CARBON CAPTURE & STORAGE (CCS)

PERTAMINA PERSPECTIVE ON

CO_2 MANAGEMENT

February 2011

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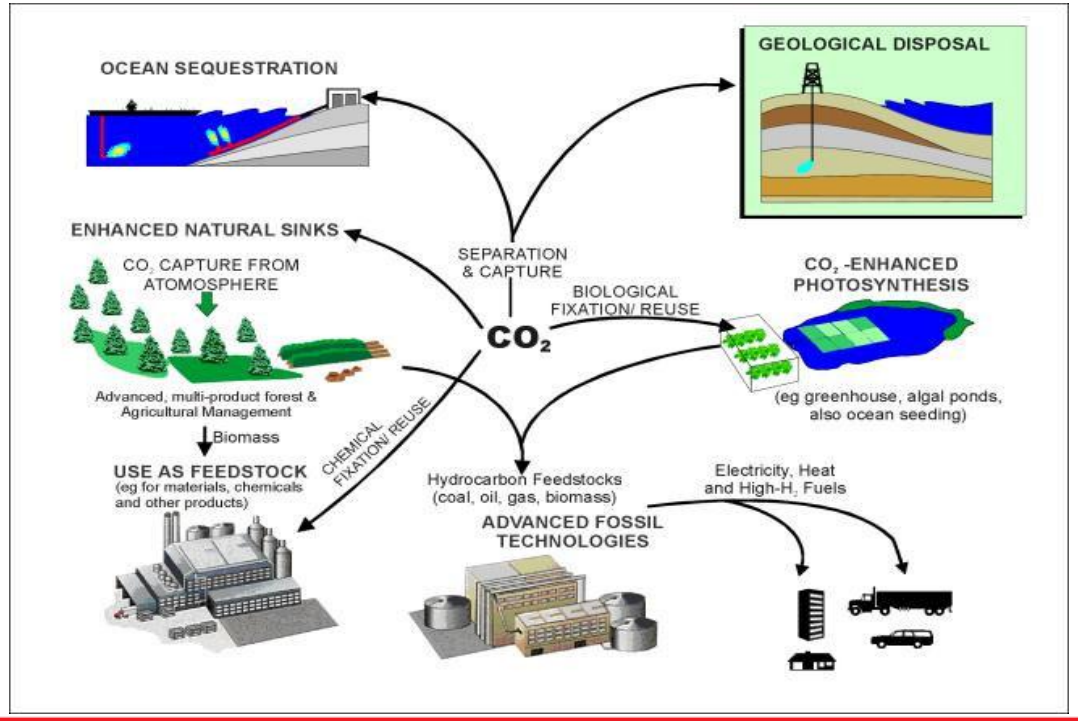
What is CCS ?

- **Carbon Capture & Storage (CCS) is one of approach to mitigating the contribution of fossil fuel emissions to global warming, which influence the climate change, based on capturing and storing CO_2 from large point sources.**
- CCS (Carbon Capture & Storage) scope :
  1. CO_2 capture →Industries with major CO2 emissions, natural gas processing, etc.
  2. CO_2 transport → Pipeline, mobile transportation systems
  3. CO_2 sequestration → Geological disposal, CO_2 injection for EOR, etc.



- Two main contribution of CCS on combating global warming :
  1. CO_2 capture → decreasing the release of Green House Gases (GHG) in to the atmosphere
  2. CO_2 sequestration → sequestering such GHG in more responsible manner

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CCS & Climate Changes: Pertamina's Participation

- **5 technological elements for mitigating climate change:**
  a) Use less energy (reduce consumption, more efficient use & conversion, etc.)
  b) Switch fuels (coal, oil, natural gas, biomass, etc.)
  c) Renewable (*solar, wind, geothermal, etc*.)
  d) CO_2 storage (*CCS*)
  e) Nuclear power

- PERTAMINA has already participated at least on three out of the five (a, b & c) elements above.

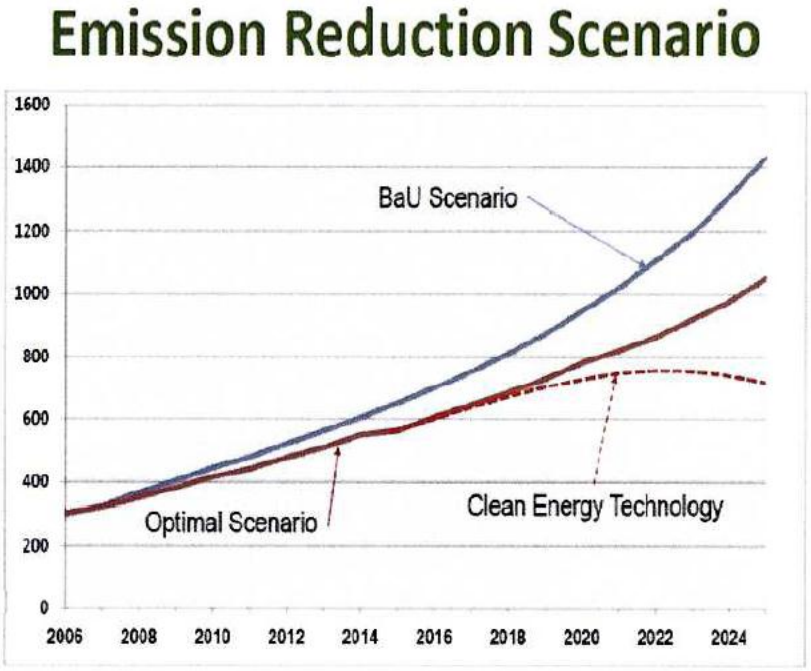
- CCS is one of several efforts to achieve a healthier environmental condition as well as to combating the global warming effect.

*Paul Freud & Olav Kaarstad "Keeping The Lights On" - Universitetsforlaget-2007

Pertamina Gas Emission

No	ACTIVITY	Green House Gas Emission [ton/yr]			OTHERS [ton/yr]					
1	UPSTREAM	CO2	CH4	N2O	NOx	SO2	CO	PM	VOC	TOC
	▪ PEP	204,574,222.38	255,647.16	18,161.03	407,779.13	9,318,028.24	_	0.00	390,627.81	843.09
	▪ PHE	65,552.94	915.52	34.68	1.88	0.30	_	0.00	427.82	2,771.34
	▪ PGE	34,952.43	_	_	1,456.16	4.88	_			
	▪ PERTAGAS	1,069,931.23	1,648.49	0.37	1,457.08	4.88	_	17.20	906.70	_
2	REFINERY	12,396,230.19	199,696.22	216.20	29,891.43	14,095.55	_	1,580.36	182,582.17	_
3	MARKETING & TRADING	574.26	56.29	0.01	0.45	3.20	3.29	0.05	125,904.55	_
	TOTAL	218,138,463.43	457,963.68	18,412.29	440,586.12	9,332,137.05	3.29	1,614.80	700,449.05	3,614.42

Pertamina Green House Gas Emission



Source: Second National Communication 2009

Total CO2 equivalent: 235.35 MT
Upstream: 216.8 MT
Refining: 18.11 MT
Marketing & Trading: 0.437 MT

Based on BaU Emission Reduction Scenario Pertamina contributes **0.056%** of CO2 equivalent of national total emission

Law 22/2001 Made Pertamina As "Just Another Player" In Indonesia Oil And Gas Industry

