The Republic of Indonesia
Ministry of Energy and Mineral Resources
PT PLN (Persero)

# Project for the Master Plan Study of Hydropower Development in Indonesia

# FINAL REPORT
# VOL. II　MAIN REPORT

August 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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## FINAL REPORT

## VOL. II MAIN REPORT

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PROJECT FOR THE MASTER PLAN STUDY OF
HYDROPOWER DEVELOPMENT
IN INDONESIA

# DRAFT FINAL REPORT
# VOLUME II
# MAIN REPORT

Table of Contents

**PART II PRE-FEASIBILITY STUDY FOR SIMANGGO-2 HEPP**

**PART III PRE-FEASIBILITY STUDY FOR MASANG-2 HEPP**

## FIGURES

# TABLES

# LIST OF APPENDICES



# LIST OF REPORT VOLUMES

# Abbreviations

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| ADB | Asian Development Bank | |
| AFD | French Development Agency | Agence Française de Développement |
| AMDAL | Environmental Impact Assessment (EIA) | Analisis Mengenai Dampak Lingkungan |
| ANDAL | Environment Impact Analysis | Analisis Dampak Lingkungan |
| APBD | Regional Budget | Anggaran Pendapatan dan Belanja Daerah |
| APBN | State Budget | Anggaran Pendapatan dan Belanja Negara |
| APLN | Already prepared for PLN portion | |
| AR1 | Access Road No.1 | |
| ASEAN | Association of South-East Asian Nations | |
| AWLR | Automatic Water Level Recorder | |
| BAKOREN | National Energy Coordination Agency | Badan Koordinasi Energi Nasional |
| BAKOSURTANAL | National Topographic Agency for Survey and Mapping | |
| BAPEDAL | Badan Pengendalian Dampak Lingkungan | Badan Pengendalian Dampak Lingkungan |
| BAPETAL | Electric Power Market Control Agency | Badan Pengawas Pasar Tenaga Listrik |
| BAPETAN | Nuclear Energy Regulatory Agency | Badan Pengawas Tenaga Nuklir |
| BAPPENAS | Ministry of National Development Planning | Badan Perencanaan Pembangunan Nasional |
| BATAN | National Nuclear Energy Agency | Badan Tenega Nuklir Nasional |
| BBG | Fuel Gas | Beban Bahan Gas |
| BBM | Fuel Oil | Beban Bahan Minyak |
| BLT | Build-Lease-Transfer | |
| BMG | Meteorological and Geophysical Agency | Badan meteorology dan Geofisika |
| BMKG | Meteorological Climatological and Geophysical Agency | Badan Meteorologi Klimatologi dan Geofisika |
| BNSP | National Professional Standard Agency | Badan Standar Nasional Pendidikan |
| BOE | Barrel of Oil Equivalent | Setara Barrel Minyak |
| BOO | Build Own Operate | |
| BOT | Build Operate-Transfer | |
| BPP | Basic Supply Cost | Biaya Pokok Penyediaan |
| BPPT | Agency for Assessment and Application of Technology | Badan Pengkajian dan Penerapan Teknologi |
| BPS | Central Statistic Agency | Badan Pusat Statistik |
| BR1 | Bridge No.1 | |
| PBU-PLN | Board of General Administration of the State Electricity Company | |
| BSN | National Standardization Accreditation Agency | Badan Standardisasi Nasional |
| BUMN | State Owned Enterprise | Badan Usaha Milik Negara |
| BUMD | Regional Owned Enterprise | Badan Usaha Milik Daerah |
| CDM | Clean Development Mechanism | |
| CER | Certified Emission Reduction (Unit for CDM) | |

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| CF | Capacity Factor | |
| COD | Commissioning Dates | |
| C/P | Counterpart | |
| CPI | Consumer Price Index | |
| DANIDA | Danish International Development Assistance | |
| DEN | National Energy Council | Dewan Energi Nasional |
| DESDM | Ministry of Energy and Mineral Resources (MEMR) | Departemen Energi dan Sumber Daya Mineral |
| DGE | Directorate General of Electricity | DJL |
| DIY | Daerah Istimewa Yogyakarta | Yogyakarta Special District |
| DJLPE | Directorate General of Electricity and Energy Utilization | Direktorat Jenderal Listrik dan Pemanfaatan Energi |
| DKI | Special Capital District (of Jakarta) | Daerah Khusus Ibukota |
| DLC | Direct Load Control | |
| DPRD | Regional Assembly | Dewan Perwakilan Rakyat Daerah |
| DSM | Demand Side Management | |
| DSN | National Standardization Council | Dewan Standardisasi Nasional |
| EPC | Engineering, Procurement and Construction | |
| ETAEMR | Education and Training Agency for Energy and Mineral Resources | |
| ETCERE | E&T Center for Electricity & New Renewable Energy | |
| ESDM | Energy and Mineral Resources | Energi dan Sumber Daya Mineral |
| FC | Foreign Currency | |
| FOB | Finance-Design-Build | |
| FSL | Full Supply Level | |
| FTP | Fast Track Program | Crash Program |
| GDP | Gross Domestic Product | |
| GEF | Global Environment Facility | |
| GHG | Greenhouse Gas | |
| GI | Substation | Gardu Induk |
| GTZ | | Deutsche Gesellschaft Technische Zusammenarbeit |
| GVA | Giga-volt-ampere | |
| GWh | Gigawatt-hour | |
| HEPP | Hydro Electric Power Project | |
| HK | Conservation Forest | Hutan Konservasi |
| HL | Protection Forest | Hutan Lindung |
| HP | Production Forest | Hutan Produksi |
| HPP | Basic selling price | Harga Pokok Penjualan |
| HPPS | 1st Hydro Power Potential Study | |
| HPPS2 | 2nd Hydro Power Potential Study | Hydro Inventory Study |
| HSD | High Speed Diesel Oil | |
| ICB | International Competitive Bid | |
| IDO | Industrial Diesel Oil | |
| IEA | International Energy Agency | |
| IEE | Initial Environmental Evaluation | |
| IMF | International Monetary Fund | |
| Inpres | Presidential Instruction | |
| IPP | Independent Power Producers | |
| IRP | Integrated Resource Planning | |
| IT | Information Technology | |

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| ITB | Bandung Engineering College | Institut Teknologi Bandung |
| IUKU | Business Permit | |
| IUPTL | Permit for Business in Electric Power Supply | Izin Usaha Penyediaan Tenaga Listrik |
| Jabar | West Java (province) | Jawa Barat |
| Jabodetabek | | Jakarta, Bogor, Depok, Tanggerang dan Bekasi |
| Jamali | | Jawa Madura Bali |
| Jateng | Central Java (province) | Jawa Tengah |
| Jatim | East Java (province) | Jawa Timur |
| Jaya | Greater Jakarta | Jakarta Raya |
| JBIC | Japan Bank for International Cooperation | |
| JETRO | Japan External Trade Organization | |
| JICA | Japan International Cooperation Agency | |
| JOGMEC | Japan Oil, Gas and Metals National Corporation | |
| JST | JICA Study Team | |
| Kalbar | West Kalimantan (province) | Kalimantan Barat |
| Kalsel | South Kalimantan (province) | Kalimantan Selatan |
| Kalteng | Central Kalimantan (province) | Kalimantan Tengah |
| Kaltim | East Kalimantan (province) | Kalimantan Timur |
| KAN | National Accreditation Committee | |
| KE | Export Credit | Kredit Ekspor |
| KEN | The National Energy Policy | Kebijakan Energi Nasional |
| Kepmen | Ministerial Decree | Keputusan Menteri |
| Keppres | Presidential Decree | Keputusan Presiden |
| KESDM | Ministry of Energy and Mineral Resources (MEMR) | Kementerian Energi dan Sumbar Daya Mineral |
| KKN | Corruption, Collusion and Nepotism | Korupsi Kolusi Nepotisme |
| KONEBA | | PT. Konservasi Energi Abadi, Indonesia |
| KP | Presidential Decree | Keputusan Presiden |
| KUBE | General Policy on Energy | Kebijakan Umum Bidang Energi |
| KUD | Village Cooperative System | Koperasi Unit Desa |
| kW | kilowatt | |
| kWh | kilowatt-hour | |
| LARAP | Land Acquisition and Resettlement Action Plan | |
| LC | Local Currency | |
| LCB | Local Competitive Bid | |
| Malut | North Maluku (province) | Maluku Utara |
| MCS | Capital of Central Java | Municipal Corporation of Semarang |
| MEMR | Ministry of Energy and Mineral Resources | |
| METI | Ministry of Economy, Trade and Industry | |
| MFO | Marine Fuel Oil | |
| Migas | Oil and Gas | Minyak dan gas |
| MJ | Megajoule | |
| MLF | Multilateral Fund | |
| MOCSME | Ministry of Cooperatives & Small and Medium Enterprises | |
| MOE | Ministry of Environment | |

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| MOF | Ministry of Fund | |
| MoFo | Ministry of Forest | |
| MOI | Ministry of Industry | |
| MOL | Minimum Supply Level | |
| MMPT | Ministry of Manpower and Transmigration | |
| MVA | Mega-volt-ampere | |
| MW | Megawatt | |
| NEDO | New Energy and Industrial Technology Development Organization | |
| NGOs | Non Governmental Organizations | |
| NJOP | Selling Value of Taxed-Object | |
| NTB | West Nusa Tenggara (province) | Nusa Tenggara Barat |
| NTT | East Nusa Tenggara (province) | Nusa Tenggara Timur |
| ODA | Official Development Assistance | |
| OECD | Organization for Economic Co-operation and Development | |
| P3B | Central Load Dispatching and Control Center | Penyaluran & Pusat Pengatur Beban |
| P3G | Geological Research and Development Center | Pusat Penelitian dan Pengembangan |
| PBF | Public Benefit Fund | |
| PDB | Gross Domestic Product (GDP) | Produk Domestik Bruto |
| PDD | Project Design Document | |
| PEN | National Energy Management Blueprint | Blueprint Pengelolaan Energi Nasional |
| Pemda | Regional Government | Koperasi Unit Desa |
| Permen | Ministerial Regulation | Peraturan Menteri |
| Persero | | Perusahaan Perseroan |
| Perpres | Presidential Regulation | Peraturan Presiden |
| Perum | State-owned Public Corporation | Perusahaan Umum |
| PF | Power Factor / Phase Factor | |
| PGN | | Perusahaan Gas Negara |
| PJB | Jawa-Bali Electric Power Generation Company | PT Pembangkitan Tenaga Listrik Jawa Bali |
| PKUK | the Holder of Electricity Proxy | Pemegang Kuasa Usaha Ketenagalistrikan |
| Pikitring | Generation and Transmission project office | Proyek Induk Pembangkit & Jaringan |
| PIUKU | Holder of Business License of Electricity for the public interest | Pemegang Izin Usaha Ketenagalistrikan untuk Kepentingan Umum |
| PIUPTL | Holder of Permit for Business in Electric Power Supply | Pemegang Izin Usaha Penyediaan Tenaga Listrik |
| PLN | State Electricity Company | Perusahaan Listik Negara |
| PLTA | Hydropower station | Pembangkit Listrik Tenaga Air |
| PLTB | Wind power station | Pembangkit Listrik Tenaga Bayu |
| PLTBM | Biomass power station | Pembangkit Listrik Tenaga Biomassa |
| PLTD | Diesel power Station | Pembangkit Listrik Tenaga Diesel |
| PLTG | Gas Turbine power station | Pembangkit Listrik Tenaga Gas |
| PLTGU | (Gas) Combined cycle power station | Pembangkit Listrik Tenaga Gas dan Uap |
| PLTM | Mini/Micro scale hydropower station | Pembangkit Listrik Tenaga Air Skala Mini/Mikro |

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| PLTMG | Gas Engine power station | Pembangkit Listrik Tenaga Mesin Gas |
| PLTMH | Microhydro power station | Pembangkit Listrik Tenaga Mikro Hidro |
| PLTN | Nuclear power station | Pembangkit Listrik Tenaga Nuklir |
| PLTP | Geothermal power station | Pembangkit Listrik Tenaga Panas Bumi |
| PLTS | Solar power station | Pembangkit Listrik Tenaga Surya |
| PLTU | Steam power station | Pembangkit Listrik Tenaga Uap |
| PO | | Perum Otorita |
| PP | Peak Period | |
| PP | Government Regulation | Peraturan Pemerintah |
| PPA | Power Purchase Agreement | |
| PQ | Prequalification | |
| RPJMN | National Mid-Term Development Plan | |
| PPP | Public-Private Partnership | |
| PT PLN Batam | | PT Pelayanan Listrik Nasional Batam |
| PT PLN Tarakan | | PT Pelayanan Listrik Nasional Tarakan |
| PU | Ministry of Public Works | Departemen Pekerjaan Umum |
| PUSAIR | Research Institute for Water Resources Development under Ministry of Public Works | Pusat Penelitian dan Pengembangan Sumber Daya Air |
| RIKEN | National Energy Conservation Plan | Rencana Induk Konservasi Energi Nasional |
| RKL | Environmental Management Plan | Pencana Pengelolaan Lingkungan |
| RPL | Environmental Monitoring Plan | Rencana Pemantauan Lingkungan |
| RAP | Resettlement Action Plan | |
| RES | Reservoir type (hydropower station) | |
| ROR | Run-of River type (hydropower station) | |
| RPS | Renewable Portfolio Standard | |
| RUED | Regional general energy plan | Rencana Umum Energi Daerah |
| RUEN | National general energy plan | Rencana Umum Energi Nasional |
| RUKD | Regional general electricity plan | Rencana Umum Ketenagalistrikan Daerah |
| RUKN | National general electricity plan | Rencana Umum Ketenagalistrikan Nasional |
| RUPTL | | Rencana Usaha Penyediaan Tenaga Listrik |
| S2JB | South Sumatera, Jambi and Bengkuku | Sumatera Selatan, Jambi dan Bengkulu |
| SAIDI | System Average Interruption Frequency Index | |
| SAIFI | System Average Interruption Frequency Index | |
| SBM | Barrel of Oil Equivalent (BOE) | Setara Barel Minyak |
| SBUs | Strategic Business Units | |
| SB1 | Spoil Bank No.1 | |
| SCF | Spanish Carbon Fund | |
| SIDA | Swedish International Development Agency | |
| SMOC&SME | Ministry of Cooperatives & Small and Medium Enterprises | |
| SNI | Indonesian National Standard | Standar Nasional Indonesia |

| Abbreviations | English | Indonesian/Others |
|---|---|---|
| Sulbar | West Sulawesi (province) | Sulawesi Barat |
| Sultra | South-east Sulawesi (province) | Sulawesi Tenggara |
| Sulsel | South Sulawesi (province) | Sulawesi Selatan |
| Sulselrabar | South Sulawesi, Southeast Sulawesi and West Sulawesi | Sulawesi Selatan , Sulawesi Tenggara dan Sulawesi Barat |
| Sulteng | Central Sulawesi (province) | Sulawesi Tengah |
| Sulut | North Sulawesi (province) | Sulawesi Utara |
| Suluttenggo | North Sulawesi1, Central Sulawesi and Gorontalo | Sulawesi Utara, Sulawesi Tengah dan Gorontalo |
| Sumbagsel | Northern part of Sumatera | Sumatera Bagian Selatan |
| Sumbagut | Southern part of Sumatera | Sumatera Bagian Utara |
| Sumbar | West Sumatera (province) | Sumatera Barat |
| Sumsel | South Sumatera (province) | |
| Sumut | North Sumatera (province) | Sumatera Utara |
| TDL | Basic Tariff of Electricity | Tarif Dasar Listrik |
| TOE | Ton of Oil Equivalent | |
| TOU | Time of Use | |
| TM | Medium Voltage | Tegangan Menengah |
| TR | Low Voltage | Tegangan Rendah |
| TT | High Voltage | Tegangan Tinggi |
| TWh | Terawatt-hour | |
| UNDP | United Nations Development Program | |
| UNEP | United Nations Environment Programme | |
| UNFCCC | U.N. Framework Convention on Climate Change | |
| UNIDO | United Nations Industrial Development Organization | |
| USAID | United States Agency for International Development | |
| UU | Law | Undang-Undang |
| VAT | Value Added Tax | |
| WASP | Weir Automatic System Planning | |
| WB | World Bank | |
| WL | Water Level | |

# CHAPTER 1 INTRODUCTION

## 1.1 BACKGROUND OF THE STUDY

Even facing the economic shocks brought by the Asian Currency Crisis in 1997 and the World Financial Crisis known as "Rehman Shock", the economy of Indonesia has recorded stout performance as shown in the recent high-level GDP growth. This tendency, approximately 6% GDP growth per year, may be supported by their export strategies and strong domestic demand and be continued in line with the recovery of the on-going world financial turmoil.

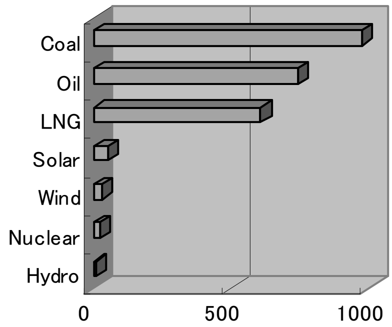
According to RUPTL by PLN, the peak loads of Indonesia power system are forecasted to grow with a high level of 9.5% annually on the average during 2008 to 2018 as the annual economic growth during the period is expected to be 6.0-6.4%. With the surge of the peak loads, the regional power systems will face difficulties; insufficient supply capacity, conduct of rolling blackout and power saving to secure the system stability. Thus, it is crucial to the power system in Indonesia to be immediately reinforced and increase its capacity of power generation.

To tackle with the power shortage, the Government of Indonesia announced in 2006 a large-scale development plan of the coal-fired stations which consists of the development of 40 power plants with the total installed capacity of 10,000MW. The plan is called the first short-term electric power development plan "Crash program", and is being executed as an emergency relief measure. Following the “Crash Program”, the second short-term electric power development plan "Crash program 2" has been conducted. The Crash Program 2, which covers 2010 to 2014, aims at diversifying primary energy sources for power generation and improve the over-dependency on the coal and utilization by the introduction of renewable energy.

On the other hand, the Government of Indonesia hosted "Conference of the Parties 13$^{th}$ Session (COP13) of Framework Convention on Climate Change" held in Bali in 2007, and arranged the Bali Road Map to aim at formulation of the frame of the post Kyoto Protocol after 2013. The Government of Indonesia also announced the national action plan for execution of comprehensive mitigation and the adaptation plans against climate change issues, which includes the reduction of GHG emission by 26% compared to that in 1990. Thus, efforts of the GHG reduction in the power sector has become an important challenge in this country.

Hydroelectric power generation is a clean, renewable and domestic power source that doesn't exhaust $CO_2$. Furthermore, it also gives power system flexibility of power adjustment and control by performing its superior load following capacity. From those viewpoints, promotion of hydropower development has become a key issue in power sector in Indonesia.

According to the estimation by the Central Research Institute of Electric Power Industry, the amounts of $CO_2$ exhaust per a kilowatt-hour by generation types are as shown in the right figure. Hydropower exhausts the least amount of $CO_2$ per a kilowatt-hour, thus, the hydroelectric power development should be steadily promoted in order to mitigate the GHG emission..




**CO2 Exhaust per 1 kWh**
**(g $CO_2$/kWh)**

In Indonesia, there are two nation-wide hydropower potential studies: the first hydropower potential study (Hydropower Potential Study) in 1981-83 and the second hydropower potential study (Hydro Inventory and Pre-feasibility Studies) in 1996-99. The outline of both studies is as follows.

**Table 1.1.1 Hydropower Potential Studies in Indonesia**

| Study | Outline |
|---|---|
| **1st hydropower potential study**<br>Hydropower Potentials Study<br>(HPPS) 1983 | Finance: World Bank, Execution: PLN, Consultant: Nippon Koei<br>1,275 hydropower potential sites were screened, and 125 sites were selected as the promising potentials (reservoir type 85 sites, and run-of-river type 40 sites).<br>The study output is succeeded to the so-called "5FS", and two projects were realized. |
| **2nd hydropower potential study**<br>Hydro Inventory & Pre-feasibility Studies<br>(HPPS2) 1999 | Finance: World Bank, Execution: PLN, Consultant: Nippon Koei<br>1,249 hydropower potential sites were screened, and 116 sites (including East Timur) were selected as the promising potentials (reservoir type 35 sites, and run-of-river type 79 sites, run-of river type with a low head dam 1 site, lake outlet type 1site). Ratio of the reservoir type has lowered in comparison with HPPS. 58 candidate sites for pumped storage schemes in Java were reviewed and ten sites were selected as the promising schemes.<br>Due to the Asian Currency Crisis, no hydropower scheme newly identified in the study was realized. However, detailed design for the Upper Cisokan pumped storage scheme, which was recommended in the study, was completed and its construction is planned under the financial assistance of the World Bank. |

Source: JICA Study Team

More than ten years have already passed since the second hydropower potential study (hereinafter referred to as “HPPS2”) completed. It can be assumed possible that the development scales and schemes which were recommended in that study may not conform to present guidelines for environmental and social considerations, fossil fuel prices which soared in recent years and also not to present electric power supply and demand balance appropriately.

According to the afore-mentioned background, it becomes necessary to review and update the hydropower development plan, and thus the Government of Indonesia requested technical assistance to the Government of Japan for reviewing and updating the existing hydropower development plan.

## 1.2 OBJECTIVES OF THE STUDY

The Study aims at technical assistance to formulate the hydropower development master plan which accords with the economic and industrial development of Indonesia in future. Followings are taken into account for formulating the master plan.

- The master plan will be based on the existing power sector plan, and be consistent with the latest power demand forecast and the transmission line plan.
- Role of hydropower in each region/river/system will be examined.
- Prioritization of candidate sites for hydropower development will be conducted, and concrete investment program shall be established.
- Pre-feasibility level study shall be conducted for selected two (2) prospective plans taking account of financing by ODA.

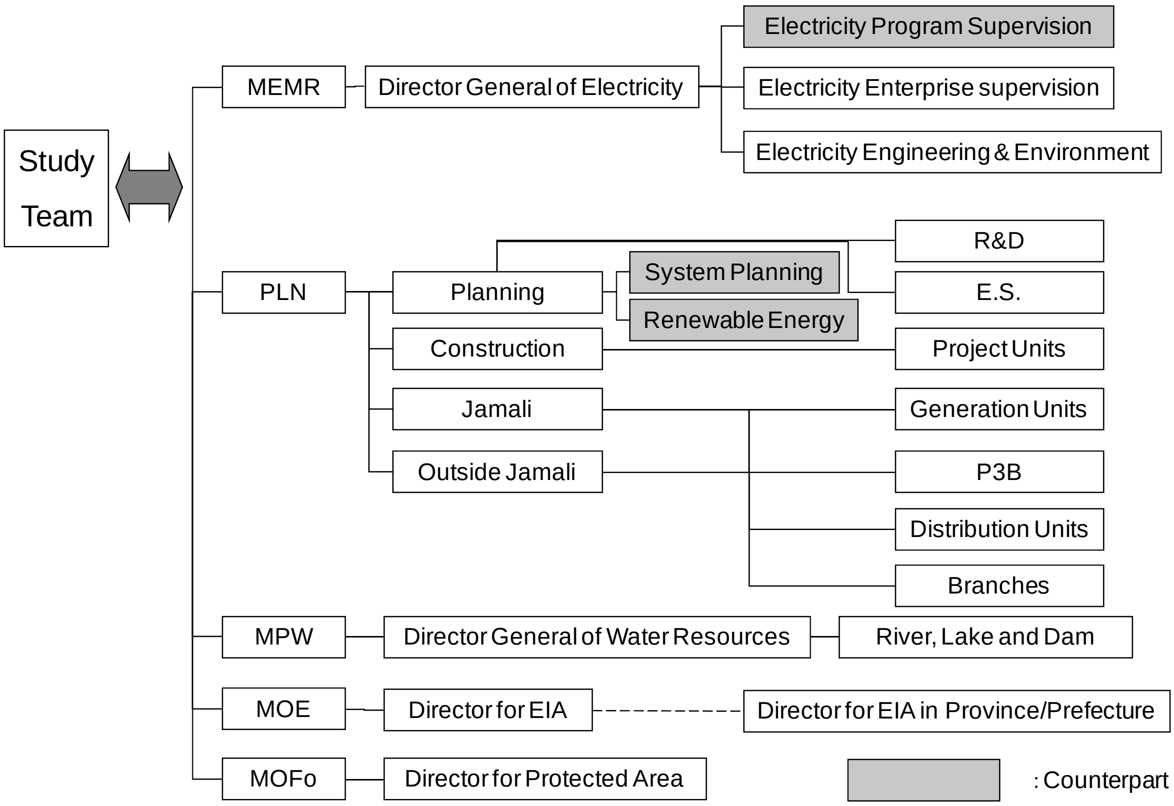
Transfer of knowledge and capacity building will be conducted through the joint implementation of the study. The Study aims to contribute to the stable power supply necessary to support the economic growth of Indonesia through the hydropower development based on the formulated master plan.

