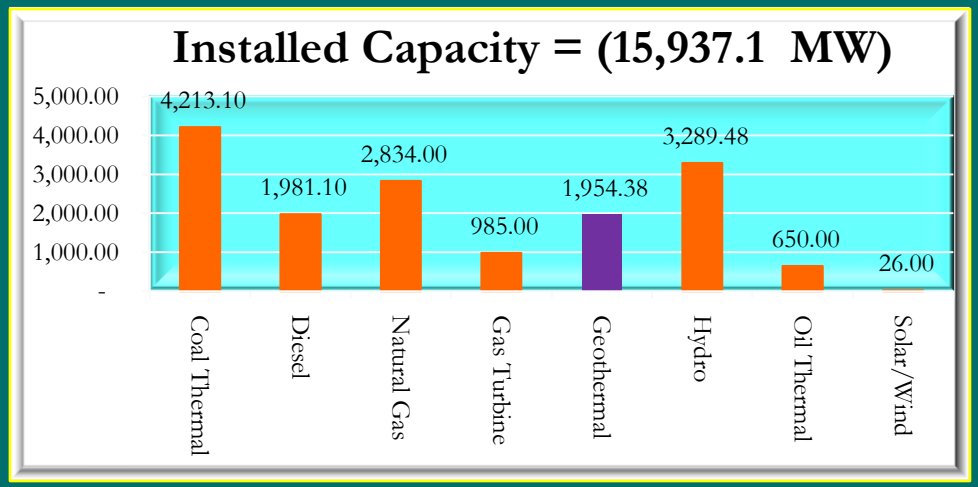
- On-line steam purity monitoring,
- Adoption of the brine reinjection system,
- Tracer testing to predict and identify proper RI sectors,
- Adoption of calcite inhibition system,
- Adoption of Silica inhibition system,
- Proper collection of suspended solids in the fluid path, and
- Adoption of a proper well utilization strategy, among others.

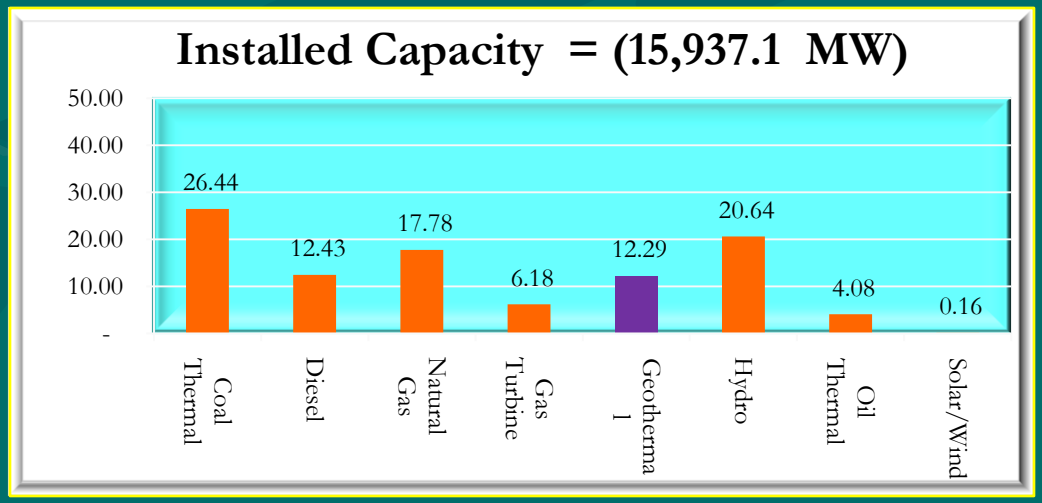
From 1977 to 2007 the accelerated development raised the geothermal power installed capacity of the country to 1954 MW, with EDC contributing 61%.

Field	Gross Cap (MW)	Steam Field Operator	Power Plant Operator
Tiwi	330.0	Chevron	National Power Corporation
Mak-Ban	425.7	Chevron	National Power Corporation
Tongonan I	112.5	Energy Development Corp.	National Power Corporation
Unified Leyte	588.4	Energy Development Corp.	Energy Development Corp.
Palinpinon I	112.5	Energy Development Corp.	National Power Corporation
Palinpinon II	80.0	Energy Development Corp.	National Power Corporation
Bacman I	110.0	Energy Development Corp.	National Power Corporation
Bacman II	40.0	Energy Development Corp.	National Power Corporation
Mindanao I	52.0	Energy Development Corp.	Marubeni (EDC BOT)
Mindanao II	54.0	Energy Development Corp.	Marubeni (EDC BOT)
Northern Negros	49.4	Energy Development Corp.	Energy Development Corp.
TOTAL	1954.1		

Source: PNOC-EDC and Chevron, 2008

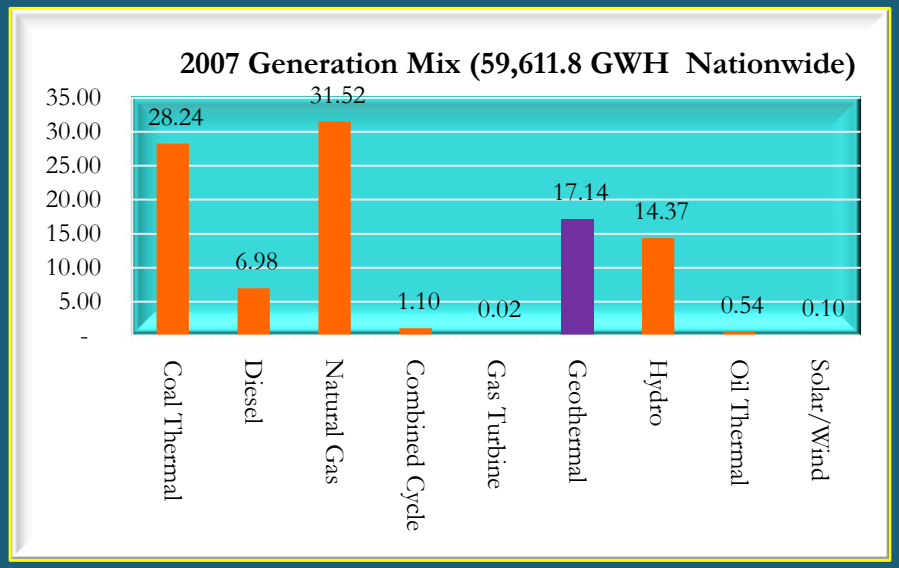
2007 Philippine Energy Mix - in terms of installed capacity, geothermal contributes 12.20% , whereas in terms of electricity generation it contributes 17.1 % indicating its high availability and dispatch priority.