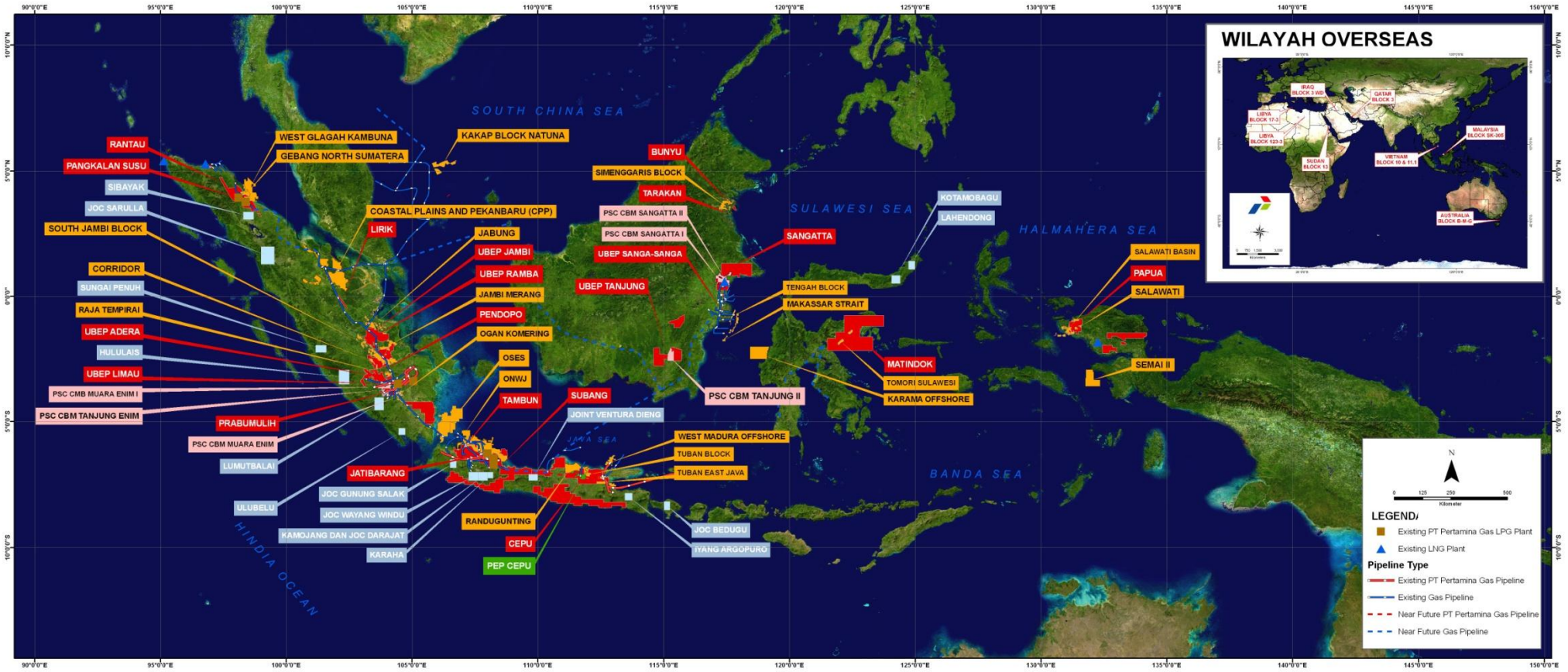
	Pre Law #22/2001	Post Law #22/2001
Regulator	• PERTAMINA assumed important regulatory functions as well as supervisory tasks	• Overall policy/direction setting for the industry: Ditjen Migas • Regulation and supervision of business entities is conducted by implementing bodies – Upstream: BP Migas – Downstream: BPH Migas
Operator	▪ PERTAMINA as the industry monopoly – Sole operator for processing and downstream – Operator for upstream; contracting with private players through PSCs	• PERTAMINA is just another player – Processing and downstream are opened for "any" operators licensed by the Government – Upstream is opened for "any" operators under PSCs with the Government
Natural resource custodian	• PERTAMINA as government's custodian – collect "rents" on behalf of government	• Custodian role is conducted by regulatory bodies

PERTAMINA'S Inisiatives to Reduce National Green House Gas Emission

- Produce the gasoline with higher octane number & lower carbon emission (Pertamax, Pertamax plus etc.)
- Urge the use of natural gas as a fuel for power generation, industrial and public transportation sectors.
- Accelerates the development of Geothermal Power Generation Projects.
- Kerosene conversion program with LPG for household and others public requirements.
- Increase LPG extraction & fractination plant developments.
- Increase LNG Receiving Facilities in Java area.
- Green House Gas management (CCS, CDM, etc).

Pertamina Gas Emission Potential Map

UPSTREAM WORKING AREA PT PERTAMINA



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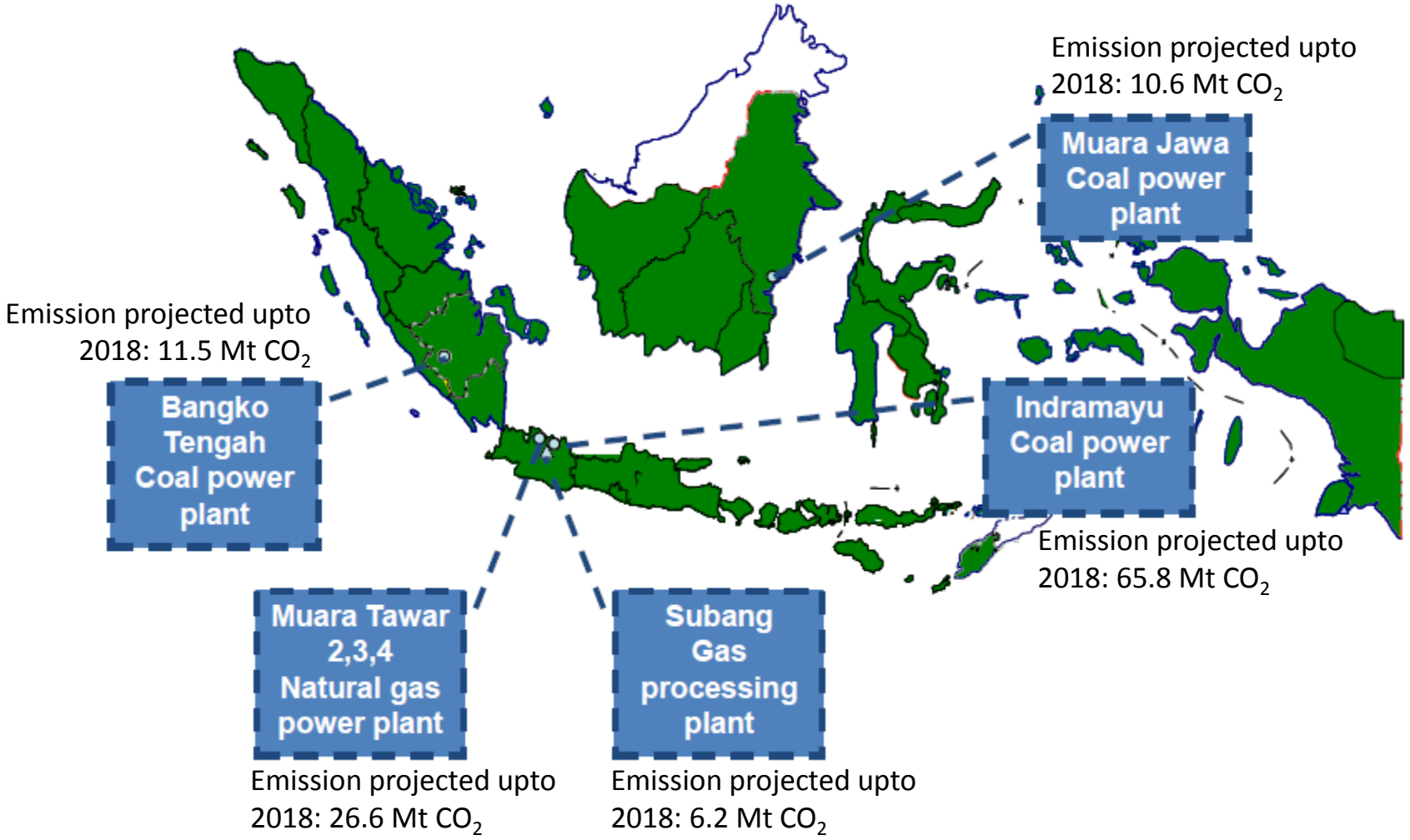
CO_2 Emission Sources Projected upto 2018 from 4 Power Plants & 1 Gas Processing Plant