## 1.3 STUDY AREA

The Study covers the whole country of Indonesia. More specifically, the Study focuses on the hydropower development potential sites listed in the inventory attached in the Minutes of Meeting agreed between MEMR, PLN and JICA on 2$^{nd}$ March, 2009.

## 1.4 COUNTERPART AGENCIES

The counterpart agencies of the Study are MEMR (Ministry of Energy and Mineral Resources) and PLN. Director of Electricity Program Supervision (DGE of MEMR), and Deputy Directors for New and Renewable Energy, and System Planning (Director of Planning and Technology, PLN) are the core counterpart. The core counterpart asks for assistances from other divisions of MEMR and PLN. Apart from MEMR and PLN, close coordination with MPW (Ministry of Public Works), MoE (Ministry of Environment) and MoFo (Ministry of Forest) are kept.




Source: JICA Study Team

**Figure 1.4.1 Counterpart Agencies**

# *PART I MASTER PLAN STUDY*

# CHAPTER 2 LAWS AND REGULATIONS, POLICIES AND ORGANIZATIONS OF POWER SECTOR

## 2.1 INDONESIAN ELECTRICITY SECTOR

### 2.1.1 INDONESIAN ELECTRICITY SECTOR OUTLOOK

The Ministry of Energy and Mineral Resources (Departemen Energi dan Sumber Daya Mineral or DESDM) has charge of administration of whole the power sector in Indonesia.

Meanwhile, the electricity sector in Indonesia is a monopoly market, with PLN (the National Electricity Company) as the sole supplier of electricity to the public and business. Although some private electricity operators are operating, they are only allowed to sell their electricity services to the public through the power system owned by PLN. To carry out its duty as a single producer, PLN has two wholly-owned subsidiaries for electric generation in the Java-Bali System, the prominently largest electricity market. They are Indonesia Power and PJB (*Pembangkitan Java Bali*). PLN has also created 6 Strategic Business Units (SBUs). One of these SBUs is used as a power transmission unit (P3B) while the rest are utilized as power distribution units. Other retail operations are carried by retail business units.

As the economy of the country began to recover, the power demand has risen, especially since 2000. The available system capacity, however, has grown in a slower pace to meet this increasing demand, resulting in low reserves with some power shortages across the country. This condition has created a concern on the reliability of power supply in the short term as load-shedding and blackout are frequently taking place, particularly in the islands outside the Java-Bali System. Moreover, the fuel subsidy reduction has induced many “captive power” producers to revert to utilizing electricity from PLN, which will further raise PLN’s demand growth.

Meanwhile, the electricity access in Indonesia is still low, with wide disparities across provinces and those outside Java-Bali lagging behind. There are over 70 million people in Indonesia, mostly categorized as the poor, who still do not have access to electricity. To attain 95% electrification rate just in Java-Bali, where expanding the electricity access will mainly be within the existing supply and distribution network, is estimated to need about 13-15 years. Hence, if PLN continues connections at the present pace, it is estimated that Indonesia’s overall electrification rate will not meet 100% in the near future.

### 2.1.2 POLICIES AND PLANS FOR ECONOMY AND INDUSTRY

Since 2004, Indonesia has achieved 5.5% average growth, maintained a surplus in its current account, guarded a strong fiscal position, reduced external debt, and nearly doubled international reserves. Inflation, though, has averaged a high 8.5% since 2004, even if it has come down from the double-digit rates of 2005–2006.

These solid fundamentals provided good underlying support in the face of the global recession. However, the moderate pace of growth over an extended period has not generated sufficient jobs to absorb the unemployed, underemployed, and new entrants to the labor market.

Furthermore, about 70% of those who are employed work in the informal sector, where wages and job security are low. The International Labour Organization estimates that in 2006 there were 52.1 million workers (about 55% of the total employed) earning no more than the equivalent of about $1 a day, and a further 7.9 million (8.2%) earning no more than $2 a day. Income inequality, as measured by the Gini coefficient, has increased from 0.32 in 2004 to 0.37 in 2009.

Insufficient job creation is a consequence of lackluster growth in the tradable sector, particularly labor-intensive manufacturing. That, in turn, is largely caused by weaknesses in the business environment (problems include legal and regulatory uncertainty and governance issues), and deficient infrastructure (such as roads, ports, and electricity supply).

Investment in infrastructure has dropped to the equivalent of about 3.5% of GDP in the past 3 years, from 7% before the Asian Currency Crisis, lagging such investment in faster-expanding economies. The government's investment coordinating agency estimates that $150 billion is needed to build and upgrade infrastructure in 2010–2014, of which the public sector could supply one-third.

Bridging that gap with private investment will require, among other things, faster progress in developing public–private partnerships, closer alignment of national and local regulations (which are sometimes in conflict), and overcoming hurdles related to acquisition of land for infrastructure projects.

**Table 2.1.1 National Accounts of Indonesia, Industry Breakdown**

| Sector | by Quarter | | | by Year | |
|---|---|---|---|---|---|
| | 1Q08 | 1Q09 | 1Q10 | 4Q09 | 1Q10 |
| 1. Agriculture, Livestock, Forestry, Farming | 19.18% | 20.07% | 18.09% | 4.61% | 2.89% |
| a. Farm Food Crops | 62.44% | 62.70% | 54.96% | 6.68% | 1.61% |
| b. Plantations | -27.15% | -25.17% | -22.76% | 2.15% | 5.44% |
| 2. Mining and Quarrying | -0.43% | -0.26% | -1.86% | 5.22% | 3.54% |
| a. Oil and Gas | -0.04% | -0.02% | -1.58% | 1.39% | -0.18% |
| b. Non-oil and Gas Mining | -0.58% | -0.19% | -2.14% | 10.52% | 8.36% |
| c. Quarrying. | -1.89% | -1.55% | -2.24% | 7.58% | 6.83% |
| 3. Manufacturing Industries | -0.13% | -0.47% | -1.01% | 4.16% | 3.59% |
| 1). Food, Beverages and Tobacco | -1.46% | 1.04% | -3.57% | 5.57% | 0.74% |
| 2). Textiles, Leather and Footwear | 0.98% | 3.42% | -0.82% | 4.61% | 0.32% |

| Sector | by Quarter | | | by Year | |
|---|---|---|---|---|---|
| | 1Q08 | 1Q09 | 1Q10 | 4Q09 | 1Q10 |
| 3). Wood and Forestry Products | 0.59% | -3.60% | -6.97% | 0.03% | -3.46% |
| 4). Paper and Printing | 1.05% | 10.17% | -2.96% | 11.55% | -1.74% |
| 5). Fertilizers, Chemicals and Rubber Prod. | -0.87% | -0.01% | 1.28% | 2.52% | 3.85% |
| 6). Cement and Non-Metal Quarrying | -2.48% | -5.13% | -4.14% | 6.39% | 7.50% |
| 7). Basic Metals and Steel | 0.36% | 2.92% | -2.31% | 4.29% | -1.01% |
| 8). Vehicles, Machinery and Equipments | 1.05% | -3.39% | 1.44% | 4.89% | 10.12% |
| 4. Electricity, Gas and Water | 1.64% | 3.41% | -2.75% | 13.99% | 7.20% |
| 5. Construction | -1.89% | -1.55% | -2.24% | 8.03% | 7.27% |
| 6. Trade, Hotel and Restaurants | -0.05% | -4.64% | 0.05% | 4.17% | 9.29% |
| a. Wholesale and Retail Trade | -0.18% | -6.09% | 0.02% | 4.02% | 10.80% |
| b. H o t e l | 0.64% | 0.34% | -0.16% | 3.94% | 3.43% |
| c. Restaurants | 0.59% | 2.90% | 0.23% | 5.18% | 2.45% |
| 7. Transport and Communications | 1.18% | 1.75% | 1.48% | 12.22% | 11.91% |
| a. Transportation | -4.13% | -1.24% | -3.07% | 6.74% | 4.77% |
| b. Communication | 6.58% | 4.01% | 4.62% | 16.35% | 17.03% |
| 8. Financial, Real Estate, Business | 1.92% | 0.82% | 2.49% | 3.77% | 5.49% |
| 9. Other Services | 0.49% | 1.22% | 0.19% | 5.69% | 4.62% |
| Gross Domestic Product | 2.41% | 1.68% | 1.93% | 5.43% | 5.69% |

Source: BPS, Danamon Calculations

## 2.2 LAWS, REGULATIONS AND POLICIES RELATED TO POWER SECTOR

The legal system of the Republic of Indonesia is stipulated in the 1945 Constitution and the Law No. 10/2004, and hierarchized in Table 2.2.1.

**Table 2.2.1 Legal Hierarchy of Indonesia**

| | Indonesian | | English |
|---|---|---|---|
| | long-title | short-title | |
| 1 | *Undang-Undang Dasar 1945* | UUD 1945 | 1945 Constitution |
| 2 | *Undang-Undang* | UU | Law |
| 3 | *Peraturan Pemerintah* | PP | Government Regulation |
| 4 | *Peraturan/Keputusan/Instruksi Presiden* | Perpres/Keppres/Inpres | Presidential Regulation/Decree/Instruction |
| 5 | *Peraturan/Keputusan Menteri* | Permen/Kepmen | Ministerial Regulation/Decree |

### 2.2.1 GENERAL SOCIO-ECONOMIC DEVELOPMENT

(1) National Mid-term Development Plan

National Mid-Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional* or RPJMN), that is issued on January 20th, 2010 as a Presidential Regulation (Perpres No. 5/2010), is an national development plan document for medium (5 years) period of 2010-2014, which consists of national development strategies; general policy; ministries/institutions program and cross–sector issues; regional and cross-regional issues; and macro economy framework.

The RPJMN functions as guidelines for ministries/government institutions in developing their 5-year Strategic Planning, input for developing and revising the Regional Mid-Term Development Plan according to national targets on RPJMN; and guidelines for the Government to develop Yearly Government Work Plan.

In RPJMN of year 2010-2014, the energy sector is described under Area “Natural Resources and the Environment”, which one of the priorities is “energy security and independency” with the objectives of:

- Diversification of energy mix that will secure the sustainability and quantity of energy supply for the whole nation and people in Indonesia on different level of income;
- Increase the utilization of new renewable energy and actively participate and harness the global carbon market;
- Increase energy efficiency and conservation in household, industry and transport sector; and
- Increase production and utilization of clean and economical energy.

(2) Decentralization and regional autonomy

The new policy of decentralization and regional autonomy is outlined in Law concerning “Local Government” (UU No. 22/1999) and Law concerning “The Fiscal Balance between the Central and Regional Governments” (UU No. 25/1999). Both laws are abutted on five principles; i) democracy, ii) community participation and empowerment, iii) equality and justice, iv) recognition of the potential and diversity within regions and v) the need to strengthen local legislatures. These five principles support Indonesia’s push for reformation, which continues to aim to eradicate the practices of corruption, collusion, and nepotism (known as KKN), within the government bureaucracy.

One of the specific reasons behind the policy is that a centralized government system cannot possibly administer Indonesia’s large population of 220 million and its diverse socio-cultural and religious background. The main aim of decentralization and regional autonomy is to bring the governments closer to their constituents so that government services can be delivered more effectively and efficiently. This is based on the assumption that district and municipal governments have a better understanding of the needs and aspirations of their communities than the central government.

Owing to the decentralization and regional autonomy, all of local governments have had to reform their internal structures to accommodate the huge increase in responsibility that has been passed on from the central government. A significant part of this process includes placing a large number of central government employees under the regional governments and increasing their financial capacity to implement regional autonomy. The absence of a detailed plan for the transition process and the lack of supporting regulations to clarify the procedures which need to be undertaken, have hampered this sweeping devolution of authorities.

The decentralization and regional autonomy policy is highly appreciated, as it aims at providing better public services to citizens. It can work well, if such services and their processes are fully within the region concerned. However, the policy is not very advantageous, if certain public services can only be generated from the matters attributed to a large system beyond the respective jurisdiction. The hydropower development must be one instance of the large systems. As a typical river system of Indonesia is much broader than the territory of one regional government (or *Kabupaten*), one can no way find the optimal hydropower within the respective jurisdiction. Because hydropower is highly dependent on geography, one hydropower plan may completely exclude any other plans, even though they are much better for Indonesia. Therefore, all of hydropower developments are demanded to be executed after consultation with the overall river development plan, if any.

### 2.2.2 ENERGY SECTOR

(1) Energy Law

The Law on Energy (UU No. 30/2007) was promulgated on August 10, 2007, which was the first comprehensive law articulating the whole energy sector in Indonesia. Until then, there existed laws on each energy sub-sector such as Electricity (UU No. 15/1985), Nuclear Energy (UU No.10/1997), Oil and Gas (UU No. 22/2001), Geothermal (UU No. 27/2003) and so on.

In this law, basic policies on management and national security of energy are stipulated, of which pricing of energy, national energy policy, establishment of new energy council and formulation of RUEN and RUED are notable and mentioned in the following.

The law articulated that energy prices should be determined on the basis of a fair economic value in principle, but that the Government and regional government should provide subsidy funds for less wealthy community groups.

The running National Energy Policy was stipulated as a Ministerial Decree and later a Presidential Regulation was issued on the policy. However, strengthening the importance of national energy policy in this law, it is subject to the approval of the House of People's Representative.

The most groundbreaking issue in the law is the establishment of National Energy Council (*Dewan Energi Nasional* or DEN). Before then, the National Energy Coordination Agency (*Badan Koordinasi Energi Nasional* or BAKOREN) established in 1980 by a Presidential Regulation (Perpres No. 46/1980) had long been in charge of coordination and integration of energy policies among different ministries and agencies related to energy under the Government. BAKOREN was headed by the Minister for Energy, and supposed to be held at least four times a year with members of nine ministers and/or chairpersons.

Newly established DEN is strengthened in function, headed by the President, and 15 members are selected among not only the cabinet but also stakeholders. Besides the President and the Vice-president, seven ministers and/or government officials are the member of DEN, appointed by the President. In addition, eight persons representing stakeholders are selected by the House of People's Representatives; two persons from academic circles, two persons from industrial circles, two persons from technological circles, one person from environmental circles, and two persons from consumers.

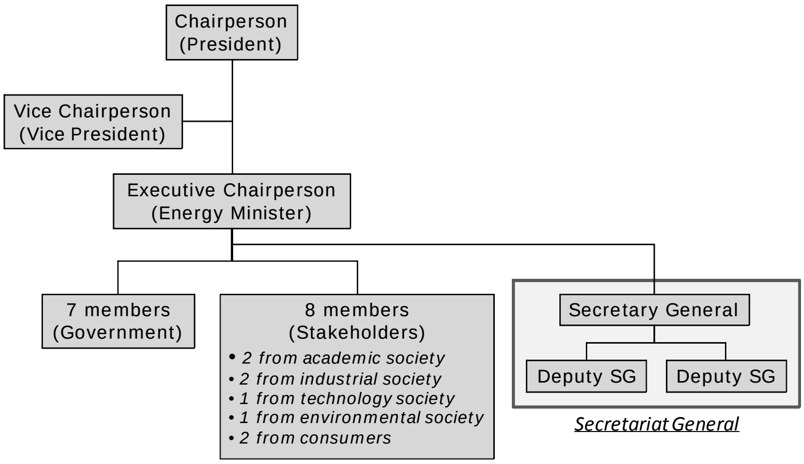



**Figure 2.2.1 Organizational Structure of DEN**

The duties of DEN are mandated as follows:

a. Designing and formulating national energy policies to be adopted by the Government with the approval of the House of People's Representatives,

b. Determining a master plan on national energy,

c. Determining responses to energy crisis and emergency conditions, and

d. Monitoring the implementation of cross-sectoral policies on energy.

A master plan on National Energy (*Rencana Umum Energi Nasional* or RUEN) stated above should be drafted by the Government, involving the regional government and taking into consideration opinions and inputs of the public, and the regional government should develop a master plan on regional energy by referring to RUEN.

(2) National Energy Policy

i) <u>National Energy Policy 2003-2020.</u>

The National Energy Policy (*Kebijakan Energi Nasional* or KEN) was formulated in March 2004 by revising the previous General Policy on Energy named "KUBE (*Kebijakan Umum Bidang Energi*)" in order to reflect the change of environment surrounding the energy sector, especially the restructuring the legal system, *i.e.* formulation of "Law No. 22/2001 on Oil and Natural Gas", "Law No. 20/2002 on Electricity" and "Law No. 27/2003 on Geothermal Energy". As well as the former KUBE, the National Energy Policy was issued as a Ministerial Decree (Kepmen No. 0983 K/16/MEM/2004).

The policy advocates the following quantitative targets:

- Electrification ratio: 90 percent in 2020.
- Share of renewable energy such as geothermal, biomass and micro/mini hydro: at least 5 percent in 2020, excluding large scale hydro.
- 1 percent reduction per annum in energy intensity.

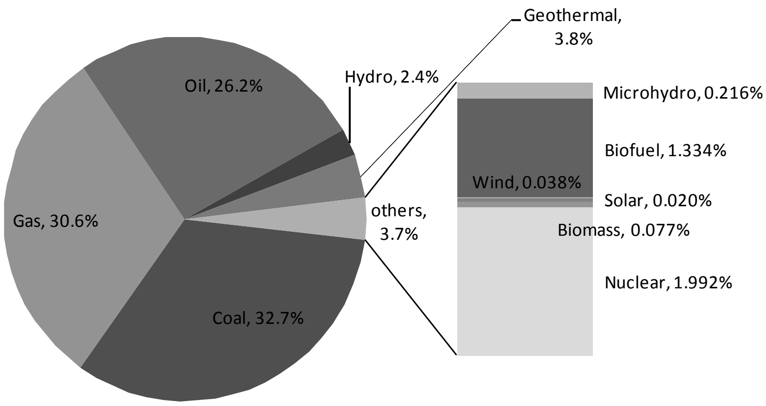
ii) National Energy Management Blueprint 2005-2025.

The National Energy Management Blueprint (*Blueprint Pengelolaan Energi Nasional* or BP-PEN) was established in 2005 to enforce the National Energy Policy, projecting longer period up to 2025. More specific quantitative targets are described as follows:

1) Minimum energy use per person is 10 SBM (BOE)[1], electrification rate is 95 % in 2025.
2) Energy elasticity less than 1 in 2025.
3) Best energy mixture realization
   - Proportion of oil is down to 26.2 %
   - Proportion of gas is up to 30.6 %
   - Proportion of coal is up to 32.7 % (including Low rank coal use, Coal liquefaction, Briquette)
   - Proportion of geothermal is up to 3.8 %
   - Proportion of other renewable energy is up to 4.4 %

Figure 2.2.2 illustrates the optimal scenario of national energy mix in 2025, prescribed in the BP-PEN 2005-2025. The percentage of alternative energy was raised to around 10 percent including hydro and nuclear. Except hydro and nuclear, the percentage of renewable energy is 5.51, which exceeds 5 percent earlier described in the National Energy Policy. However, some NGOs and experts expressed their dissatisfaction on this moderate target, and the target for alternative energy introduction was drastically raised in the Presidential Regulation detailed in the following part.

[1] *Setara Barrel Minyak* (Barrel of Oil Equivalent)

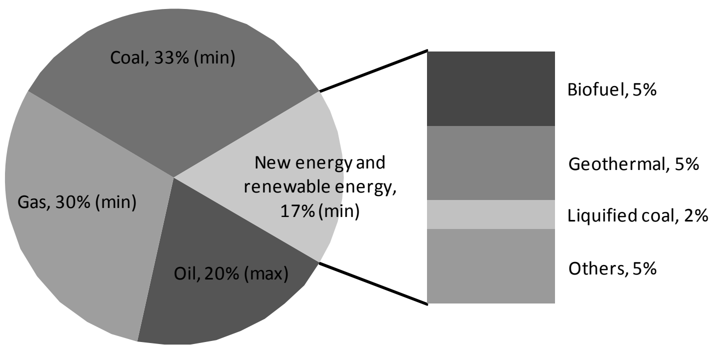



Source: *Blueprint Pengelolaan Energi Nasional* 2005-2025.

**Figure 2.2.2 National Energy Mix Target in 2025 (BP-PEN)**

iii) Presidential Regulation No. 5/2006 on National Energy Policy.

While the National Energy Policy (KEN) 2003 was issued as Ministerial Regulations, a Presidential Regulation regarding the National Energy Policy was promulgated in 2006. In this policy, two quantitative targets are expressed; one is for energy elasticity succeeding to BP-PEN 2005 and the other is for primary energy mix. The contribution of alternative energy including hydro and nuclear was raised to 17 percent from 10 percent in BP-PEN 2005 with capping the percentage of oil fuels (20 percent). Among 17 percent, biofuel and geothermal account for 5 percent respectively and liquefied coal 2 percent. Other alternative energy includes biomass, nuclear, hydro, solar and wind.




Source: Presidential Regulation No. 5/2006 on National Energy Policy.

**Figure 2.2.3 Target of National Energy Mix in 2025 (Perpres No. 5/2006)**

The article 4 of the regulation prescribes the following texts regarding National Energy Management Blueprint (Blueprint *Pengelolaan Energi Nasional* or BP-PEN);

1) BP-PEN shall be determined by the Minister of Energy and Mineral Resources after discussion with the National Energy Coordinating Board (BAKOREN).

2) BP-PEN will include at least;
   a. policy on security of energy supply in the country,

b. policy on public service obligations, and
c. energy resources management and utilization.

3) BP-PEN will be the basis for the preparation of the development and utilization pattern of each type of energy.

iv) National Energy Management Blueprint 2006-2025.

The former National Energy Policy (2003-2020) issued in 2004 was followed up with the National Energy Management Blueprint (BP-PEN) 2005-2025. After that, a Presidential Regulation, which prescribed the optimal primary mix with giving a larger role for alternative energy sources reducing dependence on oil, is promulgated. In this context, BP-PEN 2005-2025 needs to be revised to conform to the Presidential Regulation No. 5 of 2006 on National Energy Policy (KEN).

