CURRENT STATUS OF RENEWABLE ENERGY IN INDONESIA AND ITS TECHNOLOGY DEVELOPMENT AT BPPT

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OUTLINE

♦ I. PRESENT CONDITIONS
♦ II. NATIONAL ENERGY POLICY
♦ III. BPPT ENERGY PROGRAMS
I. PRESENT CONDITIONS

1.1 Fuel Dominates Energy Mix

Status energy mixed in 2005, before the Presidential Decree

SHARE OF FUEL IS HIGH (67%) IN NATIONAL FINAL ENERGY MIX

Source: Blue Print of National Energy Planning (PEN) 2005
1.2 Chronology of Energy Consumption 1995 - 2005

Million BOE

- Coal
- Fuel
- Natural Gas
- Electricity
- LPG

1.3 Export – Import Balance for Oil, Gas & Coal

Oil in 2004 (1000 barrels/day)
- Production: 1125
- Exports: 514
- Domestic Supply: 611
- Imports: 487

Natural Gas in 2004 (BSCF/day)
- Production: 8.35
- Exports: 4.88
- Domestic Supply: 3.47

Coal in 2004 (mil tons/year)
- Production: 131.72
- Exports: 92.50
- Domestic Supply: 32.91

These diagrams clearly show that if we can increase the utilization of gas and coal, then we can reduce the supply need for the oil.

Source: Blue Print of National Energy Planning (PEN) 2005
II. NATIONAL ENERGY POLICY

2.1 Energy Targets 2025 based on Presidential Decree 5, 2006

Biofuel will become at least 5% of the total National Energy MIX 2025
2.2 Roadmap to Achieve Energy Targets

The diagram illustrates the roadmap for achieving energy targets over the years 2005 to 2025. The focus is on the electric power plant and the percentage contributions of different fuels over time. The fuels include Geothermal, Coal, Natural Gas, and Oil. The graph shows an increase in Geothermal energy and a decrease in Oil and Coal, aiming towards a more sustainable fuel mix by 2025.
### III. BPPT RENEWABLE ENERGY TECHNOLOGY PROGRAMS

Various types of renewable energy systems Research, Development, Engineering and Operation have been developed in several laboratories at BPPT since 1980.

These Energy systems are given as follows:

<table>
<thead>
<tr>
<th>Fuel to generate Energy</th>
<th>Energy for Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio- Diesel</td>
<td>2. Geothermal</td>
</tr>
<tr>
<td>Bio - Oil</td>
<td>4. Fuel Cell</td>
</tr>
<tr>
<td>2. Coal Liquefaction</td>
<td>5. Wind Energy</td>
</tr>
<tr>
<td>Indirect</td>
<td>6. Coastal Wave Energy</td>
</tr>
<tr>
<td>Direct</td>
<td>7. Sea Current Energy</td>
</tr>
<tr>
<td></td>
<td>8. Micro-hydro Energy</td>
</tr>
</tbody>
</table>
III. BPPT RENEWABLE ENERGY TECHNOLOGY PROGRAMS

3.1 Technology State of The Art

For each of energy systems being developed and engineered at BPPT we apply the following technological state of the art

- Easy producable using as much a local content as possible
- Easy operable in rural areas by local technician
- Operationally efficient, if necessary by applying simple electronic control systems
- Environmentally friendly and for some systems also applying advanced materials
- Reasonably low cost and provide added values to the local operator

The above strategy are chosen in order that the energy system could be learnt fast by the people in remote rural areas and subsequently apply by them

Some example of energy systems developed at BPPT are given in the following
3.2 Biofuel

3.2.1 Definitions & Types

Biofuel by definition is fuel from vegetable oils or animal fats.

The chemical and physical properties of biofuel closely resemble to those of fossil fuel.