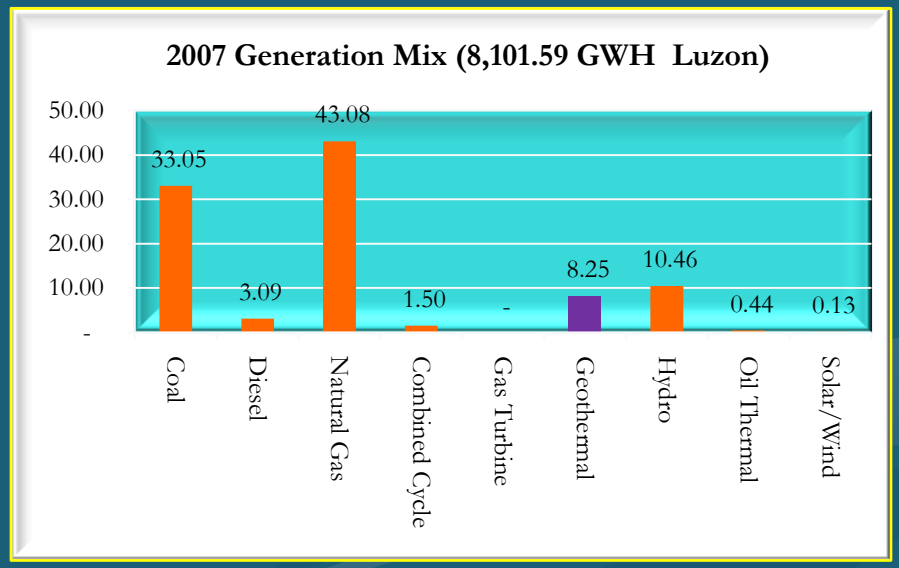


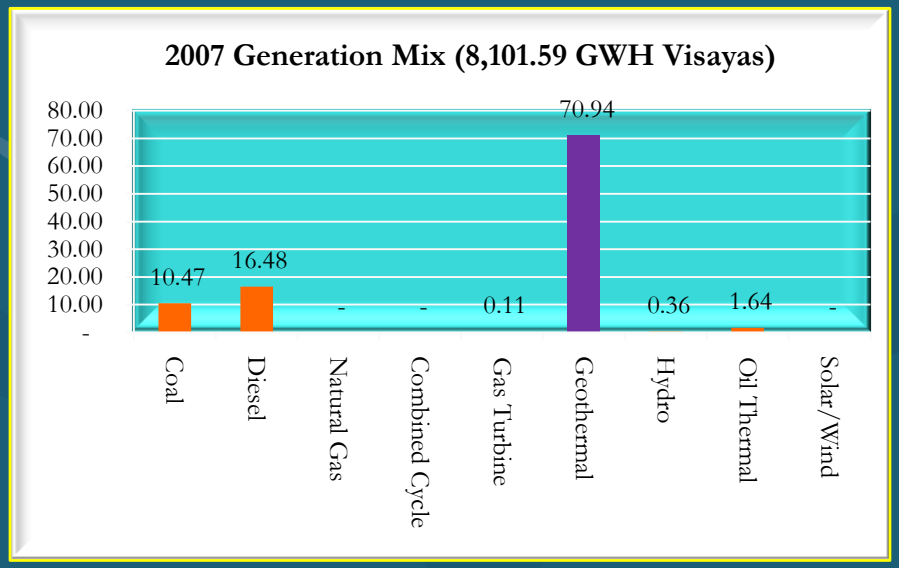


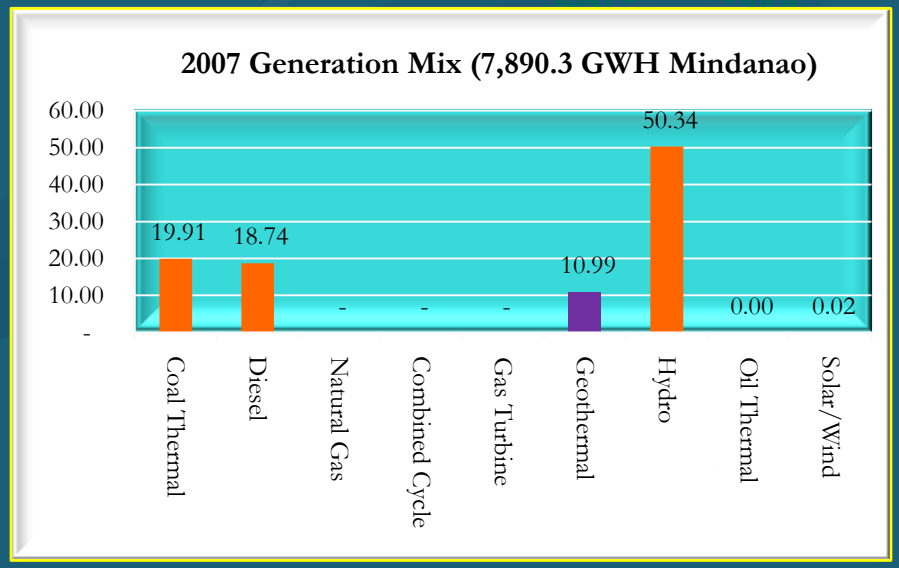
Source: DOE website, 2008

2007 Philippine Energy Mix in terms of Annual Generation









Source: DOE website, 2008

History of the Energy Development Corporation (EDC)

Company History - EDC's history is closely tied-up with the enactment and issuance of the pertinent laws and regulations that provide d incentives to developers.

Year	Event
1973	Creation of the Philippine National Oil Company (PNOC)
1976	• Creation of the Energy Development (100% GOCC) Corporation under PNOC (PNOC-EDC). • Implemented the Geothermal Development program of the government with the NZ government
1977	• Supplied steam to the first 3 MW NPC geothermal pilot plant at Tongonan, Leyte • Philippines became the 9th country that harness geothermal energy for electricity generation.
1980	Supplied steam to 2 x 1.5 MW NPC pilot plants at Palinpinon
1983	• Supplied steam to the 112.5 MW NPC plant at Tongonan • Supplied steam to the 112.5 MW NPC plant at Palinpinon • Philippines became the 2nd largest geothermal producer (includes 660 MW Chevron steam supplied plants)

Company History – EDC's entry into the power generation business was precipitated by the enactment of the BOT Law to address the power shortage.

Year	Event
1990's	EDC expanded its business operation on both the steam field and power generation sectors: • 1993/97- Supplied steam to the 150 MW Bacman 1 & 2 NPC plants • 1993- Supplied steam to the 80 MW Palinpinon 2 NPC plants • 1996-1997; Commissioned the 588.4 MW Unified Leyte plants with BOT partners (CalEn and Ormat) • 1997- 1999; Commissioned the 106 MW Mindanao plants with Marubeni as BOT partner. Entered into 10-Year Energy Conversion Agreements (ECA) with the BOT partners and a 25-Year Power Purchase Agreement (PPA) with NPC for the sale of electricity.
2001	The Electricity Production Industry Reform Act was enacted which calls for the privatization of the NPC power plants.

Company History - EDC's privatization was hastened by the passage of the EPIRA which requires privatization of the generating assets of the government (e.g., NPC plants).

Year	Event
2004	EDC revived its privatization plan.
2006	• Took over the operation of the 125 MW UMPP power plant from CalEn in June. • Conducted IPO for the first 40% Common Shares on December 13.
2007	• Commissioned the 49.4 MW NNGP merchant plant in February and entered into 5-Year Energy Supply Agreements (ESA) with Electric Cooperatives. • Follow on offering of the 20% common shares on July 10. • Took over the operation of the 180 MW Mahanagdong and the 232.5 MW Malitbog plants from CalEn in July. • Took over the operation of the 50.9 MW optimization plants from Ormat in September. • Attained 100% private status with the sale of the remaining common shares and preferred shares to Red Vulcan Holdings on November 21.

EDC's Core Competencies

Company History - EDC's core competencies covers all of the facets of geothermal power development from resource exploration up to electricity generation.

1. **Energy Exploration and Development**
   - •Geosciences
   - •Resource assessment
   - •Reservoir engineering & management
2. **Drilling**
   - •Geothermal, oil & gas, water & mineral wells
   - •Well engineering
   - •Rig management, maintenance & rehabilitation
3. **FCRS Operations and Maintenance**
4. **Power Plant Operations and Maintenance**
5. **Engineering, Design and Construction**
   - •Instrumentation and control, piping, and structural design
   - •FCRS construction

Company History - EDC's core competencies also include the environmental and social acceptability aspect of the entire geothermal development process.

