INTERNATIONAL COAL BASED POWER CONFERENCES 2016:
INDONESIA ELECTRICITY DEVELOPMENT PLAN
AND INDONESIA COAL-ASH MANAGEMENT IMPLEMENTATION

New Delhi, 17th March 2016
OVERVIEW OF INDONESIA’S ELECTRICITY CONDITION
Installed Capacity (2015)

54,488 MW

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

Electricity Consumption (2015)

228 TWh

Electricity Production (2015)

283 TWh

Electrification Ratio (December 2015)

88.30%

kWh Per Capita (2015)

910.2 kWh/capita

*) Included Non-PLN

www.gatrik.esdm.go.id
OVERVIEW OF INDONESIA’S ELECTRICITY CONDITION

THAILAND 99.3%
VIETNAM 98%
SINGAPORE 100%
MALAYSIA 99%
BRUNEI 99.7%

ELECTRIFICATION RATIO OF INDONESIA ???

www.gatrik.esdm.go.id
OVERVIEW OF INDONESIA’S ELECTRICITY CONDITION

ELECTRICITY CRISIS IN DRY SEASON 2014

[Map showing electricity crisis in various regions of Indonesia, with details on power deficits and demand.]
OVERVIEW OF INDONESIA’S ELECTRICITY CONDITION

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 Plant
  - New and Renewable Energy: 11%
  - Oil: 25%
  - Gas: 14%
  - Coal: 50%
OVERVIEW OF INDONESIA’S ELECTRICITY CONDITION

INDONESIA’S COAL-FIRED POWER PLANT

Note CFPP:
1. Labuan 2×315 MW
2. Suralaya IP 4×400 MW & 3×600 MW
   New Suralaya 1×625 MW
3. Lentar 3×315 MW
4. Indramayu 3×330 MW
5. IPP Cirebon 1×660 MW
6. Tj. Jati 4×660 MW
7. Rembang 2×315 MW
8. IPP Cifacap 2×300 MW
9. IPP Paton 4×600 MW
10. IPP Paton 1×815 MW
11. Paton PB 2×400 MW
12. Labuhan Ratu 3×350 MW

www.gatrik.esdm.go.id
INDONESIA'S COAL-FIRED POWER PLANT

www.gatrik.esdm.go.id
INDONESIA’S COAL-FIRED POWER PLANT DEVELOPMENT
INDONESIA’S COAL-FIRED POWER PLANT DEVELOPMENT

POWER GENERATION ENERGY MIX

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

ENERGY MIX OF POWER GENERATION
(Draft of RUKN 2015-2034)

REALIZATION 2013

REALIZATION 2014

TARGET 2025

TARGET 2025

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

www.gatrik.esdm.go.id
INdonesia’s coal-fired power plant development

Generation energy mix in 2025

- **National**
  - 703 TWh (50%)
  - 169 TWh (24%)
  - 7 TWh (1%)
  - 176 TWh (25%)

- **Interconnection systems (on Grid)**
  - 622 TWh
  - 169 TWh (27%)
  - 126 TWh (20%)
  - 5 TWh (1%)

- **Off Grid**
  - 81 TWh
  - 43 TWh (53%)
  - 30 TWh (36%)
  - 7 TWh (8%)

*Based on Draft of RUKN 2015-2034

www.gatrik.esdm.go.id
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.

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

**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**

- **New and Renewable Energy**
- **Oil**
- **Gas**
- **Coal**

**REALIZATION 2015**

- 53% Coal
- 24% Gas
- 11% Oil
- 12% New and Renewable Energy

**TARGET 2025**

- 50% Coal
- 24% Gas
- 1% Oil
- 25% New and Renewable Energy

**COAL FIRED POWER PLANT STILL DOMINANT AND MAJORITY**

*) NOTE: RUKN = Rencana Umum Ketenagalistrikan Nasional (General National Power Plan)
- 35,000 MW Development Program consist of **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
Why Indonesia need to build Coal Fired Steam Power Plant??