- In accordance with type of plant it is made of and the way it is processed, there are three types of biofuel namely,
  1. Bio Ethanol
  2. Bio Diesel
  3. Bio Oil/Pure Plant Oil
3.2.2 Raw materials for Biofuel

**PURE PLANT OIL (PPO) and BIODIESEL**
- Coconut
- Palm
- Jathropa

**BIOETHANOL**
- Cassava
- Mollases

**Crude bio-oil**
- Pure Plant Oil
- Biodiesel

**Biodiesel**
- BioSolar
- Solar/diesel oil
- Diesel Engine: car, Genset

**BioSolar**
- Premium

**Hydrolysis + Fermentation**
- Bioethanol (9%)
- Dihedration
- Bioethanol (FG)
- 5-20%

**Gasolin Engine**
- BioPremium
- Premium

**Methanol**
- Lignoselulosic acid
3.2.3 Development of Bioethanol plant at BPPT

Development and engineering of prototype plant for bioethanol at BPPT is carried out in Balai Besar Teknologi Pati (Center for Cassava Technology) in Sulusuban, Lampung.

This center has carried out research, development & engineering for application of bioethanol as a fuel since almost a quarter of a century ago.

Bioethanol Plant with Cassava as raw material

![Bioethanol Plant Diagram]

- Mashing unit
- Hydrolysis unit
- Fermentation unit
- Distillation unit
- Dehydration unit

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3.2.4 Development of BioDiesel Plant at BPPT

Development of prototype plant for Biodiesel are carried out step by step at BPPT

Lab Scale biodiesel production (400 L)

Engineering design and fabrication of Biodiesel pilot plant, capacity 1.5 ton/day (Modularised, skid mounted and movable)

Basic Design and Engineering Biodiesel Plant Cap. 100 ton/day

EPC Pilot Plant Biodiesel Cap. 3 ton/day, for field trial in Desa Mandiri

Coops BPPT – Pemda Riau, targeted operation Dec 2006

EPC Pilot Plant Biodiesel capacity 8 ton/day
3.2.5 Application of Biodiesel for Transportation System

Laboratory and field testing on automotive systems at BPPT

Process production & Automation

Product specific Test

Product Compliance to SNI

Various raw materials:
- CPO standard (FFA < 5 %)
- CPO off grade (FFA 5-20 %)
- Waste CPO (FFA 20-70 %)
- PFAD, CFAD (FFA > 70 %)
- RBDPO
- RBDPS
- Used Cooking Oil
- Jatropha Oil

socialization

Road Test

Laboratory Test

Road test for B-30 with range distance of 2000 km and 20,000 km

Operational Test & Evaluation carried out using B-10 for 23 BPPT operational bus, since 2004
3.2.6 Application of Pure Plant Oil for Diesel Engines and Stoves

Converter systems to adjust the viscosity of the fuel

Application on Automotive Systems

Application to household devices

Metering units to probe the efficiency
3.3 Coal Liquefaction

- Laboratory for Coal liquefaction
  Research laboratory for coal liquefaction has been established for developing various methods of liquefactions

- Plant Prototype for Coal gasification using Catalytic Circulating Fluidized Bed Coal Gasification method
3.4 BPPT Fuel Cell R&D

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Membrane Nafion (PEFC)</td>
<td>Manufacture of MEA (70% local)</td>
<td>Prototype PEFC 1 cell (80% local) (Graphite, SUS/Au)</td>
<td>Catalyst Pt &amp; non-Pt</td>
<td>Prototype PEFC (10 – 20 W)</td>
<td>Optimization of PEFC 200W</td>
<td>Optimization of PEFC 500W</td>
</tr>
<tr>
<td></td>
<td>Modified Membrane Nafion (DMFC)</td>
<td>Prototype of Local Graphite Bipolar plate</td>
<td>DMFC 1 cell (0.5W)</td>
<td>Low cost Membrane</td>
<td>Optimization of DMFC 5W</td>
<td>Optimization of DMFC 100 W</td>
<td>Application of PEFC for Electric. Gen.</td>
</tr>
</tbody>
</table>

- Local Content 80%

- 5~16 cm²

- Polymer Electrolyte Fuel Cell (PEFC)
- Direct Methanol Fuel Cell (DMFC)