With the legalization of Law Number 30 Year 2007 regarding Energy and as contained in Presidential Regulation No. 5 Year 2006, which mandates the Minister of Energy and Mineral Resources to establish BP-PEN, the blueprint will be one of the reference for national energy development.

In addition to the targets in the Presidential Regulation, the new BP-PEN succeeds those of the precedent energy policies; *i.e.*

- Electrification Ratio: 95 percent in 2025 (from RUKN and the former BP-PEN).
- Energy consumption per capita: 10 BOE in 2025 (from RIKEN and the former BP-PEN).

v) Summary of targets.

The targets prescribed in the energy policies mentioned above, are summarized in Table 2.2.2.

**Table 2.2.2 National Targets on Energy**

| | **National Energy Policy (KEN) 2003-2020** | **National Energy Management Blueprint (BP-PEN) 2005-2025** | **National Energy Policy (KEN)** | **National Energy Management Blueprint (BP-PEN) 2006-2025** |
|---|---|---|---|---|
| **Legal Basis** | Kepmen ESDM No. 0983 K/16/MEM/2004 | | Perpres RI No. 5/2006 | |
| **Date of Issue** | March 10, 2004 | | January 25, 2006 | |
| **Targets:** | | | | |
| Electrification Ratio | 90 % in 2020 | 95 % in 2025 | -- | 95 % in 2025 |
| Energy Consumption | -- | 10 BOE/capita in 2025 | -- | 10 BOE/capita in 2025 |
| Primary Energy Mix | -- | Oil: 26.2 %<br>Gas 30.6 %<br>Coal: 32.7 %<br>Hydro: 2.4 % | To national energy consumption:<br>Oil: less than 20 %<br>Gas: more than 30 %<br>Coal: more than 33 % | |
| Alternative (New and Renewable) | at least 5 % in 2020 by geothermal, biomass | Geothermal: 3.8 %<br>Others: 4.4 % | Biofuels: more than 5 %<br>Geothermal: more than 5 % | |

| | National Energy Policy (KEN) 2003-2020 | National Energy Management Blueprint (BP-PEN) 2005-2025 | National Energy Policy (KEN) | National Energy Management Blueprint (BP-PEN) 2006-2025 |
|---|---|---|---|---|
| Energy | and micro/mini hydro, excluding large scale hydro | | Liquefied Coal: more than 2 %<br>Others (biomass, nuclear, hydropower, solar, and wind power): more than 5 % | |
| Energy Intensity | 1 % reduction p.a. | -- | -- | -- |
| Energy Elasticity | -- | -- | less than 1 in 2025 | |

Source: Assembled by the Author from the original documents.

Among various targets, high-lighted boxes are considered to be currently active, and the active targets are discussed below for verification.

vi) Perception of current situation, and verification of the targets.

For these targets, we summarized the current situation on the indicators above, and then discussed the validity of them.

*Electrification ratio*

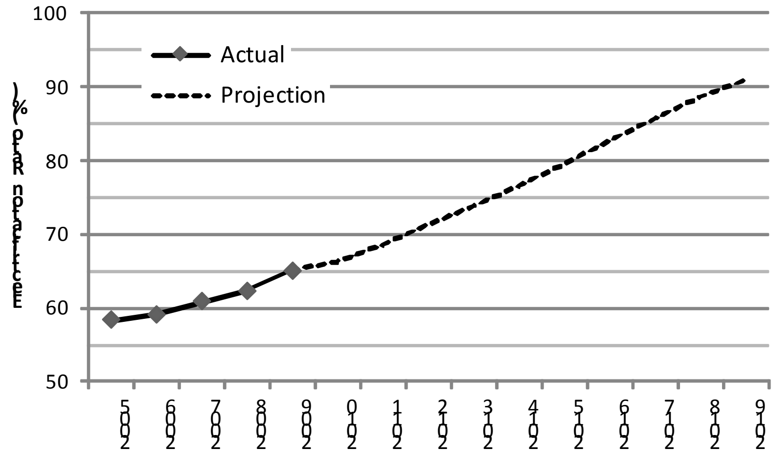
The latest RUKN indicated the status quo and orientation for electrification ratio as Table 2.2.3. The electrification ratio is 64.34 percent in the whole Indonesia in year 2007, and gives a target of 93 percent in 2025, which slightly falls behind from the target of the policies by 2 percent-points.

**Table 2.2.3 Targets for Electrification Ratio set by MEMR**

| No. | Provinsi/ Daerah/ Wilayah | 2007 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|
| 1 | NAD | 74.91 | 76 | 85 | 100 | 100 |
| 2 | Sumut | 69.32 | 84 | 96 | 100 | 100 |
| 3 | Sumbar | 68.72 | 81 | 95 | 100 | 100 |
| 4 | Riau and Riau islands | 54.66 | 70 | 80 | 90 | 100 |
| 5 | Sumatera Selatan, Jambi and Bengkulu | 49.58 | 56 | 70 | 80 | 95 |
| 6 | Lampung | 47.66 | 60 | 80 | 91 | 100 |
| 7 | Bangka Belitung | 72.45 | 80 | 90 | 100 | 100 |
| 8 | Batam | *) | 90 | 100 | 100 | 100 |
| 9 | Java-Bali-Madura | 76.11 | 85 | 95 | 100 | 100 |
| 10 | Kaltim | 68.37 | 80 | 94 | 100 | 100 |
| 11 | Kalselteng | 57.86 | 66 | 79 | 96 | 100 |
| 12 | Kalbar | 45.65 | 65 | 81 | 93 | 99 |
| 13 | Suluttenggo | 54.32 | 59 | 68 | 88 | 95 |
| 14 | Sulselrabar | 46.56 | 63 | 70 | 85 | 96 |
| 15 | NTB | 31.99 | 50 | 63 | 70 | 85 |
| 16 | NTT | 24.24 | 35 | 42 | 69 | 84 |
| 17 | Maluku and Maluku Utara | 51.59 | 60 | 75 | 90 | 100 |
| 18 | Papua and Papua Barat | 32.05 | 50 | 63 | 75 | 90 |
| | **Total Indonesia** | **64.34** | **67.2** | **79.2** | **90.4** | **93** |

*) Rural electrification ratio in Batam is included in the value in “Riau and Riau islands”.
Source: RUKN 2008.

In the meantime, PLN expressed its electrification targets in RUPTL, as Figure 2.2.4. According to the latest RUPTL issued in August 2011, the most recent electrification ratio was 65.0 percent in the whole Indonesia in 2009, and the target in 2019 is 90.9 percent, which is a bit higher than that of RUKN in 2020.




Source: RUPTL 2010-2019, PLN.

**Figure 2.2.4 Targets for Electrification Ratio set by PLN**

*Energy Consumption per capita*

According to IEA, the final energy consumption was 93,877 ktoe (thousand tonnes of oil equivalent), equivalent to 688.25 million BOE using a conversion factor 0.1364) net of non-commercial energy, as of 2008. On the other hand, total population is estimated as 228.25 million in the same year, so that energy consumption per capita will be calculated as 3.015 BOE/capita, which accounts for less than one-third of the target in 2025.

On the contrary, the population in 2025 will reach 284.3 million with using the average population growth rate of 1.3 percent p.a. during 2008-2027 which is used in RUKN. The total energy consumption required to meet the target is consequently at least 2,843 million BOE (387,785 ktoe), which is 4.13 times as much as the current energy consumption.

*Primary Energy Mix*

According to the IEA statistics, which is consistent with the statistical data of PLN and other data sources[2], energy supply and consumption in 2008 are summarized below, and the compositions of primary energy supply and final consumption in the same year, both net of non-commercial energy are illustrated in Figure 2.2.5.

Indonesia's total primary energy supply (TPES) was 198,679 ktoe (thousand tonnes of oil

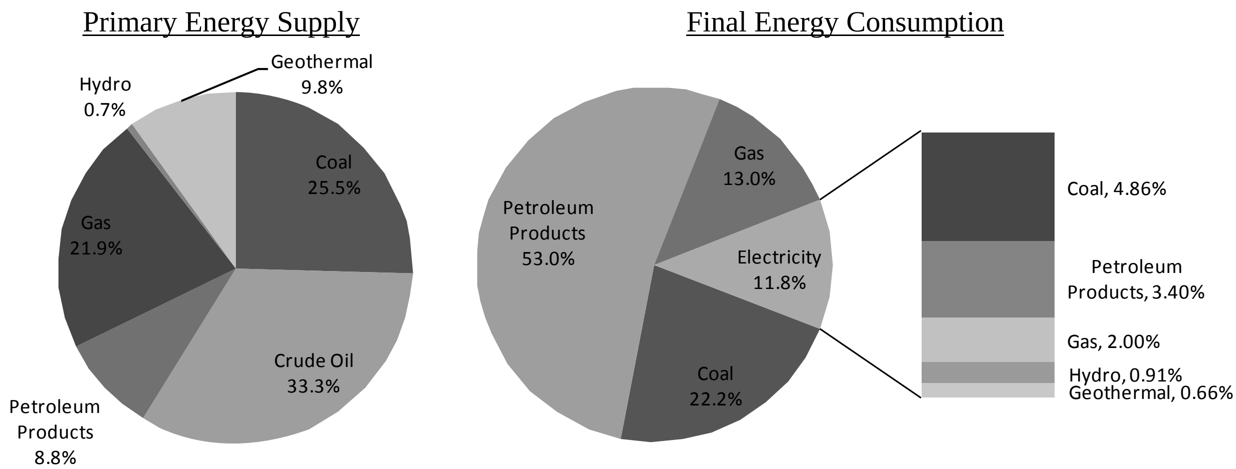
[2] Different figures are also reported in other documents, *e.g.* BP-PEN (originally sourced from Handbook EE 2006). BP-PEN reported that the contribution of hydropower in the year 2005 was 34.0 million BOE or equivalent to 54,186 GWh using a conversion factor of 1.5937 MWh/BOE, which is contradictory to the PLN's own hydropower generation, 9,830.36 GWh in the same year, even though other hydropower generation (4,729 GWh; total of designated annual energy of INALUM and PLTA Jatiluhur) is taken into account. Indonesian Energy Outlook & Statistics 2006 reported the electricity consumption derived from renewable energy in 2004, including hydro and geothermal would be 14.29 million BOE, which is also contradictory to the figure of BP-PEN. We could introduce any amount of examples of such overestimated hydropower contribution, if needed.

equivalent), including non-commercial energy[3] of 52,997 ktoe. TPES of commercial energy was 133 746 ktoe, made up of oil (42.1 %), coal (25.5 %), natural gas (21.9 %), hydropower (0.7 %) and geothermal (9.8 %). Indonesia is a net exporter of energy, and overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal were 147,335 ktoe in 2008. Coal has been recently the main export commodity in energy sector, which accounted for 128,642 ktoe or 70.7 percent to the total primary energy export (181,915 ktoe) in 2008.

Total final energy consumption (TFC) of commercial energy was 93,877 ktoe in 2008. The share of TFC by sector in 2008 was 42.1 percent for industry, 27.5 percent for transport, 12.2 percent for residential, 11.0 percent for non-energy use and 7.2 percent for other sectors.

Indonesia's energy consumption is still highly dependent on oil; final energy consumption of oil in 2008 was 49,728 ktoe, or 53.0 percent of TFC, which was a 3.1 percent increase from 48,214 ktoe in 2007, and accounting for 56.4 percent of TFC when adding the oil contribution to electricity generation.

Paying attention to renewable energy, geothermal and hydro are exclusively supplied in a commercial basis, all amounts of both of which are converted to electricity, and consumed. Geothermal contribution is 9.8 percent and fairly high in the supply basis, but only 0.66 percent in the consumption basis due to its low conversion efficiency. On the contrary, hydro contribution is 0.7 percent of the supply, and 0.91 percent of the consumption. However, there is no difference between geothermal and hydro in the point that the contribution to the total energy consumption is quite limited.




Note) Electricity indicates the net value of 13.6 percent of own use and T&D loss.

Source: Author's Calculations using "Energy Balances of Non-OECD Countries, 2008", IEA.

**Figure 2.2.5 Primary Energy Supply and Final Consumption in 2008**

Here are another figures presented in BP-PEN 2006-2025 as the projection according to RIKEN scenario, indicated in Table 2.2.4 and Figure 2.2.6, which includes meaningful facts. As of 2025, total energy consumption will pass the target of 10 BOE per capita or 2,843 million BOE in total

[3] Combustible waste and renewable sources

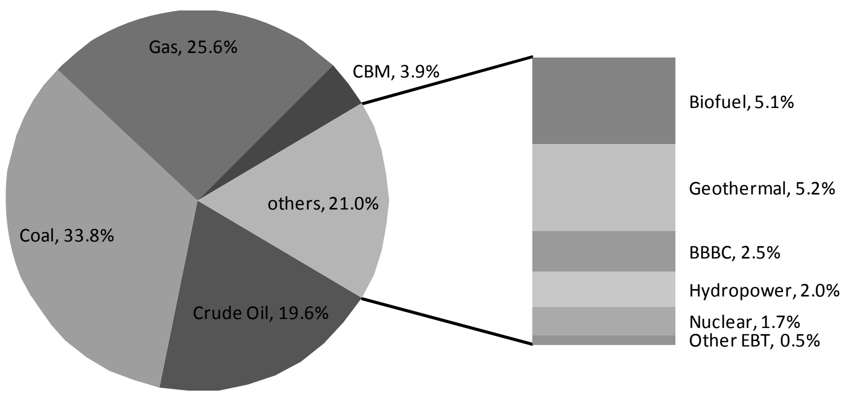
consumption, and most of primary energy contribution will also pass the targets indicated in Table 2.2.2, except Gas (29.5 percent) missing by 0.5 percent, and other alternative energy including hydro and nuclear (4.2 percent) by 0.8 percent. The Presidential Regulation gives the targets with limits, and all targets but for crude oil have lower limits. All the increment exceeding above the targets, thereby, have to be absorbed in crude oil to achieve all the targets. Considering the current consumption level of crude oil (56.4 percent), the target for oil itself seems to be a high hurdle, and we probably cannot expect the achievement of the target with a big margin. In this circumstance, achievement with some margin, which itself will be desirable, may harm the achievement of other targets. If the targets were given in the form of single figures without ranges, the energy mix in Table 2.2.4 would have been appreciated as almost achieve the targets.

**Table 2.2.4 Projection of Energy Mix (RIKEN scenario)**

(Unit: million BOE)

| Type of Energy | 2005 | 2010 | 2015 | 2020 | 2025 | |
|---|---|---|---|---|---|---|
| Crude Oil | 524.0 | 550.7 | 578.0 | 605.8 | 638.9 | 19.6% |
| Coal | 160.4 | 210.3 | 349.7 | 743.8 | 1,099.4 | 33.8% |
| Gas | 212.8 | 363.7 | 382.5 | 477.1 | 832.0 | 25.6% |
| Coal Bed Methane | -- | -- | 23.0 | 74.6 | 127.8 | 3.9% |
| Biofuel | -- | 32.5 | 89.0 | 102.4 | 166.9 | 5.1% |
| Geothermal | 23.7 | 23.7 | 61.8 | 115.8 | 167.5 | 5.2% |
| Liquefied Coal | -- | -- | 14.2 | 47.4 | 80.5 | 2.5% |
| Hydropower | 34.0 | 41.7 | 56.6 | 60.5 | 65.8 | 2.0% |
| Nuclear | -- | -- | -- | 27.9 | 55.8 | 1.7% |
| Other alternative energy | 1.6 | 3.5 | 7.4 | 11.7 | 17.4 | 0.5% |
| TOTAL | 956.5 | 1,226.1 | 1,562.1 | 2,266.9 | 3,252.2 | 100.0% |

Source: Blueprint *Pengelolaan Energi Nasional* 2006 – 2025, MEMR




Source: Blueprint *Pengelolaan Energi Nasional* 2006 – 2025, MEMR

**Figure 2.2.6 Energy Mix in 2025 projected in RIKEN 2005**

Table 2.2.5 presents the estimation of required capacity for power generation to realize the figures indicated in Table 2.2.4. Assuming all the contribution of geothermal, hydropower, and nuclear will be consumed in the form of electricity, which is reasonable both now and in the future, the required generation capacity will account for 34 GW of geothermal, 20 to 30 GW of hydro, and 12 GW of nuclear.

**Table 2.2.5 Required Capacity deduced from RIKEN scenario**

| Type of Energy | Percentage to total energy consumption | Energy consumption | | Capacity Factor* (%) | Capacity** (MWe) |
|---|---|---|---|---|---|
| | | million BOE | GWh | | |
| Geothermal | 5.2 % | 167.5 | 266,945 | 90 | 34,000 |
| Hydropower | 2.0 % | 65.8 | 104,865 | 40 | 30,000 |
| | | | | 50 | 24,000 |
| | | | | 60 | 20,000 |
| Nuclear | 1.7 % | 55.8 | 88,928 | 85 | 12,000 |
| Total | 8.9 % | 289.1 | 460,739 | -- | 66,000 - 76,000 |

*: Author's assumption.
**: rounded to GW.

Source: Author's calculation based on RIKEN 2005 scenario.

Even though 90 percent of capacity factor is a fairly high assumption for geothermal generation, the capacity requirement will exceed a reported potential figure, *i.e.*, 27,000 MW. The Ministry of Energy and Minerals Resources issued the "Road Map Development Planning of Geothermal Energy for 2004-2020", announcing officially that the target of geothermal energy development would be 6,000MW by 2020, and the target was enhanced in 2005 to 9,500 MW by 2025. Taking the same assumption for capacity factor, 9,500 MW of capacity will produce 74,898 GWh of electrical energy per annum, equivalent to 47.0 million BOE, which 1.65 percent to 2,843 million BOE, the minimum total energy consumption in 2025.

BP-PEN 2006-2025 also indicates milestones for alternative energy development in its appendices, giving another values; 16.17 GW for geothermal, and 4.2 GW for nuclear, which will bring about a better projection for geothermal, however still missing the target – 127,484 GWh (80.0 million BOE) per annum or 2.81 percent to the TFC target in 2025.

Although, RUKN nor RUPTL mentioned any concrete plan on nuclear power development, along with government policies to introduce nuclear power generation, a JICA study[4] reported a generation development master plan in Java-Madura-Bali system, including nuclear power plants with 5,000 MW of total capacity, which will be commenced in 2018, 2021, 2024, 2026, and 2028 with 1,000 MW of each capacity. Assuming 85 percent of capacity factor, 5 GW of nuclear power plants will generate 37,230 GWh (23.4 million BOE) or 0.82 percent to the TFC target in 2025.

*Energy Intensity*

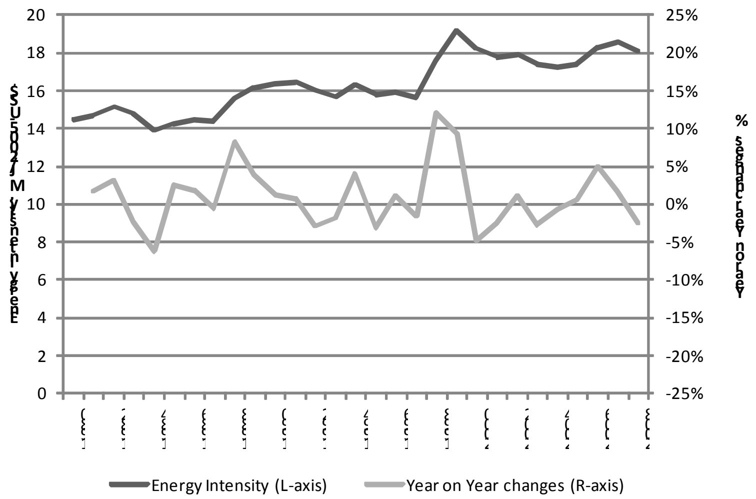
In general, energy intensity is a measure of the energy efficiency of a nation's economy, and the

[4] "The Study on Optimal Electric Power Development in Java-Madura-Bali in the Republic of Indonesia", December 2008.

lower intensity indicates higher energy efficiency. However, many factors influence an economy's overall energy intensity. It may reflect requirements for general standards of living and climate conditions in an economy.

The history of energy intensity in Indonesia defined as energy consumption measured in Megajoule (MJ) per gross domestic product (GDP) using purchasing power parity (PPP) US$ in 2005, is shown in Figure 2.2.7. Reviewing the history, the energy intensity was slightly increasing until 2000, and then has been keeping around 18 MJ/2005-US$ in recent years.

The target in KEN 2003 is a one percent reduction every year, which will bring in 13.95results in around 14 percent reduction for 15 years. Using 17.4 MJ/2005-US$ in year 2003, a one percent reduction will bring in



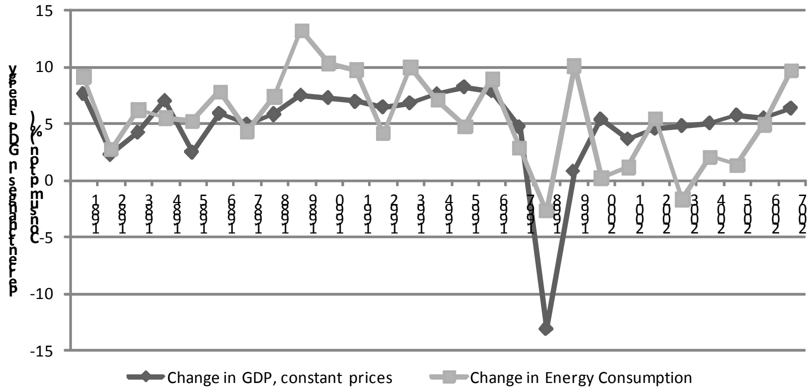

Source: International Energy Statistics, US Energy Information Administration-DOE.

**Figure 2.2.7 Trend of Energy Intensity (1980-2008)**

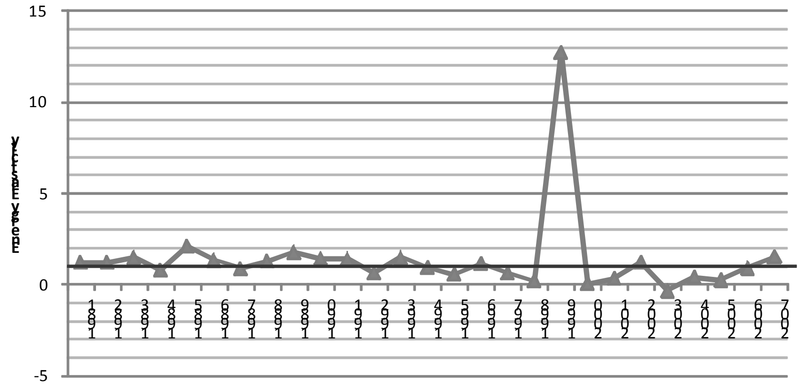
*Energy Elasticity*

Energy elasticity is defined as "the percentage change in energy consumption to achieve one per cent change in national GDP". Taking real GDP in constant Rupiahs and total primary energy consumption into consideration, the past energy elasticity trend during 1981 to 2007 is expressed in Figure 2.2.8. It seems delinked between economic growth and energy consumption in Indonesia, especially in recent years. Since 2001, economy has been keeping robust growth of around 5 percent or more, while energy consumption is distributed from negative value to 10 percent. The values of energy elasticity during the period, thereby has been fluctuated within the range from -0.354 to 1.525.

(a) Percent changes in GDP and Energy Consumption




(b) Energy Elasticity




Source: Author's calculations.