6. **Environmental Management**
   - Environmental assessment
   - Environmental policy review & licensing
   - Waste management
   - Watershed management
   - Risk assessment
   - Conflict resolution
   - Monitoring

EDC's Business Contracts

EDC's Business Contracts

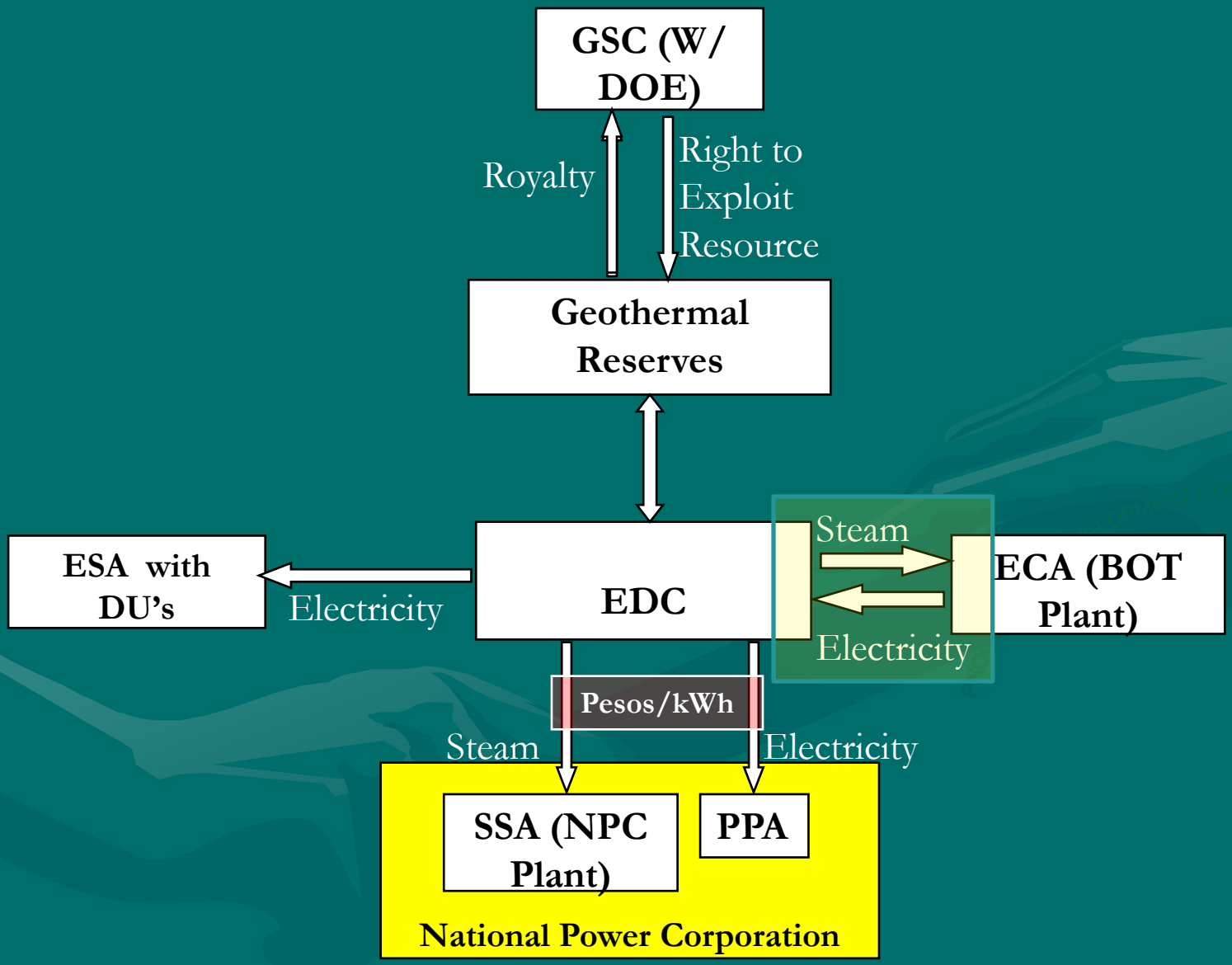
The financial existence of EDC depends largely on the stability of the long term contracts that it secured from its business partners and derives its revenues mainly from the sale of steam and electricity and on a smaller scale from drilling services and consultancy contracts.

- Geothermal Service Contracts (GSC) with the Department of Energy (DOE)- 25 years renewable for another 25 years
- Steam Sales Agreements (SSA) with (NPC)- 25 years
- Power Purchase Agreements (PPA) with NPC- 25 years
- Energy Conversion Agreements (ECA) with BOT Contractors- Ten Year cooperation period with a 25 year PPA with NPC
- Energy Sales Agreement with Cooperatives and DU's - 5 years

EDC's Business Contracts

- Geothermal Service Contracts (GSC) with the Department of Energy (DOE)- gives EDC the right to explore, develop and utilize geothermal resources in a certain contract area and in turn remits to the government taxes and royalties from the net proceeds, after cost recovery of up to 90% of expenses.
- Steam Sales Agreements (SSA) with (NPC)- EDC delivers and sells steam to NPC Power plants for conversion to electricity with a "take or pay" provision (75% of Rated Capacity),
- Power Purchase Agreements (PPA) with NPC- EDC sells electricity to NPC with a Minimum Energy Off-take provision,
- Energy Conversion Agreements (ECA) with BOT Contractors- EDC delivers steam to the BOT power plant and pays the contractor for the conversion of steam to electricity based on actual and nominated capacities, and
- Energy Sales Agreement with Cooperatives and DU's - EDC sells electricity from its own merchant plant to DU's.

EDC's Business Contracts

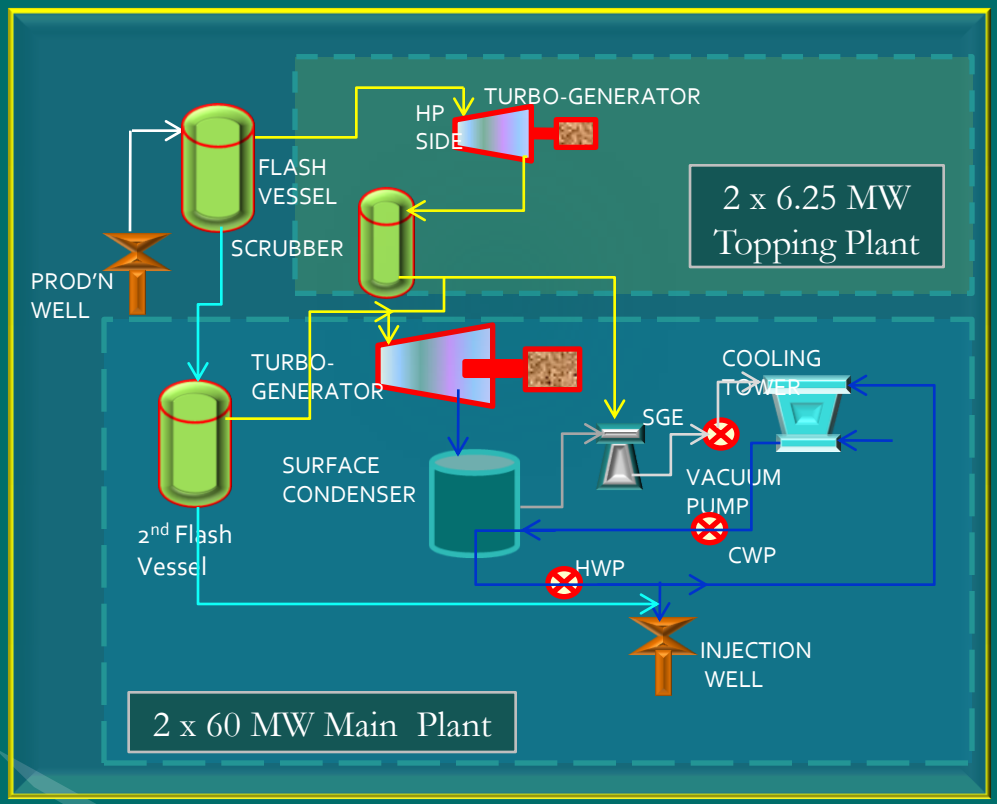


EDC as Power Plant Operator

EDC's portfolio as power plant operator includes a total capacity of 744.8 MW and is expected to increase to 1500 MW with the planned acquisition of the NPC geothermal plants and the completion of the growth projects.