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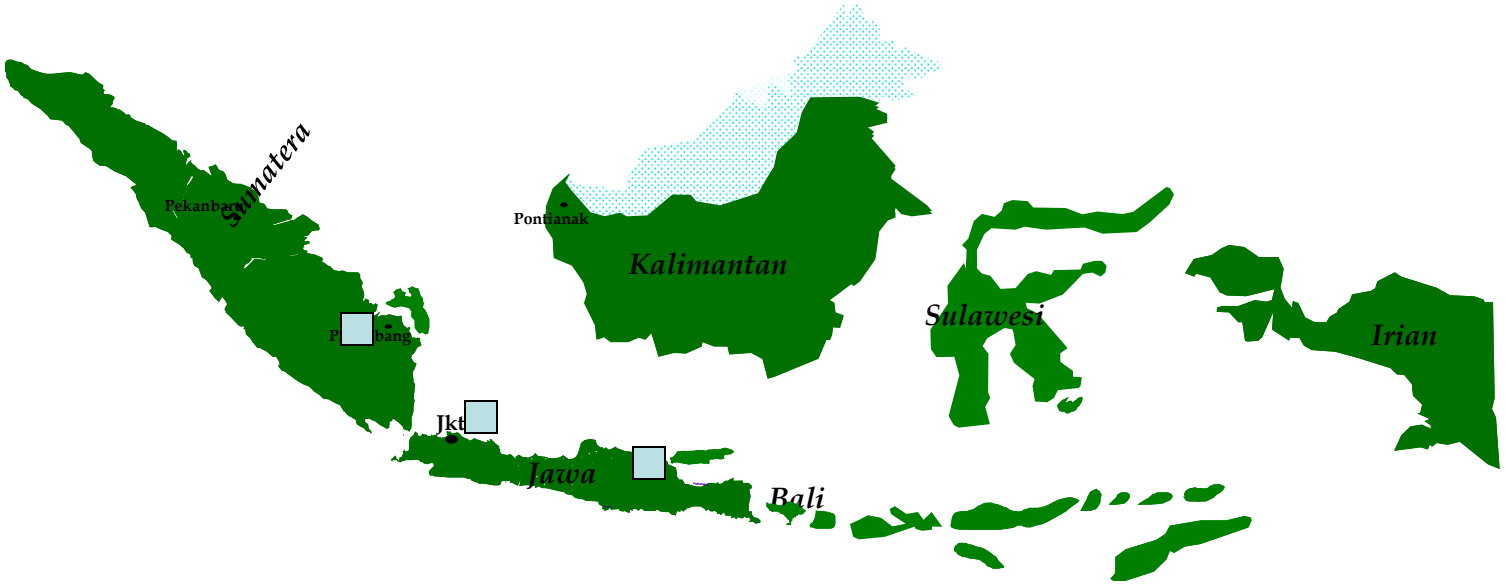
Pertamina Upstream CO_2 Removal Plants

- Subang: appr. 27 MMscfd CO2 (150 MMscfd plant capacity)
- Cilamaya: appr.3.5 MMscfd CO2 (30 MMscfd plant)
- Merbau: appr.12 MMscfd CO2 (180 MMscfd full capacity)
- Gundih: appr. 17.5 MMscfd CO2 and H2S (on going construction)
- Future Plants: East Natuna appr. 2.4 Bcsfd CO2, Cepu Gas appr. 72.5 MMscfd CO2



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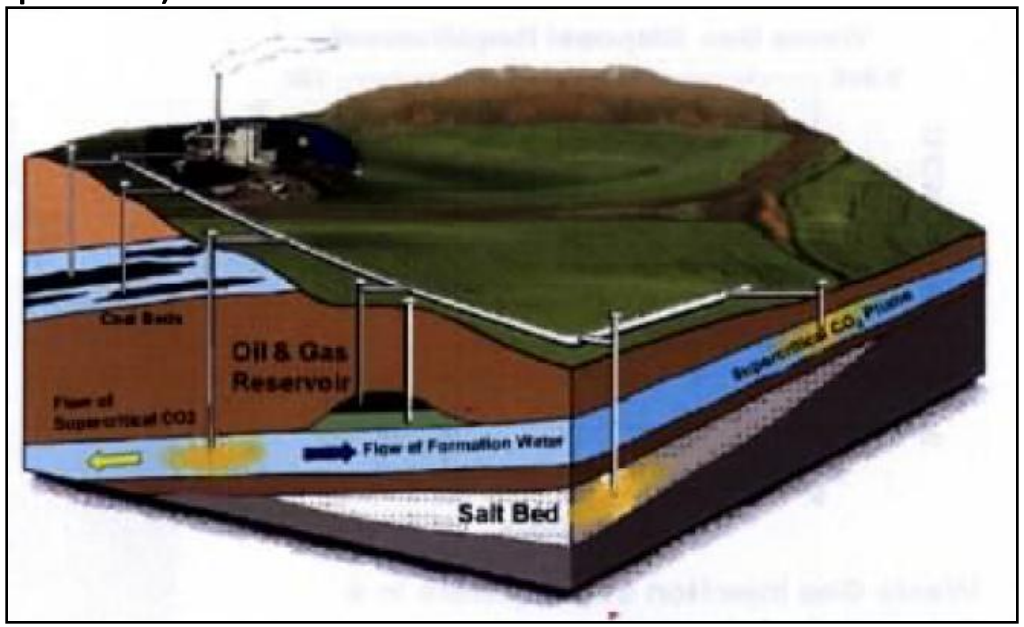
Upstream Inisiatives for CCS

- Technical capability building (partnership feasibility studies, pilot projects)
- Increase and accelerate geothermal and other clean energy alternatives developments
- Decrease direct CO2 venting from upstream gas processing plant
  - Implement CO2 EOR
  - CO2 sequestration as an integrated part of POD (for sour gas field development)



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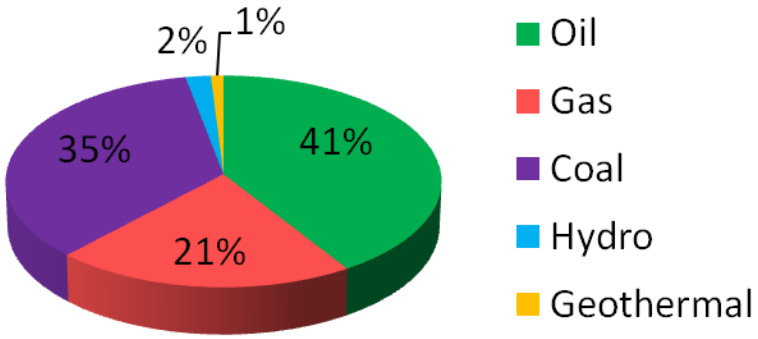
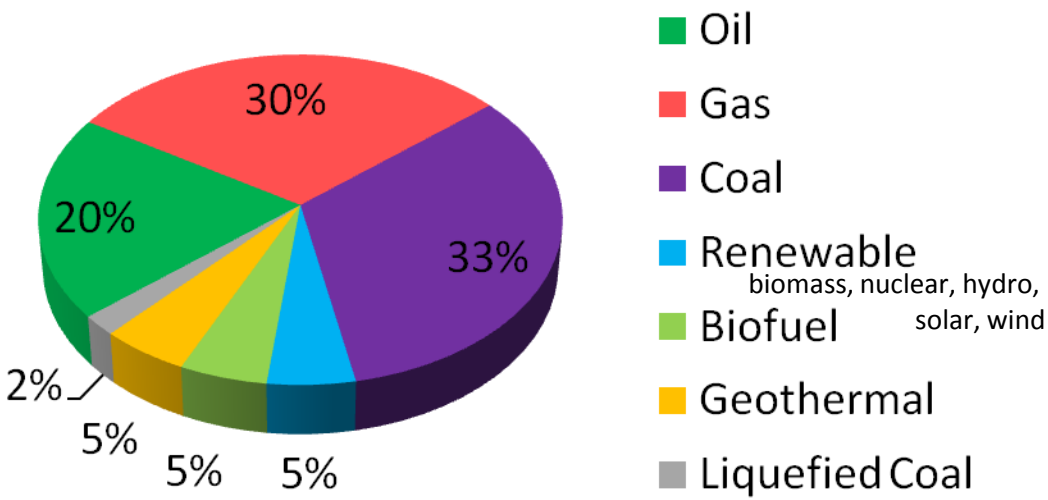
Improvement of the National Energy Mix 2025