- Cheap

- The Large Coal Reserves (29.48 billion ton)

www.gatrik.esdm.go.id
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

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>425</td>
<td>419</td>
<td>413</td>
<td>406</td>
<td>400</td>
</tr>
<tr>
<td>Domestic</td>
<td>102</td>
<td>111</td>
<td>121</td>
<td>131</td>
<td>240</td>
</tr>
<tr>
<td>Export</td>
<td>323</td>
<td>308</td>
<td>292</td>
<td>275</td>
<td>160</td>
</tr>
</tbody>
</table>
3 ENVIRONMENT IMPACT

www.gatrik.esdm.go.id
Coal-Fired Power Plant significantly contribute the Green House Gasses (GHGs) Emissions.
According to Paris Agreement COP 21 UNFCCC, all parties agree to effort the temperature increase to not exceeding 2° C, because if the aggregate of the emission fails to meet the requirement to avoid temperature increasing from exceeding 2° 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)

INDONESIA EMISSION POLICY SCENARIOS (in Mt CO2e)

- Emission reduction of 362 Mt CO2e or equal to 20% from BAU in 2020
- Emission reduction of 835 Mt CO2e or equal to 29% from BAU in 2030
- Emission reduction of 1.2 Gt CO2e or equal to 41% from BAU in 2030

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

<table>
<thead>
<tr>
<th>NO</th>
<th>SECTOR</th>
<th>GHGs Emission Reduction (Giga Ton CO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>29%</td>
</tr>
<tr>
<td>1</td>
<td>LAND BASE</td>
<td>0.596 20.69%</td>
</tr>
<tr>
<td>2</td>
<td>WASTE</td>
<td>0.03 1.04%</td>
</tr>
<tr>
<td>3</td>
<td>INDUSTRY</td>
<td>0.001 0.03%</td>
</tr>
<tr>
<td>4</td>
<td>ENERGY</td>
<td>0.222 7.71%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.849 29.47%</td>
</tr>
</tbody>
</table>
## MITIGATION ACTIONS OF ELECTRICITY GENERATION SECTOR

<table>
<thead>
<tr>
<th>NO</th>
<th>MITIGATION ACTIONS</th>
<th>Total Capacity Installed (MW)</th>
<th>GHGs Emission Reductions (mtCO₂) in year 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HYDROPOWER GENERATION (Large Scale + Minihydro)</td>
<td>93.5</td>
<td>0.456</td>
</tr>
<tr>
<td>2</td>
<td>SOLAR ENERGY (Large Scale entry to National Interconection Systems)</td>
<td>0.82</td>
<td>0.005</td>
</tr>
<tr>
<td>3</td>
<td>BIOMASS GENERATION (entry to National Interconection Systems)</td>
<td>2</td>
<td>0.001</td>
</tr>
<tr>
<td>4</td>
<td>BIOFUEL GENERATION (entry to National Interconection Systems)</td>
<td>2</td>
<td>0.011</td>
</tr>
<tr>
<td>5</td>
<td>CLEAN COAL TECHNOLOGY (CCT) UTILIZATION FOR COAL-FIRED POWER PLANT</td>
<td>1475</td>
<td>0.275</td>
</tr>
<tr>
<td>6</td>
<td>COAL BED METHANE (CBM) GENERATION</td>
<td>2</td>
<td>0.008</td>
</tr>
<tr>
<td>7</td>
<td>CO-GENERATION POWER PLANT</td>
<td>619.14</td>
<td>1.387</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>2.14</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NO</th>
<th>MITIGATION ACTIONS</th>
<th>Total Capacity Installed (MW)</th>
<th>GHGs Emission Reductions (mtCO₂) in year 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HYDROPOWER GENERATION (Large Scale + Minihydro)</td>
<td>2411</td>
<td>11.65</td>
</tr>
<tr>
<td>2</td>
<td>SOLAR ENERGY (Large Scale entry to National Interconection Systems)</td>
<td>0.82</td>
<td>0.005</td>
</tr>
<tr>
<td>3</td>
<td>BIOMASS GENERATION (entry to National Interconection Systems)</td>
<td>45</td>
<td>0.285</td>
</tr>
<tr>
<td>4</td>
<td>BIOFUEL GENERATION (entry to National Interconection Systems)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>CLEAN COAL TECHNOLOGY (CCT) UTILIZATION FOR COAL-FIRED POWER PLANT</td>
<td>17659</td>
<td>4.37</td>
</tr>
<tr>
<td>6</td>
<td>COAL BED METHANE (CBM) GENERATION</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>CO-GENERATION POWER PLANT</td>
<td>3050</td>
<td>2.77</td>
</tr>
<tr>
<td>8</td>
<td>INDUSTRIAL WASTE GAS GENERATION</td>
<td>10</td>
<td>0.016</td>
</tr>
<tr>
<td>9</td>
<td>GEOTHERMAL GENERATION</td>
<td>1160</td>
<td>8.79</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>27.88</strong></td>
</tr>
</tbody>
</table>