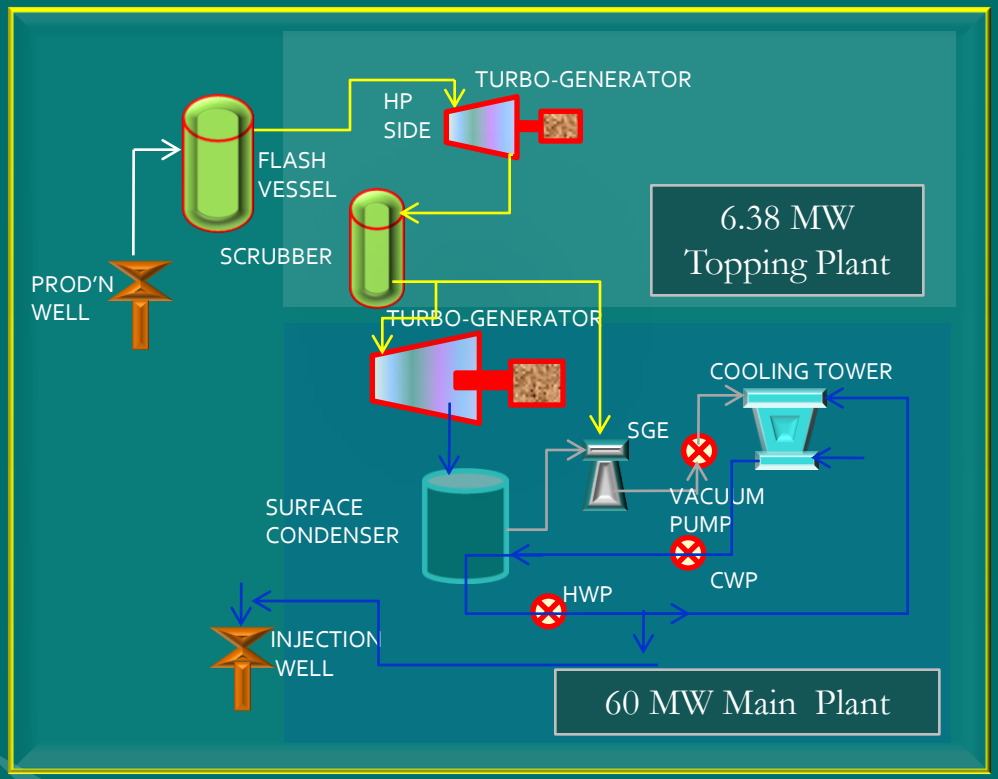
	Name of Power Plant		Total Installed Capacity, MW
PNOC-EDC OWNED PLANTS	Upper Mahiao	4 x 31.8 (GE/Ormat/Kato)	125.0
	Malitbog	3 x 77.0 (Fuji)	232.5
	Mahanagdong	3 x 60.0 (Toshiba)	180.0
	Optimization		50.9
	Mahanagdong A Topping Cycle	2 x 6.25 (Ormat/Kato)	
	Mahanagdong B Topping Cycle	1 x 6.38 (Ormat/Kato)	
	Tongonan 1 Topping Cycle	3 x 5.75 (Ormat / Kato)	
	Malitbog Bottoming Cycle	1 x 14.56 (GE/GE)	
	Northern Negros	1 x 49.0 (Fuji)	49.4
		Sub-total	***637.8***
BOT	Mindanao 1	1 x 52.3 (Mitsubishi)	52.0
	Mindanao 2	1 x 54 (Mitsubishi)	54.0
		Sub-total	***106.0***
FOR ACQUISITOIN (WITH SSA)	Palinpinon 1	3 x 37.6 (Fuji)	112.5
	Palinpinon 2	4 x 20.0 (Fuji)	80.0
	Bacman 1	2 x 55.0 (Ansaldo)	110.0
	Bacman 2	2 x 20.0 (Fuji)	40.0
	Tongonan 1	3 x 37.5 (Mitsubishi)	112.5
		Sub-total	***455.0***
		TOTAL	***1,199***

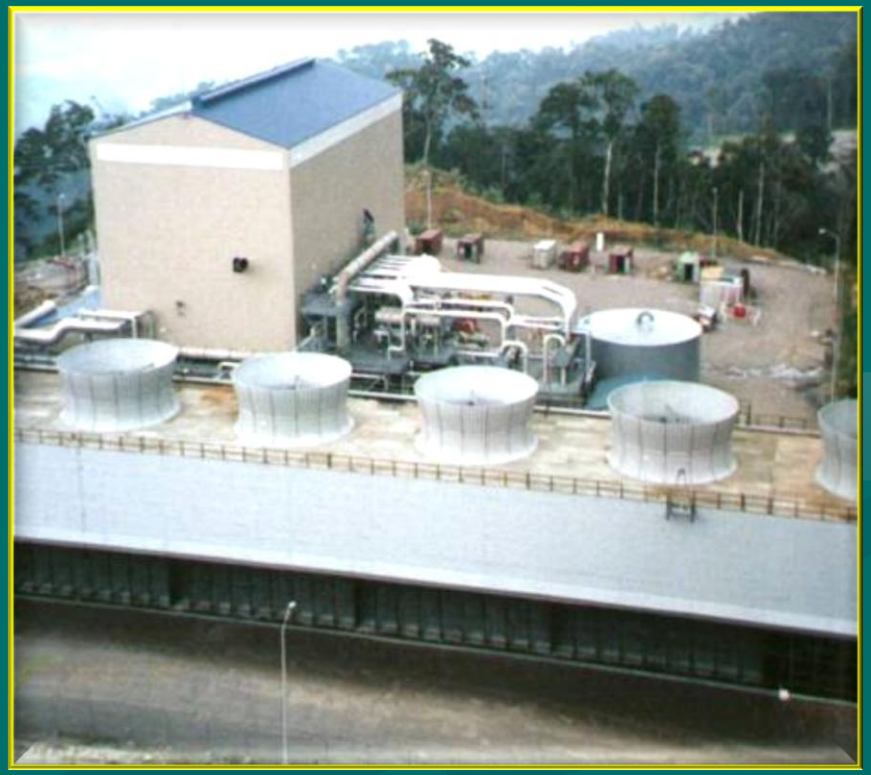
120 MW Mahanagdong A Double Flash with Topping Plants



The Mahanagdong A plant consists of 2 x 60 MW main plant and a 2 x 6.25 MW topping plant (OEC). The topping plant utilizes high pressure steam (10.96 ksca), after which the exhaust low pressure steam (5.9 ksca) is feed to the main plant. Also, the separated high pressure brine is re-flashed to produce low pressure steam (5.9 ksca) and feed to the main plant. The main plant is equipped with a 2-stage hybrid gas extraction system and a shell and tube type surface condenser.