BaU Scenario 2025



- CO_2 : ~1150 Metric-ton CO_2 Eq.
- Renewable: 155 MBOE

National Energy Mix Target 2025
Optimizing Energy Mix



- CO_2 : ~950 Metric-ton CO_2 Eq.
- Renewable: 476 MBOE [Elasticity <1]
- Reduce Oil Dependency
- More Renewables
- Reduce CO_2 Emission

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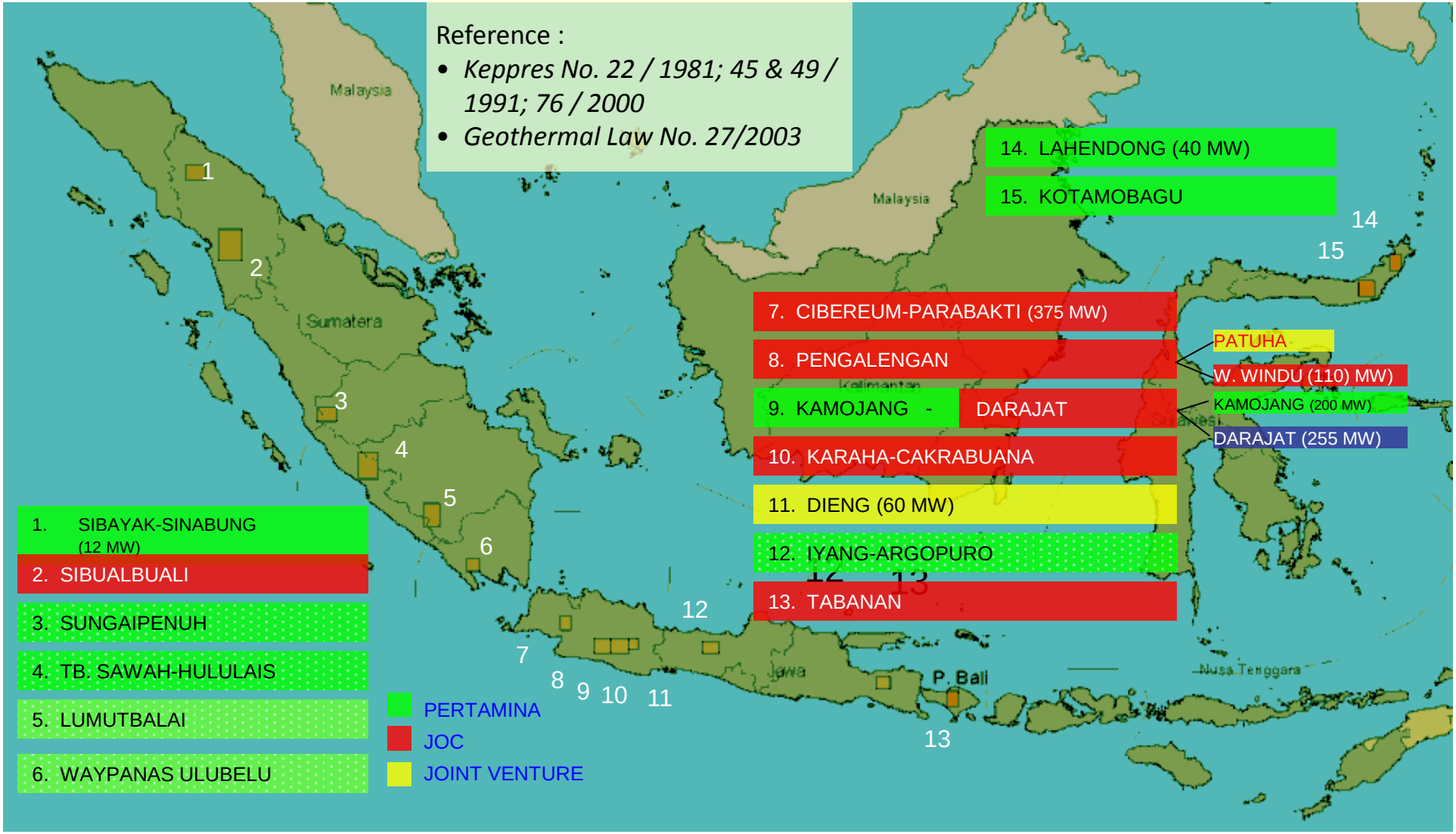
Pertamina Geothermal Energy Working Area



Installed-Electrical Capacity in Indonesia: 1,194MW

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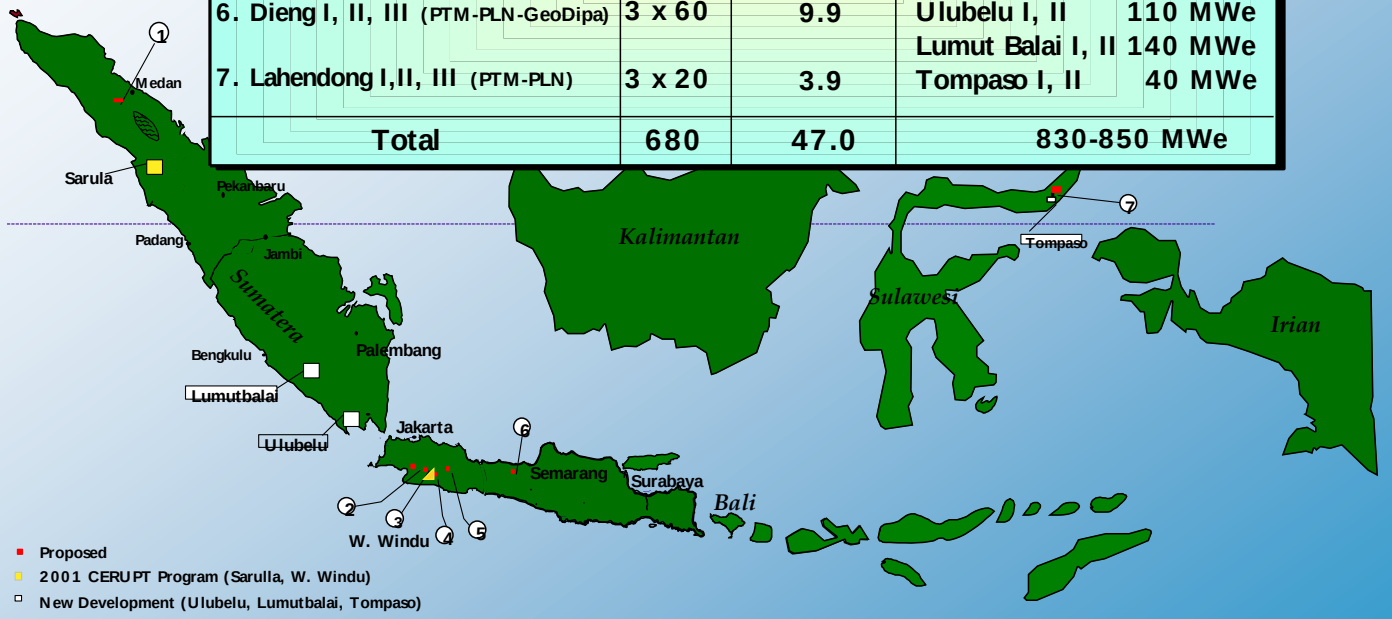
PERTAMINA CDM Target – Geothermal Sector

	2003-2006		2006-2010	
	MWe	Million Ton CER 10 years		
1. Sibayak (PTM-Dizamatra)	10	0.6	Kamojang V	40-60 MWe
			Sibayak II	20 MWe
2. Patuha I, II (PTM-MNL-GeoDipa)	2 x 60	8.1	Dieng III, IV	120 MWe
3. W. Windu I (PTM-MNL)	1 x 110	7.4	Patuha III	60 MWe
4. Darajat II, III (PTM-AI)	2 x 70	12.0	W. Windu III	100 MWe
5. Kamojang IV (PTM-Latoka)	1 x 60	5.1	Sarulla II	200 MWe
6. Dieng I, II, III (PTM-PLN-GeoDipa)	3 x 60	9.9	Ulubelu I, II	110 MWe
			Lumut Balai I, II	140 MWe
7. Lahendong I,II, III (PTM-PLN)	3 x 20	3.9	Tompaso I, II	40 MWe
Total	680	47.0	830-850 MWe	