- CH₄
- H₂
- O₂/air
- Current collector/SUS/Au
- Gasket
- Polymer electrolyte pad
- Case/SUS/acrylic
- 2~3 cm
- 5~10 cm
- 2~3 cm
- 5~10 cm
- 5~16 cm²
3.4.1 Polymer Electrolyte Fuel Cell (PEFC) Prototyping

Stack PEFC with bipolar plate graphite

50 cm² 36 cm² 5 cm²

End plate : Aluminium
Bipolar Plate : Graphite plate with EDM process
Membrane : Co-polymer hidrocarbon, Nafion-silika, sPEEK-types, sPEEEK-zeolite
Electrodes : Carbon paper, Catalyst Pt-Co and Pt-Ni

<table>
<thead>
<tr>
<th>No</th>
<th>Temp (°C)</th>
<th>Current (A)</th>
<th>Voltage (V)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>30</td>
<td>0.16</td>
<td>0.635</td>
<td>Lamp</td>
</tr>
<tr>
<td>2.</td>
<td>35</td>
<td>0.16</td>
<td>0.610</td>
<td>Lamp</td>
</tr>
<tr>
<td>3.</td>
<td>70</td>
<td>0.15</td>
<td>0.510</td>
<td>Lamp</td>
</tr>
<tr>
<td>4.</td>
<td>80</td>
<td>0.16</td>
<td>0.428</td>
<td>Lamp</td>
</tr>
<tr>
<td>5.</td>
<td>80</td>
<td>0.05</td>
<td>0.731</td>
<td>Small Fan</td>
</tr>
</tbody>
</table>
3.5 Electrical Power Generation using Solar, Geothermal, Wind, Wave & Ocean Current Energy

- Wind Energy
  - Ground based
  - Coastal based
- Airborne Windmill
- Solar Energy
- Jatropha Curcas / Palm coconut plantation
- Ocean Current Energy
- Floating Based
- Fixed Based
- Oscillating Water Column
- Heave Rider
- Wave Rider
- Wave Energy
- BPPT Energy Park Parang Racuk, Baron, Wonosari, DIY
- Control Center
3.5.1 Geothermal

**Theme**: Utilization of Low–Medium Enthalpy Geothermal resources for Power Generation Plant

**Technologies Assessment**: - Binary Cycle Power Plant


**Prototypes**: - Binary Cycle System Power Generator 2 kW
- Fracture Detector Unit (Resource Survey Tools)

Pilot Plant of Binary Cycle Power Plant 2.5 MW At Lahendong, North Sulawesi
3.5.2 SOLAR ENERGY

- Solar Energy Electrical Power Generation

- Using PV (direct energy generation)
- Located at BPPT Parking Lot Building
- at Parang Racuk Energy Park, DIY

- Using Thermal methods (indirect energy generation)
  through solar heat collector
  at Parang Racuk Energy Park, DIY
3.5.3 Wind Energy

- **Wind energy**: BPPT has developed a 4.5 m diameter Wind Turbine, 3 bladed horizontal axis, for 2.5 kW output using full composite materials.

- This wind mill was developed for low wind speed input of 3 - 5 m/s and can be operated in main land area.

- For the next three years BPPT will investigate various type of wind mill for higher wind speed input, up to and above 7 m/s. These will be based on:
  - Off shore fixed based
  - Off shore floating based
  - Airborne based
3.5.4 Coastal Wave Energy

Coastal Wave Energy electrical generation using Oscillating Water Column (OWC) has been developed at BPPT since 2003. The following simulation shows the working principle of wave energy generator using OWC method Fixed Based as well as floating based.

Wave → Oscillating water column → air stream → 2 way air turbine → electrical generator

**Fixed Based**

**Floating Based**

BPPT – OWC generator in Parang Racuk, DIY
3.5.5 Ocean Current Energy

Working principle of Ocean Current Energy generator with vertical axis.

Detail design has been finished, this year a small scaled prototype will be built for laboratory test, and next year a full scale prototype will be built and tested in the sea.
THANK YOU