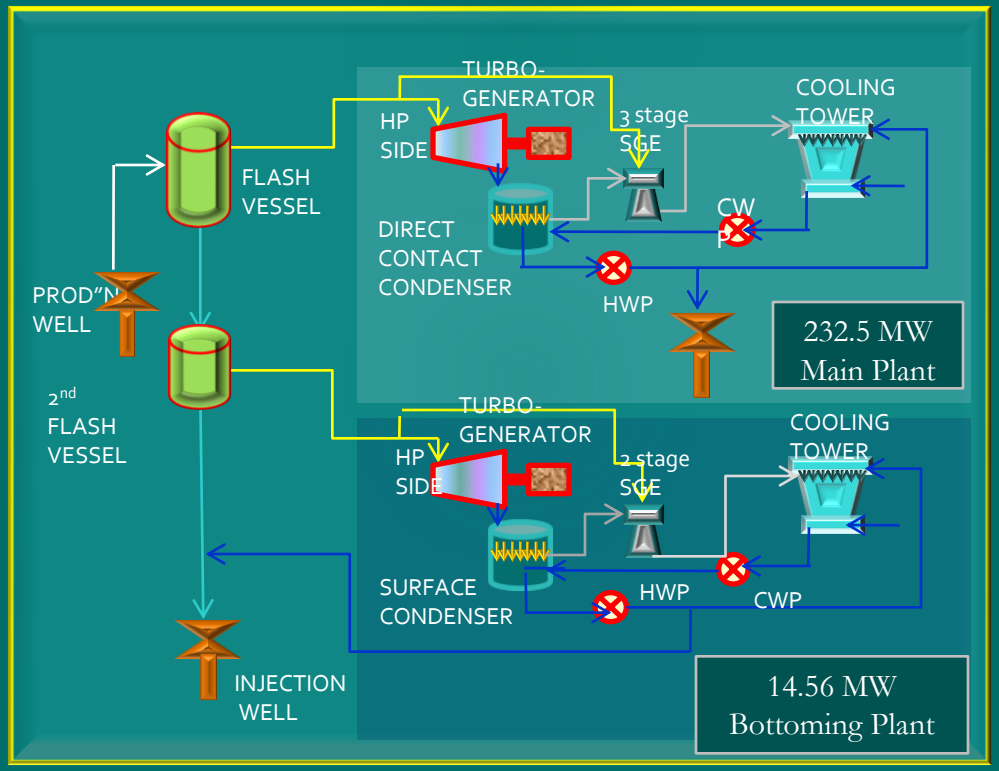
60 MW Mahanagdong B Plant with a Topping Cycle Plant





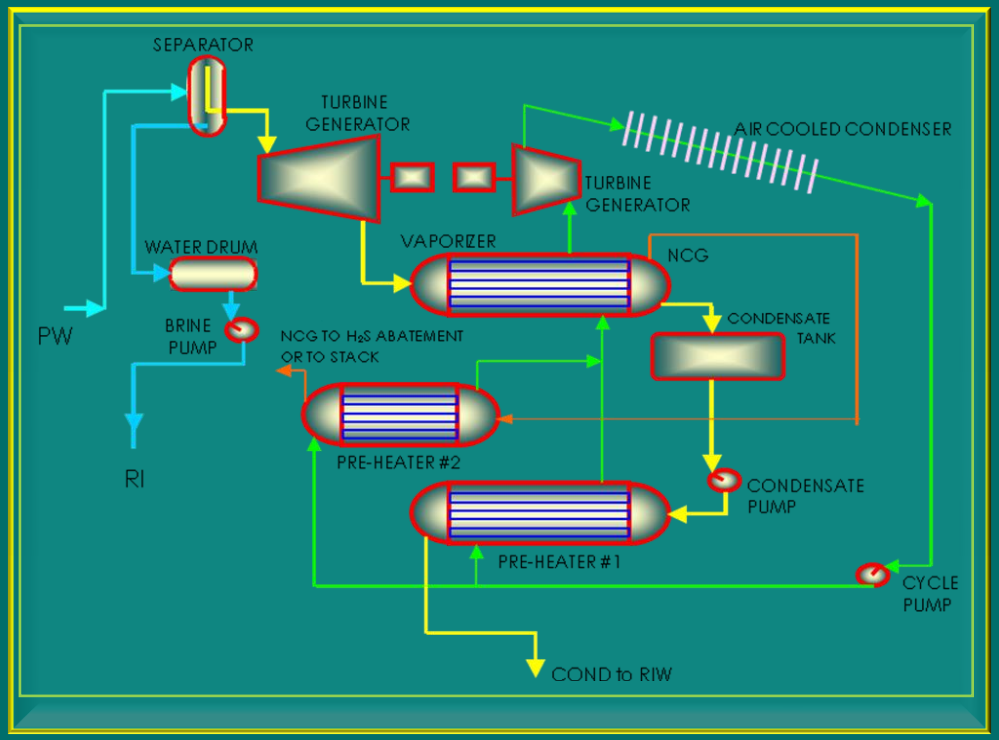
The Mahanagdong B plant consists of 1 x 60 MW main plant and a 1x 6.38 MW topping plant (OEC). The topping plant utilizes high pressure steam (10.96 ksca), after which the exhaust low pressure steam (5.9 ksca) is feed to the main plant. The main plant is equipped with a 2-stage hybrid gas extraction system and a shell and tube type surface condenser.

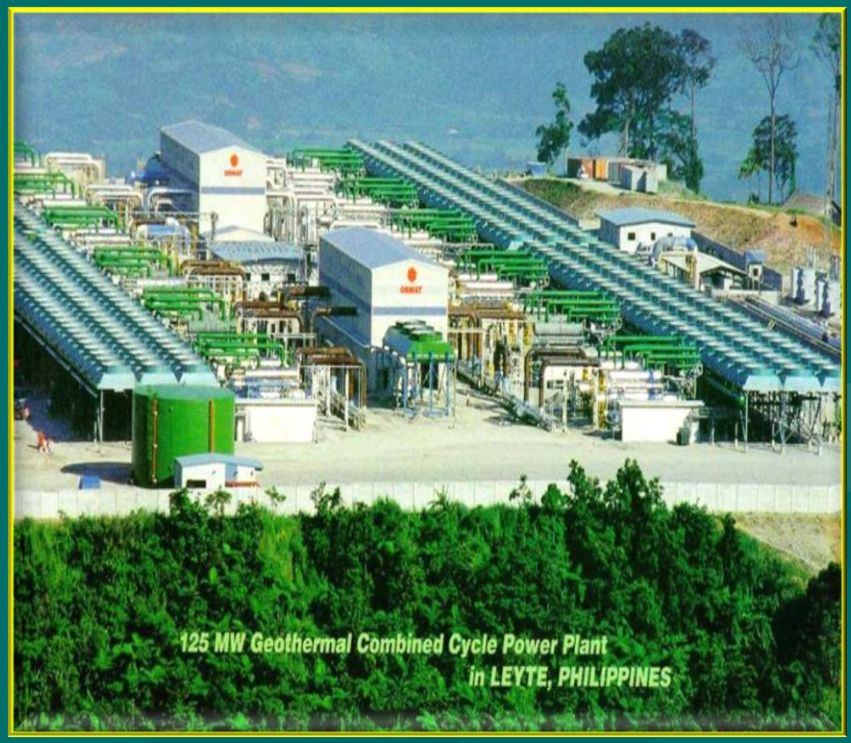
232.5 MW Malitbog Conventional with a Bottoming Plant



The Malitbog plant consists of 3 x 77.5 MW (Fuji) main plant and a 1 x 14.56 MW (Toshiba) Bottoming plant. The main plant utilizes high pressure steam (11 ksca) , while the separated brine is flashed at a lower pressure (5.96 ksca) for utilization by the bottoming plant. The main plant is equipped with a 3-stage steam gas ejector (SGE) system and a direct contact type condenser, whereas the bottoming plant is equipped with a 2-stage SGE and a shell and tube surface type condenser.