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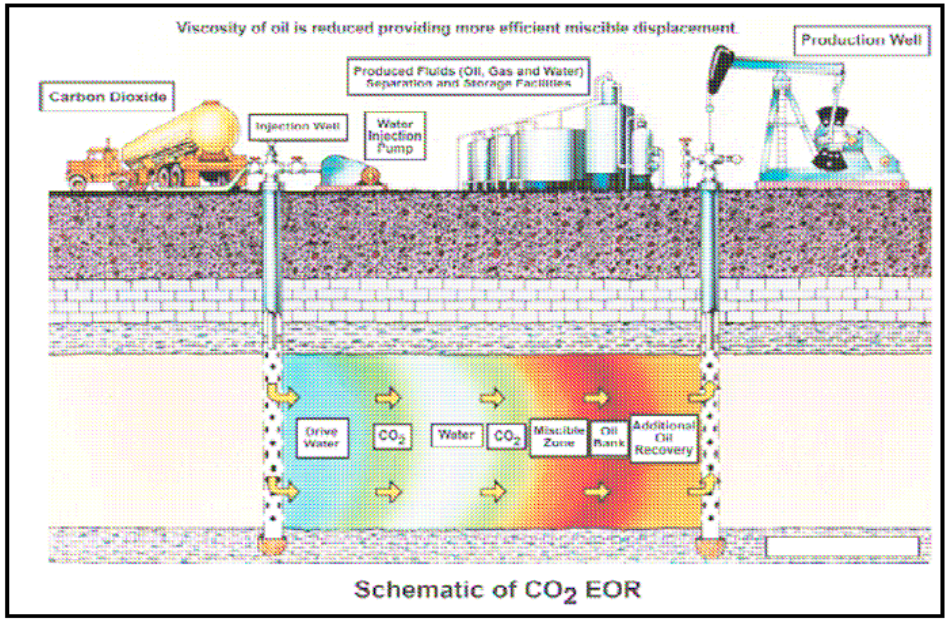
PERTAMINA GEOTHERMAL ENERGY
Installed Capacity

	Installed Capacity, MWe	BOEPD
PT PGE owned	**272**	**~ 11,097.6**
JOC [Chevron: Salak & Darajat; Star Energy: Wayang Windu]	**922**	**~ 37,617.6**
TOTAL	**1194**	**~ 48,715.2**

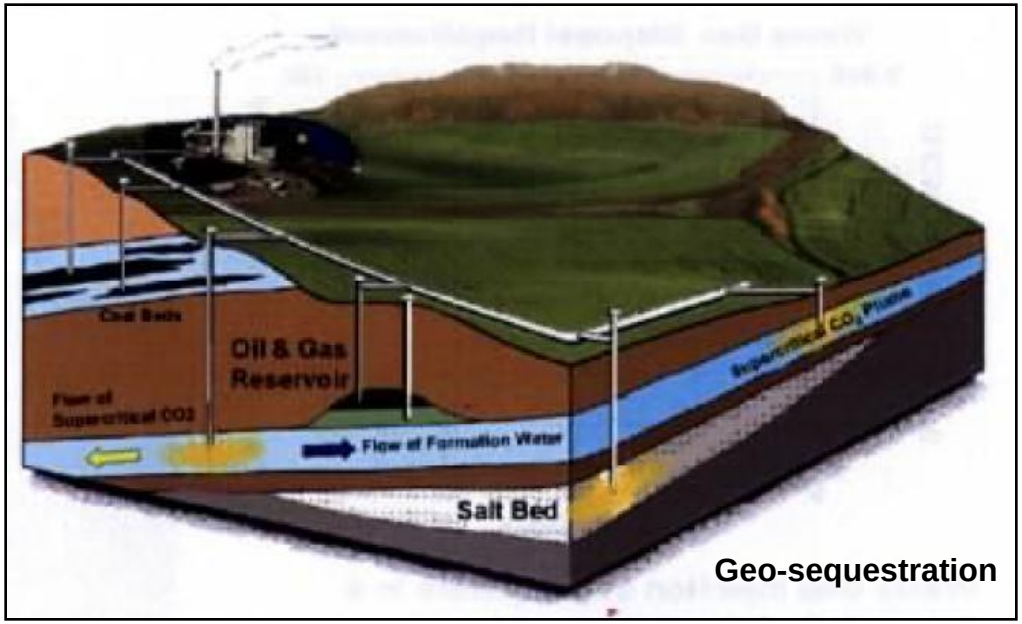
Note:
1 MWe hour ≈ 7~8 ton of steam ≈ 1.7 BOE = 40.8 BOEPD

CO_2 Utilization and CO_2 Storage

- EOR with CO2 injection feasibility studies
- CO2 sequestration feasibility studies: subsurface geological storage



Schematic of CO_2 EOR



Geo-sequestration

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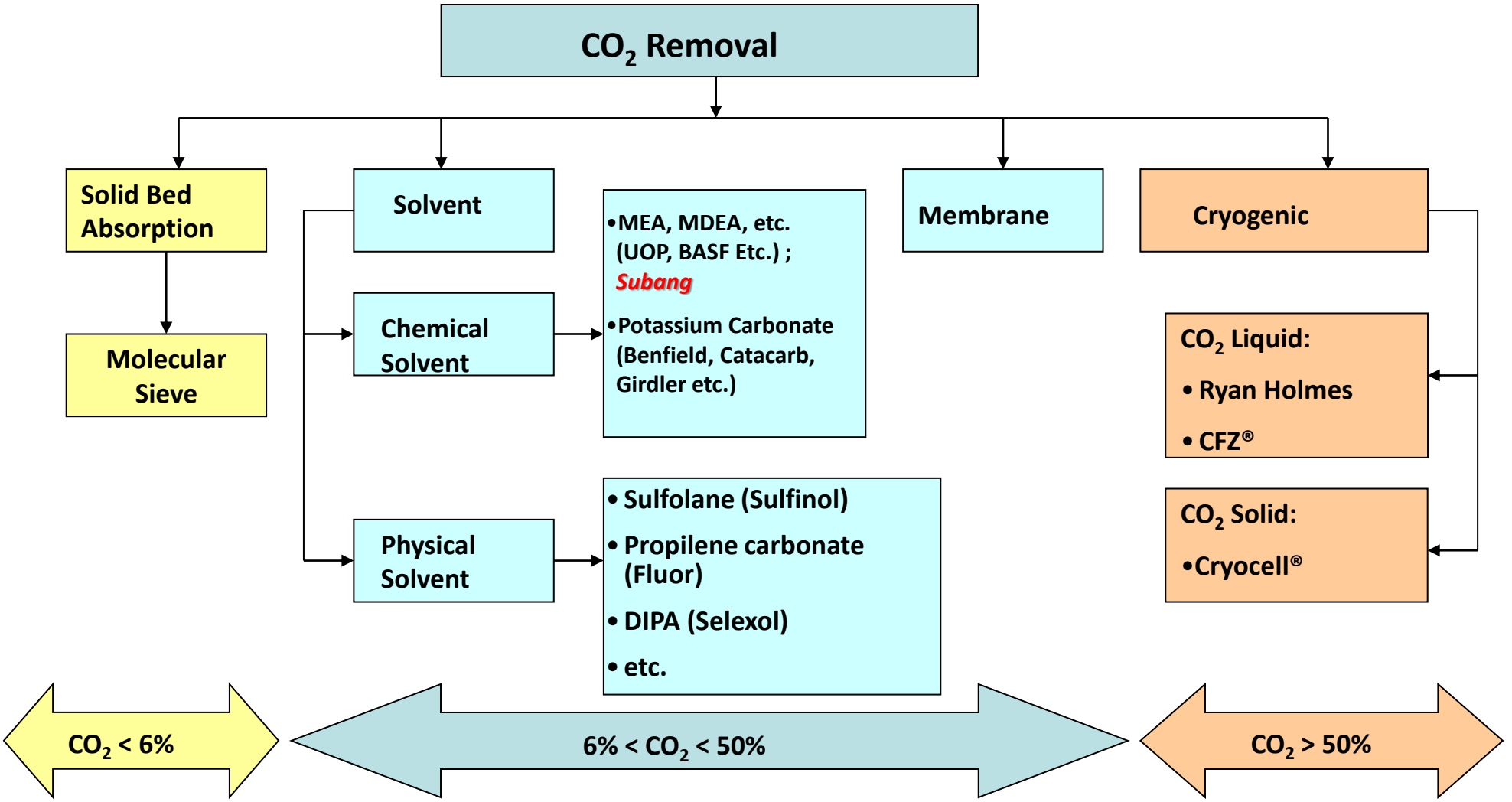
Source: Total E&P in Lemigas Workshop on CCS (2010)