**Figure 2.2.8 Trend of Energy Elasticity (1981-2007)**

## 2.2.3 POWER SECTOR

### (1) Electricity Law

In Indonesia, electric power supply business was long regulated by the Electricity Law 1985 (UU No. 15/1985). Under this law, supply of electric power should be conducted by the Government as a general rule, and carried out by the state owned enterprise established based on the prevailing legislative regulation as the Electricity Proxy Holder (PKUK). It also stipulated the determination of the National Electricity General Plan (RUKN) by the Government. In addition, it provided for participation by cooperatives and private enterprises in supply of power for public interest (excluding for self interest) upon obtaining a business permit (IUKU) stipulated by a governmental regulation.

The year 1989 saw the promulgation of a governmental regulation (PP No. 10/1989) concerning power supply and use for enforcement of the Electricity Law. This regulation assigned power supply to the PKUK in principle, but made provisions for the Energy Minister to issue permits for power supply business to cooperatives and private enterprises in certain cases. The enterprises in question had to be Indonesian corporations. The regulation also stipulated that the President was to determine

RUKN and power tariffs, the latter based on proposals from the Energy Minister.

In 1992, a Presidential Decree (Keppres No. 37/1992) was promulgated to promote private investment in power generation, transmission, and distribution business. It contained stipulations regarding priority on unsolicited projects based on the build-own-operate (BOO) basis, rupiah-denominated tariff design, and prohibition of issuance of governmental guarantees for equities and repayments. (Note that, notwithstanding these stipulations, some exceptions were treated in the actual IPP agreements, *e.g.*, US Dollar based compensation of the capital investment, and issuance of "comfort letters" to investors.)

Along with such entry by private investment into the power sector, the first step toward power sector reform was taken in 1994, when the status of *Perusahaan Umum Listrik Negara* (PLN) was changed from a state-owned public corporation (*Perusahaan Umum* or Perum) to a state-owned joint-stock corporation (*Perusahaan Perseroan* or Persero). This was followed in 1995 by the unbundling of the generation, transmission, and distribution divisions in the area served by the PLN Java-Bali system. The generation division was divided in two, into Indonesia Power and *Pembangkitan Tenaga Listrik Java Bali* (PJB)[5]. The distribution division was split into four units for the regions of eastern Java (*Java Timur*), western Java (*Java Barat*), central Java (*Java Tengah*), and Jakarta. Each of the units was required to be financially self-supporting as a quasi-independent entity receiving allocations of expenditures in line with the management targets established in advance with the head office. The Java-Bali transmission division was transferred to "*Penyaluran dan Pusat Pengatur Beban*" (P3B) Java Bali, a subsidiary of the generation unit. As a result of these steps, the power market became a so-called "single-buyer" market in which the PLN transmission division purchased power from the PLN generation division and independent power producers (IPPs). Power sector reform in regions other than Java-Bali is proceeding through regional decentralization of the PLN.

In 2002, the Indonesian government enacted a new electricity law (UU No. 15/2002) to promote power sector reform. This new law introduced the principle of competition into the sector and was aimed at more efficient supply. It also called upon local governments to take responsibility for power supply services through participation in formulation of regional power development plans (RUKD) and other such tasks in the context of decentralization promoted on the national level. In the enactment of this legislation, the government planned to open up the power market by 2007. To oversee the market, the government decided to institute the Electric Power Market Control Agency (*Badan Pengawas Pasar Tenaga Listrik* or BAPETAL). BAPETAL was to determine the areas in which the power market was to be thrown open to competition (competitive areas) and those in which it was to remain under governmental control with an emphasis on the character of power as a public infrastructure (non-competitive areas). The agency was to see that there was fair competition in power supply to large- and medium-scale customers and also to play the role of determining power tariffs for small-scale customers. Java-Madura-Bali (Jamali) and the Batam islands were supposed to constitute the subject of the first phase of power market liberalization.

[5] At the time of their establishment, the entities were PJB I and PJB II. Their names were changed to Indonesia Power and PJB, respectively, in September 2000.

In December 2004, however, the Indonesian constitutional court ruled that the new electricity law enacted in 2002 was invalid because its provisions for free competition in power services were in violation of the constitution. In handing down its ruling, the court cited the provisions of Article 33 of the constitution, which states that economic sectors important to the national interest and public welfare are to be regulated by the government and developed so as to furnish the maximum benefit to the citizenry. It also asserted that, with repeal of the new 2002 law, the 1985 Electricity Law (No. 15/1985), which had been rescinded, was to be effectuated again in order to maintain a legal framework. At the same time, it held that contracts concluded with the government under the new 2002 law were to remain in force.

In response to this situation, on 16 January 2005, the Government issued a Regulation (PP No.3/2005), which reaffirmed the status quo by accepting private participation under the 1985 Electricity Law. It also announced its intention to enact a new electricity law in the near future. While taking the form of amending the Government Regulation No. 10/1989 for re-effectuation of the 1985 Electricity Law, the Government Regulation No. 3/2005 empowered private enterprises to participate in the power sector.

These circumstances formed the background of enactment of the prevailing electricity law (UU No. 30/2009) on September 23, 2009. While the new Electricity Law inherits the 1985 Electricity Law in principle, some revisions are made. Conforming to the decentralization, some authorities and obligations are attached to the regional governments though the authorities and responsibilities of electricity supply remains in the Central Government. For instance, the regional governments have to draft the regional electricity general plan (*Rencana Umum Ketenagalistrikan Daerah* or RUKD) considering the national electricity general plan (*Rencana Umum Ketenagalistrikan Nasional* or RUKN). RUKN itself which was so far issued as a Ministerial Decree, requires the approval of the House of Representatives. In addition, the electricity tariff which was so far decided by the President, also requires the approval of the House of Representatives. The key characteristics of new electricity law are summarized as follows:

i) General provisions

Under the new Electricity Law, PLN is not a holder of an exclusive electricity authorization from the Government to provide electricity for public use (*Pemegang Kuasa Usaha Ketenagalistrikan* or PKUK). As a consequence, PLN no longer has a monopoly to supply and distribute electricity to end customers.

Instead, the supply of electricity for public use may be carried out by state-owned enterprises (*Badan Usaha Milik Negara* or BUMN), regional-owned enterprises (*Badan Usaha Milik Daerah* or BUMD), private business entities, cooperatives and self-supporting communities. However, the new Electricity Law gives the right of first priority to BUMN (*i.e.* PLN) to supply electricity for public use.

ii) Electricity business licenses

Under the new Electricity Law, there are two types of electricity licenses.

a) Provision of electricity business:

- Provision of Electricity Business License for Public Use (*Izin Usaha Penyediaan Tenaga Listrik* or IUPTL); and
- Provision of Electricity Business License for Own Use (*Izin Operasi*).

b) Electricity-supporting businesses:

- Electricity Supporting Services License (*Izin Usaha Jasa Penunjang Tenaga Listrik*); and
- Electricity Supporting Industry License (*Izin Usaha Industri Penunjang Tenaga Listrik*).

An IUPTL covers the following business activities:

- power generation;
- transmission;
- distribution; and/or
- selling of electricity.

An IUPTL is a license to carry out an electricity business for public use that is granted, in accordance with their respective authorities, by the Minister/Governor/Regent/Mayor to a BUMN, BUMD, private business entity, cooperative or self-supporting community.

The provision of electricity business for public use may be carried out as an integrated activity to cover all business activities, from construction and operation of a power plant, to transmission, distribution and sale of electricity to end customers, all within one 'business area'. Business activities in distribution and/or sale of electricity to end customers will also be restricted to only one 'business area'. Business areas will be stipulated by the Government for the provision of electricity for public use.

The new electricity law gives a right of first priority to BUMN (*i.e.* PLN) to undertake the provision of electricity for public use.

The Government has authority to grant IUPTLs to business entities where:

- the relevant business area crosses multiple provinces;
- the business entity is a BUMN; or
- the business entity sells its power or leases its transmission line to a holder of an IUPTL issued by the Government.

Guidelines on and procedures for obtaining electricity licenses will be subject to Government regulation.

iii) Tariff

The Government, with approval from the House of Representatives, will stipulate the tariff for electricity that is sold to end customers by the holder of an IUPTL, having regard to national and regional interests, as well as to the end consumers' and power producer's interests. Meanwhile, for 'regional scope', the Regional Government (*Pemerintah Daerah* or Pemda), with approval from the Regional Assembly (*Dewan Perwakilan Rakyat Daerah* or DPRD), will stipulate the tariff in accordance with tariff guidelines provided by the Government.

The Government may stipulate different tariffs in each region within a business area. The holder of an IUPTL is prohibited from stipulating a tariff to end customers without approval from the Government or Pemda. Failure to comply with this may result in an administrative sanction.

The Government and Pemda, in accordance with their respective authority, must also approve the sale price of electricity from the holder of an IUPTL (*i.e.* from the power producer to the holder of an integrated IUPTL) and the fee for use of a transmission line.

The comparison between the 1985 Electricity Law and 2009 Electricity Law is summarized in Table 2.2.6.

**Table 2.2.6 Comparison of Electricity Laws**

| | UU No. 15/1985 | UU No. 30/2009 |
|---|---|---|
| General Plan on Electricity (RUKN) | [Article 5]<br>- The Government shall completely and integratedly stipulate the general planning of electricity.<br>- In arranging the general planning, the Government shall be obliged to take into account the idea and view living in the community. | [Article 7]<br>- General Plan on National Electricity (RUKN) will be drawn up based on the National Energy Policy and stipulated by the Government after consultation with the House of Representatives of the Republic of Indonesia.<br>- RUKN will be drawn up with the participation of Regional Government (Pemda).<br>- General Plan on Regional Electricity (RUKD) will be drawn up based on RUKN and stipulated by Pemda after consultation with the Regional Assembly (DPRD). |
| Responsibility of Electricity Supply | [Article 7]<br>- Electric power supply undertaking shall be conducted by the Government and carried-out by the state-owned undertaking established based on the prevailing legislative regulation as Electricity Proxy Holder (PKUK).<br>- In the effort to meet the electric power requirement more equally and to increase the state's ability to supply electric power, both for public interest, as long as it does not cause losses to the Government wide opportunities can be granted to cooperatives and other undertaking bodies to supply electricity | [Article 11]<br>- Electric Power Supply Business for the public interest may be carried out by BUMN, BUMD, private business entities, cooperatives and communities, having business activities in the electric power supply sector.<br>- BUMN will be given the first priority to perform electric power supply business for the public. |

| | UU No. 15/1985 | UU No. 30/2009 |
|---|---|---|
| | based on an Electricity Undertaking License (IUKU). | |
| Electric Power Supply Business Permit | [Article 1]<br>- KUK (the Proxy for power Affairs)<br>- IUKU (License for Power Business for Public Interest) | [Article 19]<br>- IUPTL (Permit for Business in Electric Power Supply)<br>- *Izin Operasi* (Operation Permit) |
| Rural Electrification | -- | [Article 4]<br>- The Government and the Regional Government will prepare the fund for poor citizen, development of electric power supply facilities for underdeveloped region, development of electric power in the isolated and border area; and rural electrification. |
| Electricity Tariff | [Article 16]<br>- The Government shall regulate the selling price of the electric power. | [Article 34]<br>- The Government according to the authority will determine the electric power tariff for consumers with the approval of the House of Representatives of the Republic of Indonesia.<br>- The Regional Government according to the authority will determine the electric power tariff for consumers with the approval of the DPRD based on the guidelines stipulated by the Government. |

Source: JICA Study Team

(2) Fast track program

Indonesia has been suffering with power shortage as infrastructure development has failed to keep pace with growth. According to PLN, the existing generating capacity is 30,500 MW, and a power deficit of 4,555 MW as of January 2010.

Amidst the situation, the President launched two regulations in July 2006 and January 2010 to accelerate generation development which mandated PT PLN (Persero) to build coal-fired electric power generation. Originally, the president regulation stipulated 40 coal fired power station (80 units) with the total capacity of 8,922 – 11,422 MW, to be established by the end of 2009.

The second phase, which is meant to be completed by 2014, will add 10,150 MW, with the focus on cleaner energies such as geothermal, hydropower, and gas. In the second phase, PLN will build 21 plants with total generating capacity of 5,118 MW at an estimated cost of $5.9 billion. IPPs are expected to provide the rest of the power by building 72 plants with total capacity of 5,035 MW at an estimated cost of $10.05 billion.

PLN also plans to sign PPAs this year for PGE[6]'s 40 MW geothermal plant in Lahendong, North Sulawesi, and its 220 MW plant in Lumut Balai, South Sumatra. Both plants are included in the

[6] PT Pertamina Geothermal Energi

second phase of the fast track program.

The above two fast track programs are summarized as Table 2.2.7.

**Table 2.2.7 Summary of Fast Track Program Phase I & Phase II**

| | **Phase I** | **Phase II** |
|---|---|---|
| Target period | 2006 to 2009 | 2010 to 2014 |
| Developer | - PLN 100 % | - PLN 50.4 % (37.0 %)<br>- IPP 49.6 % (63.0 %) |
| Total installed capacity | 9,340 MW | 10,153 MW |
| - Java-Bali | 7,430 MW | 5,770 MW |
| - Outside of Java-Bali | 1,901 MW | 4,383 MW |
| Type of Generation | Coal Fired SPP 100 % | Hydro 12 %<br>Gas Combined Cycle 15 %<br>Geothermal 39 %<br>Coal Fired SPP 33 %<br>Gas Turbine 1 % |
| Legislation | Perpres No. 71/2006. | Perpres No. 4/2010.<br>Permen ESDM No. 2/2010. |
| Investment | Approx. 8,000 million US$ | 15,960 million US$ |

i) Fast Track Program (phase I)

The first fast track program was announced in 2006 as a Presidential Regulation (Perpres No. 71/2006). In the attempt to increase the power plants' capacity to meet electricity demand with reducing oil fuel consumption, the Government mandated PLN to construct coal based power plants. The Fast Track Program or Crash Program, commonly referred to as the 10,000 MW Project was originally to be built in 35 locations in total, consisting of 10 locations in Java-Bali areas with a total capacity of 7,490 MW and 25 locations outside of Java with total capacity 2,047 MW by 2010.

Out of 35 locations to be developed, PLN has already signed EPC contracts for 32 locations by the end of year 2008, while for the other three outside Java locations are still in the Letter of Intent stage and bidding process. Overall, some of the constructions (out of the total 10,000 MW) are running on schedule, while some others are awaiting the fund availability.

ii) Fast Track Program (phase II)

- The Presidential Regulation concerning Assignment for PLN Company to Accelerate the Establishment of Power Plant by Utilizing Renewable Energy, Coal, and Gas (Perpres No. 4/2010).

This was established on January 8th 2010 and valid until December 2014. This regulation gives an opportunity to the utility (PLN) to build power plants which are using renewable energy, coal and natural gas as fuel trough joint cooperation with private sector. The technology of the power plants shall be environmental friendly and partly produced within Indonesia. During engineering, procurement and construction of the power plant and its transmission line, the Government will guarantee the feasibility of the business according to the existing regulation. Facilities such as free import tax of the equipment and others will be given under the Minister of Finance jurisdiction.

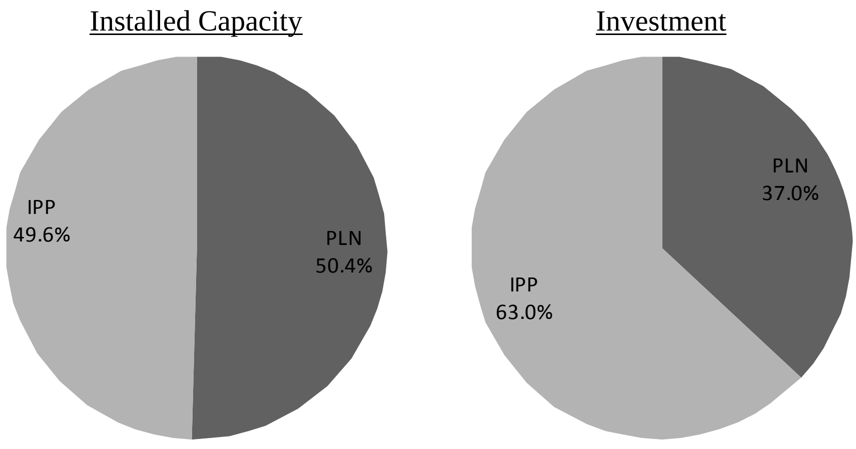
- The Ministerial Regulation concerning Projects List of Acceleration of the Establishment of Power Plant by Utilizing Renewable Energy, Coal, and Gas and Others Which Interconnected to the Transmission Line (Permen ESDM No. 2/2010).

This was established on January 27th 2010 and valid until December 2014. According to this Ministerial Regulation, the total number of renewable energy power plant projects will be built are 5,181 MW (52% out of the total are coming from renewable energy-geothermal and hydro). PLN will build around 11 projects of geothermal power plants with total installed capacity around 880 MW and two (2) projects of hydro power plants with total installed capacity around 1,174 MW. However around 33 projects of geothermal power plants with total installed capacity around 3,097 MW and one (1) project of hydro power plants around 30 MW are open to be offered for private sector participation in cooperation with PLN.

- The Presidential Regulation concerning Coordination Team of Acceleration Program (Perpres No. 6/2010).

This regulation issued on January 22nd, 2010 is aimed to support the Presidential Regulation (Perpres No. 4/2010) by establishing the Coordination Team that will continuously work until 2014. This regulation has mandated the team to carry out the preliminary stage of the acceleration program phase II.

According to the Ministerial Regulation, the characteristics of the program are summarized in Figure 2.2.9 to Figure 2.2.11. Figure 2.2.9 indicated that the capacities to be developed by PLN and private are almost the same, but the private investment is larger than that of PLN, which means that the unit investments per capacity of IPPs are larger than those of PLN. PLN estimated the unit investment cost by each generation type as shown in Table 2.2.8, and the unit investments of same type of generation of IPP are higher than those of PLN.




Source: PLN.

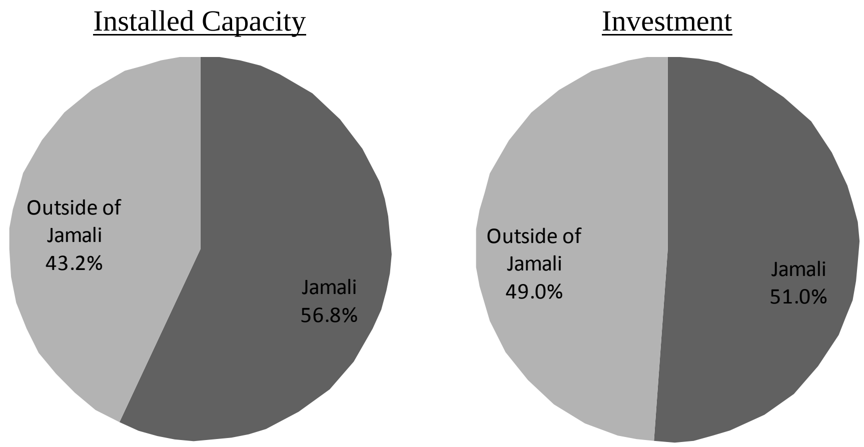
**Figure 2.2.9 Capacity and Investment by Owner (PLN/IPP)**

**Table 2.2.8 Unit Investment in Fast Track Program II**

| Type | Unit investment (US$/kW) |
|---|---|
| **PLN** | |
| - PLTA | 1,500 |
| (Pumped Storage) | 662 |
| - PLTP | 1,500 — 1,800 |
| - PLTU | 1,300 — 2,071 |
| - PLTG | 500 |
| - PLTGU | 850 |
| **Private** | |
| - PLTA | 1,500 |
| - PLTP | 2,200 — 2,857 |
| - PLTU | 1,300 — 2,250 |
| - PLTG | 1,000 |

Source: PLN.

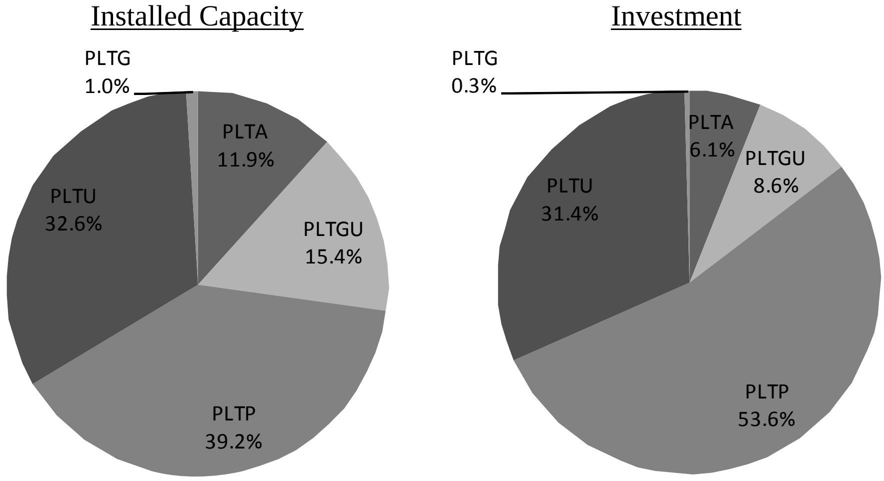
By regions shown in Figure 2.2.10, capacity to be developed in Java is 56.8 percent and the rest in outside of Java, while the capacity in Java was 79 percent in Fast Track Program I. In terms of investment, the amounts in Java and outside of Java are almost the same.




Source: PLN.

**Figure 2.2.10 Capacity and Investment by region (Java/outer Java)**

From the viewpoint of generation type, PLTP occupies the top of 39.2 percent of total capacity or 3,977 MW and coal thermal (PLTU) of 32.6 percent, combined cycle (PLTGU) of 15.4 percent and hydro (PLTA) follow.




Source: PLN.

**Figure 2.2.11 Capacity and Investment composition by type of generation**

(3) Electricity tariff

The electricity tariff supplied by PLN has long not been revised since 2003, which should be determined by the President on the proposal of the energy minister under the electricity law 1985. As aforementioned, the authority of tariff has been modified under the active electricity law, and the Government will determine the electric power tariff for consumers with the approval of the House of Representatives.

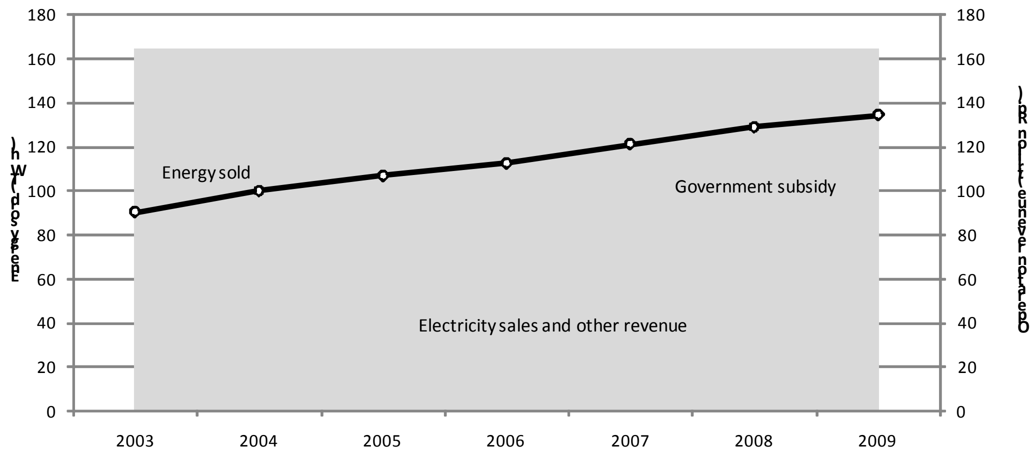
Figure 2.2.12 presents the operation revenue, operation expenses, and energy sold of PLN during 2003 – 2009. Electricity sales and other revenue (shown in the upper figure) has been increasing approximately proportional to the amount of energy sold, as is obvious under a fixed tariff. On the contrary, the surge of electricity supply cost (shown in the lower figure) is significant, which could be attributed to fuel & lubricant oil expenses (mostly fuel) in particular, due to fossil price hike in recent years. The large amount of the Government subsidy, which was peaked in 2008 accounting for 78,577,390 million Rupiah, has been appropriated to compensate the gap between revenue and expenses of PLN. Electricity subsidy in 2010 was reportedly 55.1 trillion Rupiah, which comprised 4.9 percent of the state expenditure (1,126 trillion Rupiah) in the same year.