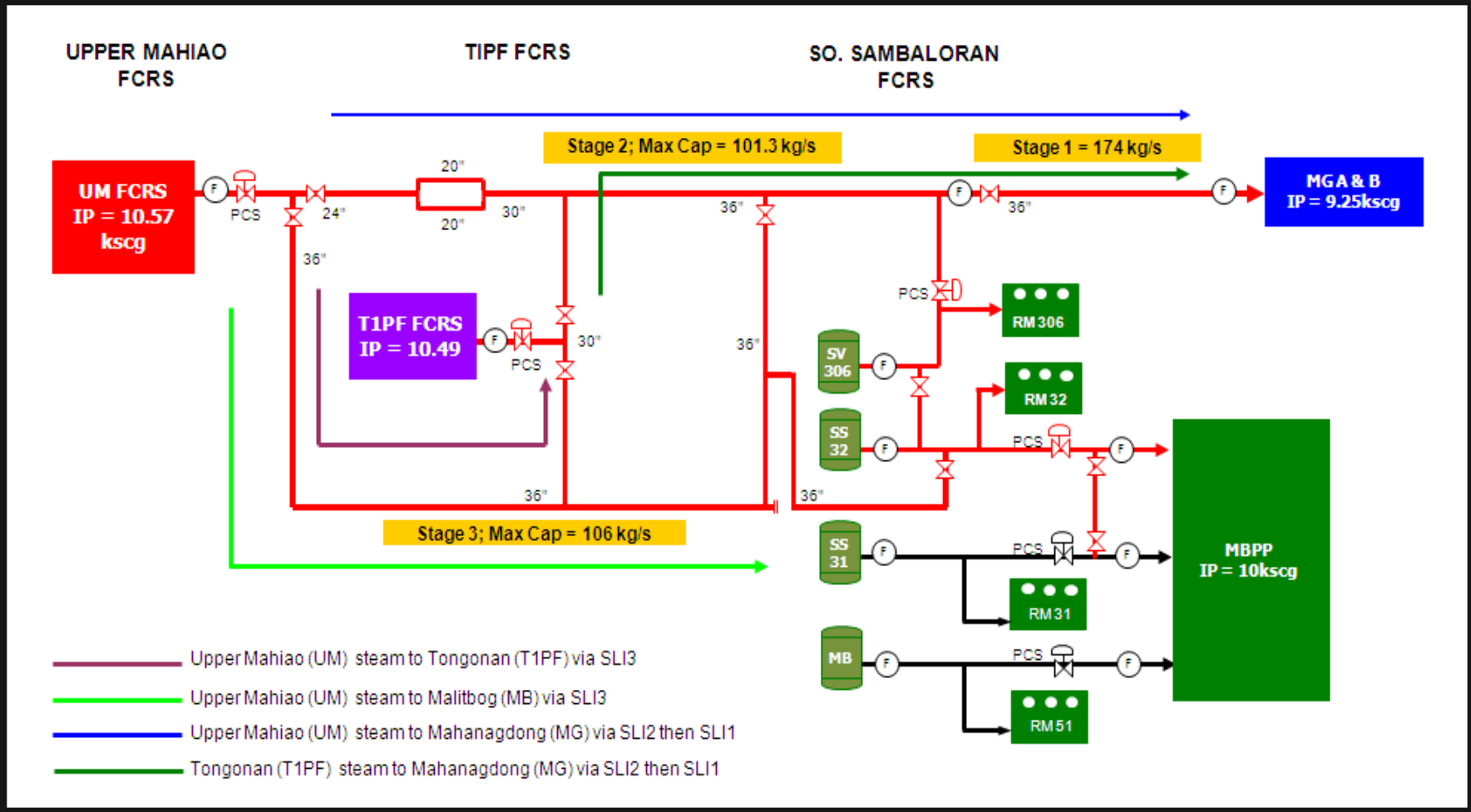
125 MW Upper Mahiao Combined-Cycle Power Plant





The main features of the Upper Mahiao plant is that; 1) High pressure steam is feed to a non-condensing turbine (STG) which exhausts to a vaporizer were liquid pentane is being vaporized and drives the pentane turbine (OEC). 2) The plant consists of 4 x 23.86 MW STG's, with each STG having 3 x 4.5 MW OEC's. 3) It also has another 1 x 4.6 MW OEC where the heating fluid is brine. 4) HP steam at the NPC Tongonan plant also feeds 2 x 5.75 MW OEC Topping plants.