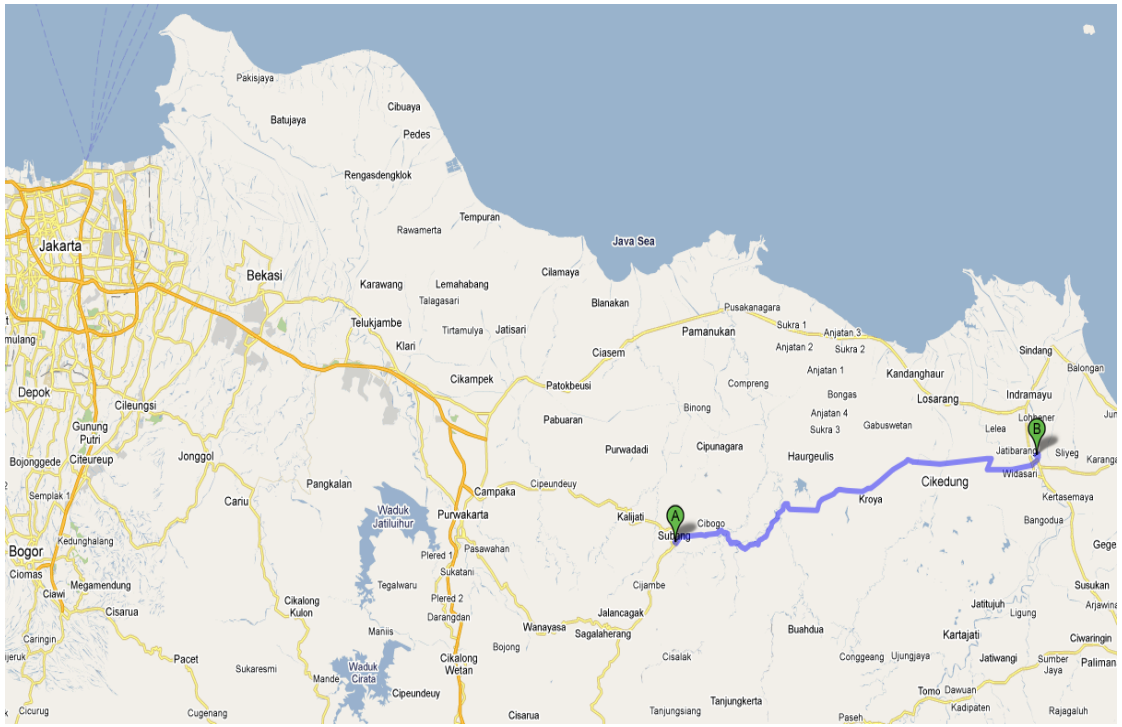
Upstream CCS Related Current Activities

- Bulk CO_2 removal technology development,
- EOR studies on CO_2 injection to improve oil recovery,
- CO_2 sequestration studies, and
- Study on Gas to Liquid (GTL) and Coal Liquefaction Technologies.

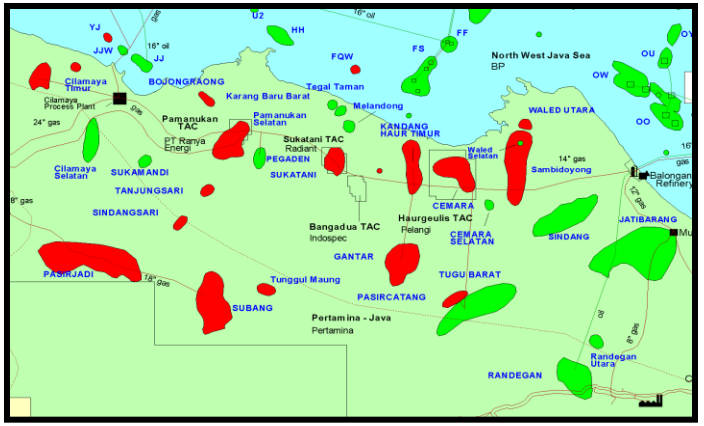
CO_2 Removal Technology



Candidate for CO2 Flooding EOR Pilot Project

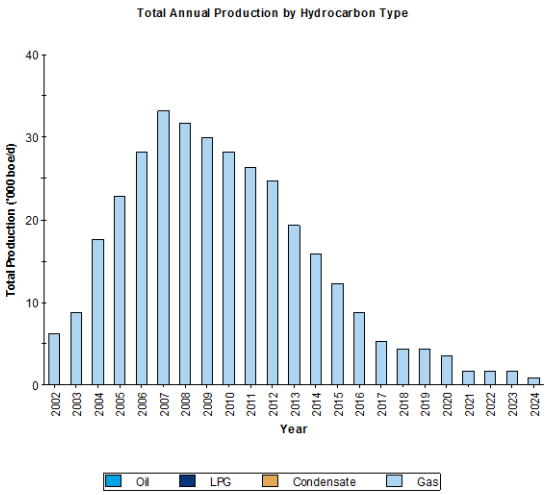


- Jatibarang Field, West Java
- CO2 source from Subang and Cilamaya CO2 Removal Plant



Subang Field

- Original Gas In Place : 1,046,931.55 MMScf
- Remaining Gas : 635,694.66 MMScf
- Kandungan CO_2 : 20 %-mol