In this background, the Government revised the basic electricity tariff (Tarif Dasar Listrik or TDL) in June 2010 which is valid from July 1 2010, for the first time since July 2003, by issuing a ministerial regulation of MEMR (Permen ESDM No.07/2010). There are eight categories in the basic tariff same as the former TDL; i) social, ii) residential, iii) business, iv) industrial, v) government offices and public street lighting, vi) railway, vii) bulk use for PIUKU[7], and viii) multi-purpose, and Table 2.2.9 presents the last and active basic electricity tariffs in each category. Besides differences in grouping by capacity limits, and calculation methods, raise of consumption charge (Rp/kWh) for large

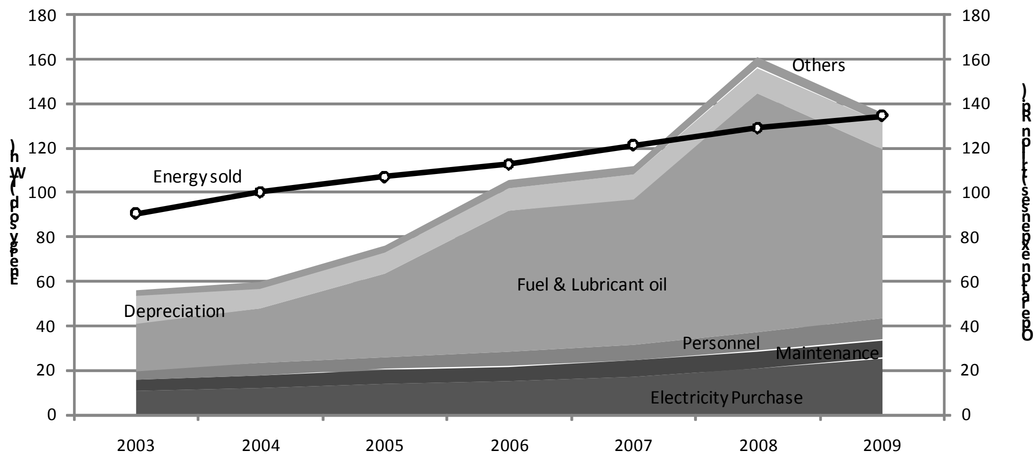
[7] *Pemegang Izin Usaha Ketenagalistrikan untuk Kepentingan Umum* (Holder of Business License of Electricity for the Public Interest) (see 2.3.3)

consumers are remarkable, while the tariff for small consumers remains the same. Average power rate is said to be increased by 10 percent.

(a) Operation revenue and energy sold




(b) Operation expenses and energy sold




Source: Author's calculation based on PLN Statistics 2007, 2008 and 2009.

**Figure 2.2.12 PLN's revenue and expenses**

**Table 2.2.9 Old and New Basic Electricity Tariff**

| | Category | 1-Jul-03 to 30-Jun-10 | | | | 1-Jul-10 to date | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | |
| i) Social | | | | | | | | | |
| 1 | S-1/TR | 220 VA | -- | Monthly Subscription (Rp) | 14,800 | 220 VA | -- | Monthly Subscription (Rp) | 14,800 |
| 2 | S-2/TR | 450 VA | 10,000 | Block-I : 0 to 30 kWh<br>Block-II : 30 to 60 kWh<br>Block-III : above 60 kWh | 123<br>265<br>360 | 450 VA | 10,000 | Block-I : 0 to 30 kWh<br>Block-II : 30 to 60 kWh<br>Block-III : above 60 kWh | 123<br>265<br>360 |
| 3 | S-2/TR | 900 VA | 15,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 200<br>295<br>360 | 900 VA | 15,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 200<br>295<br>360 |
| 4 | S-2/TR | 1,300 VA | 25,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 250<br>335<br>405 | 1,300 VA | RM1 | | 605 |
| 5 | S-2/TR | 2,200 VA | 27,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh | 250<br>370 | 2,200 VA | RM1 | | 650 |

| | Category | 1-Jul-03 to 30-Jun-10 | | | | 1-Jul-10 to date | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | |
| | | | | Block-III : above 60 kWh | 420 | | | | |
| 6 | S-2/TR | Above 2,200 VA to 200 kVA | 30,500 | Block I : On for 0 to 60 hrs<br>Block II : above 60 hrs | 380<br>430 | Above 3,500 VA to 200 kVA | RM1 | | 755 |
| 7 | S-3/TM | Above 200 kVA | 29,500 | Block WBP<br>Block LWBP | K x P x 325<br>P x 325 | Above 200 kVA | RM2 | Block WBP<br>Block LWBP | K x P x 605<br>P x 605 |
| ii) Residential | | | | | | | | | |
| 1 | R-1/TR | up to 450 VA | 11,000 | Block I: 0 to 30 kWh<br>Block II: 30 to 60 kWh<br>Block III: above 60 kWh | 169<br>360<br>495 | up to 450 VA | 11,000 | Block I: 0 to 30 kWh<br>Block II: 30 to 60 kWh<br>Block III: above 60 kWh | 169<br>360<br>495 |
| 2 | R-1/TR | 900 VA | 20,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 275<br>445<br>495 | 900 VA | 20,000 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 275<br>445<br>495 |
| 3 | R-1/TR | 1,300 VA | 30,100 | Block-I : 0 to 20 kWh<br>Block-II : 20 to 60 kWh<br>Block-III : above 60 kWh | 385<br>445<br>495 | 1,300 VA | RM1 | | 790 |
| 4 | R-1/TR | 2,200 VA | 30,200 | Block-I : 0 to 20 kWh<br>Block-II : 20 up to 60 kWh<br>Block-III : above 60 kWh | 390<br>445<br>495 | 2,200 VA | RM1 | | 795 |
| 5 | R-2/TR | Above 2,200 VA up to 6,600 VA | 30,400 | | 560 | Above 3,500 VA up to 5,500 VA | RM1 | | 890 |
| 6 | R-3/TR | Above 6,600 VA | 34,260 | | 621 | Above 6,600 VA | RM2 | Block-I:<br>Block-II: | H1 x 890<br>H2 x 1,380 |
| iii) Business | | | | | | | | | |
| 1 | B-1/TR | up to 450 VA | 23,500 | Block I: 0 to 30 kWh<br>Block II: above 30 kWh | 254<br>420 | up to 450 VA | 23,500 | Block I: 0 to 30 kWh<br>Block II: above 30 kWh | 254<br>420 |
| 2 | B-1/TR | 900 VA | 26,500 | Block-I : 0 to 108 kWh<br>Block-II : above 108 kWh | 420<br>465 | 900 VA | 26,500 | Block-I : 0 to 108 kWh<br>Block-II : above 108 kWh | 420<br>465 |
| 3 | B-1/TR | 1,300 VA | 28,200 | Block-I : 0 to 146 kWh<br>Block-II : above 146 kWh | 470<br>473 | 1,300 VA | RM1 | | 790 |
| 4 | B-1/TR | 2,200 VA | 29,200 | Block-I : 0 to 264 kWh<br>Block-II : above 264 kWh | 480<br>518 | Above 2,200 VA up to 5,500 VA | RM1 | | 905 |
| 5 | B-2/TR | Above 2,200 VA up to 200 kVA | 30,000 | Block-I : On for 0 to 100 hrs<br>Block-II : above 100 hrs | 520<br>545 | Above 6,600 VA up to 200 kVA | RM2 | Block I:<br>Block II: | H1 x 900<br>H2 x 1,380 |
| 6 | B-3/TM | Above 200 kVA | 28,400 | Block WBP<br>Block LWBP | K x 452<br>452 | Above 200 kVA | RM3 | Block WBP<br>Block LWBP | K x 800<br>800 |
| iv) Industrial | | | | | | | | | |
| 1 | I-1/TR | up to 450 VA | 26,000 | Block I: 0 to 30 kWh<br>Block II: above 30 kWh | 160<br>395 | up to 450 VA | 26,000 | Block I: 0 to 30 kWh<br>Block II: above 30 kWh | 160<br>395 |
| 2 | I-1/TR | 900 VA | 31,500 | Block-I : 0 to 72 kWh<br>Block-II : above 72 kWh | 315<br>405 | 900 VA | 31,500 | Block-I : 0 to 72 kWh<br>Block-II : above 72 kWh | 315<br>405 |
| 3 | I-1/TR | 1,300 VA | 31,800 | Block-I : 0 to 104 kWh<br>Block-II : above 104 kWh | 450<br>460 | 1,300 VA | RM1 | | 790 |
| 4 | I-1/TR | 2,200 VA | 32,000 | Block-I : 0 to 196 kWh<br>Block-II : above 196 kWh | 455<br>460 | 2,200 VA | RM1 | | 905 |
| 5 | I-1/TR | Above 2,200 VA up to 14 kVA | 32,200 | Block-I : On for 0 to 80 hrs<br>Block-II : above next 80 hrs | 455<br>460 | Above 3,500 VA up to 14 kVA | RM2 | | 915 |
| 6 | I-2/TR | Above 14 kVA up to 200 kVA | 32,500 | Block WBP<br>Block LWBP | K x 440<br>440 | Above 14 kVA up to 200 kVA | RM2 | Block WBP<br>Block LWBP | K x 800<br>800 |
| 7 | I-3/TM | above 200 kVA | 29,500 | Block WBP<br>On for 0 to 350 hrs | K x 439 | above 200 kVA | RM3 | Block WBP | K x 680 |

| | Category | 1-Jul-03 to 30-Jun-10 | | | | 1-Jul-10 to date | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | | Capacity limit | Load charge (Rp/kVA/ month) | Consumption charge (Rp/kWh) | |
| | | | | 350 hrs above<br>Block LWBP | 439<br>439 | | | Block LWBP | 680 |
| 8 | I-4/TT | 30,000 kVA and above | 27,000 | Block WBP and LWBP | 434 | 30,000 kVA and above | RM3 | Block WBP and LWBP | 605 |
| v) Government Offices and Public Street Lighting | | | | | | | | | |
| 1 | P-1/TR | up to 450 VA | 20,000 | | 575 | up to 450 VA | 20,000 | | 685 |
| 2 | P-1/TR | 900 VA | 24,600 | | 600 | 900 VA | 24,600 | | 760 |
| 3 | P-1/TR | 1,300 VA | 24,600 | | 600 | 1,300 VA | RM1 | | 880 |
| 4 | P-1/TR | 2,200 VA | 24,600 | | 600 | above 2,200 VA up to 5,500 VA | RM1 | | 885 |
| 5 | P-1/TM | Above 2,200 VA up to 200 kVA | 24,600 | | 600 | Above 6,600 VA up to 200 kVA | RM2 | Block I:<br>Block II: | H1 x 885<br>H2 x 1,380 |
| 6 | P-2/TM | Above 200 kVA | 23,800 | Block WBP<br>Block LWBP | K x 379<br>379 | Above 200 kVA | RM3 | Block WBP<br>Block LWBP | K x 750<br>750 |
| 7 | P-3/TR | -- | -- | | 635 | -- | RM2 | | 820 |
| vi) Railway | | | | | | | | | |
| 1 | T/TM | Above 200 kVA | 23,000 | Block WBP<br>Block LWBP | K x 360<br>360 | Above 200 kVA | 25,000 | Block WBP<br>Block LWBP | K x 390<br>390 |
| vii) Bulk Use for PIUKU | | | | | | | | | |
| 1 | C/TM | Above 200 kVA | 22,500 | Block WBP<br>Block LWBP | K x 350<br>350 | Above 200 kVA | 30,000 | Block WBP<br>Block LWBP | K x 445<br>445 |
| viii) Multipurpose | | | | | | | | | |
| 1 | M/TR,TM,TT (L/TR,TM,TT) | -- | -- | | 1,380 | -- | -- | | 1,450 |

Note)
RM1, RM2, RM3: Applied Minimum Account
H1: National Average Percentage saving on Lighting Time x Connected Power (kVA)
H2: Energy consumption – H1
LWBP : Off-Peak Load Time
WBP: Peak Load Time

Source: Permen ESDM No.07/2010, June 2010.

### (4) Renewable energy promotion

i) Small and Medium Scale Power Generation Schemes for Renewable Energy (Ministerial Decree: No. 1122 K/30/MEM/2002 and Ministerial Regulation: No. 002/2006)

These two ministerial regulations stipulate the incentives and preferential treatments for small to medium scale renewable energy power generations by private sector.

The MEMR mandated PLN to purchase electricity generated by private investors and cooperatives using renewable energy for promotion of renewable energy utilization, including wind, solar, mini/micro hydro, waste (agricultural or industrial), heat, geothermal etc. In MEMR Ministerial Decree (Kepmen No. 1122/2002) promulgated in June, 2002, purchase obligation was imposed on PLN about a private (company/group) dispersed power supply by renewable energy less than 1 MW. In addition, the object of purchase obligation was extended to the output of 1-10 MW in the MEMR Ministerial Regulation (Permen No. 2/2006) in January 2006.

Table 2.2.10 shows the summary of the purchase obligation of renewable energy articulated the above regulations.

**Table 2.2.10 Purchase Obligation of Small and Medium Scale Renewable Energy Generation**

| | **Kepmen ESDM No. 1122 K/30/MEM/2002.** | **Permen ESDM No. 2/2006.** |
|---|---|---|
| Output | Less than 1 MW | 1 MW to 10 MW |
| Contract term | 1 year | 10 years |
| Purchase price | (Low voltage) 0.8 × BPP<br>(Medium voltage) 0.6 × BPP | |

Source: JICA Study Team.

In Table 2.2.10, BPP (*Biaya Pokok Penyediaan*) means "Basic supply cost of electricity" of each PLN supply region (*Wilayah*) where the project is planned, but the figures were not disclosed for the time being after the promulgation of the above regulations, so that it was difficult for investors to assess the financial viability of projects.

Finally in 2008, MEMR disclosed the BPPs in each PLN region by a Ministerial Decree (Permen ESDM No. 269-12/26/600.3/2008) as indicated in Table 2.2.11. For instance, investors of some project could expect around Rp. 1,200/kWh of selling price in North Sumatera, but Rp. 500/kWh in Java Bali region from the same project with medium voltage interconnection.

Generally, electricity supply cost is higher in undeveloped region due to lower demand density and less scale merit of generation. In addition, recent oil price hike boosted supply cost of diesel generation commonly used in countryside. The supply cost in Kalimantan Maluku, Papua, NTT and NTB where most of electric power is produced by diesel generators, is as much as Rp. 3,000/kWh at low voltage connection. Hence, this purchase obligation scheme is advantageous for the promotion of rural electricity supply, replacing diesel by renewable energy sources.

**Table 2.2.11 Basic Supply Cost (BPP) by Region**

(unit: Rp./kWh)

| No. | System | BPP-TT (HV) | BPP-TM (MV) | BPP-TR (LV) |
|---|---|---|---|---|
| 1 | North Sumatera | 1,891 | 1,984 — 2,158 | 2,308 — 2,603 |
| 2 | South Sumatera | 565 | 667 — 1,164 | 860 — 1,433 |
| 3 | Bangka Belitung | - | 2,476 | 2,919 |
| 4 | West Kalimantan | 2,315 | 2,546 | 3,145 |
| 5 | Central and South Kalimantan | 1,148 | 1,611 | 1,998 |
| 6 | East Kalimantan | 1,732 | 1,965 | 2,260 |
| 7 | North Sulawesi | 974 | 1,676 | 2,063 |
| 8 | South Sulawesi | 1,103 | 1,249 | 1,505 |
| 9 | Maluku | - | 2,320 | 2,919 |
| 10 | Papua | - | 2,526 | 3,192 |
| 11 | NTB | - | 2,289 | 2,743 |
| 12 | NTT | - | 2,433 | 3,072 |
| 13 | Java-Bali | 783 | 849 — 859 | 1,005 — 1,030 |

Source: Permen ESDM No.269-12/26/600.3/2008

After all such circumstances, a Ministerial Regulation (Permen ESDM No. 5/2009) was issued on March 24, 2009, which abandoned the pricing rule mentioned above, and awarded PLN its arbitrary decision of power purchase price from small scale renewable energy projects.

ii) The Ministerial Regulation concerning Purchasing Price by PLN of Generated Electricity from Small and Medium Scale Renewable Energy Power Plant or Excess Power (Permen ESDM No. 31/2009)

The aim of this Ministerial Regulation issued on November 13th, 2009 is to enhance the electricity generated by small and medium scale of renewable energy power plant or excess power to be purchased by state owned company, regional owned company, cooperative and the society. It has mandated PLN to buy the renewable generated electricity until optimum 10 MW. This regulation doesn't provide feed-in tariff for specific type of renewable energy, but it offers different price for renewable energy generated in different regions as follows:

a. Rp 656/kWh × *F* for Medium Voltage interconnection; and

b. Rp 1,004/kWh × *F* for Low Voltage interconnection;

where *F* is the incentive factor as shown in Table 2.2.12.

**Table 2.2.12 Incentive Factor by Regions for Power Purchase**

| Region | Incentive Factor (*F*) |
|---|---|
| Java Bali | 1.0 |
| Sumatera, Sulawesi | 1.2 |
| Kalimantan, NTB, NTT | 1.3 |
| Maluku, Papua | 1.5 |

Source: Permen ESDM No. 31/2009.

PLN may buy the electricity generated from renewable energy power plant with higher price from the "floor price" provided by this regulation. This higher price is calculated from Estimated Own-Price by the PLN and approved by the Minister of Energy and Mineral Resource.

iii) Government Regulation on Electricity Supply and Utilization (PP No. 3/2005)

This is the first amendment on the Government Regulation No. 10 Year 1989 on Electricity Supply and Utilization. As are visions of the Government Regulation (PP No.10/1989) in order to secure national electricity, regarding the new and renewable energy development. The regulation puts priority to utilize locally available renewable energy resources for electricity generation. Incentive is given to private investors through the simpler procurement process, without tender in case of:

a. purchase of electric power from electric power generation which uses renewable energy, marginal gas, mine-mouth coal, and other local energy;
b. purchase of excess electric power; or
c. local electric power system in crisis condition of electric power supply.

iv) Ministerial Regulation on Electric Power Price Standard, purchased by PLN from Geothermal Generation (Permen ESDM No. 32/2009)

This Ministerial Regulation issued on December 4th, 2009 is aimed to reach optimal implementation of geothermal development according to the RUPTL (the Electricity Business Planning of PLN). It is mentioned in the regulation that the optimum price (ceiling price) of electricity generated by geothermal power plant is US¢ 9.70. This price will be bought by PLN whereas the power line of geothermal power plant is interconnected to high-voltage grid.

## 2.3 ORGANIZATIONS

### 2.3.1 GOVERNMENT AUTHORITIES

(1) MEMR

The Ministry of Energy and Mineral Resources (*Departemen Energi dan Sumbar Daya Mineral* or DESDM) is one of the central bureaucracies, which has charge of administration of whole the energy sector. The ministry once consisted of three directorates general ("Oil and Gas", "Electricity and Energy Utilization", and "Mineral, Coal and Geothermal"), but has four directorates general ("Oil and Gas", "Electricity", "Minerals and Coal", and "Alternative (new & renewable) Energy and Energy Conservation") at present after the recent reorganization in November 2010. Among the directorates general, DGE (*Direktorat Jenderal Listrik* or DJL), a counterpart of this study, has charge of whole the power sector including national planning for electricity, rural electrification etc. Other than directorates general, three agencies are organized under the ministry, namely "Geology", "Energy & Mineral Resources R&D", and "Energy & Mineral Resources E&T."

The organizational structures of MEMR and DGE are illustrated in Figure 2.3.1 and Figure 2.3.2 respectively.