**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

[www.gatrik.esdm.go.id](http://www.gatrik.esdm.go.id)
SC, $\eta = 35-40\%$

Cirebon (SC 1x660 MW)

Paiton 3 (SC 1x815 MW)

2011

2015

Central Java IPP (USC 2x1000 MW)

Indramayu #1 (USC 1000 MW)

2020

2025

Indramayu #2 (USC 1000 MW)

IGCC 1000 MW Class

USC, 43%

Cirebon (USC 1x1000 MW)

2000–3000 MW per year

IGCC 1000 MW Class

45-48%

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

www.gatrik.esdm.go.id
Coal-Fired Power Plant operation were found to have 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

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

Polychlorinated dibenzofurans (PCDFs) 135 congeners
Dioxin-Furan (PCDD/F) emissions affect to human health

- 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.
ENVIRONMENT IMPACT

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 obliges install the air pollution control systems such as electrostatic precipitator/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 of pollution

- Headache
- Fatigue
- Respiratory illness
- Cardiovascular illness
- Gastroenteritis
- Cancer risk
- Nausea
- Skin irritation
- Volatile organic compounds
- Particulate matter
- Ozone
- CO
- Lead
- Nerve damage
- SO₂
- NOₓ
- Soil contamination
- Water pollution

- Bacteria
- Parasites
- Chemicals

Air pollution

www.djk.esdm.go.id
US Emissions

Electric Power Generation: Major Source of Emissions

- 2000 Sulfur Dioxide
- 2000 Nitrogen Oxides
- 1999 Mercury

* 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 SO₂, 22% of NOₓ, and 37% of man-made mercury to the environment.
What are the Health and Environmental Effects of SO\textsubscript{2}, NO\textsubscript{x}, and Mercury?

**Effects of Nitrogen Oxides (NO\textsubscript{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\textsubscript{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 affected 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.
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.
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

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>coal demand (ton)</td>
<td>11,429,993</td>
<td>16,646,179</td>
<td>18,324,551</td>
<td>32,489,734</td>
<td>89,933,938</td>
</tr>
</tbody>
</table>

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)
INDONESIA IMPLEMENTATION OF COAL-ASH MANAGEMENT
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

IMPLEMENTATION OF COAL-ASH MANAGEMENT

COAL-FIRED POWER PLANT

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

http://m3hoiz.wordpress.com
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.
IMPLEMENTATION OF COAL-ASH MANAGEMENT

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 SiO₂ with amorf and crystalin, Al₂O₃ and Fe₂O₃. 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), beryllium (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 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

1. Mandatory of having an environmental permit
   - As a substitution a raw material.
   - As a substitution an energy sources.

2. Utilization of Hazardous and Toxic Waste Permit
   - Apply for a license to the Minister with all requirements as attachments

CONDITIONS:
- Copy of environmental permit.
- Copy of agreement production trial (if any)
- Applier Identity.
- Deed of Incorporation
- Production trial documents (if any)
- Design, technology, methodology, process and capacity documents.
- Utilization SOP.
- Other documents which according the rules and regulations.
## Expiring period

<table>
<thead>
<tr>
<th>PERMIT</th>
<th>Expiring period</th>
</tr>
</thead>
<tbody>
<tr>
<td>storing</td>
<td>5 years and can be extended</td>
</tr>
<tr>
<td>collecting</td>
<td>5 years and can be extended</td>
</tr>
<tr>
<td>transporting</td>
<td>5 years and can be extended (the recommendation)</td>
</tr>
<tr>
<td>utilizing</td>
<td>5 years and can be extended</td>
</tr>
<tr>
<td>processing</td>
<td>5 years and can be extended</td>
</tr>
<tr>
<td>disposing</td>
<td>10 years and can be extended</td>
</tr>
</tbody>
</table>
Validity period is expired and cannot be extended.