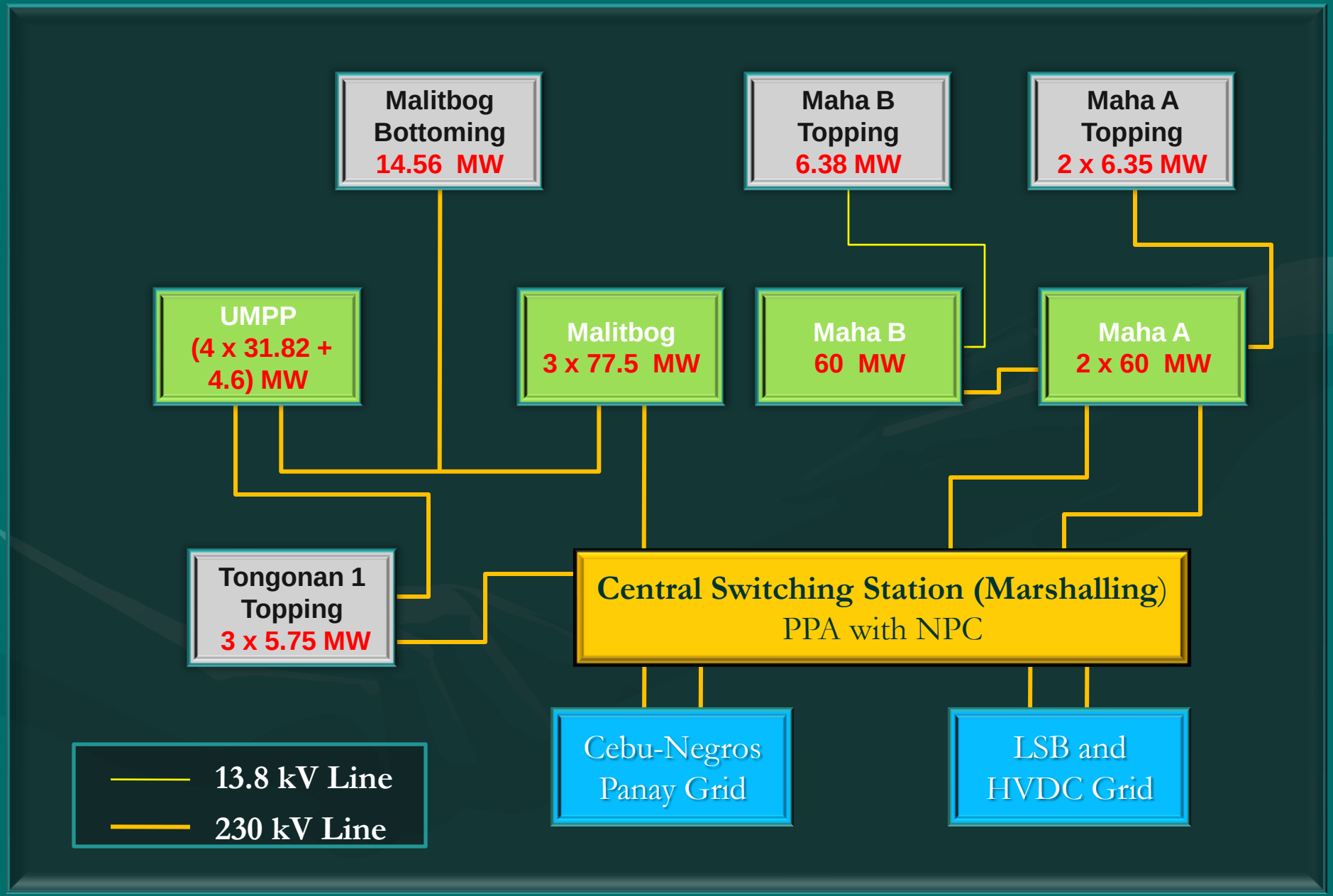
LGPF Steam Line Interconnection Diagram

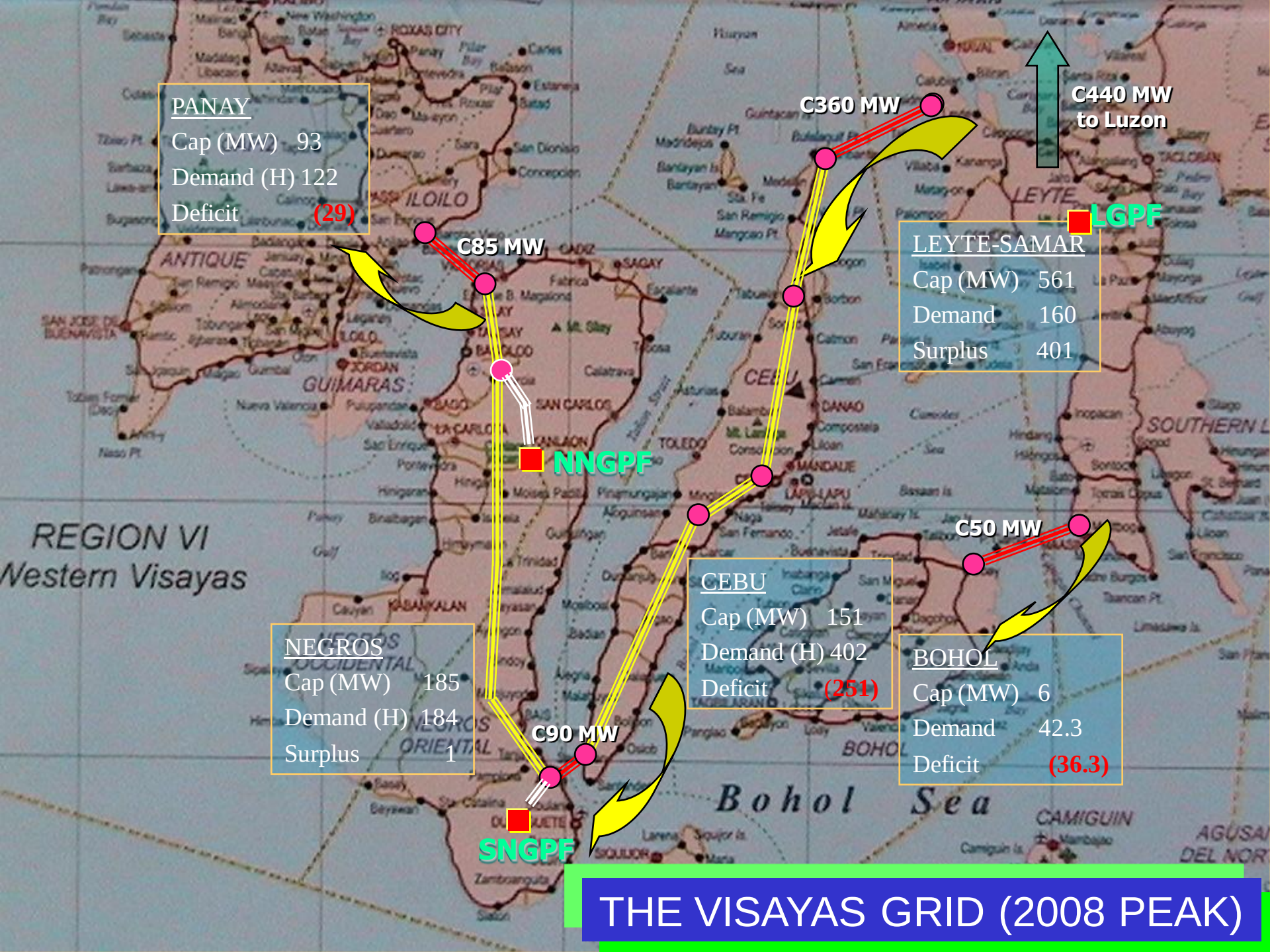


Notes:

1. UM Plant Interface Pressure (IP) has the greatest IP for all sectors; UM can divert steam to all sectors via the SLI.
   - Excess steam from UM prioritizes steam shortfall of the Malitbog Power Plant
   - Excess steam after supplying the shortfall of the Malitbog Power Plant is being diverted to the Mahanagdong Power Plant (via SLI2)
   - In the event that the Tongonan Main Plant will need steam for their capacity testing, steam will be diverted via SLI3.
2. Tongonan Sector (T1PF) can only divert steam to the Mahanagdong Power Plant
3. Malitbog Sector can divert steam to Mahanagdong Power Plant, however in-situ steam of MB is not enough to sustain maximum load of the Malitbog Main Plant making it dependent of steam from Upper Mahiao sector