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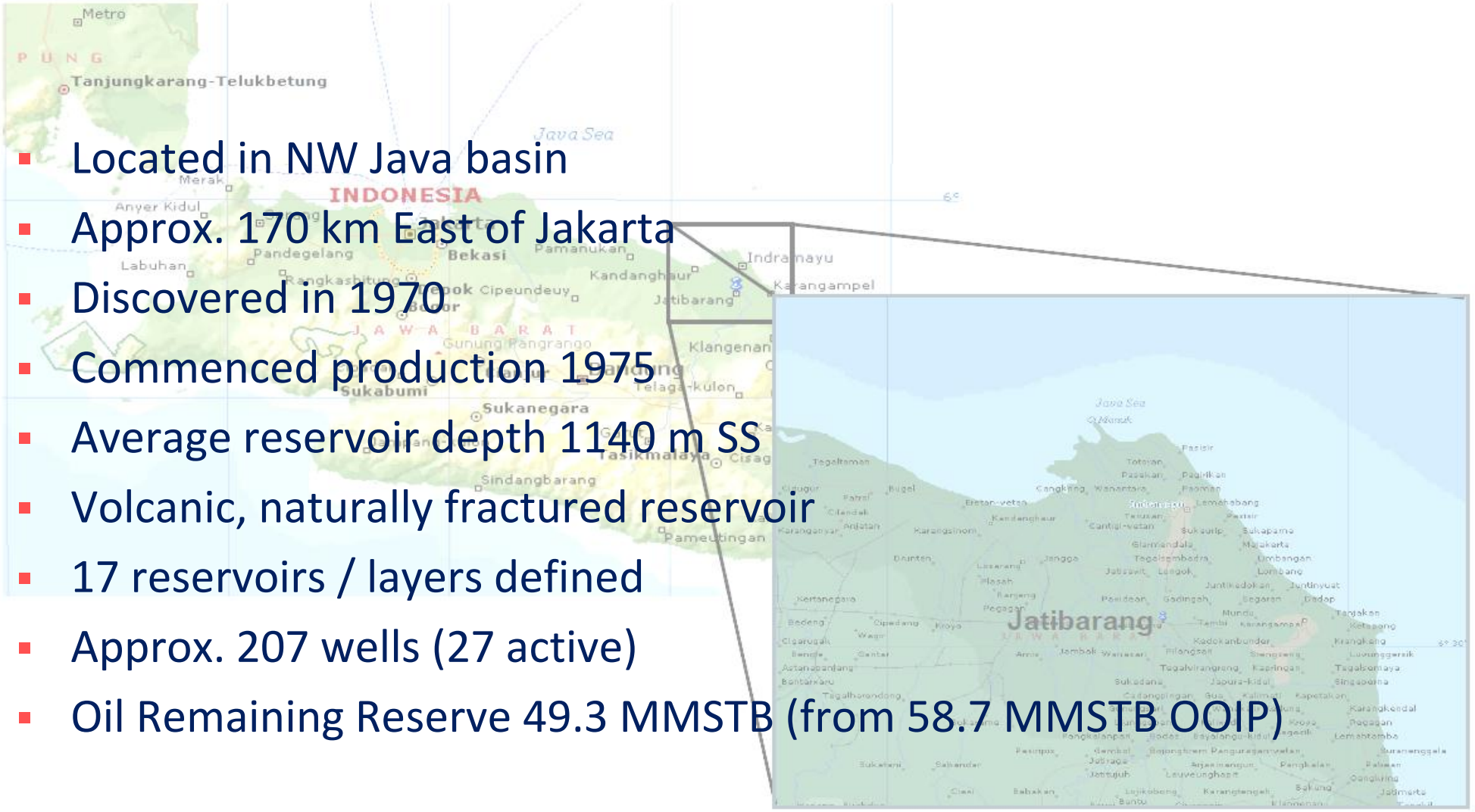
Jatibarang Field



- Located in NW Java basin
- Approx. 170 km East of Jakarta
- Discovered in 1970
- Commenced production 1975
- Average reservoir depth 1140 m SS
- Volcanic, naturally fractured reservoir
- 17 reservoirs / layers defined
- Approx. 207 wells (27 active)
- Oil Remaining Reserve 49.3 MMSTB (from 58.7 MMSTB OOIP)

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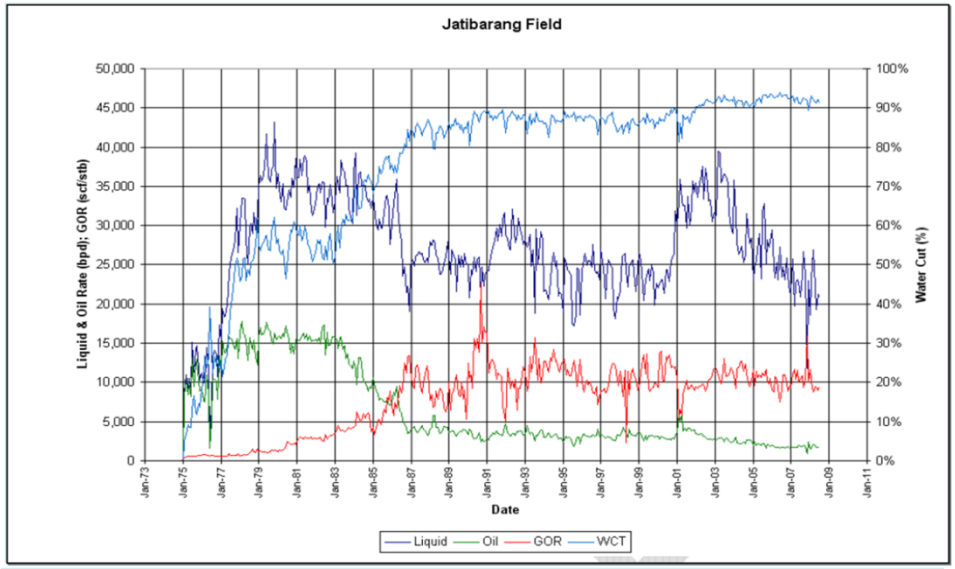
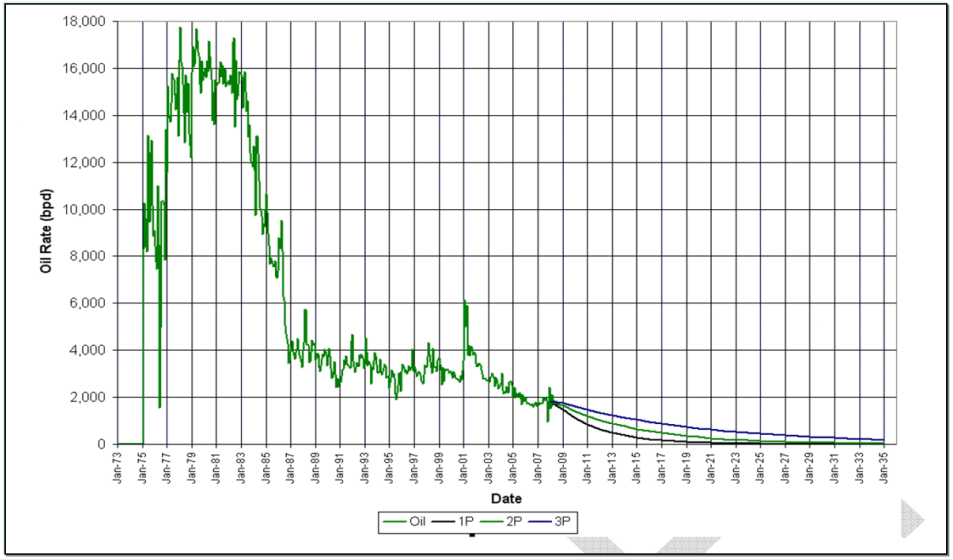
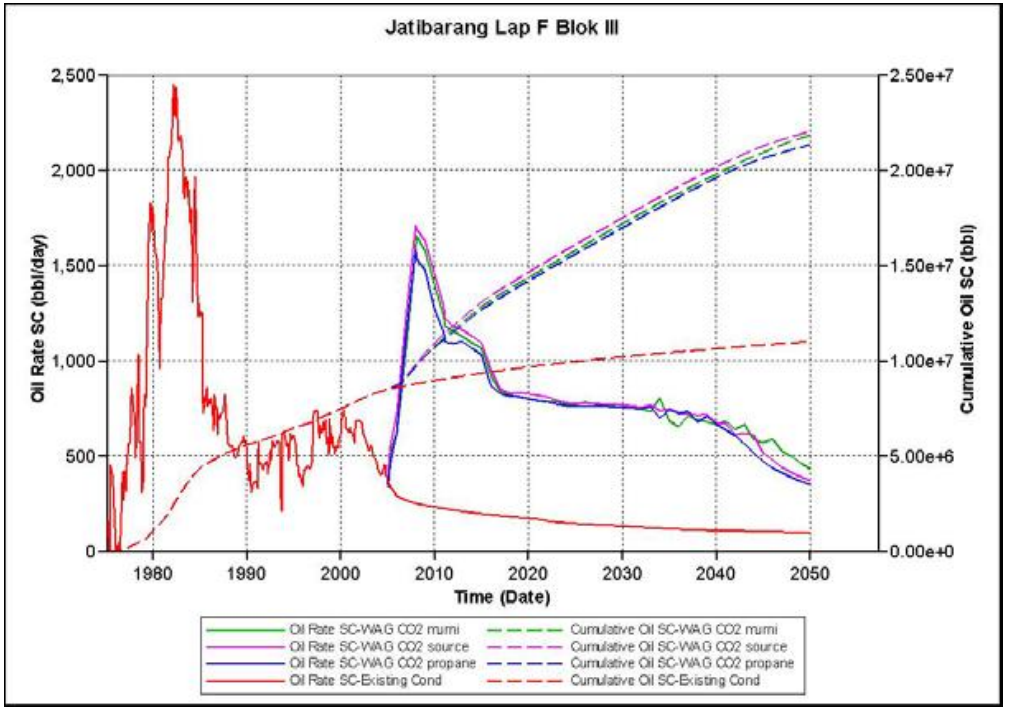
Jatibarang Production History and CO2 Injection Simulation







