KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL

INTERNATIONAL COAL BASED POWER CONFERENCES 2016:

INDONESIA ELECTRICITY DEVELOPMENT PLAN AND INDONESIA COAL-ASH MANAGEMENT IMPLEMENTATION

New Delhi, 17th March 2016

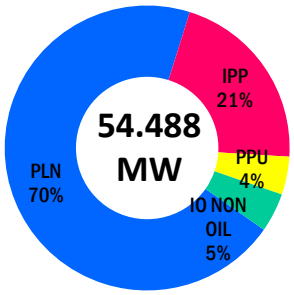
OUTLINE

INTERNATIONAL CONFERENCE ON COAL-BASED POWER, MARCH 16TH 2016

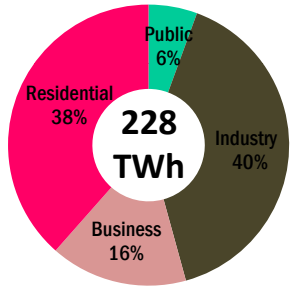
1. OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION
2. INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT
3. ENVIRONMENT IMPACT
4. INDONESIA IMPLEMENTATION OF COAL-ASH MANAGEMENT
5. SOLUTION AND CONCLUSION

1 OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION

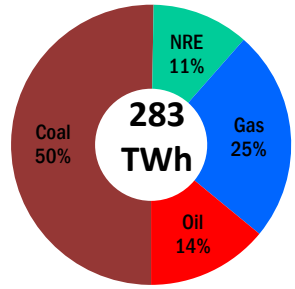
OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION



Persentage of Power Plant Capacity



Persentage of Electricity Consumption*)



Persentage of Energy Mix*)

*) Included Non-PLN

Installed Capacity (2015)

54,488 MW

(PLN: 38,204 MW, IPP: 11,519 MW, PPU: 2,349 MW, IO Non Oil: 2,416 MW)

Electicity Consumption (2015)

228 TWh

Electricity Production(2015)

283 TWh

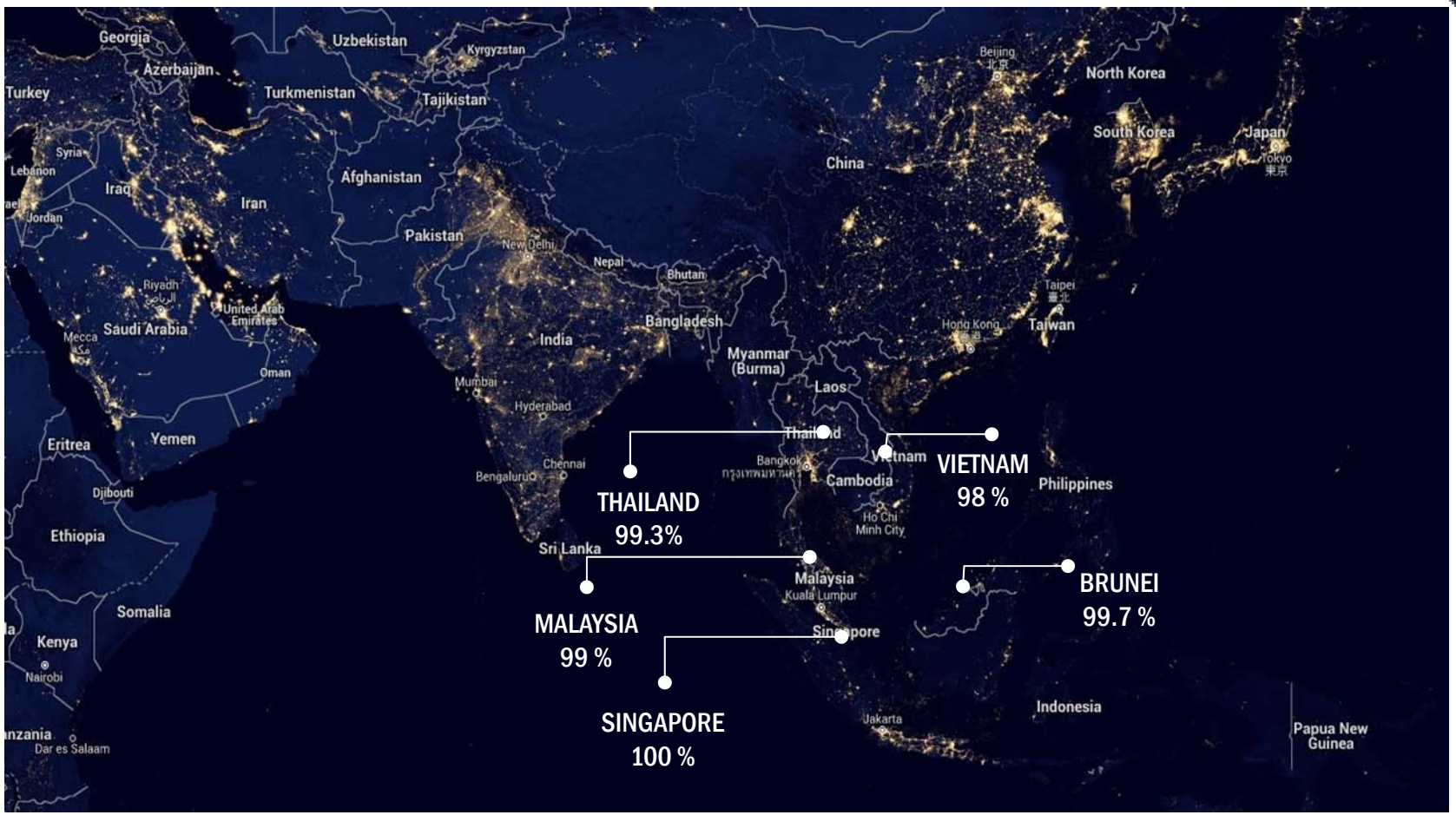
Electrification Ratio (Desember 2015)

88.30%

kWh Per Capita (2015)

910.2 kWh/capita

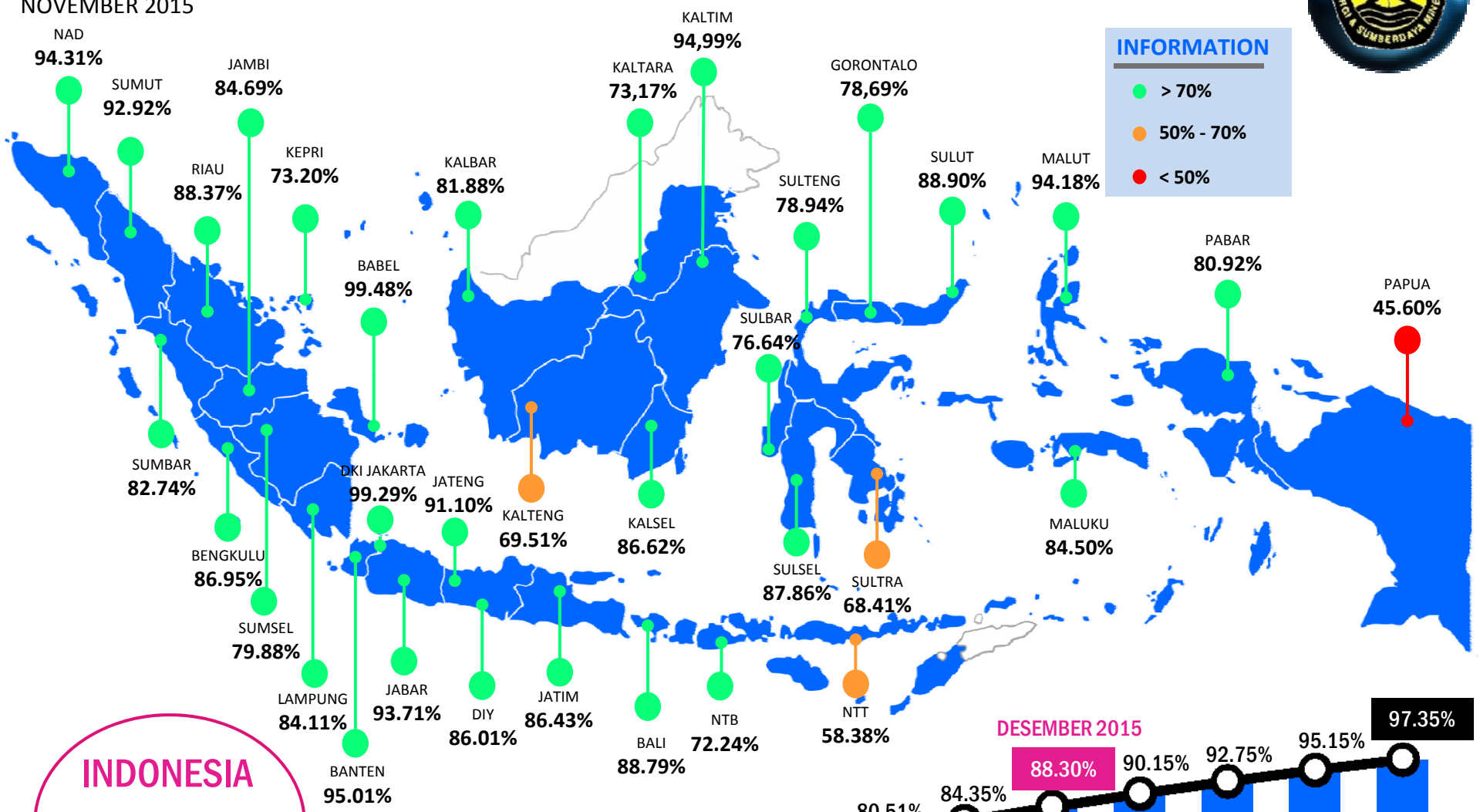
OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION



ELECTRIFICATION RATIO OF INDONESIA ???

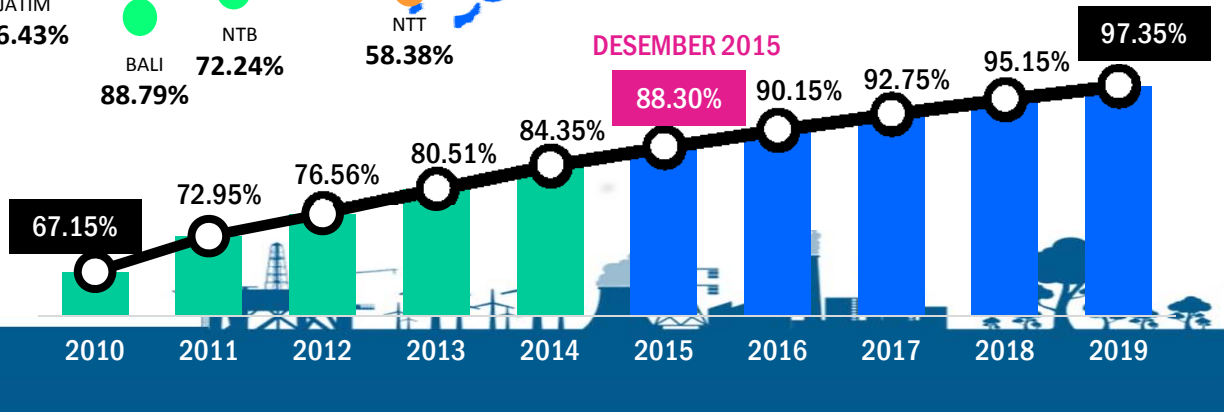
OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION

NOVEMBER 2015



INDONESIA

88.30%



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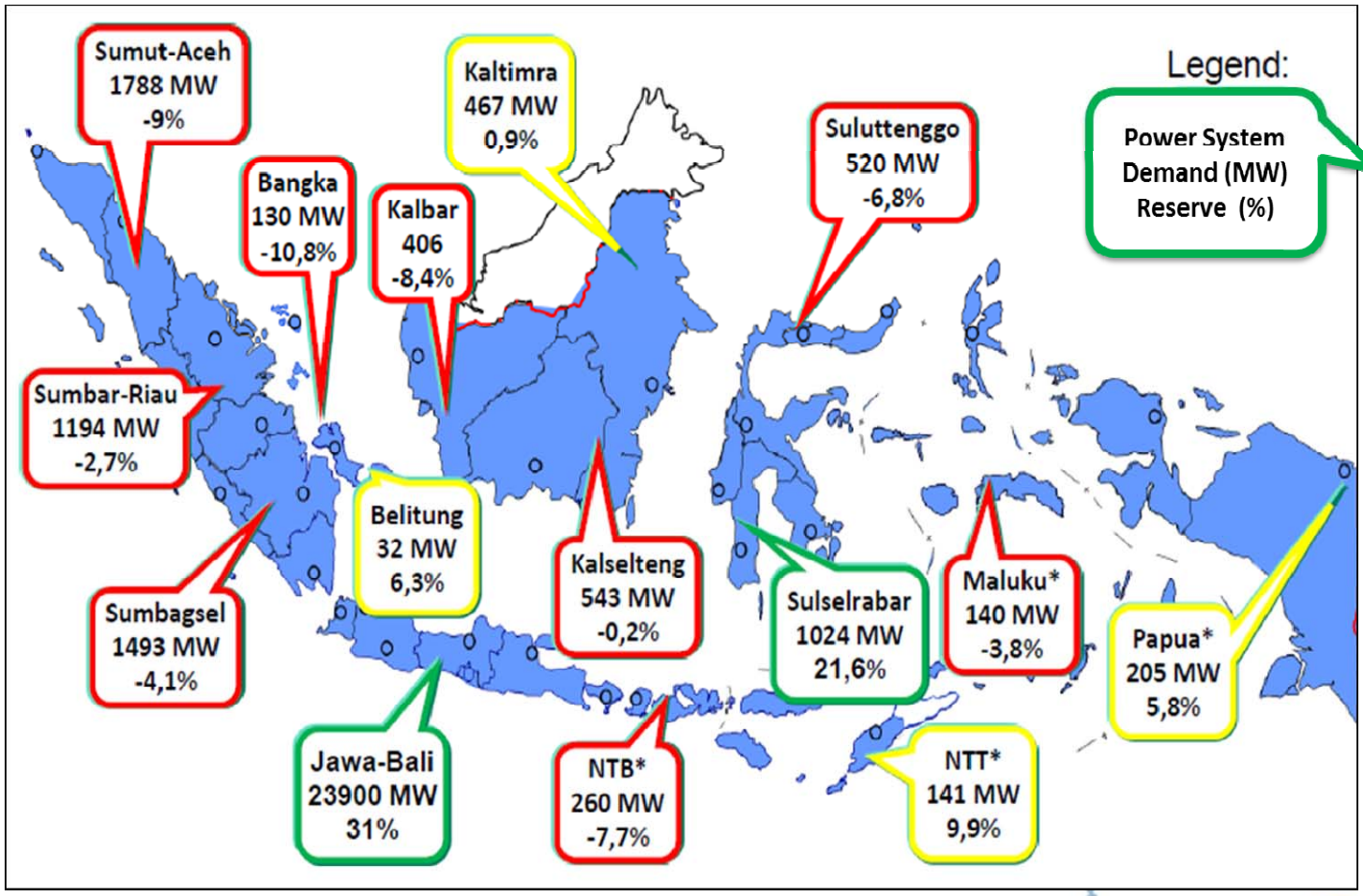
OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION