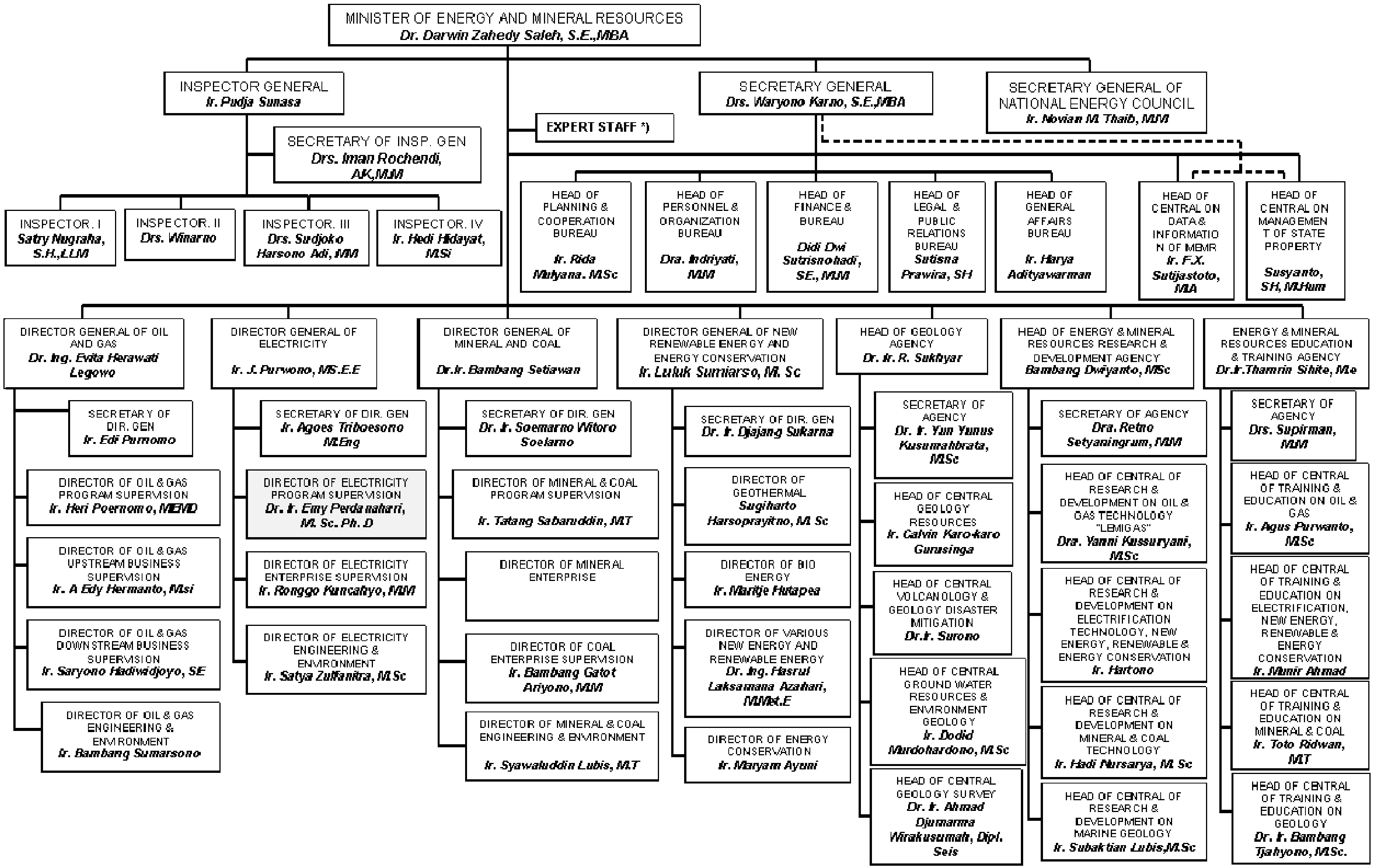
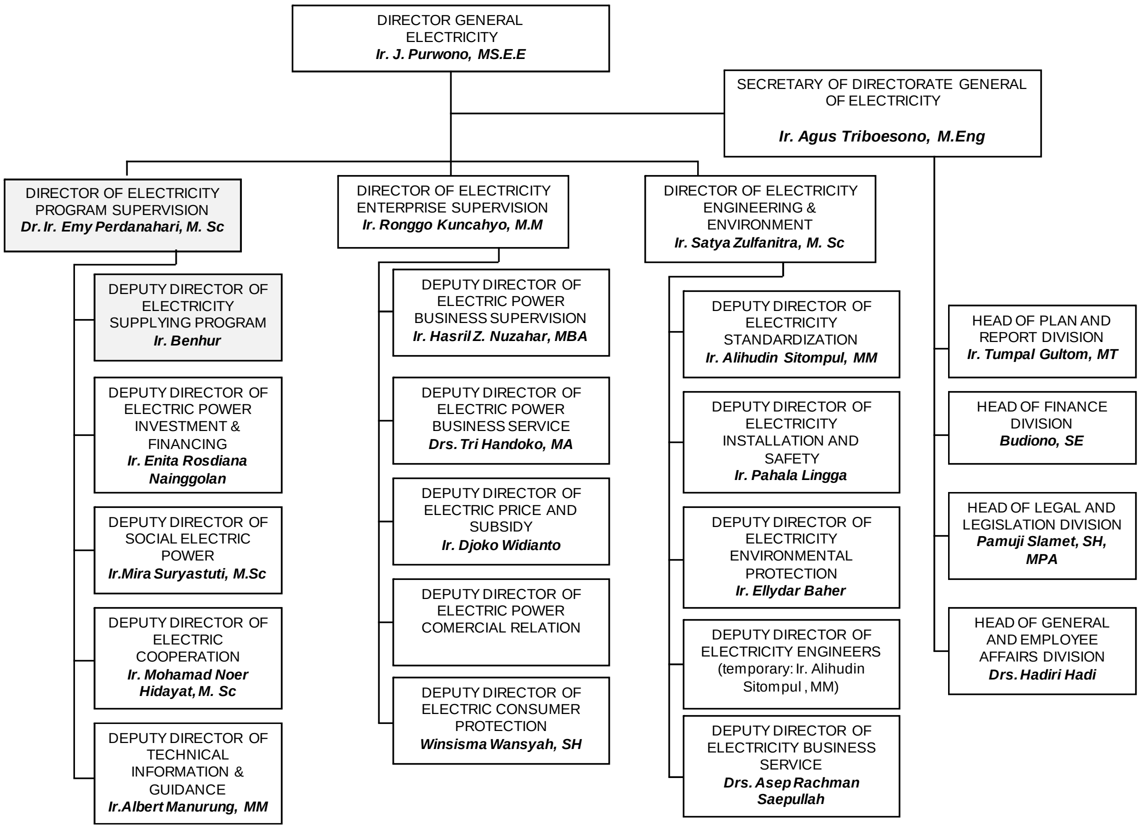



**Figure 2.3.1 Organization of MEMR (as of November 29, 2010.)**




(As of November 29, 2010)

**Figure 2.3.2 Organization of DGE**

(2) BAPPENAS

The National Development Planning Agency (*Badan Perencanaan Pembangunan Nasional* or BAPPENAS) is an organizationally crosscutting agency with the main function of advising the President in the formulation, evaluation and implementation of national development plans. It serves as a contact point for rural electrification projects being implemented with financial cooperation and technical cooperation from other countries.

During the Suharto regime, BAPPENAS had tremendous power as the coordinating agency for national government projects that involved the assignment of development budgets or overseas assistance. However, the passage of the National Property Law (UU No. 17/2003) greatly curtailed the authority of BAPPENAS.

(3) MOCSME and KUD

Ministry of Cooperatives and Small & Medium Enterprises organizes Village Unit Cooperatives (*Koperasi Unit Desa* or KUD) to rectify the regional disparity between cities and countryside. The ministry supports agricultural activity and other social and economic development through KUDs. KUDs also carry out electrification projects that supplement PLN functions in regions where PLN will not be able to extend its grid within the near future. MOCSME also has its own development budget with which it implements mini/micro scale hydropower development, though only for a few projects per year. It has also provided guidance for the improvement of operation and maintenance frameworks for KUDs implementing electrification projects.

(4) BATAN and BAPETEN

The Government of Republic of Indonesia issued Government Regulation No. 65 on December 5, 1958 establishing the Atomic Energy Council and the Atomic Energy Institute so that the development and application of atomic energy could enhance the welfare of the people. This was later followed by the enactment of the Law No. 31/1964 regarding the Basic Stipulations on Atomic Energy and Government Regulation No. 33/1965 which also renamed the Atomic Energy Institute into the National Atomic Energy Agency (*Badan Tenaga Atom Nasional* or BATAN).

The enactment of Law No. 10 in 1997 on Nuclear Energy stipulated among others the separation of the executing function on the beneficial applications of nuclear energy (BATAN), from the regulatory function held by the Nuclear Energy Regulatory Agency (*Badan Pengawas Tenaga Nuklir* or BAPETEN). In accordance with the Law No. 10/1997 and the latest Presidential Decree No. 64/2005, BATAN has been stipulated as a Non Departmental Government Institution which is under and responsible to the President. BATAN is led by the Chairman and its program is under the coordination of the Minister for Research and Technology. The main duties of BATAN are to conduct research, development and the beneficial applications of nuclear energy in accordance with the laws and regulations.

In conducting its duties, BATAN has the following functions:

- To assess and prepare the national policy in the field of research, development, and the beneficial uses of nuclear energy,
- To coordinate functional activities in implementing the all duties of BATAN,
- To support and foster activities of government institutions in the field of research, development and beneficial uses of nuclear energy,
- To conduct general administrative services in the field of general planning, administration, organization and procedures, personnel management, financing, archiving, procurement as well as education and training.

On the other hand, the main task of BAPETEN is to conduct surveillance of all activities that use nuclear energy by managing the regulation, licensing and inspections. In conducting its task, BAPETEN has the following functions:

- Formulation of national policies in the field of supervision of the use of nuclear energy; preparation and creation of national plans and programs in the field of supervision of nuclear energy utilization;
- The management and preparation of regulations and the review of the implementation of nuclear safety, radiation safety, and security of nuclear materials;

- Implementation of licensing and inspection of construction and operation of nuclear reactors, nuclear installations, nuclear materials facilities, and sources of radiation as well as the development of nuclear preparedness; implementation of cooperation in the field of monitoring of the use of nuclear energy by government agencies or other organizations both inside and outside of the territory of Indonesia;
- Implementation of surveillance and control of nuclear materials; implementation of guidance and information concerning the efforts to ensure the safety and health of the workers, the members of the public as well as environmental protection;
- Implementation of the improvement of human resources development and quality in the BAPETEN; implementation of administrative guidance, control and supervision within BAPETEN environment;
- Implementation of other tasks given by the President.

### 2.3.2 PT PLN (PERSERO)

After the independence in 1945, then President Soekarno established Electricity and Gas Bureau under the Department of Public Works and Energy with power plant capacity of 157.5 MW.

On January 1, 1961, Gas and Electricity Bureau was changed to BPU-PLN (Board of General Administration of the State Electricity Company) that focused on electricity, gas and coke sectors. On January 1, 1965 BPU-PLN was dismissed and two state owned enterprises were formalized, namely *Perusahaan Listrik Negara* (PLN), a state-owned electricity company, to manage electricity power and *Perusahaan Gas Negara* (PGN) to manage gas power.

In 1972, in accordance with Government Regulation No. 17 on the State-owned Electricity Company was enacted as a State-owned General Electricity Company and as PKUK responsible to provide electricity to meet public needs. While the Government policy was giving opportunity to the Private Sectors to focus on the provision of electricity, the status of PLN was changed from a General Company to Corporation as well as PKUK in providing electricity for public needs until present.

As a result of power sector reform halted by the rule of the constitutional court on Electricity Law 2002 detailed in 2.2.3, the current organization of PLN is half-unbundled as indicated in Table 2.3.1.

**Table 2.3.1 Business Institution of PLN**

| | Java-Madura-Bali | Sumatera | PPS | Other region |
|---|---|---|---|---|
| **Generation** | PT Indonesia Power<br>PT PJB<br>PT PLN (Persero) | Kit Sumbagut<br>Kit Sumbagsel | PT PLN Batam<br>PT PLN Tarakan<br>[Subsidiary of PLN] | Wilayah Kalbar<br>Wilayah Kalselteng<br>Wilayah Kaltim<br>Wilayah Suluttenggo<br>Wilayah Sulselrabar<br>Wilayah Maluku<br>Wilayah Papua<br>Wilayah NTB |
| **Transmission & System Operation** | P3B Java Bali | P3B Sumatera | | |
| **Distribution* & Customer Service** | Distribusi Jatim<br>Distribusi Jateng dan DIY<br>Distribusi Jabar & Banten | Wilayah NAD<br>Wilayah Sumut<br>Wilayah Sumbar | | |

| | Java-Madura-Bali | Sumatera | PPS | Other region |
|---|---|---|---|---|
| | Distribusi Jaya & Tangerang<br>Distribusi Bali | Wilayah Riau<br>Wilayah S2JB<br>Wilayah Babel<br>Wilayah Lampung | | Wilayah NTT |

* Power generation in isolated small grids is included.

Source: JICA Study Team.

Apart from the business units shown in the table, generation and transmission project offices (*Proyek Induk Pembangkit dan Jaringan* or Pikitring) are instituted to implement construction projects for power stations, transmission lines and substations in five regions; i) North Sumatera, Aceh and Riau, ii) South Sumatera, Jambi, Lampung, Bengkulu, Bangka Belitung and West Sumatera, iii) Java, Bali and Nusa Tenggara, iv) Kalimantan, and v) Sulawesi, Maluku and Papua.

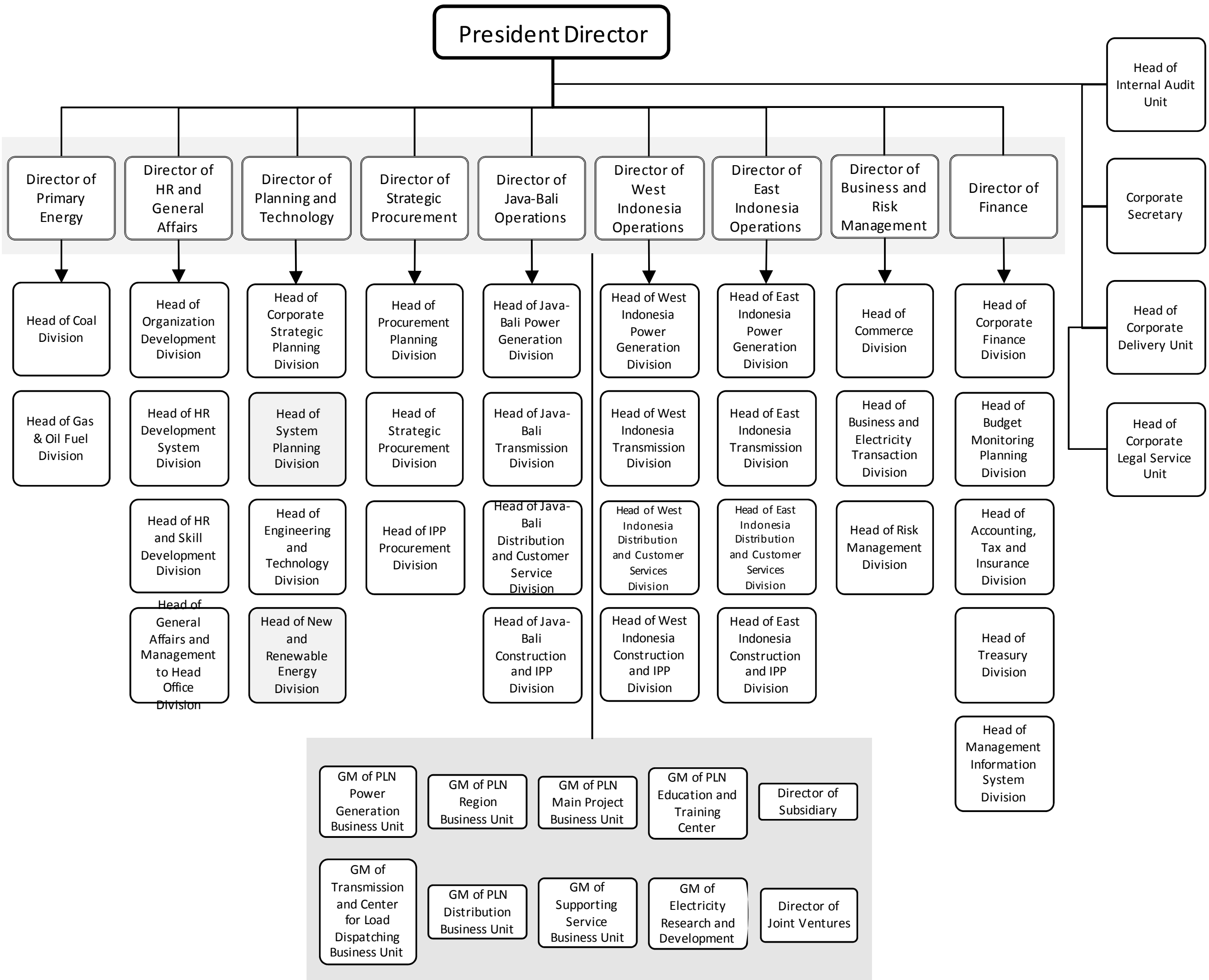



**Figure 2.3.3 Organization Structure of PT PLN (Persero)**

### 2.3.3 OTHER ELECTRICITY BUSINESS ENTITIES

Late 1980's, private entrepreneurs (including cooperatives) were entitled to enter the power supply business that has long been monopolized by the public corporation (Perum) PLN, as PIUKU (Holder of Business License of Electricity for the Public Interest) based on the Electricity Law (No. 15/1985) in order to respond the rapid increase of power demand originated by economic growth in Indonesia.

The first IPP invitation in Indonesia (Paiton I & II) was carried out in 1990. The PPA of Paiton I project was concluded in February 1994 and financial close was got about 14 months later. Many IPP projects stood up based on the Presidential Decree (Keppres No. 37/1992), and before the Asian Currency Crisis in 1997, PPA and ESC (Energy Sales Contract) of 26 IPP projects (10,800 MW in total capacity and 13-14 billion dollars of total investment) were concluded. However, large review on the most part of such contracts was pressed by the Asian Currency Crisis in 1997. PLN made the power purchase agreements with IPPs on the dollar basis, but the sales income of PLN was paid in local currency, so that PLN was forced to bear the large negative spread, and the financial situation of PLN largely turned worse. On this account the Government of Indonesia declared interruption or review of much IPP projects in the Presidential Decree (Keppres No. 39/1997) and started financial restructuring plan such as raise of electricity rate, debt equity swap, reevaluation of assets etc.

About interrupted or reviewed IPP projects, renegotiation of PPA was started based on the Presidential Decree (Keppres No. 15/2003) in 2003 and considered to be a review, a renegotiation of PPA is reopened by Presidential Decree (Keppres No. 15/2003), and at present, 14 projects are concluded (business continuation), seven projects are abandoned, five projects are bought and one project is under dispute. As the result of renegotiation, PPA with 6.4-8.5 cent/kWh of purchase price at first was reduced to 4.2-5.7 cent/kWh.

So far, 22 IPPs (include Jatiluhur Hydro Power Plant) are already in operational stage with total capacity of 4,718 MW as indicated in Table 2.3.2.

**Table 2.3.2 IPP Projects in Operational Stage**

| | Project | Fuel | Location | Company | Capacity (MW) | AF (%) | Contract Term |
|---|---|---|---|---|---|---|---|
| 1 | Cikarang | Gas | Jabar | PT Cikarang Listrindo | 150 | 72 | 1998 -- 2018 |
| 2 | Sengkang | Gas | Sulsel | PT Energi Sengkang | 195 | 85 | 1999 -- 2028 |
| 3 | Salak | Geo. | Jabar | Chevron Geothermal Salak Ltd/ Dayabumi Salak ratama Ltd. | 165 | 90 | 1997 -- 2027 |
| 4 | Pare-pare | MFO | Sulsel | PT Makassar Power | 60 | 80 | 1998 -- 2013 |
| 5 | Paiton I | Coal | Jatim | PT Paiton Energy | 1,230 | 85 | 2000 -- 2040 |
| 6 | Paiton II | Coal | Jatim | PT Jawa Power | 1,220 | 83 | 2000 -- 2030 |
| 7 | Drajat | Geo. | Jabar | Pertamina, Chevron Drajat Ltd., Texaco Drajat Ltd. and Drajat Geothermal Ind. | 180 | 95 | 2000 -- 2030 |
| 8 | Wayang Windu | Geo. | Jabar | Pertamina and Magma Nusantara Limited | 220 | 90 | 2000 -- 2042 |
| 9 | Dieng | Geo. | Jateng | PT Geo Dipa Energy | 60 | 85 | 2002 -- 2044 |
| 10 | Palembang | Gas | Sumsel | PT Asrigita Prasarana | 150 | 85 | 2004 -- 2024 |
| 11 | Cilacap | Coal | Jateng | PT Sumber Segara Primadaya | 562 | 80 | 2007 -- 2037 |

| | Project | Fuel | Location | Company | Capacity (MW) | AF (%) | Contract Term |
|---|---|---|---|---|---|---|---|
| 12 | Panaran | Gas | Pulau Batam | PT Dalle Energy Batam | 55 | 80 | 2005 -- 2016 |
| 13 | Panaran | Gas | Pulau Batam | PT Mitra Energi Batam | 55 | 84 | 2005 -- 2016 |
| 14 | Kawasan Industri Kabil | Gas | Pulau Batam | PT Indo Matra Power | 17 | 90 | 2005 -- 2017 |
| 15 | Panaran | Gas | Pulau Batam | PT Jembo Energindo | 24 | 65 | 2008 -- 2011 |
| 16 | Gunung Megang | Gas | Sumsel | PT Metaepsi Pejebe Power Generation | 80 | 80 | 2005 -- 2025 |
| 17 | Palu | Coal | Sulteng | PT Pusaka Jaya Palu Power (PJPP) | 27 | 80 | 2007 -- 2032 |
| 18 | Kamojang | Geo. | Jabar | PT Pertamina Geothermal Energi | 60 | 90 | 2008 -- 2038 |
| 19 | Embalut | Coal | Kaltim | PT Cahaya Fajar Kaltim | 45 | 72 | 2008 -- 2038 |
| 20 | Sebayak | Geo. | Sumut | PT Dizamatra Powerindo | 10 | 90 | 2008 -- 2038 |
| 21 | Mobuya | Hydro | Sulut | PT Cipta Daya Nusantara | 3 | 80 | 2007 -- 2027 |
| 22 | Purwakarta (Jatiluhur) | Hydro | Jabar | Perum Jasa Tirta | 150 | -- | 2006 -- 2011 |
| | **Total** | | | | **4,718** | | |

Source: PLN Annual Report 2009.

There are 15 IPP under construction phase with the total capacity 2,272 MW and 25 IPP in the financing phase by total capacity 3,425 MW.

**Table 2.3.3 IPP Projects in Developing Stage**

| | Project | Fuel | Location | Company | Capacity (MW) | AF (%) | Contract Term | Stage |
|---|---|---|---|---|---|---|---|---|
| 1 | Asahan 1 | Hydro | Sumut | PT Bajradaya Sentranusa | 180 | 75 | 2010 - 2040 | Operation |
| 2 | Celukan Bawang | Coal | Bali | PT General Energy Bali | 380 | 85 | 2011 - 2041 | Construction |
| 3 | Poso | Hydro | Sulteng | PT Poso Energy | 195 | 80 | 2011 - 2041 | Construction |
| 4 | Pontianak | Coal | Kalbar | PT Equator Manunggal Power | 50 | 80 | 2010 - 2035 | Construction |
| 5 | Paiton Expansion | Coal | Jatim | PT Paiton Energy | 800 | 85 | 2012 - 2042 | Financing |
| 6 | Cirebon | Coal | Jabar | PT Cirebon Electric Power | 660 | 80 | 2011 - 2041 | Financing |
| 7 | Sarulla | Geo. | Sumut | Sarulla Operation Ltd | 330 | 90 | 2011 - 2041 | Financing |
| 8 | Simpang Belimbing | Coal | Sumsel | PT Guo Hua Energi Musi Makmur (GHEMM) | 227 | 80 | 2011 - 2041 | Financing |
| 9 | Kuala Tanjung | Coal | Sumut | PT Ranyza Energi | 225 | 84 | 2010 - 2040 | Financing |
| 10 | Baturaja | Coal | Sumsel | PT Priamanaya Power Energi | 225 | 80 | 2011 - 2041 | Financing |
| 11 | Banjarsari | Coal | Sumsel | PT Bukit Pembangkit Innovative | 200 | 80 | 2010 - 2040 | Financing |
| 12 | Jeneponto | Coal | Sulsel | PT Bosowa Energy | 200 | 80 | 2013 - 2043 | Financing |
| 13 | Patuha | Geo. | Jabar | PT Geo Dipa Energi | 180 | 85 | 2011 - 2041 | Financing |
| 14 | Bedugul | Geo. | Bali | Bali Energi Ltd. | 175 | 95 | 2011 - 2041 | Financing |
| 15 | Tanjung Kasam | Coal | Batam | PT TJK Power | 110 | 85 | 2009 - 2038 | Financing |
| 16 | Dieng | Geo. | Jateng | PT Geo Dipa Energi | 60 | 85 | 2011 - 2041 | Financing |
| 17 | Samboja | Coal | Kaltim | PT Indo Ridlatama Power | 50 | 80 | 2011 - 2041 | Financing |
| 18 | Others (24 IPPs with less than 50 MW of each capacity) | | | | 234 | 55-95 | 2009 - 2041 | |
| | **Total** | | | | **4,481** | | | |

Source: PLN Annual Report 2009.

IPP procurement under 50 MW capacity is delegated to local Unit in order to accelerate the procurement process of the IPP, while IPP procurement greater than 50 MW is centralized.

# CHAPTER 3 POWER SYSTEM DEVELOPMENT PLAN

## 3.1 CURRENT STATUS OF POWER SYSTEM

### 3.1.1 GENERATION FACILITIES

The total generation capacity in Indonesia is 30,210 MW as of the end of 2009, as summarized in Table 3.1.1. Around three-fourths of total generation capacity is installed in Java-Bali region, a seventh in Sumatra and the rest in the other regions remain nine percent. The diversification of generation is to some extent realized in Java-Bali, Sumatra, Kalimantan and Sulawesi, while the eastern part of Indonesia (*Indonesia Bagian Timur* or IBT) depends on exclusively diesel generation (PLTD).