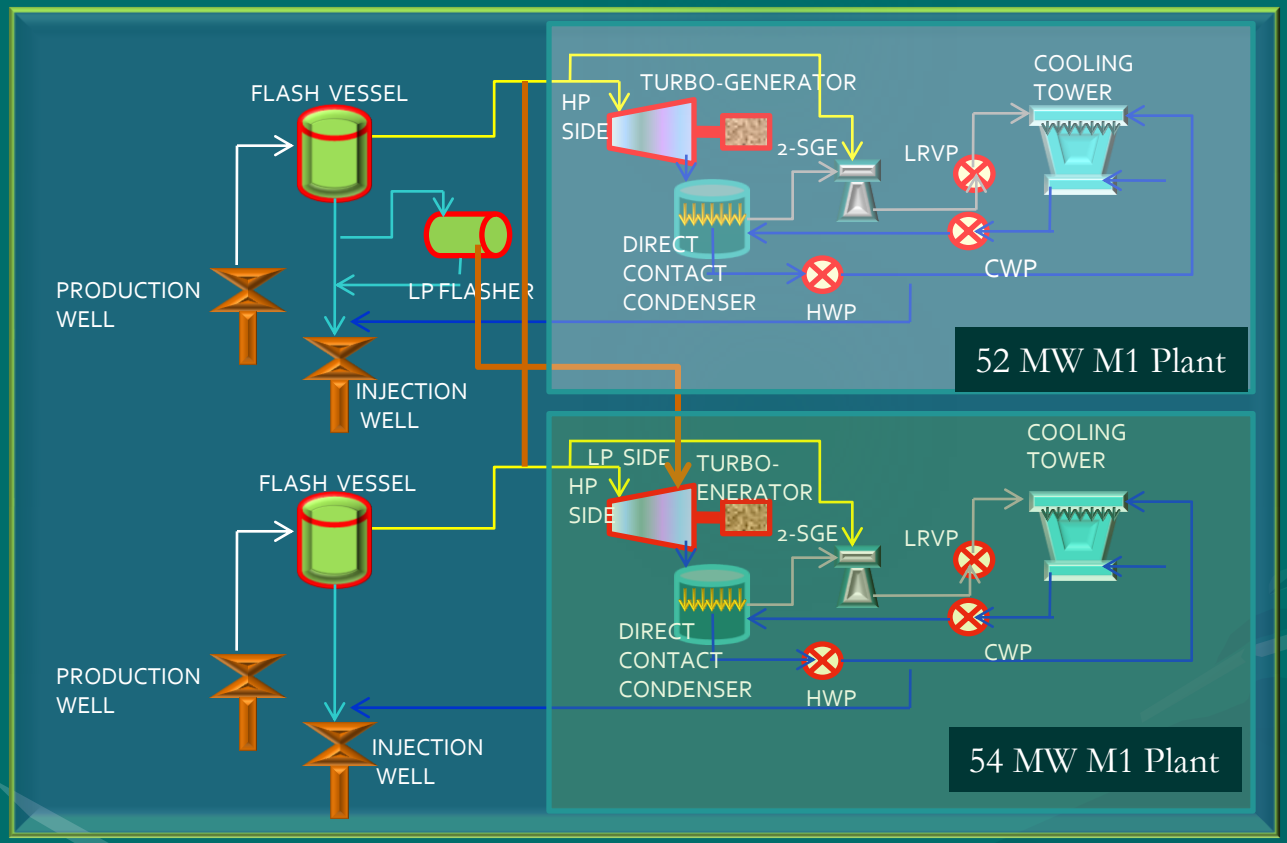
Unified Leyte Central Switching Station





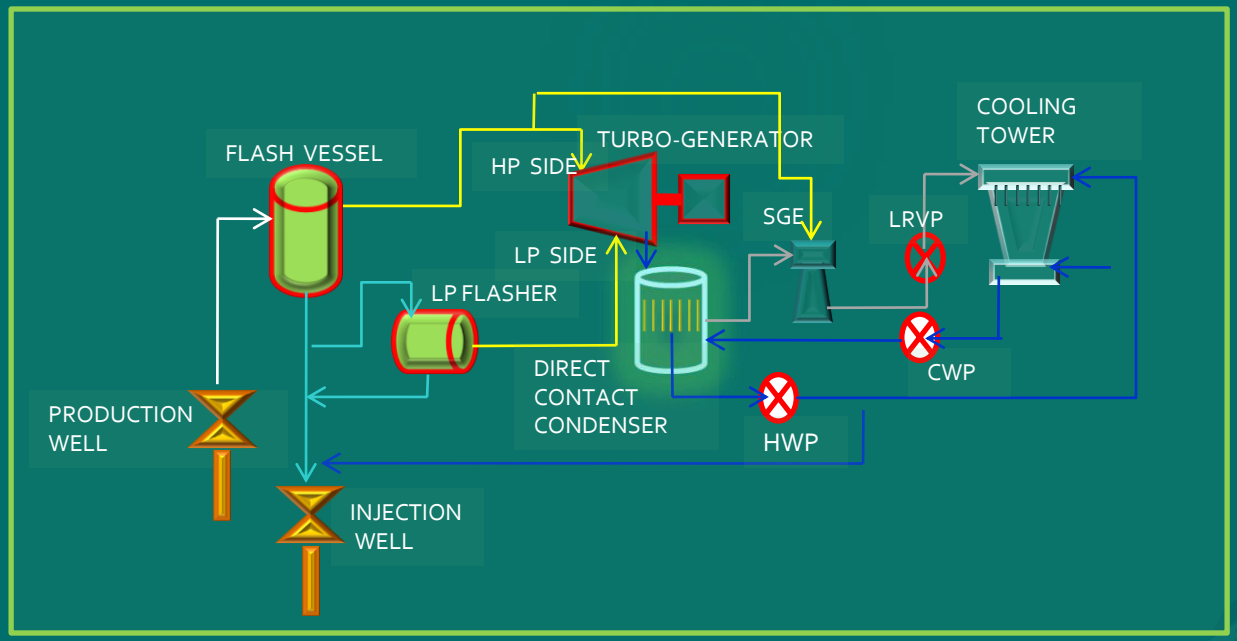
THE VISAYAS GRID (2008 PEAK)

52 MW M1 and 54 MW M2 Mindanao Plants



The Mindanao plants consists of 1 x 52 MW and 1 x 54 MW, both Mitsubishi units. Both plants admit steam at 7.0 ksca at the high side, whereas M2 admits steam at its later stages at 3.31 ksca which comes from the re-flashed separated brine from M1. For added flexibility, the high pressure steam lines of both plants are inter connected. Both plants are equipped with 2-stage steam gas ejectors with a vacuum pump at the 3rd stage and a direct contact top-exhaust condensers.

49.37 MW North Negros Plant



The North Negros plant consist of 1 x 49.37 MW (Fuji) which admits steam at the high side (5.7 ksca) and at the low side (3.03 ksca), which comes from the separated brine flashed at a lower pressure. The plant is equipped with a hybrid gas extraction system and a direct contact type condenser.

Power Plant Performance (NPC and EDC-owned)

	Plant	Gross Capacity (GWH)	Energy Sold/Paid (GWH)				Capacity Factor (%)			
			2004	2005	2006	2007	2004	2005	2006	2007
Steam Sales	Tongonan 1	985.5	760.6	746.9	754.1	752.9	77%	76%	77%	76%
	Palinpinon 1	985.5	741.2	786.6	764.8	769.9	75%	80%	78%	78%
	Palinpinon 2	700.8	649.3	634.3	631.4	599.2	93%	91%	90%	86%
	Bacman 1	963.6	724.7	722.7	722.7	722.7	75%	75%	75%	75%
	Bacman 2	350.4	285.9	250.8	262.8	262.8	82%	72%	75%	75%
Electricity Sales	Mindanao 1	458.1	437.9	423.2	394.9	410.4	96%	92%	86%	90%
	Mindanao 2	473.0	422.3	421.3	402.7	407.8	89%	89%	85%	86%
	Unified Leyte	5,154.4	4,214.9	4,268.0	4,244.2	4,303.8	82%	83%	82%	83%
	North Negros	432.7	N/A	N/A	N/A	102.3	N/A	N/A	N/A	24%

The NPC-owned power plants pays at "take or pay levels" (75% of R.C.- SSA) when steam is available even if the plant can't operate, whereas the EDC-owned plants consistently delivered at least the required "minimum energy off-take levels" to NPC (PPA).

[1] Gross capacity = installed capacity x 8760 hrs

[2] Consists of UMPP, Malitbog, Maha A and B, and opti plants

EDC's Expansion Projects

EDC's Expansion Projects consists of the expansion of the existing project areas (Nasulo, M3, Dauin) and greenfield projects . With its planned entry into other renewable sources, EDC is seriously considering the Burgos Wind project.

Project	Location	Capacity (MW)	Commissioning Date
Nasulo	Negros Oriental	20	July 2010
Tanawon	Sorsogon	50	Nov 2010
Minadanao 3	North Cotabato	50	Dec 2011
Dauin	Negros Oriental	40	Jan 2014
Kayabon	Sorsogon	40	Jan 2014
Rangas	Sorsogon	40	Feb 2014
Cabalian	Southern Leyte	40	Jan 2016
Burgos, Wind	Ilocos Norte	86	Nov 2010

EDC's Privatization

Whys is there a need to privatize PNOC-EDC?

EDC was Privatized for the following specific objectives;

a) to generate funds for the government,
b) to generate capital to finance the development of new geothermal areas,
c) to remove from the national government the burden of additional debt financing of the loans of PNOC EDC,
d) to comply with the provision of RA 9136 on the privatization of the government owned generating assets, i.e., privatization of the NPC power plants,
e) to avoid operational inefficiencies brought about by government regulations on the procurement of goods and services and on employee benefits, and
f) to enhance the competitiveness of the company with the advent of the Open Access market and the WESM.

Conclusion

Conclusion

Many factors contributed to the favorable growth of geothermal energy in the Philippines. The abundance of geothermal resource in the country, strong government support and the deliberate focus in acquiring and maintaining technical expertise laid the strong foundation to the rapid increase in the utilization of geothermal as a prime energy source. With its recent privatization, the company is poised to continue with the pursuit of geothermal growth projects and acquire geothermal assets offered to the private investors. With the advent of reforms in the country's power industry, the global call for renewable sources of energy and the increasing fossil fuel prices, the growth of geothermal energy in the Philippines continues to have a bright outlook.