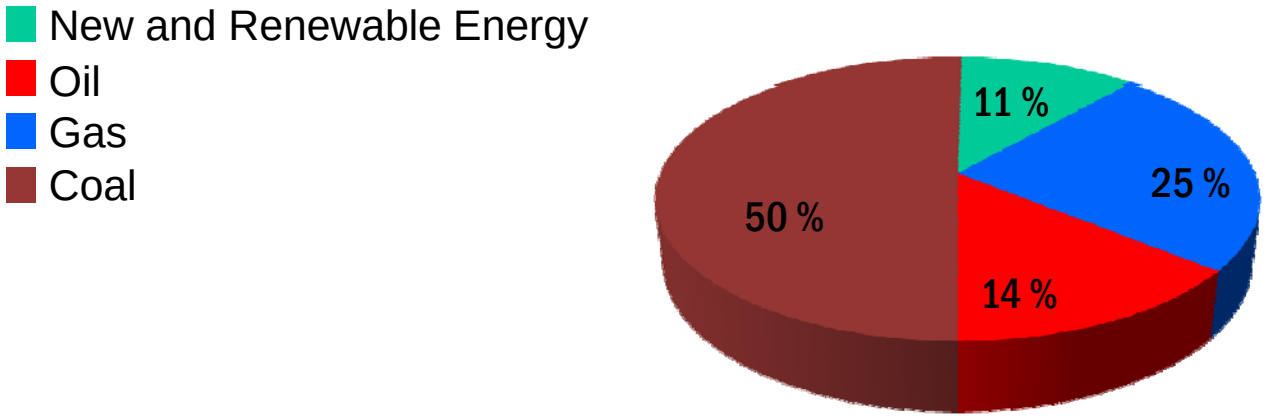
ELECTRICITY CRISIS IN DRY SEASON 2014



INDONESIA'S COAL-FIRED POWER PLANT

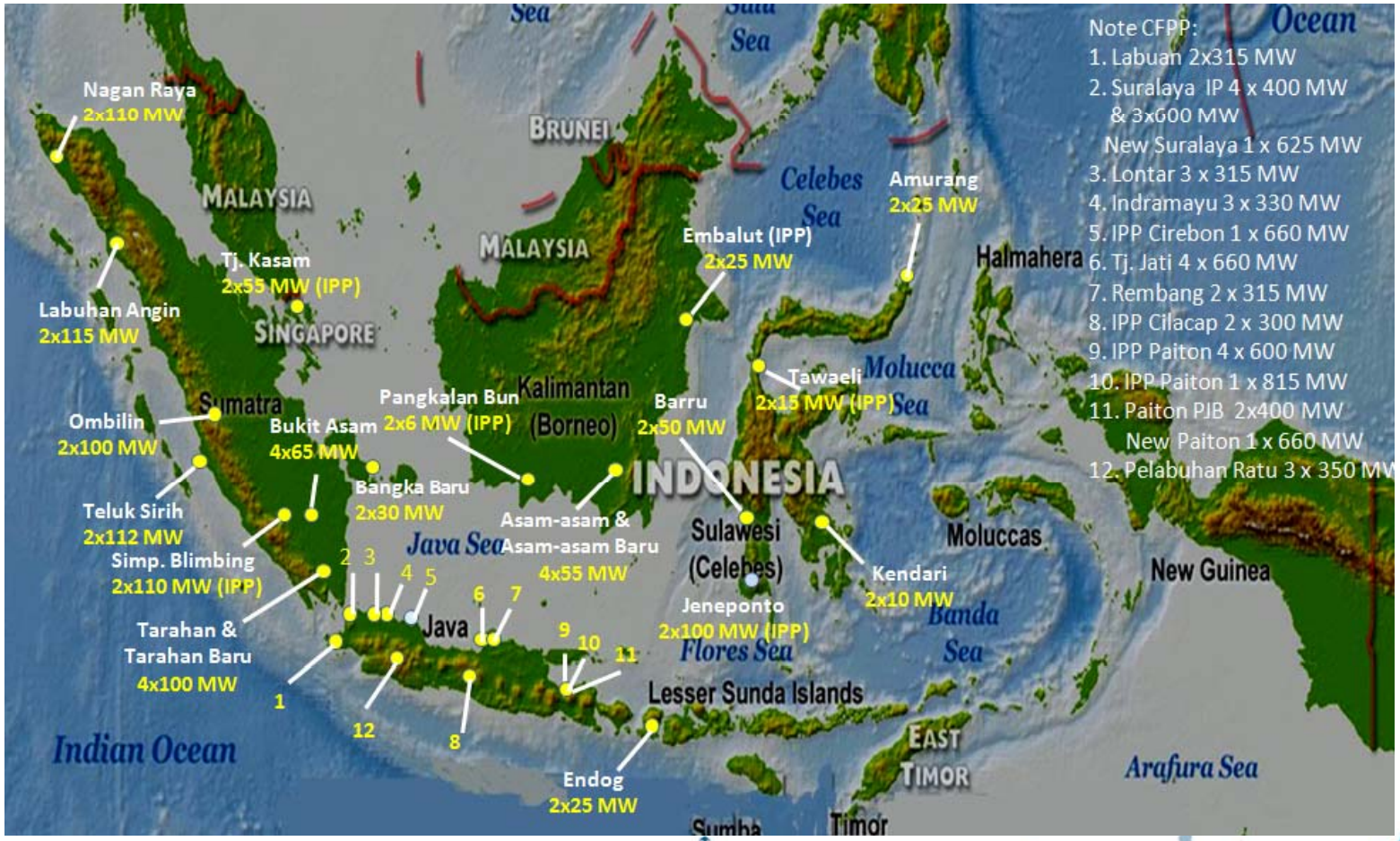
- Installed capacity existing :
  - **56 units Coal-Fired Power Plant** interconnected (**20.889,5 MW**.)
  - **19 units Coal-Fired Power Plant** in mechanism *Private Power Utility* (PPU) which are **1.750 MW** installed capacity.

- Power Plant Composition which is 50.28 % as Coal-Fired Power Pant



OVERVIEW OF INDONESIA'S ELECTRICITY CONDITION

INDONESIA'S COAL-FIRED POWER PLANT



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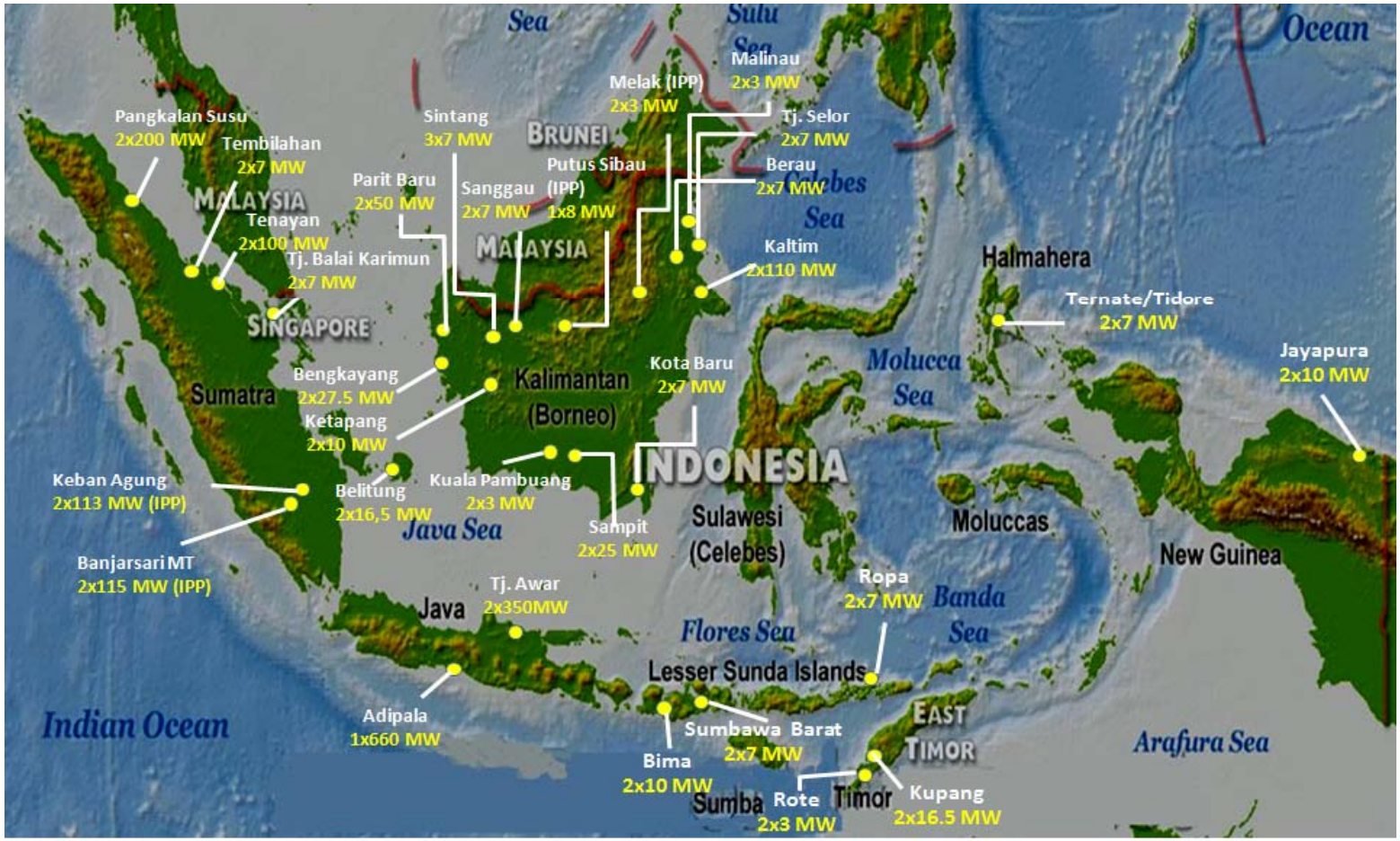
INDONESIA'S COAL-FIRED POWER PLANT



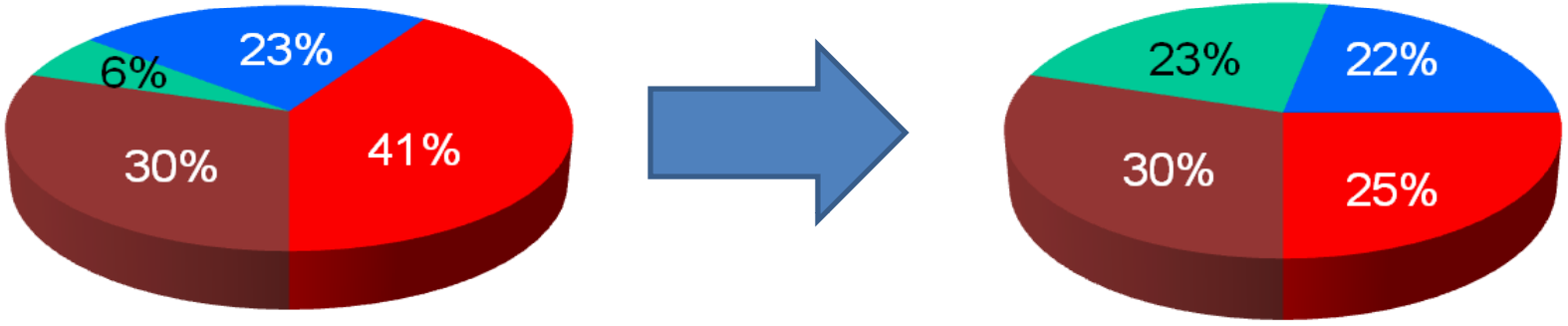
2 INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT

POWER GENERATION ENERGY MIX

New and Renewable Energy
Oil
Gas
Coal

FINAL ENERGY MIX

(National Energy Policy, GR No.79/2014)

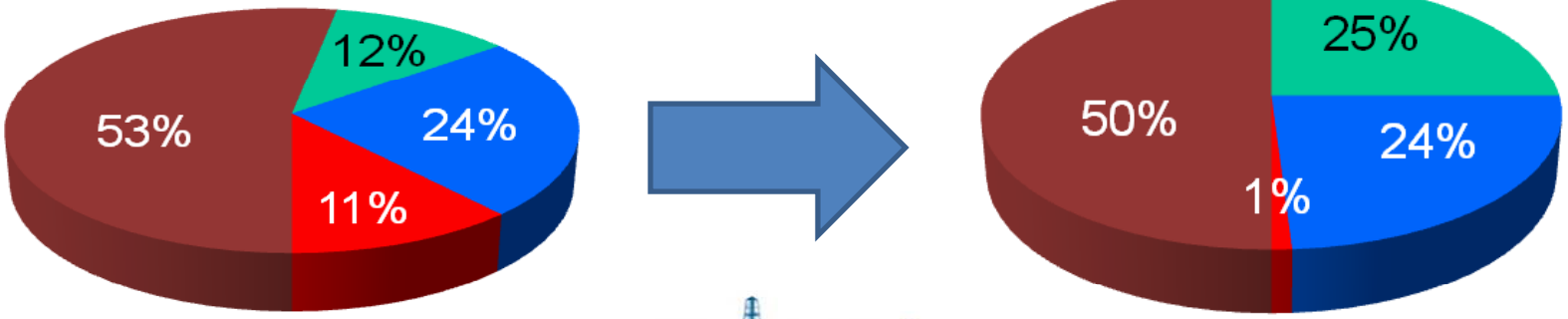


REALIZATION 2013

TARGET 2025

ENERGY MIX OF POWER GENERATION

(Draft of RUKN 2015-2034)