**Table 3.1.1 Summary of Generation Capacity in Indonesia as of 2009**

(unit: MW)

| Region | PLTD | PLTG | PLTGU | PLTU | PLTA/ PLTM | PLTP | Total |
|---|---|---|---|---|---|---|---|
| **PLN** | | | | | | | |
| Java-Bali | 76 | 2,086 | 6,643 | 7,320 | 2,386 | 360 | 18,871 |
| Sumatra | 798 | 662 | 818 | 1,175 | 868 | -- | 4,321 |
| Kalimantan | 676 | 95 | 60 | 130 | 30 | -- | 991 |
| Sulawesi | 471 | 123 | -- | 25 | 207 | 60 | 886 |
| Maluku | 181 | -- | -- | -- | -- | -- | 181 |
| Papua | 161 | -- | -- | -- | 4 | -- | 165 |
| Nusa Tenggara | 256 | -- | -- | -- | 2 | -- | 258 |
| **TOTAL** | **2,619** | **2,966** | **7,521** | **8,650** | **3,497** | **420** | **25,673** |
| **IPP** | | | | | | | |
| Java-Bali | -- | 150 | -- | 3,050 | 150 | 575 | 3,925 |
| Sumatra | -- | 118 | 150 | -- | -- | 10 | 278 |
| Kalimantan | -- | -- | -- | 45 | -- | -- | 45 |
| Sulawesi | 60 | -- | 195 | 27 | 7 | -- | 289 |
| Maluku | -- | -- | -- | -- | -- | -- | -- |
| Papua | -- | -- | -- | -- | -- | -- | -- |
| Nusa Tenggara | -- | -- | -- | -- | -- | -- | -- |
| **TOTAL** | **60** | **268** | **345** | **3,122** | **157** | **585** | **4,537** |
| **Total (PLN+IPP)** | | | | | | | |
| Java-Bali | 76 | 2,236 | 6,643 | 10,370 | 2,536 | 935 | 22,796 |
| Sumatra | 798 | 780 | 968 | 1,175 | 868 | 10 | 4,599 |
| Kalimantan | 676 | 95 | 60 | 175 | 30 | -- | 1,036 |
| Sulawesi | 531 | 123 | 195 | 52 | 214 | 60 | 1,175 |
| Maluku | 181 | -- | -- | -- | -- | -- | 181 |
| Papua | 161 | -- | -- | -- | 4 | -- | 165 |
| Nusa Tenggara | 256 | -- | -- | -- | 2 | -- | 258 |
| **TOTAL** | **2,679** | **3,234** | **7,866** | **11,772** | **3,654** | **1,005** | **30,210** |

Note: PLN includes its subsidiaries.

Source: Assembled by the Study Team based on RUPTL 2010-2019.

Apart from its own generation facilities, PLN has been renting diesel generators and/or purchasing excess power from captive power generation out of Java-Bali regions in recent years as a countermeasure to ease the tight situation of electricity demand-supply as indicated in Table 3.1.2.

**Table 3.1.2 Capacity of Rented Generation/Excess Power**

(unit: MW)

| No. | PLN Wilayah | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| 1 | NAD | 8.0 | 11.0 | 53.0 |
| 2 | Babel | 23.5 | 23.5 | 27.0 |
| 3 | Sumbar | 3.0 | 3.0 | 0.7 |
| 4 | S2JB | 3.6 | 3.6 | 50.2 |
| 5 | Riau | 56.4 | 102.7 | 31.3 |
| 6 | Kit Sumbagsel | 88.0 | 88.0 | 140.0 |
| 7 | Kit Sumbagut | 60.0 | 185.0 | 241.5 |
| | **Sumatra** | **242.5** | **416.8** | **543.7** |
| 8 | Kalbar | 53.0 | 89.0 | 96.0 |
| 9 | Kalselteng | 34.6 | 68.8 | 46.5 |
| 10 | Kaltim | 80.5 | 126.5 | 156.5 |
| | **Kalimantan** | **168.1** | **284.3** | **299.0** |
| 11 | Sulselrabar | 26.0 | 125.0 | 54.0 |
| 12 | Suluttenggo | 42.5 | 111.1 | 54.0 |
| | **Sulawesi** | **68.5** | **236.1** | **108.0** |
| 13 | NTB | 32.0 | 63.0 | 40.0 |
| 14 | NTT | 13.0 | 16.0 | 21.0 |
| 15 | Maluku | 12.5 | 12.5 | 13.0 |
| 16 | Papua | 32.4 | 44.2 | 48.6 |
| | **Total** | **569.0** | **1,072.9** | **1,073.3** |

Source: RUPTL 2009-2018, RUPTL 2010-2019; PLN.

The characteristics of the existing generation facilities in respective regions are stated in the following.

(1) Java-Madura-Bali

The generation capacity in the Java-Madura-Bali (Jamali) system accounted for 75 percent of total capacity in Indonesia as of 2009. Two subsidiaries of PLN (PT Indonesia Power and PT PJB), three business units of PLN (Tanjung Jati B, Muara Tawar and PLTGU Cilegon) and 10 IPPs[1] operated power plants in Jamali system. The generation capacity in Jamali system is shown in Table 3.1.3. Out of 22,796 MW of installed capacity in total, 18,871 MW or 82.8 percent was operated by PLN and its subsidiaries, and 3,925 MW or 17.2 percent was operated by IPPs. 10 IPPs consisted of three coal thermal power stations (PLTU), one gas turbine station (PLTG), five geothermal power stations (PLTP) and one hydropower station (PLTA).

[1] 2009 counts PLTA Jatiluhur as a hydropower IPP operated by PO Jatiluhur, but PLN annual report 2008 did not.

**Table 3.1.3 Generation Capacity in Java-Madura-Bali System**

(unit: MW)

| | Type of Generation | | Indonesia Power | PJB | PLN | subtotal PLN | IPP | Total | % |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **PLTA** | **Hydro** | **1,103** | **1,283** | **--** | **2,386** | **150** | **2,536** | **11.1** |
| **2** | **PLTU** | **Steam** | **3,900** | **1,800** | **1,620** | **7,320** | **3,050** | **10,370** | **45.5** |
| | - Batubara | - Coal | 3,400 | 800 | 1,620 | 5,820 | 3,050 | 8,870 | 38.9 |
| | - BBG/BBM | - Gas/Oil | -- | 1,000 | -- | 1,000 | -- | 1,000 | 4.4 |
| | - BBM | - Oil | 500 | -- | -- | 500 | -- | 500 | 2.2 |
| **3** | **PLTGU** | **Combined-Cycle** | **2,676** | **3,227** | **740** | **6,643** | **--** | **6,643** | **29.1** |
| | - BBG/BBM | - Gas/Oil | 1,180 | 2,587 | 740 | 4,507 | -- | 4,507 | 19.8 |
| | - BBM | - Oil | 1,496 | 640 | -- | 2,136 | -- | 2,136 | 9.4 |
| **4** | **PLTG** | **Gas Turbine** | **846** | **382** | **858** | **2,086** | **150** | **2,236** | **9.8** |
| | - BBG/BBM | - Gas/Oil | 40 | 62 | -- | 102 | 150 | 252 | 1.1 |
| | - BBM | - Oil | 806 | 320 | 858 | 1,984 | -- | 1,984 | 8.7 |
| **5** | **PLTD** | **Diesel** | **76** | **--** | **--** | **76** | **--** | **76** | **0.3** |
| **6** | **PLTP** | **Geothermal** | **360** | **--** | **--** | **360** | **575** | **935** | **4.1** |
| | **Jamali Total** | | **8,961** | **6,692** | **3,218** | **18,871** | **3,925** | **22,796** | **100.0** |

Source: RUPTL 2010-2019, PLN.

Against the peak load of 17,219.64 MW in 2009, the total installed capacity including 3,925 MW of IPPs' was 22,796 MW, which brought about 32.4 percent of reserve margin. In terms of energy, the contribution of IPPs was 30,301 GWh or 25.9 percent of total energy supply as indicated in Table 3.1.4.

**Table 3.1.4 Energy Balance in Jamali in 2009**

(Unit: GWh)

| PLN Operational Unit/ Province | Purchased | Received from other unit | Own Production | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|---|
| Jatim | 0.12 | 22,744.15 | 20.96 | 22,765.20 | 1,519.63 | 6.68% | 21,245.52 | 6.43 |
| Jateng dan DIY | 12.49 | 16,312.60 | 0.44 | 16,325.51 | 1,083.09 | 6.63% | 15,242.00 | -- |
| Jabar dan Banten | 71.53 | 38,451.63 | 0.24 | 38,523.40 | 2,974.05 | 7.72% | 35,320.91 | 0.12 |
| Jakarata Raya dan Tangerang | 0.40 | 34,676.15 | -- | 34,676.55 | 3,143.15 | 9.06% | 30,677.55 | -- |
| Bali | 3.74 | 2,953.59 | 9.29 | 2,966.61 | 155.02 | 5.23% | 2,811.59 | 2.09 |
| P3B Jawa-Bali | 30,213.08 | 86,889.42 | -- | 117,102.50 | 2,541.64 | 2.17% | -- | 17,211.00 |
| PT Indonesia Power | -- | 378.13 | 42,793.03 | 41,267.61 | -- | -- | -- | -- |
| PT PJB | -- | 118.24 | 30,852.12 | 29,668.10 | -- | -- | -- | -- |
| Kit Muara Tawar | -- | 2.46 | 3,929.73 | 3,905.82 | -- | -- | -- | -- |
| Kit Cilegon | -- | 0.92 | 3,997.92 | 3,916.28 | -- | -- | -- | -- |
| Kit Tanjung Jati B | -- | 18.82 | 8,900.35 | 8,225.50 | -- | -- | -- | -- |
| **Java-Bali** | **30,301.36** | **--** | **90,504.08** | **116,796.97** | **11,416.58** | **9.77%** | **105,297.57** | **17,219.64** |

Source: PLN Statistics 2009, PLN.

Table 3.1.5 presents the energy composition of PLN and its subsidiaries by generation type in 2009. As stated in Section 2.2.2, the Government launced the indication to reduce the dependence on oil fuel to 20 percent at maximum of total energy consumption in 2025. Currently, some old oil fired power plants (PLTU and PLTGU) and diesel plants (PLTD) are operated, and dual fuel (gas/oil) fired plants such as Gresik GT also consuming oil due to constraint of gas supply.

### Table 3.1.5 Energy composition by generation type in Jamali in 2009

(unit: GWh)

| PLN Operational Unit/ Province | Hydro | Steam | Gas Turbine | Combined Cycle | Geo-thermal | Diesel | Total |
|---|---|---|---|---|---|---|---|
| Distribusi Jatim | 2.17 | -- | -- | -- | -- | 18.79 | 20.96 |
| Distribusi Jateng dan DIY | 9.98 | -- | -- | -- | -- | -- | 0.44 |
| - Jawa Tengah | 0.44 | -- | -- | -- | -- | -- | 0.44 |
| - DI Yogyakarta | -- | -- | -- | -- | -- | -- | -- |
| Distribusi Jabar dan Banten | -- | -- | -- | -- | -- | 0.24 | 0.24 |
| - Jawa Barat | -- | -- | -- | -- | -- | 0.24 | 0.24 |
| - Banten | -- | -- | -- | -- | -- | -- | -- |
| Distribusi Jaya dan Tengerang | -- | -- | -- | -- | -- | -- | -- |
| P3B Jawa Bali | -- | -- | -- | -- | -- | -- | -- |
| PT Indonesia Power | 3,585.81 | 24,397.12 | 1,831.99 | 9,721.70 | 3,127.74 | 128.66 | 42,793.02 |
| PT PJB | 2,356.66 | 12,477.02 | 63.48 | 15,954.96 | -- | -- | 30,852.12 |
| Kit Muara Tawar | -- | -- | 3,929.73 | -- | -- | -- | 3,929.73 |
| Kit Cilegon | -- | -- | -- | 3,997.92 | -- | -- | 3,997.92 |
| Kit Tanjung Jati B | -- | 8,900.35 | -- | -- | -- | -- | 8,900.35 |
| **Jamali Total** | **5,954.62** | **45,774.49** | **5,825.20** | **29,674.58** | **3,127.74** | **147.69** | **90,494.78** |
| | 6.58% | 50.58% | 6.44% | 32.79% | 3.46% | 0.16% | 100.00% |

Source: PLN Statistics 2009, PLN.

(2) Sumatra

In Sumatra, PLN’s power supply business has been unbundled next to Java-Bali. There are two business units of PLN in generation sector; *Pembangkit Sumatra Bagian Utara* (Kit Sumbagut; Northern Sumatra Generation) and *Pembangkit Sumatra Bagian Selatan* (Kit Sumbagsel; Southern Sumatra Generation). Other than Kit Sumbagut and Kit Sumbagsel, seven regional distribution offices (Wilayah) conduct operation and maintenance of their own generation facilities mostly in isolated systems.

The installed and rated generation capacity of PLN are shown in Table 3.1.6 and Table 3.1.7 respectively. Since most part of the island is connected to the main grid, the percentage of diesel generation is low while each Wilayah has its own diesel generation for power supply through small grids, and type of generation is well balanced. Other than PLN’s generation facilities, two IPPs are operating gas fueled power plants in south Sumatra with the total capacity of 230 MW.

There is no geothermal generation (PLTP) in Sumatra so far, but 13 geothermal projects with the total capacity of 1,767 MW announced in the fast track program (phase II) would increase the variation of generation mix by 2014.

### Table 3.1.6 PLN's installed Generation Capacity in Sumatra System

(unit: MW)

| PLN Operational Unit/ Province | Hydro | Steam | Gas Turbine | Combined Cycle | Geo-thermal | Diesel | Total |
|---|---|---|---|---|---|---|---|
| NAD | 1.75 | -- | -- | -- | -- | 153.45 | 155.20 |
| Sumut | -- | -- | -- | -- | -- | 15.66 | 15.66 |
| Sumbar | 0.65 | -- | -- | -- | -- | 33.75 | 34.40 |
| Riau | -- | -- | -- | -- | -- | 167.53 | 167.53 |
| - Riau | -- | -- | -- | -- | -- | 83.21 | 83.21 |
| - Riau Kepulauan | -- | -- | -- | -- | -- | 84.32 | 84.32 |
| S2JB | 1.60 | -- | -- | -- | -- | 52.60 | 54.20 |
| - Sumatra Selatan | -- | -- | -- | -- | -- | 18.14 | 18.14 |
| - Jambi | -- | -- | -- | -- | -- | 11.74 | 11.74 |
| - Bengkulu | 1.60 | -- | -- | -- | -- | 22.72 | 24.32 |
| Bangka Belitung | -- | -- | -- | -- | -- | 101.13 | 101.13 |
| Lampung | -- | -- | -- | -- | -- | 8.03 | 8.03 |
| Kit Sumbagut | 253.50 | 490.00 | 233.49 | 817.88 | -- | 108.18 | 1,903.05 |
| Kit Sumbagsel | 607.96 | 685.00 | 314.82 | 40.00 | -- | 211.42 | 1,859.20 |
| **Total** | **865.46** | **1,175.00** | **548.31** | **857.88** | **--** | **851.75** | **4,298.40** |
| | 20.1% | 27.3% | 12.8% | 20.0% | 0.0% | 19.8% | 100.0% |

Source: PLN Statistics 2009, PLN.

### Table 3.1.7 PLN's rated Generation Capacity in Sumatra

(unit: MW)

| PLN Operational Unit/ Province | Hydro | Steam | Gas Turbine | Combined Cycle | Geo-thermal | Diesel | Total |
|---|---|---|---|---|---|---|---|
| NAD | 1.60 | -- | -- | -- | -- | 96.48 | 98.08 |
| Sumut | -- | -- | -- | -- | -- | 8.71 | 8.71 |
| Sumbar | 0.40 | -- | -- | -- | -- | 19.45 | 19.85 |
| Riau | -- | -- | -- | -- | -- | 98.11 | 98.11 |
| - Riau | -- | -- | -- | -- | -- | 48.11 | 48.11 |
| - Riau Kepulauan | -- | -- | -- | -- | -- | 50.00 | 50.00 |
| S2JB | 1.47 | -- | -- | -- | -- | 35.84 | 37.31 |
| - Sumatra Selatan | -- | -- | -- | -- | -- | 4.95 | 4.95 |
| - Jambi | -- | -- | -- | -- | -- | 18.29 | 18.29 |
| - Bengkulu | 1.47 | -- | -- | -- | -- | 12.60 | 14.07 |
| Bangka Belitung | -- | -- | -- | -- | -- | 54.38 | 54.38 |
| Lampung | -- | -- | -- | -- | -- | 2.65 | 2.65 |
| Kit Sumbagut | 252.80 | 400.00 | 112.10 | 550.00 | -- | 46.90 | 1,361.80 |
| Kit Sumbagsel | 597.23 | 574.95 | 266.67 | 37.88 | -- | 104.37 | 1,581.10 |
| **Total** | **853.50** | **974.95** | **378.77** | **587.88** | **--** | **466.89** | **3,261.99** |
| | 26.2% | 29.9% | 11.6% | 18.0% | 0.0% | 14.3% | 100.0% |

Source: PLN Statistics 2009, PLN.

Against the peak load of 3,493 MW in 2009 which was jumped 23 percent from 2,841 MW in the previous year, the available capacity was 3,539 MW including 278 MW of IPPs', which brought about 24.4 percent of reserve margin in the whole Sumatra. Looking into the energy balance presented in Table 3.1.8, PLN purchased 2,472.87 GWh of electric energy from IPPs which came to 12.4 percent of electricity supply of PLN, and the contribution of rented generators accounted for 1,802.34 GWh jumped from 1,318.05 GWh in the previous year, which was considerable in Riau, S2JB and Bangka Belitung where the grid of P3B did not fully reach.

**Table 3.1.8 Energy Balance in Sumatra in 2009**

(unit: GWh)

| PLN Operational Unit/Province | Purchased | Received from other unit | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|---|---|
| NAD | -- | 1,206.82 | 288.32 | 34.33 | 1,521.50 | 222.10 | 14.60% | 1,299.40 | 78.76 |
| Sumut | 55.18 | 6,725.47 | 32.39 | 0.09 | 6,812.54 | 619.54 | 9.09% | 6,136.26 | 8.87 |
| Sumbar | 2.31 | 2,118.71 | 76.04 | -- | 2,194.97 | 155.25 | 7.07% | 2,027.85 | 15.60 |
| Riau | 49.82 | 1,703.23 | 742.30 | 230.12 | 2,473.28 | 260.71 | 10.54% | 2,196.03 | 131.36 |
| S2JB | 284.44 | 3,734.82 | 88.48 | 23.91 | 4,106.60 | 419.95 | 10.23% | 3,682.10 | 25.18 |
| Bangka Belitung | 17.83 | -- | 436.35 | 187.29 | 444.14 | 42.10 | 9.48% | 402.04 | 78.94 |
| Lampung | -- | 2,315.79 | 2.70 | -- | 2,318.40 | 272.09 | 11.74% | 2,046.31 | 0.83 |
| P3B Sumatra | 2,063.29 | 16,417.97 | -- | -- | 18,481.26 | 660.17 | 3.57% | -- | 3,153.68 |
| Sumbagut | -- | 62.52 | 9,237.95 | 987.29 | 8,945.07 | -- | 0.00% | -- | -- |
| Sumbagsel | -- | 18.34 | 7,945.59 | 339.31 | 7,525.85 | -- | 0.00% | -- | -- |
| | **2,472.87** | **--** | **18,884.45** | **1,802.34** | **20,519.94** | **2,651.91** | **12.92%** | **17,789.99** | **3,493.22** |

Source: PLN Statistics 2009, PLN.

(3) Kalimantan

In Kalimantan, there are three PLN branch units; *Wilayah Kalimantan Barat* (Kalbar), *Wilayah Kalimantan Selatan and Kalimantan Tengah* (Kalselteng) and *Wilayah Kalimantan Timur* (Kaltim).

Electricity supply including generation, transmission and distribution & service is being conducted in the form of vertical integration by these three offices in each region. Each office has a large power system connected by 150 kV transmission lines; *Khatulistiwa* system in *Wilayah Kalbar*, *Barito* system in *Wilayah Kalselteng*, and *Mahakam* system in *Wilayah Kaltim*. These power systems are not connected each other and there are also small power grids with diesel generators.

As shown in Table 3.1.9 and Table 3.1.10, 1,149 MW of total capacity of generation facilities owned and operated by PLN exists, among which 739 MW or 64.3 percent is available, as of the end of 2009.

While diesel generation (PLTD) and PLTG are main generation facilities in Khatulistiwa system (West Kalimantan), there are some steam generation (PLTU) fueled by domestic coal and hydropower generation (PLTA) in Barito system (Southeast Kalimantan), and steam generation (PLTU), gas turbine (PLTG) and combined cycle generation (PLTGU) operated in Mahakam system (East Kalimantan). However, diesel generation consisted of around 70 percent of total installed capacity in Kalimantan.

**Table 3.1.9 PLN's Installed Generation Capacity in Kalimantan**

(unit: MW)

| PLN Operational Unit/Province | Hydro | Steam | Gas Turbine | Combined Cycle | Diesel | Diesel Gas | Total |
|---|---|---|---|---|---|---|---|
| Kalbar | 0.20 | -- | 34.00 | -- | 259.55 | -- | 293.75 |
| Kalselteng | 30.00 | 130.00 | 21.00 | -- | 213.27 | -- | 394.27 |
| - Kalimantan Selatan | 30.00 | 130.00 | 21.00 | -- | 130.25 | -- | 311.25 |
| - Kalimantan Tengah | -- | -- | -- | -- | 83.02 | -- | 83.02 |
| Kaltim | -- | 14.00 | 52.80 | 60.00 | 320.43 | 14.00 | 461.23 |
| **Total** | **30.20** | **144.00** | **107.80** | **60.00** | **793.25** | **14.00** | **1,149.25** |
| | 2.6% | 12.5% | 9.4% | 5.2% | 69.0% | 1.2% | 100.0% |

Source: PLN Statistics 2009, PLN.

**Table 3.1.10 PLN's Rated Generation Capacity in Kalimantan**

(unit: MW)

| PLN Operational Unit/Province | Hydro | Steam | Gas Turbine | Combined Cycle | Diesel | Diesel Gas | Total |
|---|---|---|---|---|---|---|---|
| Kalbar | 0.18 | -- | 31.00 | -- | 149.24 | -- | 180.42 |
| Kalselteng | 30.00 | 124.00 | 18.00 | -- | 134.14 | -- | 306.14 |
| - Kalimantan Selatan | 30.00 | 124.00 | 18.00 | -- | 73.42 | -- | 245.42 |
| - Kalimantan Tengah | -- | -- | -- | -- | 60.72 | -- | 60.72 |
| Kaltim | -- | -- | 50.40 | 56.00 | 145.58 | -- | 251.98 |
| **Total** | **30.18** | **124.00** | **99.40** | **56.00** | **428.96** | **--** | **738.54** |
| | 4.1% | 16.8% | 13.5% | 7.6% | 58.1% | 0.0% | 100.0% |

Source: PLN Statistics 2009, PLN.

There is no large scale private generation in Kalimantan but PLTU Pontianak with the capacity of 45 MW capacity, contributing 425 GWh or 8.2 percent of total energy supply in 2009. The peak load of 988.47 MW which jumped from 741.23 MW in the previous year, exceeded the rated capacity of PLN in Kalimantan in 2009. Looking into each system, while installed capacities of PLN generation in each system exceeded the peak loads respectively, its rated capacities were below the peak loads. As a result, around 30 percent of total electricity supply was dependent on rented generators as indicated Table 3.1.11.