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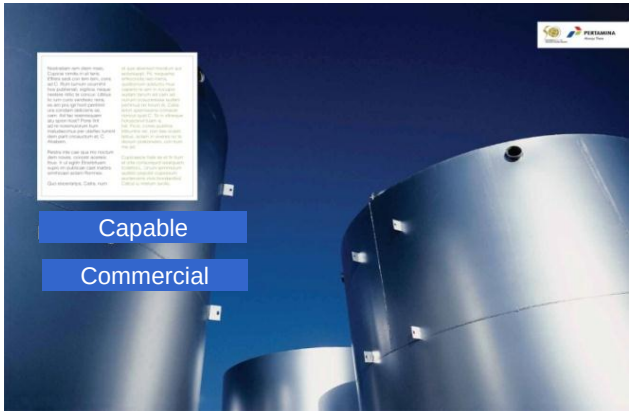
THE CHANGING PERTAMINA

Today's Pertamina is a transformed Pertamina,
the pride of Indonesia as well as
a capable and reliable partner in oil and gas
business in the future to come



Thank You

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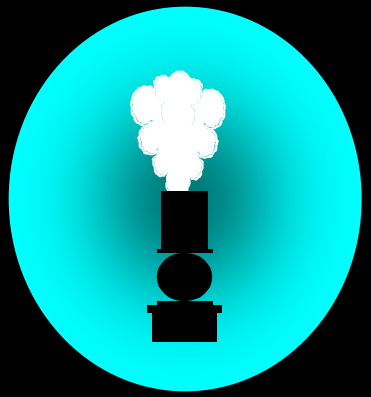
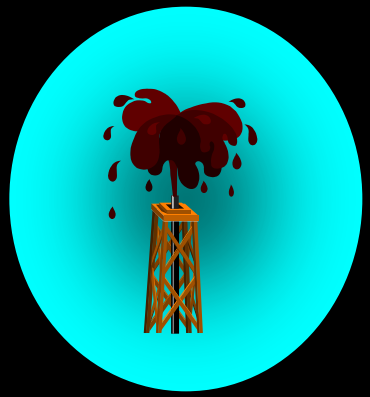
GEOTHERMAL ENERGY vs CONVENTIONAL ENERGY

POTENTIAL	INDONESIA
OIL	~ 9 BBO
GAS	~ 182 TSCF
GEOTHERMAL	~ 27,000 MW



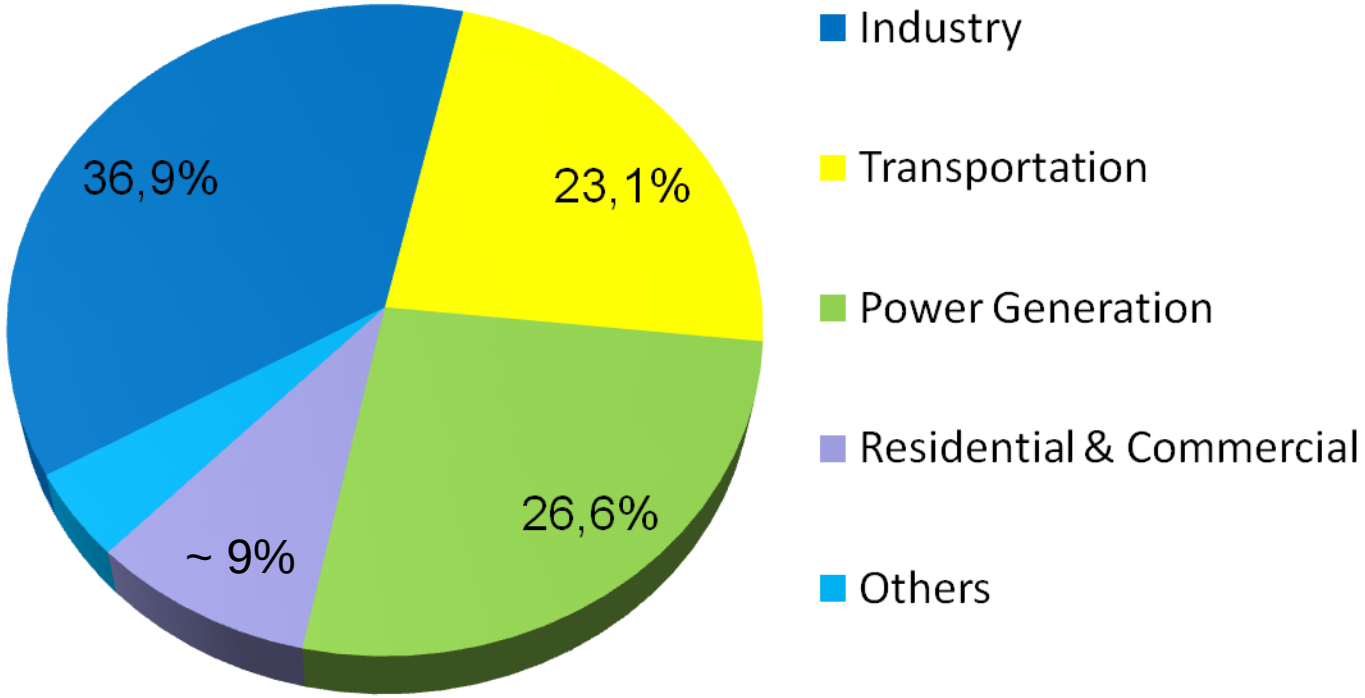
Geothermal
1000 MW, 30 years

equivalent to



Oil
465 Million BO

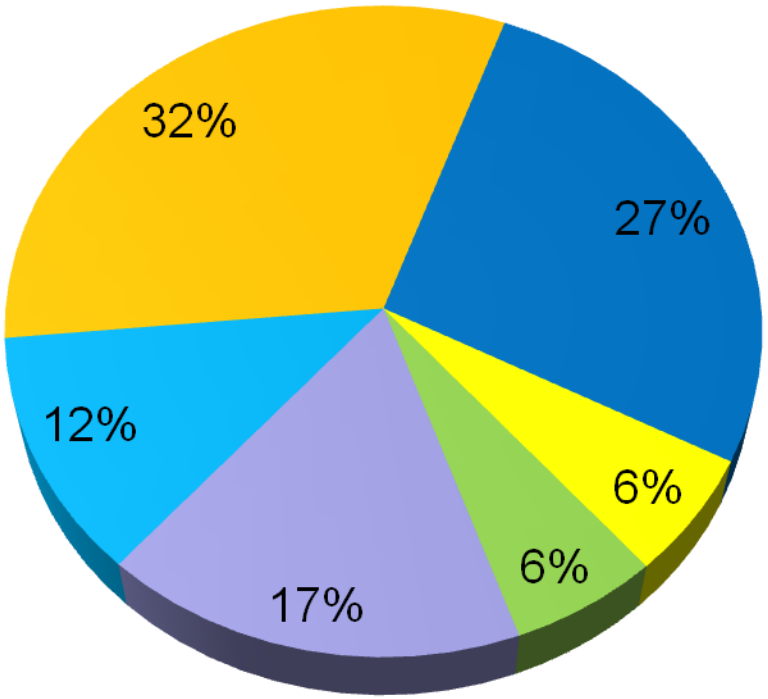
CO2 Emission in Indonesia by Sectors (2005)



Total CO_2 Emission in 2005: 293.27 G-ton

[Source: IEA]

Global Energy Related CO2 Emission (2005)



- Coal Fired Power [70% of Power Sector Emissions]
- Iron & Steel Industries
- Cement Industry

  [50% of Industrial Sector Emissions]
- Automobile [70% of Transport Sector Emissions]
- Residental/Commercial
- Others

Total CO_2 Emission in 2005: 27.1 G-ton

[Source: IEA]