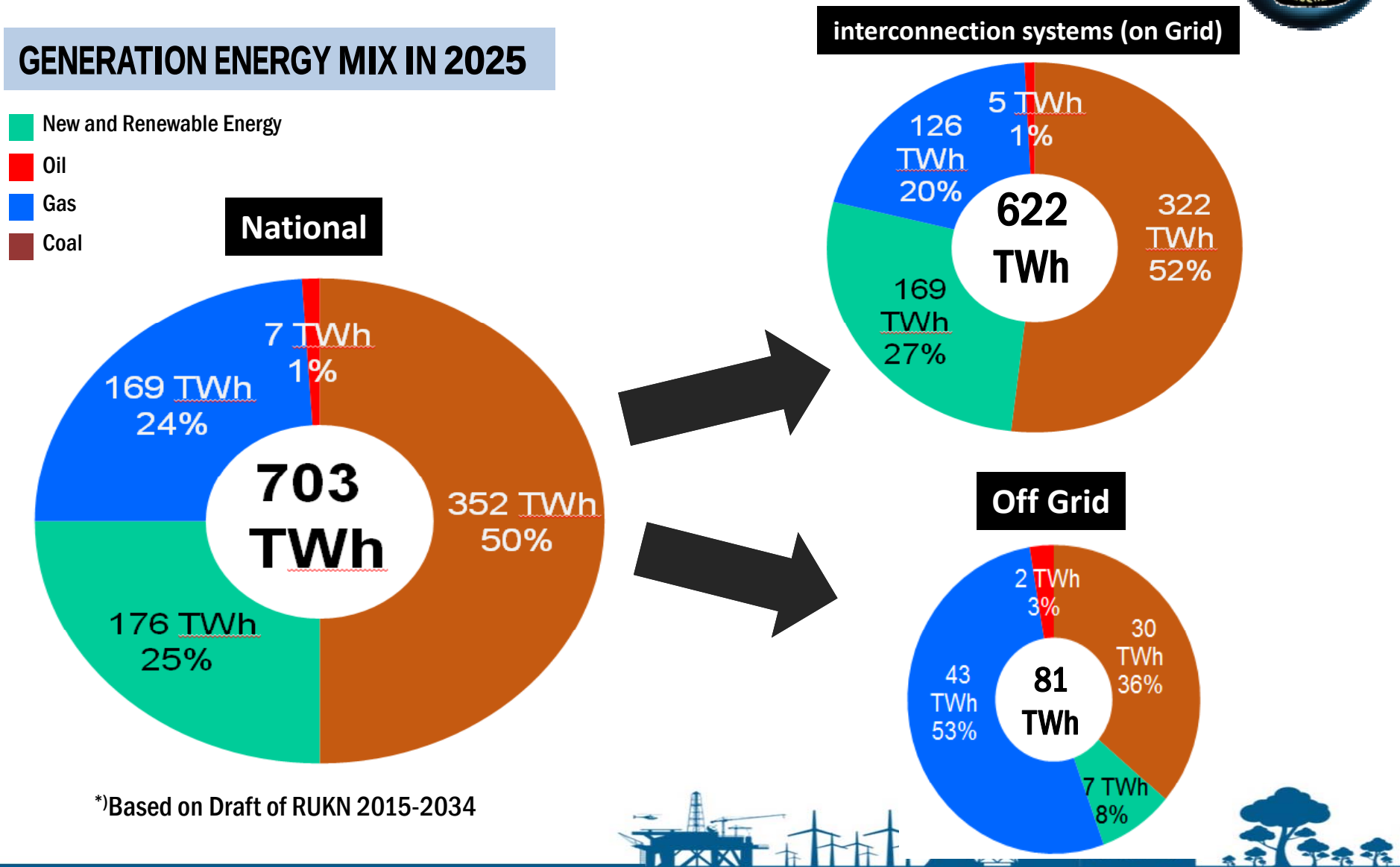
REALIZATION 2014

RUKN = Rencana Umum Ketenagalistrikan Nasional
(General National Power Plan)

TARGET 2025

INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT

GENERATION ENERGY MIX IN 2025



*)Based on Draft of RUKN 2015-2034

35,000 MW PROGRAM

ELECTRICITY DEVELOPMENT OF 2015-2019 TO FULFILL ELECTRICITY GROWTH 8.7% AND ELECTRIFICATION RATIO 97.35% IN 2019

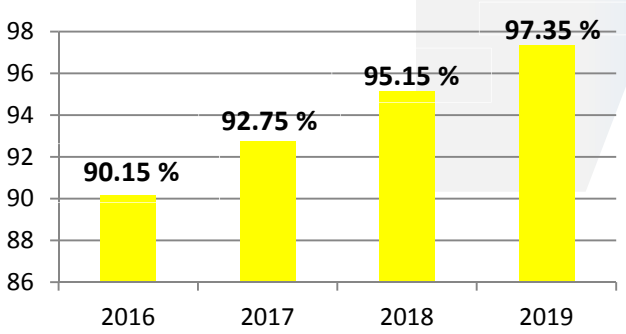
Currently the installed just cover about **88.30 %** household, lower than Singapore (100,0%), Brunei (99,7%), Thailand (99,3%), Malaysia (99,0%), dan Vietnam (98,0%)

For the next 5 years, demand for electricity will grow up about **8,7%** per year in average, with a target of electrification ratio about **97,35%** at the end of 2019

ELECTRIFICATION RATIO AND CAPACITY

CURRENT CONDITION	UNIT	TOTAL
ELECTRIFICATION	%	88.3
CAPACITY	MW	54,9

Electrification Ratio



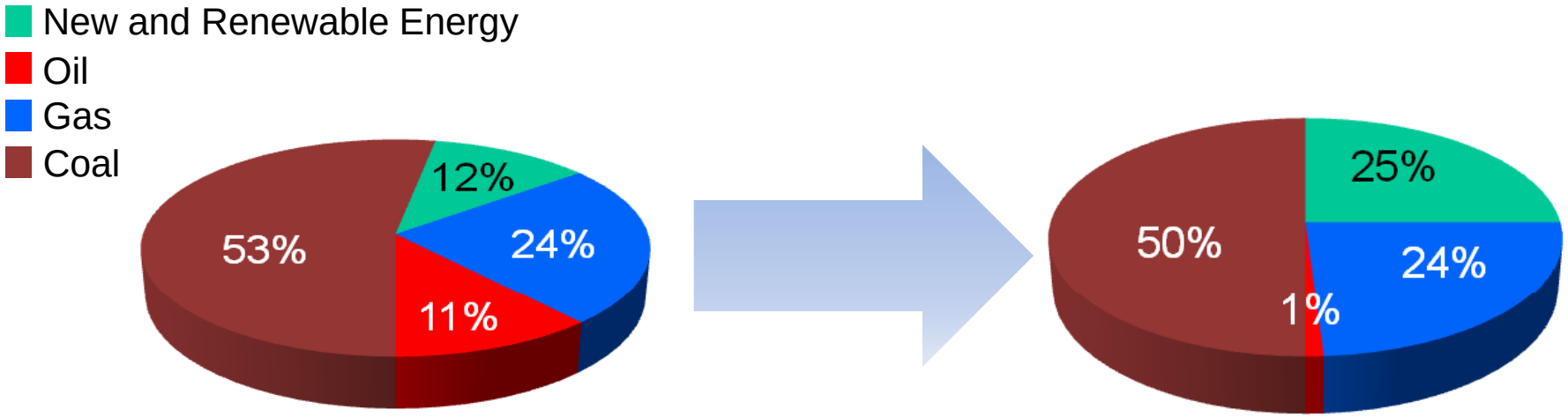
To fulfill electricity demand growth and to achieve electrification ratio target, it is required new additional capacity around 35,000 MW (exclude 7.4 GW on going project) for period 2015-2019

35,000 MW PROGRAM

EXTERNAL FACTOR ON THE 35,000 MW PROGRAM WHICH IS INFLUENCE THE GOAL:

1. The changes of assumptions which is affect to the change of annual electricity demand
2. Demand availability to absorb of electricity supply to return of the investment

INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT



REALIZATION 2015

TARGET 2025

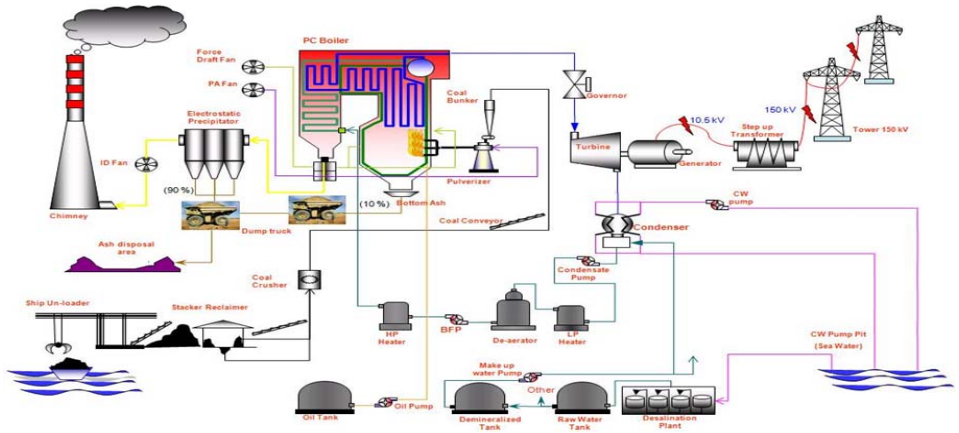
COAL FIRED POWER PLANT STILL DOMINANT AND MAJORITY

*) NOTE : RUKN = Rencana Umum Ketenagalistrikan Nasional (General National Power Plan)

INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT

- 35.000 MW Development Program consist **19,940 MW** (PLN (**2,115 MW**) + IPP (**17,825 MW**)) as Coal-Fired Power Plant.

- on-going 7,000 MW Project (construction), which's Coal-Fired Power Plant as 5,888 MW (PLN 42 units = 3,484 MW + IPP 15 units = 2,404 MW)

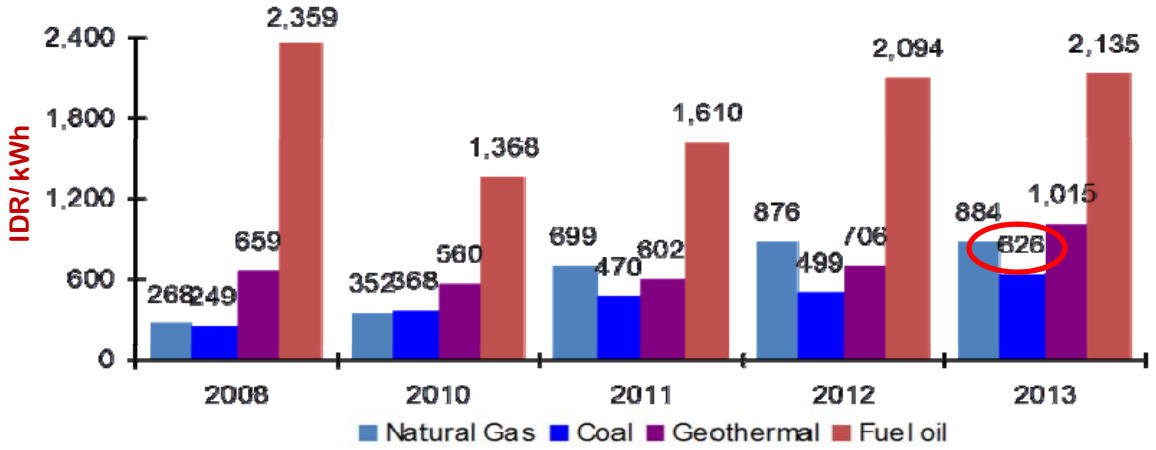


Total **25,820 MW** as Coal Fired Power Plant Development

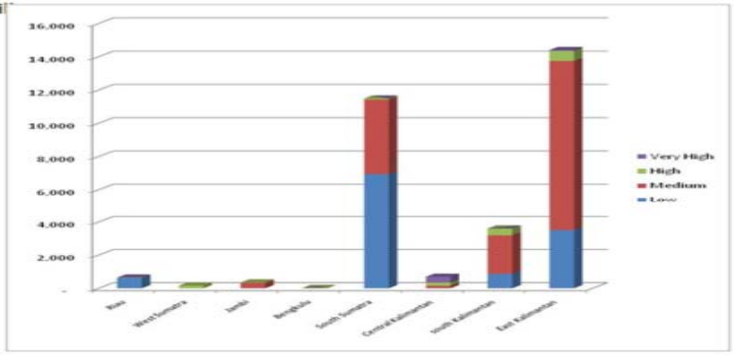
INDONESIA'S COAL-FIRED POWER PLANT DEVELOPMENT

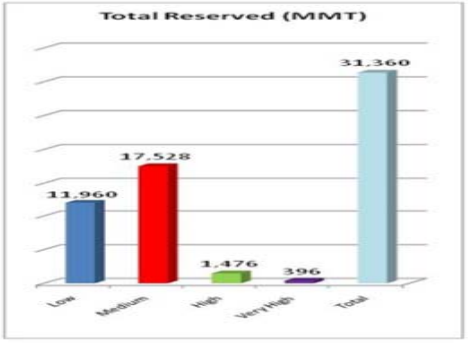
Why Indonesia need to build Coal Fired Steam Power Plant??