License expired: If any applicant applying before expiring period, that applicant has got license although bureaucracy has not finished yet.

Revoked by Minister, governors or regent/mayors by virtue of their authority.

Business entities were dissolved.

Environmental permit revoked.

Who revoked the license: Licensor, superior of licensor court.

www.gatrik.esdm.go.id
5 SOLUTION AND CONCLUSION
Moumentum 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!

Fly ash → Slag → Sodium silicate (water glass) + NaOH

Jannie van Doentor – CEO Zoobond Group
### Solution and Conclusion

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Bituminous Coal</th>
<th>Sub-Bituminous Coal</th>
<th>Lignite</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>20-60</td>
<td>40-60</td>
<td>15-45</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>5-35</td>
<td>20-30</td>
<td>10-25</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>10-40</td>
<td>4-10</td>
<td>4-15</td>
</tr>
<tr>
<td>CaO</td>
<td>1-12</td>
<td>5-30</td>
<td>15-40</td>
</tr>
<tr>
<td>MgO</td>
<td>0-5</td>
<td>1-6</td>
<td>3-10</td>
</tr>
<tr>
<td>SO₃</td>
<td>0-4</td>
<td>0-2</td>
<td>0-10</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0-4</td>
<td>0-2</td>
<td>0-6</td>
</tr>
<tr>
<td>K₂O</td>
<td>0-3</td>
<td>0-4</td>
<td>0-4</td>
</tr>
<tr>
<td>LOI</td>
<td>0-15</td>
<td>0-3</td>
<td>0-5</td>
</tr>
</tbody>
</table>
SOLUTION AND CONCLUSION

Geopolymer for Grouting materials

Geopolymer for Airport Pavement

www.gatrik.esdm.go.id
Bending Test Results: Crack Pattern

BG-80°C

BG-60°C

BG-40°C

BG-Normal

B-OPC
Comparison of Properties

(Concrete in General)

(Sustainability)

(Concrete Using Coal Ash)

www.gatrik.esdm.go.id
### Challenges

<table>
<thead>
<tr>
<th>Resident Construction Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Million Housing Program</td>
</tr>
<tr>
<td>Dam Construction Development</td>
</tr>
<tr>
<td>50 Dam Program</td>
</tr>
<tr>
<td>Road Construction Development</td>
</tr>
<tr>
<td>10,000 kilometer of Road Program</td>
</tr>
</tbody>
</table>

www.gatrik.esdm.go.id
**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

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Fly ash normally produced from burning anthracite or bituminous coal. Pozzolanic Properties</td>
<td>SiO2 + Al2 O3 + Fe2 O3 ≥ 70%</td>
</tr>
<tr>
<td>C</td>
<td>Fly ash normally produced from lignite or sub-bituminous coal Pozzolanic and cementations properties</td>
<td>SiO2 + Al2 O3 + Fe2 O3 ≥ 50%</td>
</tr>
<tr>
<td>N</td>
<td>Natural Pozzolan</td>
<td>SiO2 + Al2 O3 + Fe2 O3 ≥ 70%</td>
</tr>
</tbody>
</table>
Portland Cement Demand

Portland Cement Consumptions (OPC) of Indonesia in 2015

Source: Ministry of Public Work and Residential
Comparison of Prices (Materials)

Source: Ministry of Public Work and Residential

www.gatrik.esdm.go.id
Applied technology

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

Source: Ministry of Public Work and Residential

www.gatrik.esdm.go.id
SOLUTION AND CONCLUSION

**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)
SOLUTION AND CONCLUSION

Future Product Development

- Culverts
- Precast I Girder
- Voided Slab
- Curb
- Traffic Barriers
- Lightweight Embankments
- Precast Wall Panels
- Road Posts
- GRC Panels
- Ready Mix Concrete
- Breakwater
- All Portland Cement Binder Based

www.gatrik.esdm.go.id
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