- Cheap



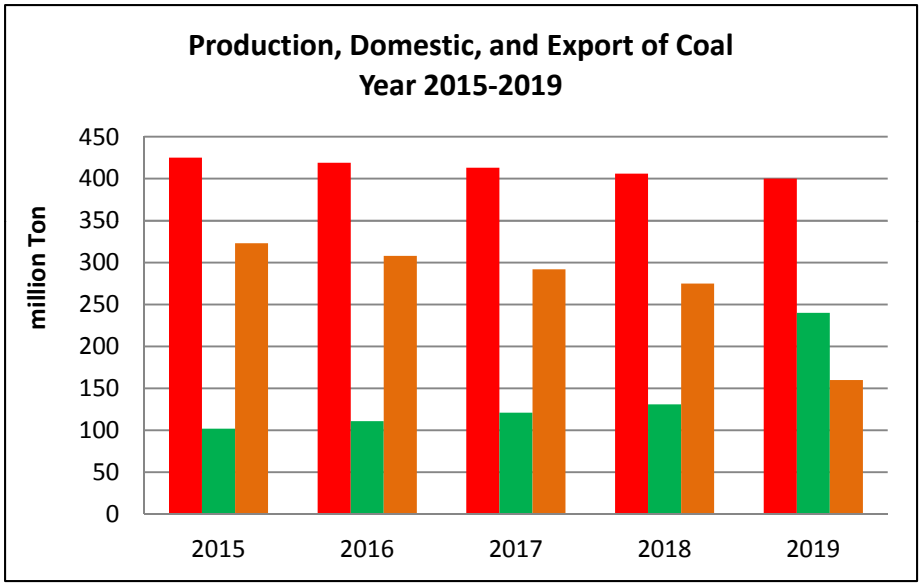
- The Large Coal Reserves (29.48 billion ton)





Jenis BB	Wilayah								
	Riau	West Sumatra	Jambi	Bengkulu	South Sumatra	Central Kalimantan	south Kalimantan	East Kalimantan	TOTAL
Low	620	-	-	-	6,949	-	873	3,518	11,960
Medium	4	3	333	4	4,479	153	2,325	10,227	17,528
High	21	156	16	15	61	186	410	611	1,476
Very High	-	-	-	-	-	354	-	42	396
Total	645	159	349	19	11,489	693	3,608	14,398	31,360

REGULATION OF MANDATORY FOR DOMESTIC MARKET OBLIGATION (DMO) --- DOMESTIC UTILIZATION OF COAL



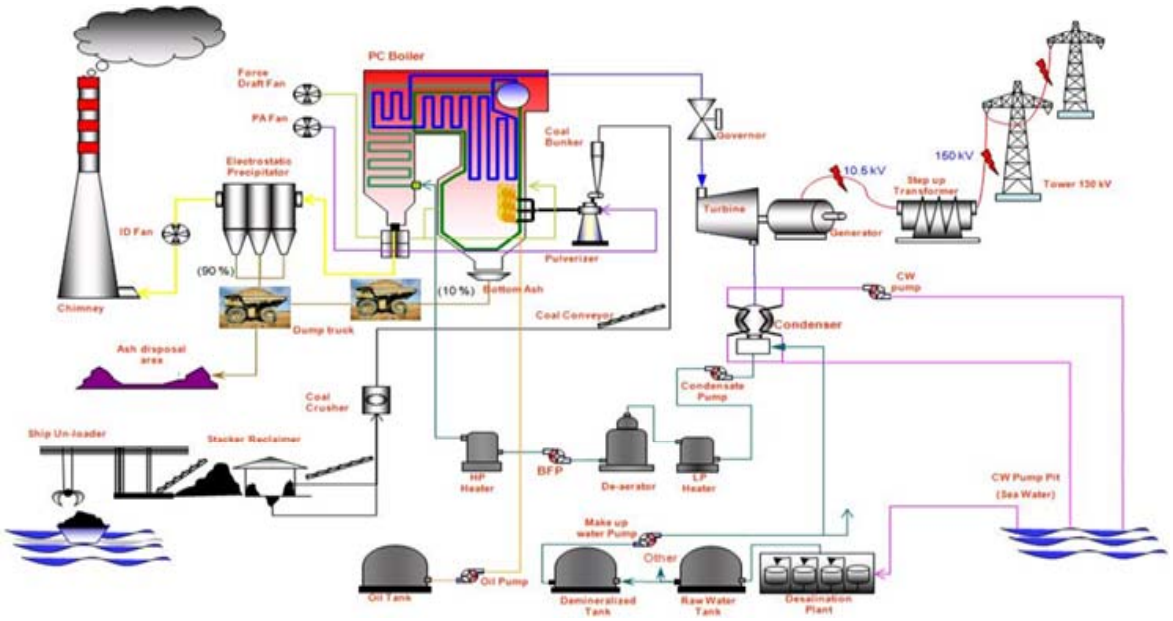
PRESIDENT REGULATION NO. 02 YEAR 2015 CONCERN MEDIUM-TERM DEVELOPMENT PLAN (RPJM):

- Coal Production will reducing as 400 million ton in 2019
- Percentage Domestic of Coal Production in 2015 as 24% and will increasing as 60% in 2019

	2015	2016	2017	2018	2019
Production (mton)	425	419	413	406	400
Domestic (mton)	102	111	121	131	240
Export (mton)	323	308	292	275	160

3 ENVIRONMENT IMPACT

GLOBAL ISSUE

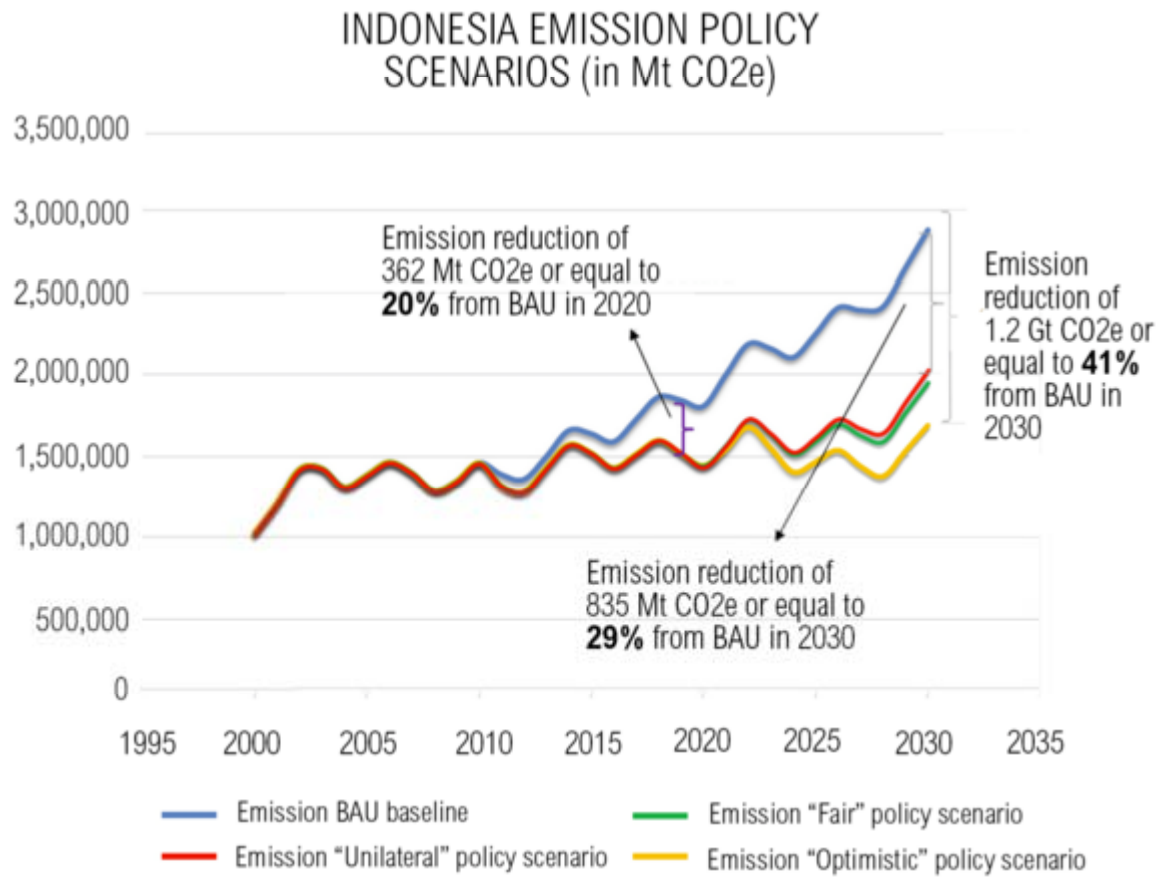


Coal-Fired Power Plant significantly contribute **the Green House Gasses (GHGs) Emissions**

INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC)

- According to Paris Agreement COP 21 UNFCCC, all parties agree to effort the temperature increase to not exceeding 2^{o} C, because if the aggregate of the emission fails to meet the requirement to avoid temperature increasing from exceeding 2^{o} C, adaptation efforts would be increasingly difficult to implement.
- The other side, Indonesia is an emerging economy and still a developing country with development challenges such as poverty, inequality and struggling for creating job, remain to be overcome.
- Indonesia INDC presents the opportunity for Indonesia to achieve development with less emission and at the same time strengthened resilience to cope with climate change
- Indonesia INDC should benefit the poor, facilitates poverty alleviation and narrowing the inequality gap, and not merely emission reduction
- And Indonesia's INDC realize to ensure the following criteria to be met: providing green jobs, including increasing its access to low-medium income people, improving income level and strengthening the resilience to climate impact of the poor, promoting growth, reduce emission, and strengthen the environmental integrity.

INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC)

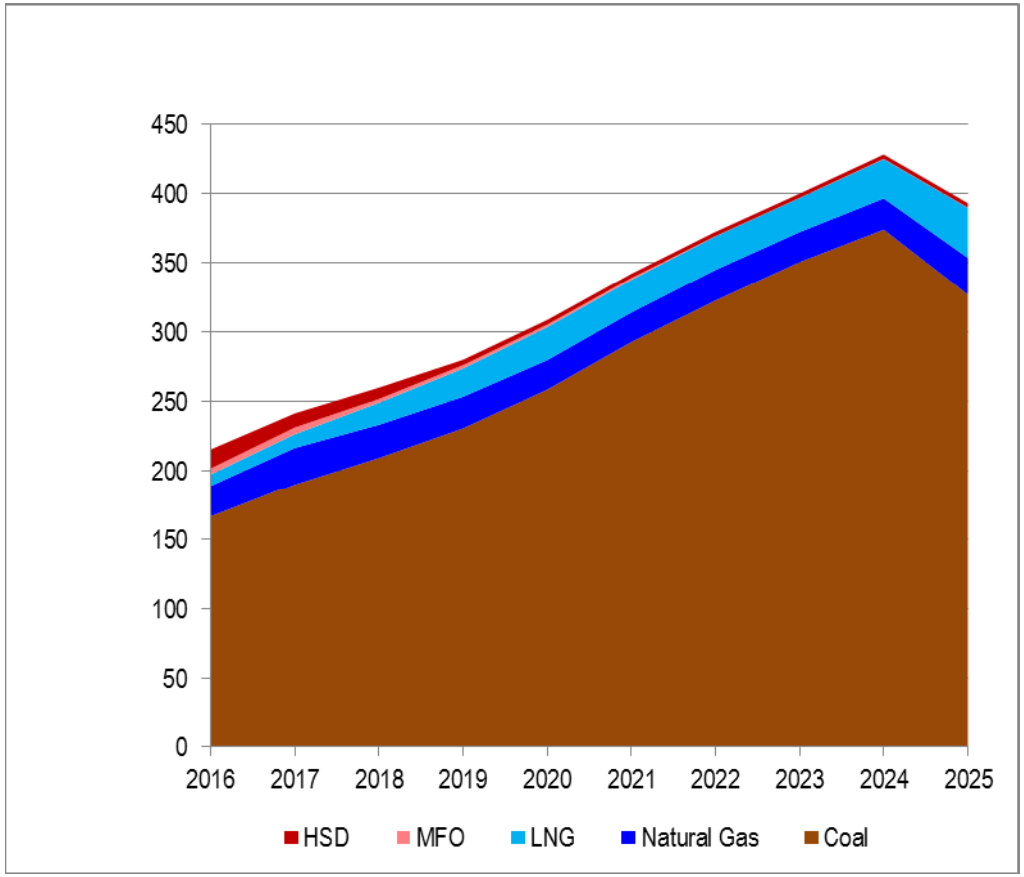


INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC)

President Joko “Jokowi” Widodo announced Indonesia’s INDC on November 30 that Indonesia has committed to reduce GHC emissions by 29 percent by 2030 compared to business-as-usual projected emissions.

NO	SECTOR	GHGs Emission Reduction (Giga Ton CO2e)			
		29%		41%	
1	LAND BASE	0.596	20.69%	0.75	26.03%
2	WASTE	0.03	1.04%	0.045	1.56%
3	INDUSTRY	0.001	0.03%	0.002	0.07%
4	ENERGY	0.222	7.71%	0.393	13.64%
		0.849	29.47%	1.19	41.31%

GHGs EMISSIONS FORM ELECTRICITY GENERATION (2016 – 2025)



MITIGATION ACTIONS OF ELECTRICITY GENERATION SECTOR

NO	MITIGATION ACTIONS	Total Capacity Installed (MW)	GHGs Emission Reductions ($mtCO_2$) in year 2014
1	HYDROPWER GENERATION (Large Scale + Minihydro)	93.5	0.456
2	SOLAR ENERGY (Large Scale entry to National Interconection Systems)	0.82	0.005
3	BIOMASS GENERATION (entry to National Interconection Systems)	2	0.001
4	BIOFUEL GENERATION (entry to National Interconection Systems)	2	0.011
5	CLEAN COAL TECHNOLOGY (CCT) UTILIZATION FOR COAL-FIRED POWER PLANT	1475	0.275
6	COAL BED METHANE (CBM) GENERATION	2	0.008
7	CO-GENERATION POWER PLANT	619.14	1.387
TOTAL			2.14

NO	MITIGATION ACTIONS	Total Capacity Installed (MW)	GHGs Emission Reductions ($mtCO_2$) in year 2020
1	HYDROPWER GENERATION (Large Scale + Minihydro)	2411	11.65
2	SOLAR ENERGY (Large Scale entry to National Interconection Systems)	0.82	0.005
3	BIOMASS GENERATION (entry to National Interconection Systems)	45	0.285
4	BIOFUEL GENERATION (entry to National Interconection Systems)	0	0
5	CLEAN COAL TECHNOLOGY (CCT) UTILIZATION FOR COAL-FIRED POWER PLANT	17659	4.37
6	COAL BED METHANE (CBM) GENERATION	0	0
7	CO-GENERATION POWER PLANT	3050	2.77
8	INDUSTRIAL WASTE GAS GENERATION	10	0.016
9	GEOTHERMAL GENERATION	1160	8.79
TOTAL			27.88

TOTAL OF GHGs EMISSION REDUCTION 2010 - 2020 **30.02**

CLEAN COAL TECHNOLOGY

- To meet the rapidly growing demand and address supply shortage, coal-based generation provides a quick and low-cost solution in Indonesia;
- Coal-based generation contributes to increased CO_2 emissions;
- GoI is keen on reducing greenhouse gas emissions while keeping expanding power production and enhancing energy security;
- CCT offers a potential solution to GoI's dual goal with respect to power sector development/energy security and environmental sustainability.

Rational for USC/IGCC introduction in Indonesia

Technical availability

✓ Is USC & IGCC readily available ?

→ **USC: readily available, IGCC: available in 2020**

✓ When can it be introduced in Indonesia?

→ **USC: 2017, IGCC: 2025**

Alignment with Indonesia's Policy

✓ Is it possible to use low rank coal (LRC) ?

→ **Yes, LRC can be utilized**

✓ Does it contribute to GHG emission reduction ?

→ **Yes, GHG emission amount will be reduced**

Economic validity

✓ Is it economically viable ?

→ **Yes, Generation cost will be lower than Sub-c or SC**

CCT for Coal Fired Power Plants

USC

Matured technology to achieve low electricity costs & low GHG emissions

- Proven and already commercialized technology
- Introduced all around the world
- Can utilize low rank coal with above average ash melting point
- Economic superiority to SC
- Lower GHG emission compared to SC

IGCC*

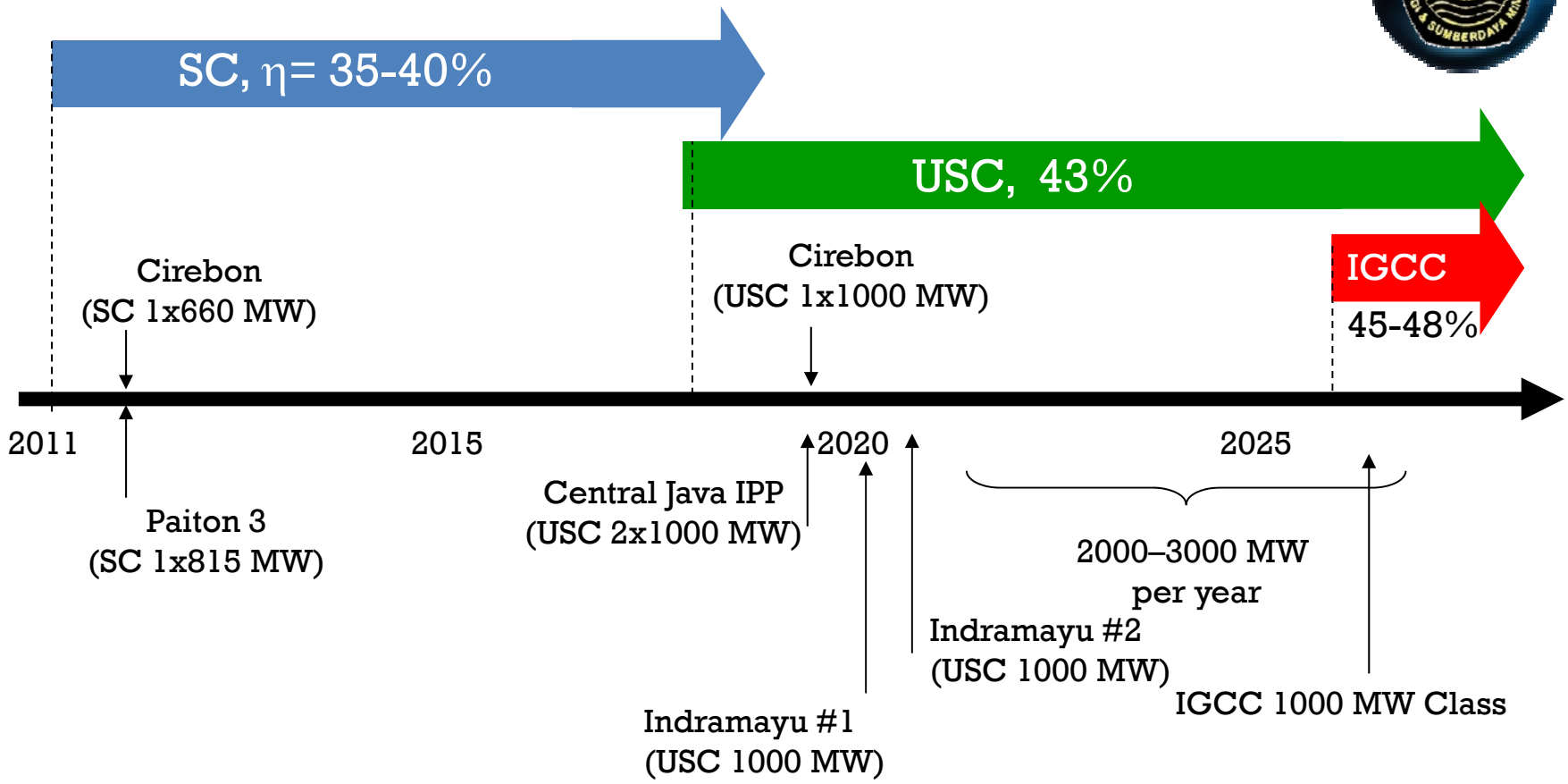
Promising technology to achieve low electricity cost, lower GHG emissions & LRC utilization

- Technology yet to be commercialized
- Will be introduced at the beginning of 2020s in commercial base in the world
- Promising technology for low rank coal with low ash melting point
- Economic superiority to SC and USC
- Lower GHG emission compared to SC & USC

Target for introduction of USC and IGCC in Indonesia

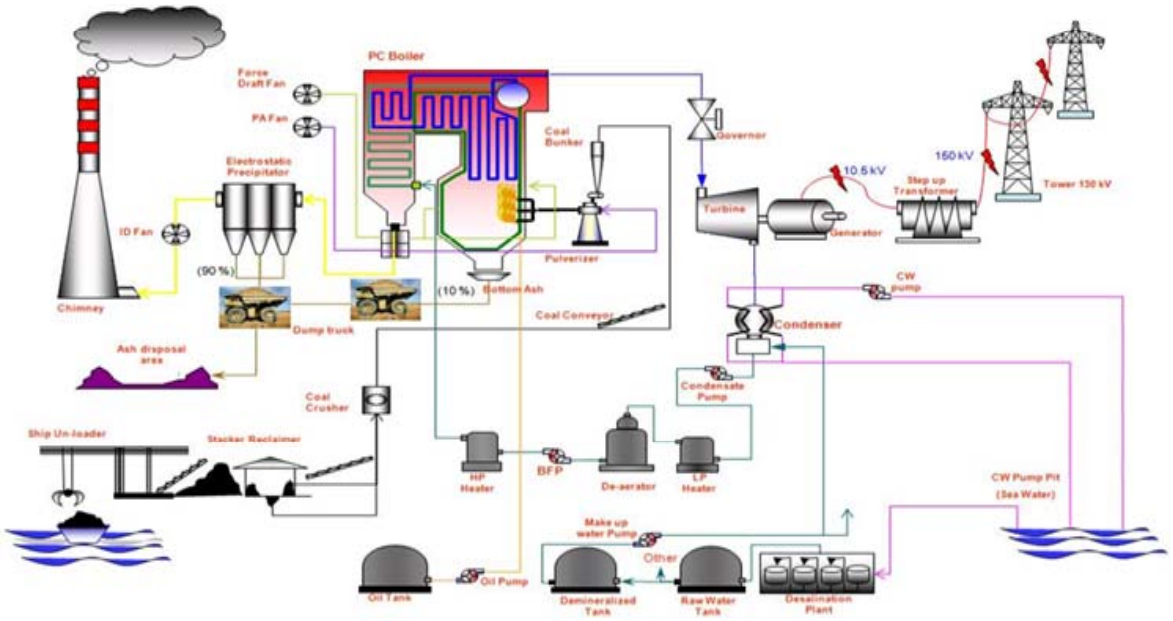
- USC should be introduced for next new coal fired power plant project (2017)
- IGCC will be introduced around 2025, considering the development situation in the world

*) Integrated Gasification Combined Cycle



*) Source: *The Project for Promotion of Clean Coal Technology (CCT) in Indonesia*, Interim Report, October 2011, Jakarta, JICA Study Team, with modification

GLOBAL ISSUE



Coal-Fired Power Plant operation were finded **the Dioxin-Furans Emissions**

Original Persistent Organic Pollutants

– signed May 2001 – Indonesia ratified in July 2009

"Dirty Dozen"

Pesticides

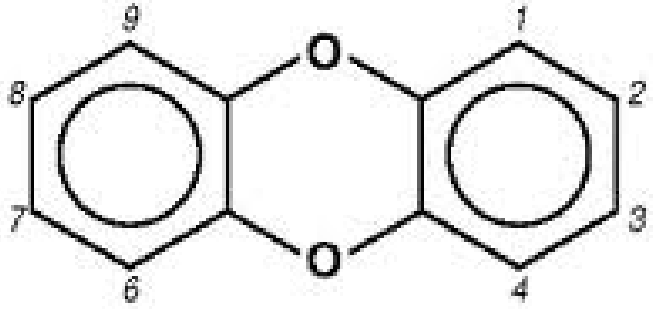
1. Aldrin
2. Chlordane
3. Dieldrin
4. Endrin
5. Heptachlor
6. Mirex
7. Toxaphene
8. DDT
9. Hexachlorobenzene (HCB)

Non-pesticide

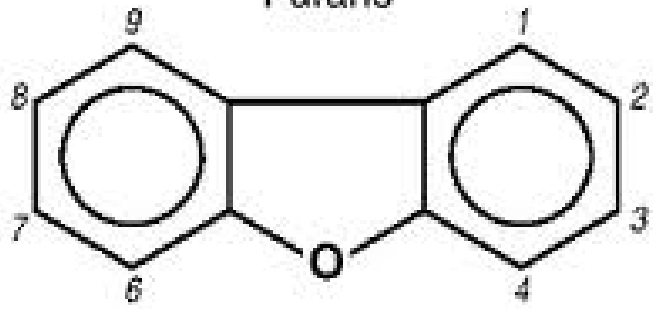
10. Polychlorinated biphenyls (PCBs)
11. Polychlorinated dibenzo-*p*-dioxins ("dioxins") and
12. polychlorinated dibenzofurans ("furan")

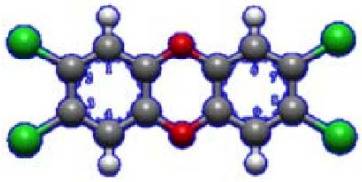
Assessment Dioxins/furans

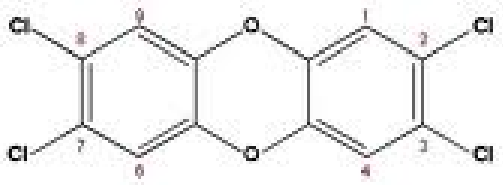
Dioxins



Furans

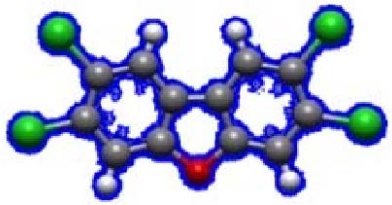


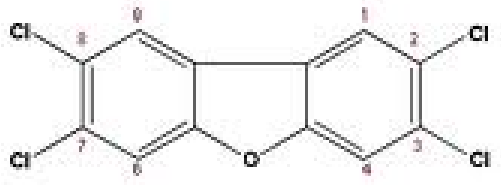




2,3,7,8-Tetrachlorodibenzo-p-dioxin

Polychlorinated dibenzo-p-dioxins (PCDDs)
75 derivative dibenzo-p-dioxin





2,3,7,8-Tetrachlorodibenzofuran

polychlorinated dibenzofurans (PCDFs) 135 congeners

ENVIRONMENT IMPACT

Dioxin-Furan (PCDD/F) emissions affect to human health

SEVESO Accident

Dioxin-Furan (PCDD/F) at Boiler Accident

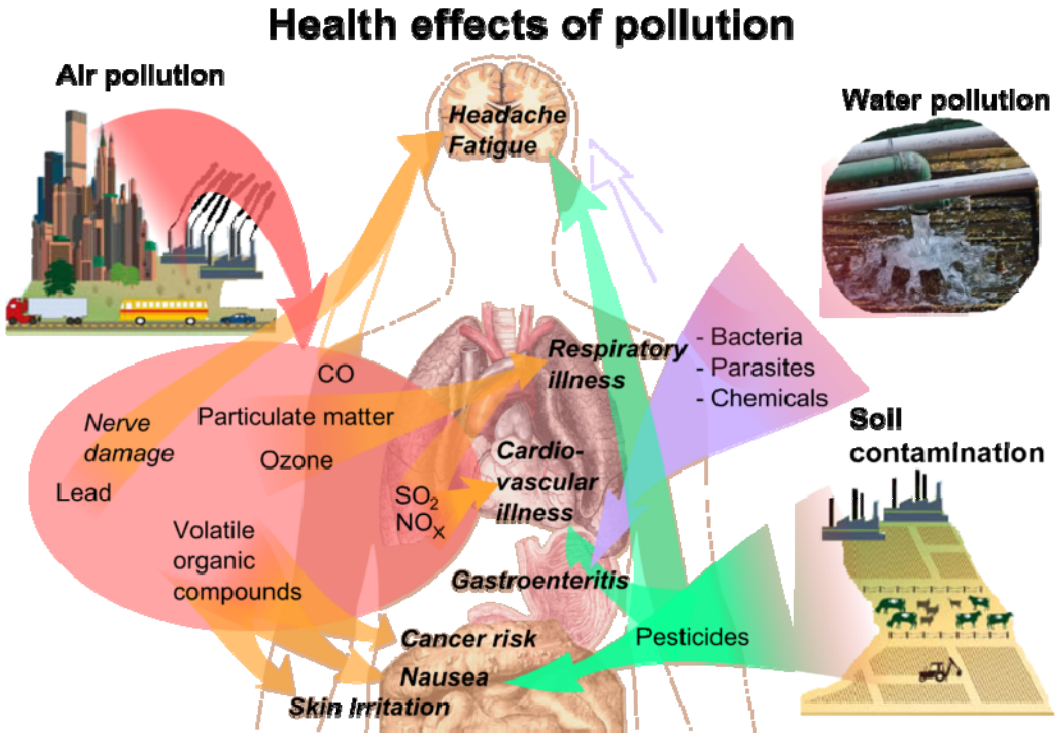
- Toxic, provoke the cancer.
- In addition to cancer, exposure to dioxin can also cause severe reproductive and developmental problems (at levels 100 times lower than those associated with its cancer causing effects). Dioxin is well-known for its ability to damage the immune system and interfere with hormonal systems
- In addition to cancer, exposure to dioxin can also cause severe reproductive and developmental problems (at levels 100 times lower than those associated with its cancer causing effects). Dioxin is well-known for its ability to damage the immune system and interfere with hormonal systems
- Carcinogenic, provoke the tumor.
- Indicate that endocrine and reproductive effects should be among the most sensitive effects in human, cause of Dioxin exposure
- Mutagenic, if bioaccumulation happens.

LOCAL ISSUE

HOW ABOUT ENVIRONMENT IMPACT FROM COAL-FIRED POWER PLANT DEVELOPMENT IN LOCAL ISSUE???

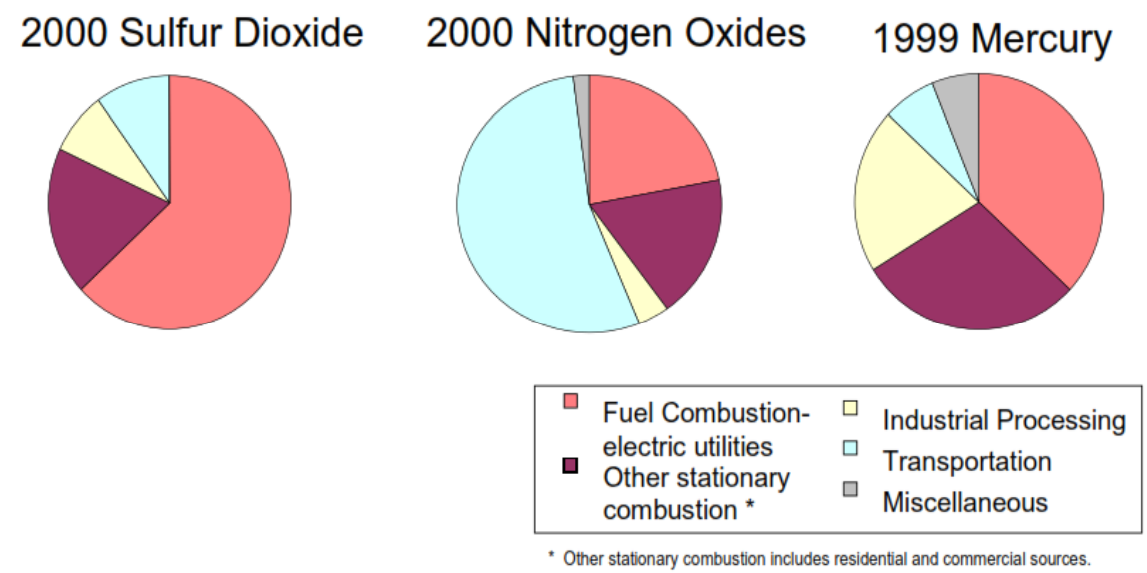
- Gas emission or air pollution???
  - Emissions of air pollutants, notably Sulfur dioxide (SOx), Nitrogen oxides (NOx), Particulate Matter (Dust) from the power plant operation ??
  - Air pollution attributable to scattering coal dusts from coal stockyard and Particulate matters from coal ash treatment yard ??
    - Ministry of Environment Regulation No. 21 Year 2008 concern emission standards from fossil-fuel-fired Power Plant, give mandatory to Coal-Fired Plant oblige install the air pollution control systems such as electrostastic precipator/baghouse filters/ fabric filters, for beyond compliance the power plant install the flue-gas desulfurizor and utilizing Low-NOx burner/two-stage combustion
    - Coal used as fuel are stored at coal stockyard after forwarded from unloading berth via conveyor and Dust scattering will be controlled by taking very possible measure (ex. Enclosed conveyer, water spraying)
- fly ash & bottom ash impact???
  - In Government Regulation No. 101 Year 2014 concern Hazardous Waste and Toxic Management, fly ash & bottom ash is Hazardous Waste and Toxic Categories which has many mandatories of treatment and many permits that must be executed (storage clearance, collecting permit, transportation license, utilization permit, treatment permit and landfill permit)

Health effects



US Emissions

Electric Power Generation: Major Source of Emissions



* Other stationary combustion includes residential and commercial sources.

- Power generation continues to be an important source of these major pollutants.
- Power generation contributes 63% of SO_2, 22% of NO_X, and 37% of man-made mercury to the environment.

ENVIRONMENT IMPACT

US EPA

What are the Health and Environmental Effects of SO_2, NO_X, and Mercury?

Effects of Nitrogen Oxides (NO_x)

- Contributes to death and serious respiratory illness (e.g., asthma, chronic bronchitis) due to fine particles and ozone.
- Acidifies surface water, reducing biodiversity and killing fish.
- Damages forests through direct impacts on leaves and needles, and by soil acidification and depletion of soil nutrients.
- Damages forest ecosystems, trees, ornamental plants, and crops through ozone formation.
- Contributes to coastal eutrophication, killing fish and shellfish.
- Contributes to decreased visibility (regional haze).
- Speeds weathering of monuments, buildings, and other stone and metal structures.

Effects of Sulfur Dioxide (SO_2)

- Contributes to death and serious respiratory illness (e.g., asthma, chronic bronchitis) due to fine particles.
- Acidifies surface water, reducing biodiversity and killing fish.
- Damages forests through direct impacts on leaves and needles, and by soil acidification and depletion of soil nutrients.
- Contributes to decreased visibility (regional haze).
- Speeds weathering of monuments, buildings, and other stone and metal structures.

Effects of Mercury (Hg)

- Humans are effected primarily by eating contaminated fish.
- Human neurological effects can include:
  - impaired motor and cognitive skills, particularly in young children;
  - cardiac, respiratory, and immune system impairments are strongly suspected.
- Loons, mink, otter, and other fish-eating animals also exhibit adverse effects.

US EPA

How Do Fine Particles ($PM_{2.5}$) Affect Human Health?

Health effects include:

- Increased premature deaths, primarily in the elderly and those with heart or lung disease;
- Aggravation of respiratory and cardiovascular illness, leading to hospitalizations and emergency room visits in children and individuals with heart or lung disease;
- Decreased lung function and symptomatic effects such as those associated with acute bronchitis, particularly in children and asthmatics;
- New cases of chronic bronchitis;
- Increased work loss days, school absences, and emergency room visits;
- Changes to lung structure and natural defense mechanisms.

ENVIRONMENT IMPACT

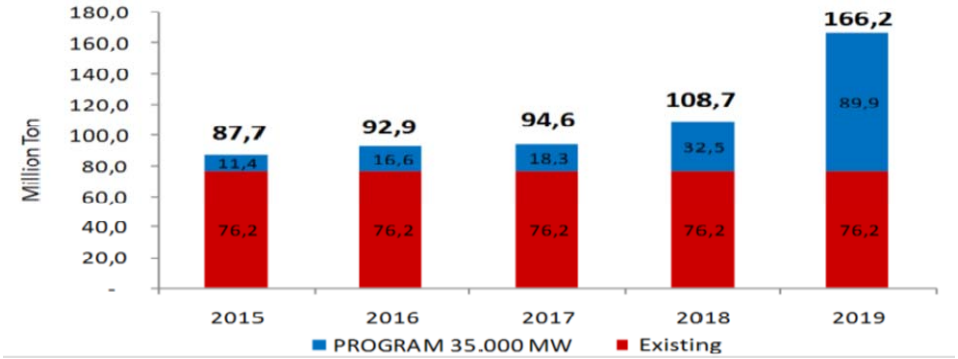
❑ fly ash & bottom ash impact

➢ Huge quantity of fly ash & bottom ash will be produced :

a. The coal consumption will increasing to 11.42 million ton in year 2015 and 89.93 million ton in year 2019 for the new one

	2015	2016	2017	2018	2019
coal demand (ton)	11,429,993	16,646,179	18,324,551	32,489,734	89,933,938

b. The total coal consumption(new power plant and existing power plant) will reach 87.7 million ton in year 2015 and 166.2 million ton in year 2019



c. fly ash dan bottom ash production will attain 4.38 million ton in year 2015 and 8.31 million ton in year 2019 (assumptions 5% from fuel consumption)

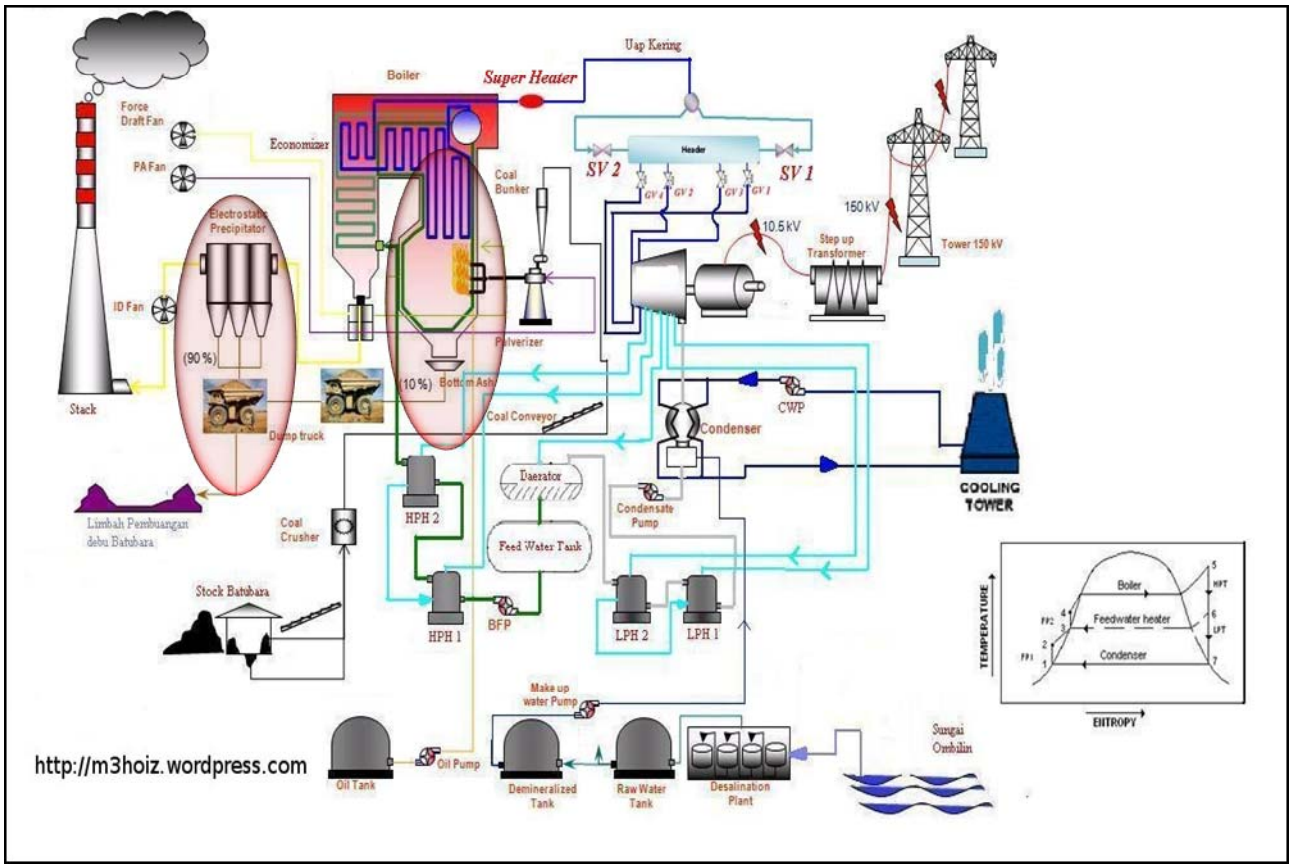
4 INDONESIA IMPLEMENTATION OF COAL-ASH MANAGEMENT

REGULATION

1. Law No. 32 Year 2009 regarding Environment Protection and Management;
   - ✓ *Article 22 : every business and/or activity having substantial impact on the environment shall be obliged to have AMDAL (Environment Impact Assessment).*
   - ✓ *Article 34 : every business and/or activity excluding from the criteria for undertaking AMDAL compulsorily as referred to in Article 23 paragraph (1) shall be obliged to have UKL-UPL (Environment Management and Monitoring Efforts) .*
   - ✓ *Article 36 : every business and/or activity obliged to have AMDAL or UKL-UPL shall be obliged to have environmental permit .*
   - ✓ *Article 59 : everybody producing hazardous and toxic waste (waste of B3) shall be obliged to manage the produced hazardous and toxic waste.*
   - ✓ *Article 69; (1) : everybody shall be prohibited from:*

     b). importing hazardous and toxic waste from outside the territory of the Unitary State of Republic of Indonesia
2. Government Regulation No. 101 Year 2014 regarding Hazardous and Toxic Waste Management.

COAL-FIRED POWER PLANT



Produce :

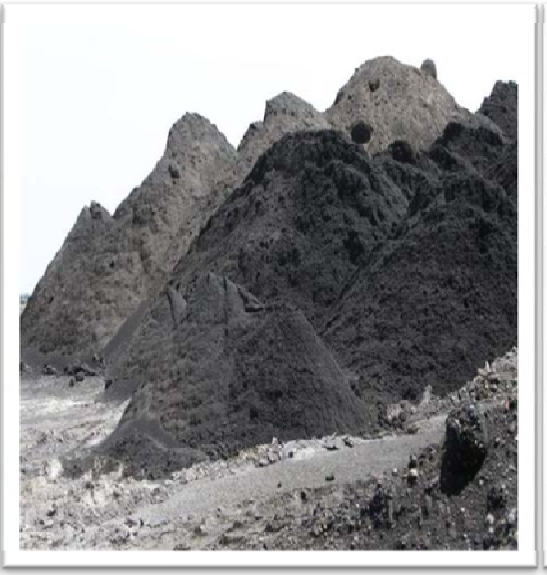
1. Fly Ash from ESP
2. *Bottom Ash* from Boiler
3. *Gypsum* with high sulfur content

Government Regulation No. 101 Year 2014

Fly Ash & Bottom Ash Category

- Fly Ash and Bottom Ash from Coal-Fired Power Plant listed in **Annex I Table 4** as Hazardous and Toxic Special Waste from specific resource.
- Waste Code : B 400.

Source : PT Purabarutama, 2013



Source : Google.images (lightworker.org)

Source : PT LOC, 2015

Mechanism of Hazardous and Toxic Waste Management

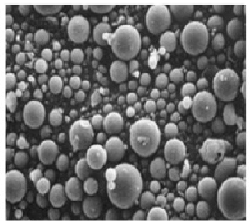
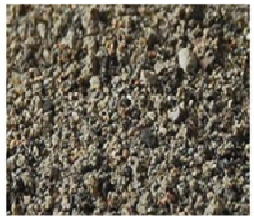
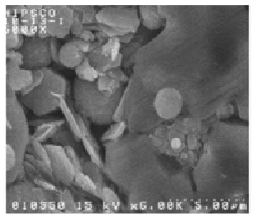
Fly Ash and Bottom Ash

- ✓ Hazardous and Toxic Waste Management as follow as **reducing**, **storing**, **collecting**, **transporting**, **utilizing**, **treatment** and/or **disposal** activity.
- ✓ Hazardous and Toxic Waste Management shall be doing by everybody producing hazardous and toxic waste and/or Hazardous and Toxic Waste Utilizing Actor and/or Hazardous and Toxic Waste Treatment Actor and/or Hazardous and Toxic Waste Disposal Actor which shall be obliged to secure license from Minister, governors or regent/mayors by virtue of their authority.
- ✓ Excluding from obligation of Hazardous and Toxic Waste Management, special destine for activity of utilization of hazardous and toxic waste – as byproduct .
- ✓ Hazardous Waste from specific resource, obligation of the Hazardous Waste Management can be excluded case by case.

UTILIZATION OF HAZARDOUS AND TOXIC WASTE

Fly Ash and *Bottom Ash*

1. Very small size (0.5 µm – 100 µm) and pozzolanic.
2. Content high SiO_2 with amorf and crystalin, Al_2O_3 and Fe_2O_3. Bottom ash is like small sand, content many of Si, Al, Fe, Ca, and Mg.
3. fly ash & bottom ash content Arsenic (As), barium (Ba), berrylium (Be), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), fluorin (F), lead (Pb), mangan (Mn), nikel (Ni), selenium (Se), strontium, thalium (Th), vanadium and zinc (Zn).

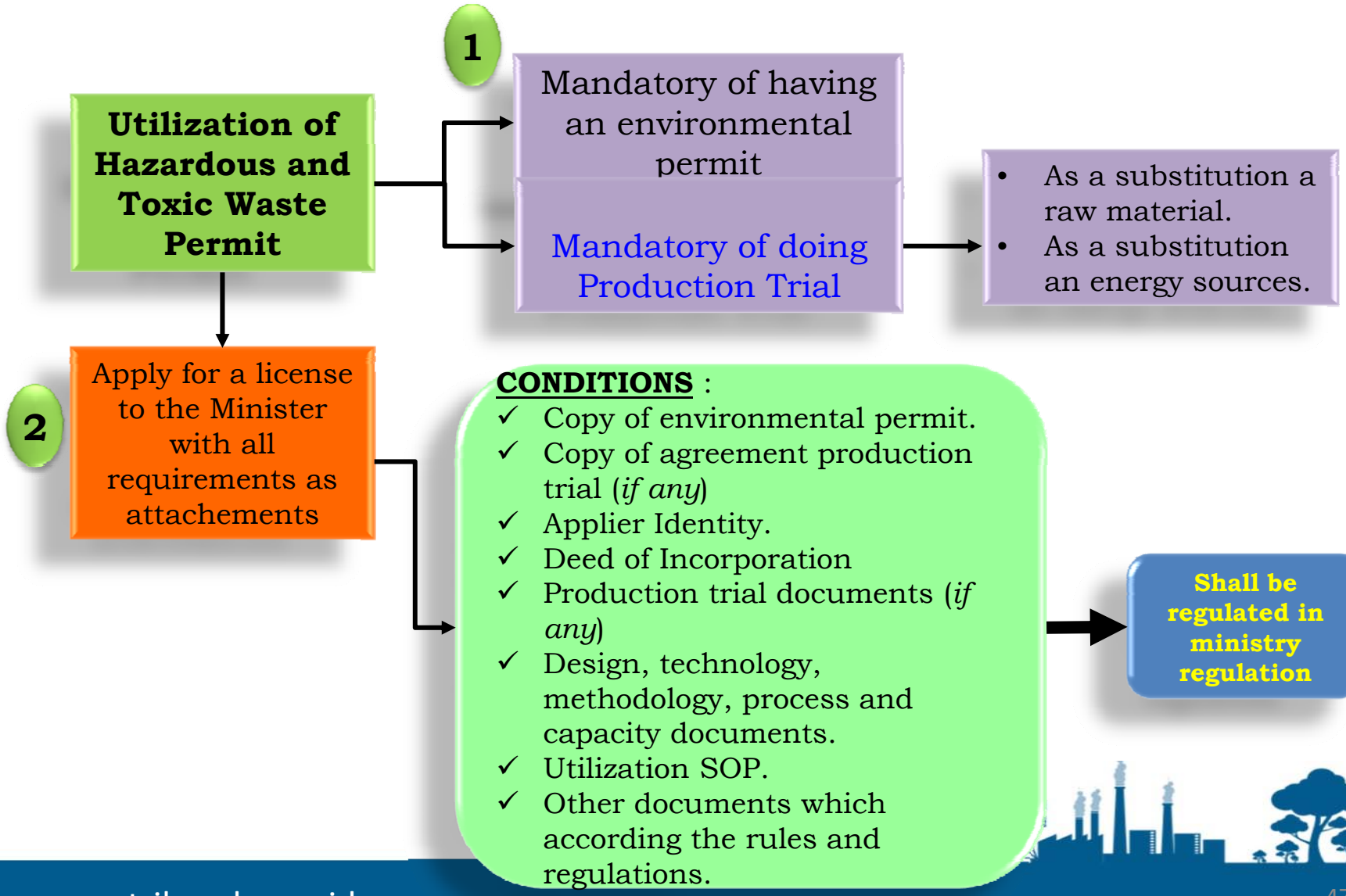





UTILIZATION OF HAZARDOUS AND TOXIC WASTE

Government Regulation No 101 Year 2014

- ✓ Utilization of Hazardous Waste shall be obliged by anyone which produce Hazardous Waste.
- ✓ In case of the party being unable to manage directly hazardous waste, the management thereof may be entrusted to the other party.
- ✓ Utilization of Hazardous and Toxic Waste is covering :
  - ◈ As a substitution of raw materials;
  - ◈ As a substitution of energy sources;
  - ◈ As a raw material; and
  - ◈ As a science and technology updating .
- ✓ Utilization of Hazardous and Toxic Waste should consider :
  - ◈ Technology availability;
  - ◈ Product standards; and
  - ◈ Environmental quality standards.

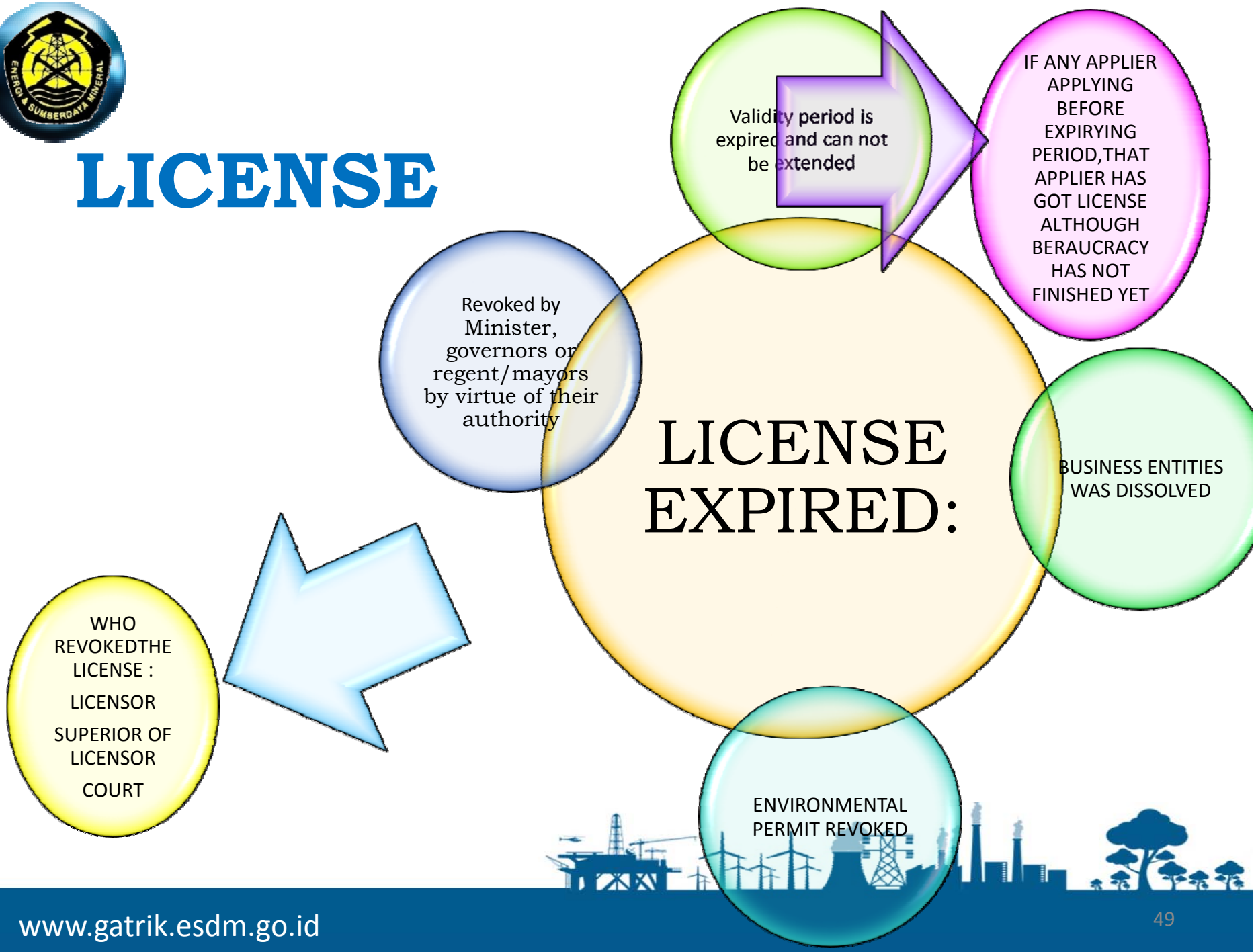
UTILIZATION OF HAZARDOUS AND TOXIC WASTE PERMIT MUST BE COMPLETED



Expirying period

PERMIT	Expirying period
storing	5 years and can be extended
collecting	5 years and can be extended
transporting	5 years and can be extended (the reccomendation)
utilizing	5 years and can be extended
processing	5 years and can be extended
disposing	10 years and can be extended

LICENSE


Validity period is expired and can not be extended
IF ANY APPLIER APPLYING BEFORE EXPIRYING PERIOD,THAT APPLIER HAS GOT LICENSE ALTHOUGH BERAUCRACY HAS NOT FINISHED YET
Revoked by Minister, governors or regent/mayors by virtue of their authority
LICENSE EXPIRED:
BUSINESS ENTITIES WAS DISSOLVED
WHO REVOKEDTHE LICENSE :
LICENSOR
SUPERIOR OF LICENSOR
COURT
ENVIRONMENTAL PERMIT REVOKED

5 SOLUTION AND CONCLUSION

Momerandum of Understanding Ministry of Energy and Mineral Resources + Ministry of Environment and Forestry + Ministry of Public Work and Residential

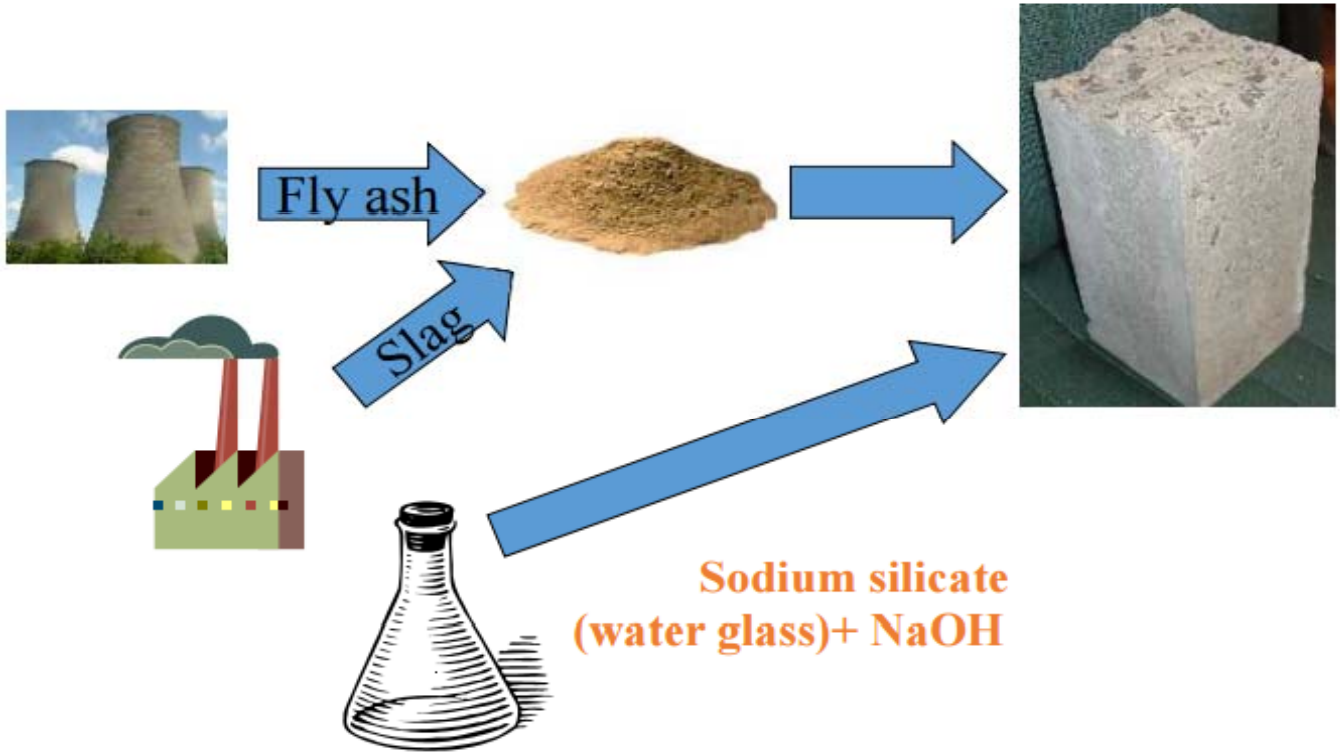
Coverage :

- Research and Development of Fly Ash and Bottom Ash Utilization for Public Work and Residential Construction..
- Full Skill Prototype of Utilization for Public Work and Residential Development.
- Fly Ash and Bottom Ash Utilization for Public Work and Residential Development, Standardization, SOP, Guidelines and etc.
- Dissemination and capacity building of Fly Ash and Bottom Ash Utilization for Public Work and Residential Development Policy, Technology, System from Coal-Fired Power Plant.

Geopolymer Research Products has been started since 2005

1. Portland Cement substitution up to 20% cement replacement
2. Geopolymer Concrete
3. Geopolymer Paving
4. Toxic Imobilization with geopolymer
5. Geopolymer Repair Materials
6. Crack-healing for concretes
7. Reclaimed Asphalt
8. Synthetic Aggregates
9. Soil Stabilization
10. Coating materials
11. Temperature Sensor
12. Geopolymer Bridge (collaboration with Institute of Road Engineering Agency for Research and Development-Ministry of Public Works and Housing)

Geopolymer is an ancient concrete!



Jannie van Deventer – CEO Zeobond Group

SOLUTION AND CONCLUSION

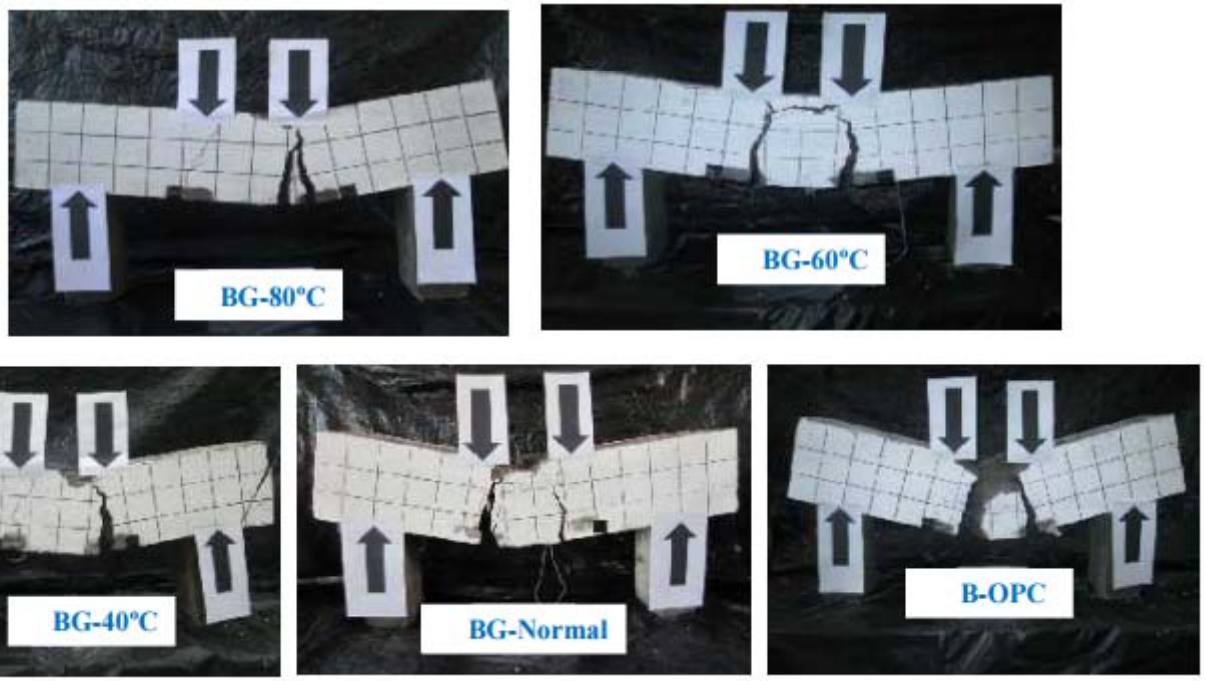
Compounds	Bituminous Coal	Sub-Bituminous Coal	Lignite
SiO_2	20-60	40-60	15-45
Al_2O_3	5-35	20-30	10-25
Fe_2O_3	10-40	4-10	4-15
CaO	1-12	5-30	15-40
MgO	0-5	1-6	3-10
SO_3	0-4	0-2	0-10
Na_2O	0-4	0-2	0-6
K_2O	0-3	0-4	0-4
LOI	0-15	0-3	0-5

SOLUTION AND CONCLUSION

Geopolymer for Grouting materials

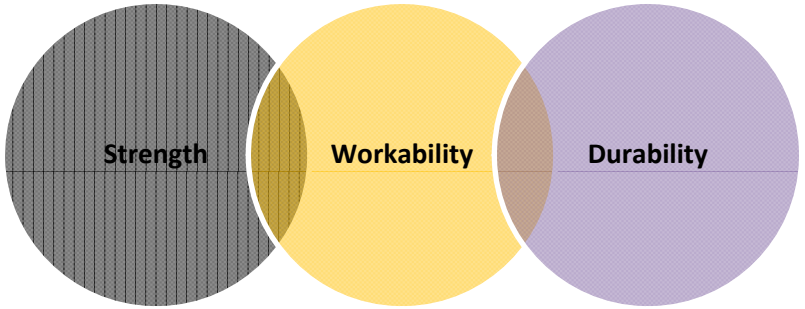
Geopolymer for Airport Pavement

Bending Test Results: Crack Pattern

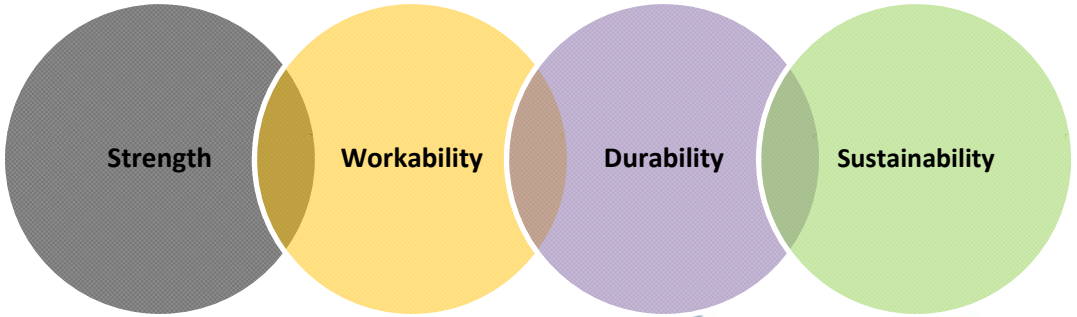


Comparison of Properties

(*Concrete in General*)



(*Concrete Using Coal Ash*)



Challenges

Resident Construction Development
1 Million Housing Program
Dam Construction Development
50 Dam Program
Road Construction Development
10.000 kilometer of Road Program

Fly Ash Standardization

ASTM

ASTM C618 - 12a

Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

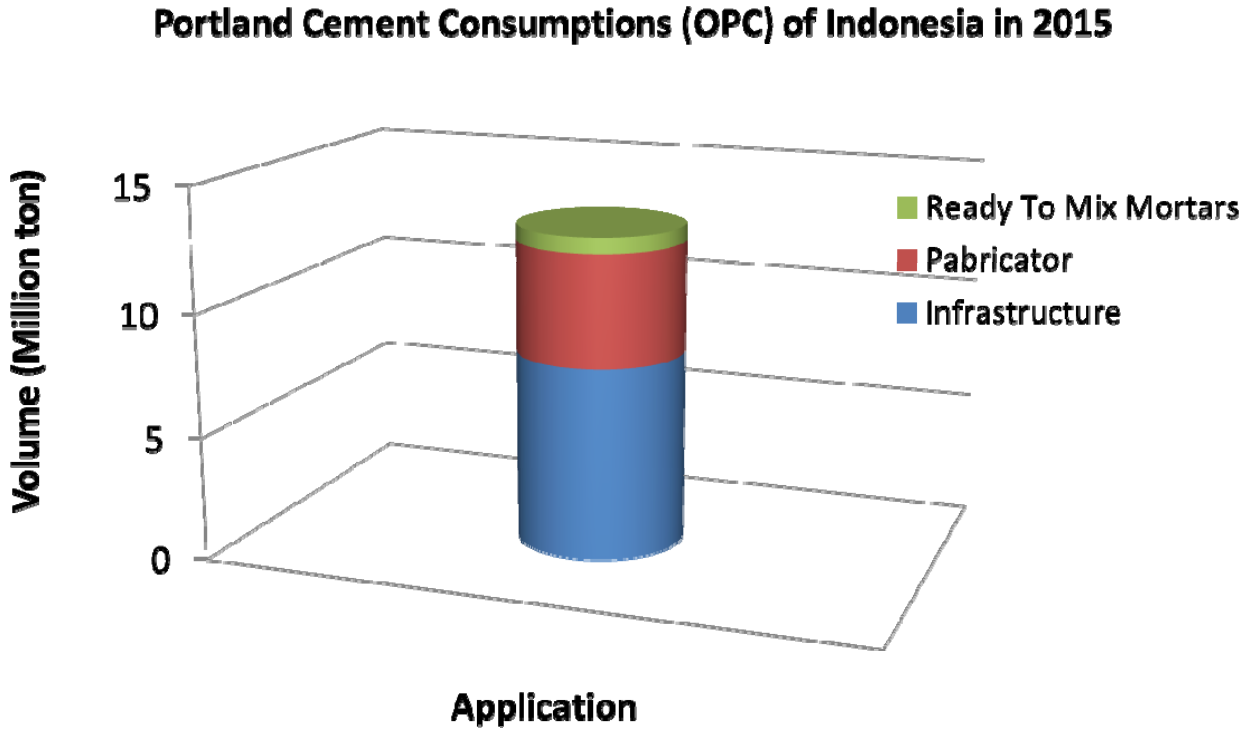
INDONESIA NATIONAL STANDARD (SNI-STANDARD NASIONAL INDONESIA)

SNI 2460:2014

Spesifikasi abu terbang batubara dan pozolan alam mentah atau yang telah dikalsinasi untuk digunakan dalam beton

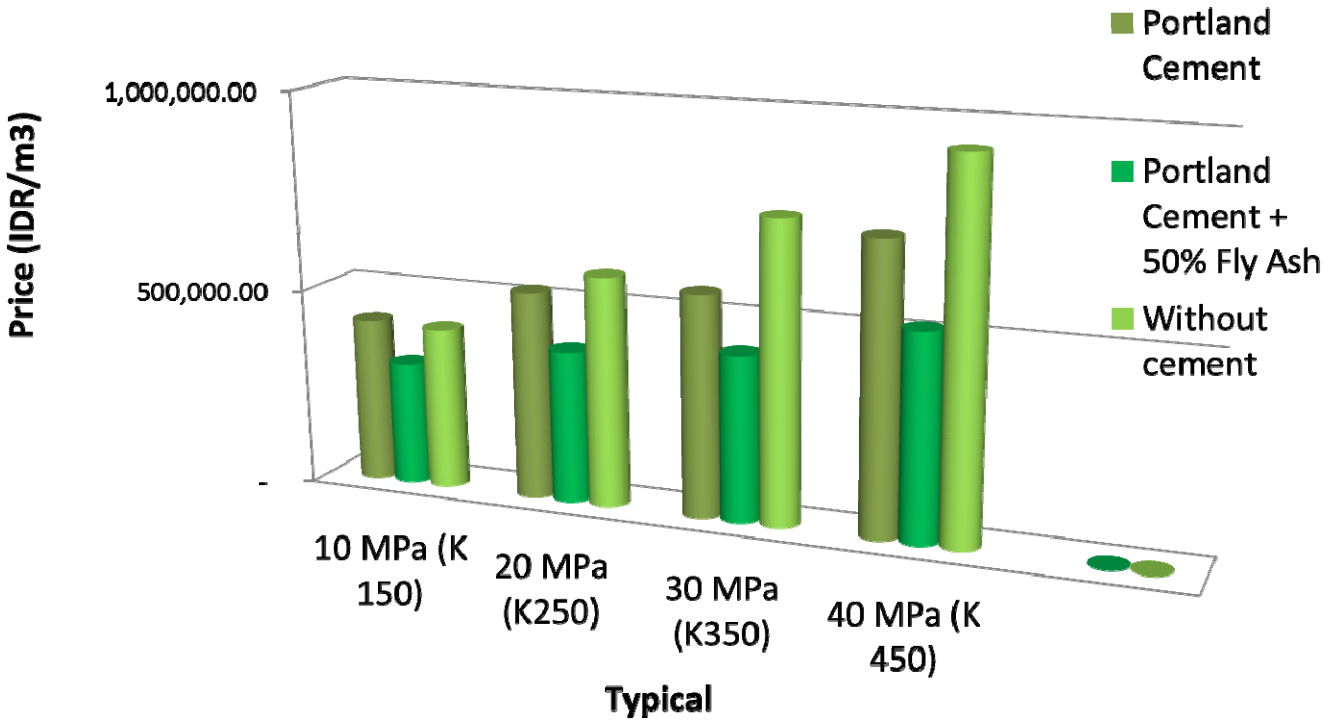
Class	Description	Requirement
F	Fly ash normally produced from burning anthracite or bituminous coal . Pozzolanic Properties	$SiO_2 + Al_2O_3 + Fe_2O_3 \geq 70\%$
C	Fly ash normally produced from lignite or sub-bituminous coal Pozzolanic and cementations properties	$SiO_2 + Al_2O_3 + Fe_2O_3 \geq 50\%$
N	Natural Pozzolan	$SiO_2 + Al_2O_3 + Fe_2O_3 \geq 70\%$

Portland Cement Demand



Source : Ministry of Public Work and Residential

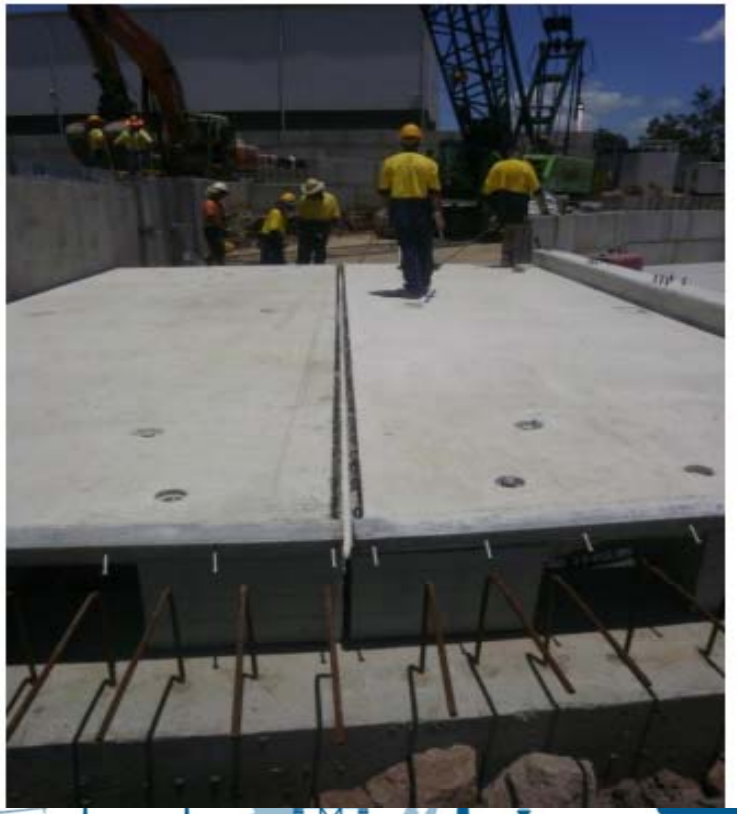
Comparison of Prices (Materials)



Source : Ministry of Public Work and Residential

Applied technology

Geopolimer Concrete Technologies(100 % fly ash) in road and bridge construction in Australia



Source : Ministry of Public Work and Residential

Applied technology

(50 % OPC – 50% F.A) in Indonesia for *Mass Concrete*

- Suramadu bridge (finished)
- Pulau Balang bridge (under construction)
- Teluk Kendari bridge (under construction)

Future Product Development

All Portland Cement Binder Based

Culverts

Precast I Girder

Voided Slab

Curb

Traffic Barriers

Lightweight Embankments

Precast Wall Panels

Road Posts

GRC Panels

Ready Mix Concrete

Breakwater

CONCLUSION

- Coal Fired Steam Power Plants (CFSPP) play a significant role in providing Electricity Energy to fulfill highly growth Energy Demand in Indonesia,
- Optimize “massively” the utilization of fly ash & bottom ash in construction application (infrastructure or concrete) with respect to environmental sustainable
- MoU is best practice to reducing the quantity of fly ash and bottom ash

TERIMA KASIH