**Table 3.1.11 Energy Balance in Kalimantan in 2009**

(unit: GWh)

| PLN Wilayah | Purchased | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|---|
| Kalbar | 1.26 | 740.51 | 590.22 | 1,290.98 | 127.63 | 9.89% | 1,163.35 | 245.09 |
| Kalsel dan Kalteng | 101.62 | 1,758.42 | 265.92 | 1,988.90 | 196.69 | 9.89% | 1,792.21 | 334.76 |
| Kaltim | 322.20 | 896.79 | 723.16 | 1,910.49 | 165.87 | 8.68% | 1,744.62 | 408.62 |
| **Total** | **425.08** | **4,975.04** | **1,579.30** | **5,190.37** | **490.19** | **9.44%** | **4,700.18** | **988.47** |

Source: PLN Statistics 2009, PLN.

(4) Sulawesi

In Sulawesi, two branch units (*Wilayah Suluttenggo* and *Wilayah Sulselrabar*) of PLN mainly conduct electricity business. Each business unit has one relatively large power system and dozens of small systems. In the northern part of Sulawesi covering three provinces; *Sulawesi Utara* (North Sulawesi), *Sulawesi Tengah* (Central Sulawesi) and Gorontalo, *Wilayah Suluttenggo* operates power business. Minahasa-Kotamobagu system is the large system in the territory of *Wilayah Suluttenggo* which covers 54 percent of electricity demand in the supply area of the Wilayah through 150 kV and 70 kV transmission lines. In other areas where Minahasa-Kotamobagu system doesn't reach, there are 19 small grids supplying electricity by diesel generators.

On the other hand, in the southern part of Sulawesi covering the provinces of *Sulawesi Selatan* (South Sulawesi), *Sulawesi Barat* (West Sulawesi) and *Sulawesi Tenggara* (South-east Sulawesi), *Wilayah Sulselrabar* conducts electricity supply. Sulsel system is the large system which covers 86 percent of electricity demand in the supply area of the *Wilayah Sulselrabar*. Other than Sulsel system, there are six small grids also supplied by diesel generators in the territory of *Wilayah Sulselrabar*.

**Table 3.1.12 PLN's Installed Generation Capacity in Sulawesi**

(unit: MW)

| PLN Operational Unit/ Province | Hydro | Steam | Gas Turbine | Geo-thermal | Diesel | Wind | Total |
|---|---|---|---|---|---|---|---|
| Suluttenggo | 60.62 | -- | -- | 40.00 | 256.61 | 0.80 | 358.03 |
| - Sulawesi Utara | 54.66 | -- | -- | 40.00 | 117.64 | 0.80 | 213.10 |
| - Gorontalo | -- | -- | -- | -- | 40.66 | -- | 40.66 |
| - Sulawesi Tengah | 5.96 | -- | -- | -- | 98.31 | -- | 104.27 |
| Sulselrabar | 149.32 | 25.00 | 122.72 | -- | 220.89 | -- | 517.93 |
| - Sulawesi Selatan | 147.72 | 25.00 | 122.72 | -- | 144.57 | -- | 440.01 |
| - Sulawesi Tenggara | 1.60 | -- | -- | -- | 73.09 | -- | 74.69 |
| - Sulawesi Barat | -- | -- | -- | -- | 3.23 | -- | 3.23 |
| **Total** | **209.94** | **25.00** | **122.72** | **40.00** | **477.50** | **0.80** | **875.96** |
| | 24.0% | 2.9% | 14.0% | 4.6% | 54.5% | 0.1% | 100.0% |

Source: PLN Statistics 2009, PLN.

**Table 3.1.13 PLN's Rated Generation Capacity in Sulawesi**

(unit: MW)

| PLN Operational Unit/ Province | Hydro | Steam | Gas Turbine | Geo-thermal | Diesel | Wind | Total |
|---|---|---|---|---|---|---|---|
| Suluttenggo | 53.86 | -- | -- | 40.00 | 142.06 | 0.80 | 236.72 |
| - Sulawesi Utara | 46.79 | -- | -- | 40.00 | 55.22 | 0.80 | 142.81 |
| - Gorontalo | -- | -- | -- | -- | 19.51 | -- | 19.51 |
| - Sulawesi Tengah | 7.07 | -- | -- | -- | 67.33 | -- | 74.40 |
| Sulselrabar | 147.51 | 9.00 | 84.50 | -- | 128.00 | -- | 369.01 |
| - Sulawesi Selatan | 145.96 | 9.00 | 84.50 | -- | 58.27 | -- | 297.73 |
| - Sulawesi Tenggara | 1.55 | -- | -- | -- | 68.02 | -- | 69.57 |
| - Sulawesi Barat | -- | -- | -- | -- | 1.71 | -- | 1.71 |
| **Total** | **201.37** | **9.00** | **84.50** | **40.00** | **270.06** | **0.80** | **605.73** |
| | 33.2% | 1.5% | 14.0% | 6.6% | 44.6% | 0.1% | 100.0% |

Source: PLN Statistics 2009, PLN.

Other than PLN generation, there are two IPPs (PLTGU and PLTD) with the capacity of 255 MW in *Sulawesi Selatan*, and one IPP (PLTU) in *Sulawesi Tengah* with the capacity of 27 MW as stated in Section 2.3.3. In 2009, PLN purchased 1,838 GWh of electricity from two IPPs in *Sulawesi Selatan* which accounted for 51.9 percent of electricity supply in *Wilayah Sulselrabar*, and 217 GWh from one IPP in *Sulawesi Tengah* which comprised 13.7 percent of electricity supply in *Wilayah Suluttenggo*. In *Wilayah Suluttenggo*, the available capacity of PLN and an IPP was 264 MW against the peak load of 296.84 MW, which brought the situation that 54 MW of rented generators were required, and in *Wilayah Sulselrabar*, the available capacity was 624 MW against the peak load of 628.70 MW, by which also put south Sulawesi to the verge of power crisis without rented generators.

**Table 3.1.14 Energy Balance in Sulawesi in 2009**

(unit: GWh)

| PLN Wilayah | Purchased | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|---|
| Suluttenggo | 216.85 | 1,115.76 | 309.60 | 1,587.22 | 151.27 | 9.53% | 1,435.95 | 296.84 |
| Sulselrabar | 1,838.42 | 1,554.44 | 192.13 | 3,540.57 | 341.06 | 9.63% | 3,199.34 | 628.70 |
| **Total** | **2,055.27** | **3,056.52** | | **5,127.79** | **492.33** | **9.60%** | **4,635.29** | 925.54 |

Source: PLN Statistics 2009, PLN.

(5) Maluku

PLN Wilayah Maluku is the single operator of electricity business in Maluku province and North Maluku province. Maluku comprises of around one thousand islands extending across an area of 851,000 square kilometer, only 10 percent of which is land, so that it is quite difficult to cover the area with a large power system. Therefore, there is no interconnected system in the region but several isolated systems covering main cities such as Ambon in Ambon island, Ternate in Ternate island, Soasiu in Tidore island, Tual in Kei Kecil island, Tobello in Halmahera island, Masohi in Seram island and Labuna in Bacan island. All the generation units of PLN are diesel generators in Maluku with the total installed capacity 181.66 MW. The rated capacity is almost half of the installed capacity; 92.05 MW against the peak load 109.68 MW in 2009, by which PLN required 13 MW capacity of rented generators, having produced 96.79 GWh or 20.7 percent of total electricity supply.

**Table 3.1.15 PLN's Generation Capacity in Maluku**

(unit: MW)

| PLN Operational Unit/ Province | Diesel | | (2)/(1) |
|---|---|---|---|
| | Installed capacity (1) | Rated capacity (2) | |
| **Maluku and Maluku Utara** | **182.21** | **92.05** | **50.5%** |
| - Maluku | 116.18 | 57.08 | 49.1% |
| - Maluku Utara | 66.03 | 34.97 | 53.0% |

Source: PLN Statistics 2009, PLN.

**Table 3.1.16 Energy Balance in Maluku in 2009**

(unit: GWh)

| PLN Wilayah | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|
| Maluku and Maluku Utara | 379.71 | 96.79 | 468.00 | 47.69 | 10.19% | 420.31 | 109.68 |

Source: PLN Statistics 2009, PLN.

(6) Papua

PLN Wilayah Papua conducts electricity business in Papua province and West Papua province. There are ten small grids in and around the main cities in Papua; Jayapura, Wamena, Merauke, Timika Nabire, Fakfak, Manokwari, Sorong in the island of New Guinea, Serui in Yapen island, and Biak in Biak island. In spite of its huge hydro potential, almost all of the generation units in Papua are diesel generators as shown in Table 3.1.17.

**Table 3.1.17 PLN's Generation Capacity in Papua**

(unit: MW)

| | Hydro | Diesel | Total |
|---|---|---|---|
| Installed capacity (1) | 4.04 | 166.66 | 170.70 |
| | 2.4% | 97.6% | 100.0% |
| Rated capacity (2) | 2.62 | 90.87 | 93.49 |
| | 2.8% | 97.2% | 100.0% |
| Ratio (2)/(1) | 64.9% | 54.5% | 54.8% |

Source: PLN Statistics 2009.

Also in Papua, the peak load of 130.75 MW exceeded the available capacity of 93.5 MW in 2009, and rented generators with the total capacity of 48.6 MW were introduced in the year.

**Table 3.1.18 Energy Balance in Papua in 2009**

(unit: GWh)

| PLN Wilayah | Purchased | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|---|
| Papua | 29.97 | 411.26 | 301.61 | 730.76 | 66.33 | 9.08% | 664.43 | 130.75 |

Source: PLN Statistics 2009.

(7) Nusa Tenggara

There are 566 islands in *Nusa Tenggara*, the "Southeastern Islands", stretching 1,300 kilometers east to west, of which 42 inhabited islands. Administratively, Nusa Tenggara is divided into two provinces — *Nusa Tenggara Barat* (West Nusa Tenggara) and *Nusa Tenggara Timur* (East Nusa Tenggara). PLN conducts electricity supply in *Nusa Tenggara* through two regional offices (Wilayah) along with the administrative districts.

1) Nusa Tenggara Barat (NTB)

The two largest islands in Nusa Tenggara Barat (NTB) are Lombok in the west and the larger Sumbawa island in the east. Power supply in NTB is conducted through three small grids; Lombok system in Lombok island, and Sumbawa system and Bima system in Sumbawa island.

Almost all the generation in NTB is produced by 157 diesel generators with the total installed capacity of 140 MW. Among the installed capacity, 97.88 MW was available against the 139.28 MW of peak load.

**Table 3.1.19 PLN's Generation Capacity in NTB**

(unit: MW)

| | Hydro | Diesel | Total |
|---|---|---|---|
| **Installed capacity (1)** | 0.40 | 139.18 | 139.58 |
| | 0.3% | 99.7% | 100.0% |
| **Rated capacity (2)** | 0.25 | 97.63 | 97.88 |
| | 0.26% | 99.7% | 100.0% |
| **Ratio (2)/(1)** | 62.5% | 70.1% | 70.1% |

Source: PLN Statistics 2009.

**Table 3.1.20 Energy Balance in NTB in 2009**

(unit: GWh)

| PLN Wilayah | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|
| NTB | 545.77 | 244.38 | 751.52 | 56.42 | 7.51% | 695.10 | 139.28 |

Source: PLN Statistics 2009.

2) Nusa Tenggara Timur (NTT)

*Nusa Tenggara Timur* consists of about 550 islands, but is dominated by the three main islands of Flores, Sumba, and West Timor, the western half of the island of Timor. Other islands include Adonara, Alor, Komodo, Lembata, Menipo, Raijua, Rincah, Rote Island (the southernmost island in Indonesia), Savu, Semau, and Solor. Among them, PLN conducts power supply through small isolated grids in islands of Flores (Ruteng, BaJava, Ende, Maumere and Larantuka), Sumba (Waingapu and Waikabubak), West Timor (Kupang, Soe, Kefamenanu, and Atambua), Alor (Kalabahi), and Lembata. As well as other island region, power supply in NTT depends on diesel generation. Other than diesel generation, just two small scale hydropower plants (PLTM) are operated in Waikabubak (800 kW) in Sumba island and in Ruteng (300 kW) in Flores island. The available capacity in 2009 was 73.4 MW dipping from the peak load of 85.06 MW, bringing about the requirement of rented generators. However, it is more important to look into the balance in each small system since each power system is thoroughly isolated one by one due to the geographical reason.

**Table 3.1.21 PLN's Generation Capacity in NTT**

(unit: MW)

| | Hydro | Diesel | Total |
|---|---|---|---|
| **Installed capacity (1)** | 1.37 | 110.72 | 112.09 |
| | 1.2% | 98.8% | 100.0% |
| **Rated capacity (2)** | 0.94 | 72.46 | 73.40 |
| | 1.3% | 98.7% | 100.0% |
| **Ratio (2)/(1)** | 68.6% | 65.4% | 65.5% |

Source: PLN Statistics 2009.

**Table 3.1.22 Energy Balance in NTT in 2009**

(unit: GWh)

| PLN Wilayah | Own Production | Rented | Net Production | Energy Loss and own use | | Energy sold | Peak load (MW) |
|---|---|---|---|---|---|---|---|
| NTT | 279.35 | 143.05 | 417.20 | 29.48 | 7.07% | 387.72 | 85.06 |

Source: PLN Statistics 2009.

## 3.1.2 ELECTRICITY SUPPLY AND DEMAND

The electricity supply and demand from 2000 to 2009 are presented in Table 3.1.23. During the period, PLN own generation has been increased by 3.7 percent per year, and reached 115 TWh in 2009, while electricity sales has been increased by higher 6.2 percent per year, and reached 136 TWh in the same year. The gap between the supply and the demand was bridged by the electricity purchased from IPPs and generated from rented diesel generators, which have increased rapidly by 16.5 percent and 25.2 percent per year respectively during the same period. Transmission and distribution loss has been stable around 10 to 11 percent in recent five years. Load factor has been decreasing in recent years with getting spired peak load. However, in 2008 and 2009, energy deficit resulted in the less peak load and the higher load factor.

**Table 3.1.23 Electricity Supply and Demand (Year 2000-2009)**

| Year | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PLN Own generation | (GWh) | 83,504 | 87,587 | 88,069 | 90,046 | 93,113 | 98,177 | 101,664 | 107,984 | 113,340 | 115,434 |
| Rented | (GWh) | 687 | 767 | 1,225 | 2,435 | 3,078 | 3,105 | 2,804 | 3,257 | 4,707 | 5,195 |
| Energy production (Generation end) | (GWh) | 84,190 | 88,355 | 89,293 | 92,481 | 96,191 | 101,282 | 104,469 | 111,241 | 118,047 | 120,628 |
| Own use | (GWh) | 3,416 | 3,710 | 3,768 | 4,040 | 5,824 | 5,302 | 4,274 | 5,230 | 5,380 | 5,225 |
| | (%) | 4.1 | 4.2 | 4.2 | 4.4 | 6.1 | 5.2 | 4.1 | 4.7 | 4.6 | 4.3 |
| Energy Production (Transmission end) | (GWh) | 80,774 | 84,645 | 85,526 | 88,441 | 90,367 | 95,980 | 100,195 | 106,012 | 112,667 | 116,797 |
| Purchased | (GWh) | 9,135 | 13,299 | 19,067 | 20,539 | 24,053 | 26,688 | 28,640 | 31,199 | 31,390 | 36,169 |
| Energy supply | (GWh) | 89,909 | 97,944 | 104,592 | 108,980 | 114,420 | 122,667 | 128,835 | 137,211 | 144,056 | 151,572 |
| Loss T&D | (GWh) | 10,483 | 13,261 | 17,228 | 18,402 | 13,132 | 14,237 | 14,736 | 15,239 | 15,094 | 15,359 |
| | (%) | 11.7 | 13.5 | 16.5 | 16.9 | 11.5 | 11.6 | 11.4 | 11.1 | 10.5 | 10.1 |
| Other loss | (GWh) | 261 | 162 | 275 | 137 | 1,190 | 1,398 | 1,489 | 725 | -56 | 160 |
| Energy sold | (GWh) | 79,165 | 84,520 | 87,089 | 90,441 | 100,097 | 107,032 | 112,610 | 121,247 | 129,019 | 136,053 |
| Peak load | (MW) | 15,320 | 16,314 | 17,157 | 17,949 | 18,897 | 19,354 | 23,687 | 27,282 | 21,120 | 23,438 |
| Load factor | (%) | 69.5 | 71.1 | 72.1 | 71.9 | 72.6 | 75.5 | 64.2 | 59.6 | 80.8 | 76.4 |

Source: JICA Study Team based on PLN Statistics 2009.

According to PLN, there is a lot of waiting demand for power connection as shown in Table 3.1.24; 1,252 MVA in Java and 1,229 MVA in outer Java in 2009, of which it is difficult to say how much capacity would be actually used since the application would most likely be made at their peak capacity with some margin. In any case, the existence of such waiting list has influence on demand forecast discussed in the following part.

**Table 3.1.24 Waiting List for Power Connection in 2009**

| PLN Operational Unit/ Province | New Applicants | | Connected | | Discharging/ Cancelled | | Waiting | |
|---|---|---|---|---|---|---|---|---|
| | Total | Capacity (MVA) | Total | Capacity (MVA) | Total | Capacity (MVA) | Total | Capacity (MVA) |
| Sumatra | 572,651 | 800.6 | 215,817 | 393.5 | 10,139 | 11.8 | 346,695 | 395.3 |
| Kalimantan | 306,074 | 630.2 | 50,341 | 74.8 | 64 | 0.2 | 255,669 | 555.1 |
| Sulawesi | 193,911 | 369.0 | 41,952 | 91.3 | 77 | 0.1 | 151,882 | 277.7 |
| Maluku dan Malut | 16,002 | 45.14 | 10,760 | 15.37 | -- | -- | 5,242 | 29.78 |
| Papua | 31,879 | 60.13 | 9,210 | 16.49 | -- | -- | 22,669 | 43.64 |
| Distribusi Bali | 44,140 | 183.53 | 15,055 | 90.51 | 14,121 | 43.21 | 14,964 | 49.81 |
| NTB | 163,759 | 148.96 | 7,400 | 19.12 | 959 | 0.43 | 155,400 | 129.42 |
| NTT | 26,998 | 34.82 | 7,199 | 9.98 | 11 | 0.04 | 19,788 | 25 |
| PT PLN Batam | 15,668 | 69.33 | 15,668 | 69.33 | -- | -- | -- | -- |
| PT PLN Tarakan | 1,649 | 3.64 | 553 | 1.57 | -- | -- | 1,096 | 2.08 |
| **Outside Java** | **2,251,456** | **1,801.80** | **640,113** | **560.27** | **35,574** | **12.17** | **1,575,769** | **1,229.4** |
| **Java** | **1,239,666** | **3,405.74** | **899,644** | **2,026.30** | **17,966** | **126.96** | **322,056** | **1,252.5** |
| **Indonesia** | **3,491,122** | **5,207.54** | **1,539,757** | **2,586.57** | **53,540** | **139.13** | **1,897,825** | **2,481.8** |

Source: PLN Statistics 2009.

## 3.2 EXISTING POWER DEVELOPMENT PLAN

### 3.2.1 OVERVIEW

According to the electricity law, there are two national power development plans in Indonesia; RUKN and RUPTL. RUKN is prepared by MEMR as the representative of the Government, and published every year in principle. Under the current Electricity Law, RUKN should be approved by the Parliament. On the other hand, RUPTL is a business plan prepared by PT PLN (Persero) as the PKUK also under the Electricity Law.

The features of RUKN and RUPTL are summarized as below.

| Item | RUKN | RUPTL |
|---|---|---|
| Prepared by | MEMR | PT. PLN (Persero) as PKUK |
| Target duration | 20 years | 10 years |
| Latest edition | RUKN 2008.<br>November 13, 2008. | RUPTL 2010-2019.<br>July 8, 2010. |
| Legislation | Kepmen ESDM No. 2682 K/21/MEM/2008 | Kepmen ESDM No. 2026 K/20/MEM/2010 |
| Contents | - Primary energy potential<br>- Demand forecast | - Demand forecast<br>- Generation & transmission development plan |

Source: JICA Study Team

### 3.2.2 DEMAND FORECAST

Future electricity demand is one of the key issues on evaluating the total amount of hydropower development up to 2027. Therefore, in the section, the Study Team would review the previous demand forecasts, and determine the demand indicator to be referred to the hydropower development up to 2027.

There are some authorized future demand forecasted values; RUKN drafted by MEMR including demand forecast for the coming 20 years, RUPTL drafted by PT PLN predicting the coming 10 years. Other than those two, JICA also conducted several region-wise master plan studies including demand forecasting in the electricity sector. At present, RUKN 2008 issued in November 2008 and RUPTL 2010-2019 issued in June 2010 are the latest authorized documents respectively.

The assumptions used in estimating the demand and power supply in the RUKN and RUPTL can be seen in Table 3.2.1. RUKN estimated that the economy in all areas in Indonesia for 20 years to come (2008-2027) will grow at 6.1 percent per year, and RUPTL did that the value for ten years (2009-2018) will grow at 6.2 percent per year. The latest edition of the RUPTL contains the same figure of 6.1 percent for the rate of GDP growth over the ten-year period 2009 - 2019 for Indonesia as a whole, but has revised rates for the gross regional domestic product (GRDP) in the Java-Madura-Bali (Jamali) region and other regions taken together. In other words, whereas the previous edition foresaw growth in Indonesia as a whole coupled with growth in the outside islands, the latest edition envisions growth driven more strongly by the Jamali region, which has the biggest economy.

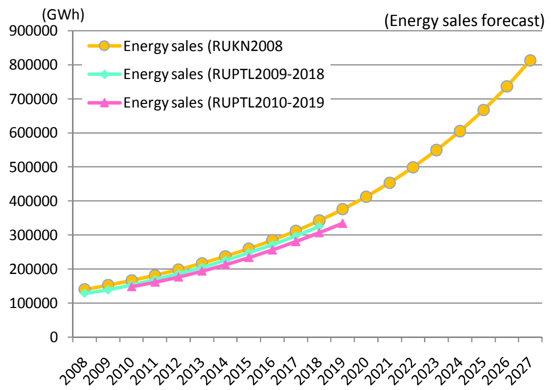
**Table 3.2.1 Basic Assumptions for Demand Forecast**

| Assumptions | RUKN 2008-2027 | RUPTL 2009-2018 | RUPTL 2010-2019 |
|---|---|---|---|
| **1 GDP Growth (%)** | | | |
| - Java-Madura-Bali | 6.1 | 6.0 | 6.2 |
| - Outside Java-Madura-Bali | 6.2 | 6.5 | 6.0 |
| - Indonesia | 6.1 | 6.2 | 6.1 |
| **2 Population Growth (%)** | | | |
| - Java-Madura-Bali | 1.0 | 0.92 | 0.76 |
| - Outside Java-Madura-Bali | 1.7 | 1.52 | 1.40 |
| - Indonesia | 1.3 | 1.17 | 1.02 |
| **3 GDP elasticity** | | | |
| - Java-Madura-Bali | 1.64 | 1.59 | 1.46 |
| - Outside Java-Madura-Bali | 1.34 | 1.59 | 1.64 |
| - Indonesia | 1.51 | 1.57 | 1.50 |
| **4 Energy sales growth (%)** | | | |
| - Java-Madura-Bali | 10.0 | 9.5 | 9.1 |
| - Outside Java-Madura-Bali | 8.3 | 9.9 | 10.7 |
| - Indonesia | 9.2 | 9.7 | 9.3 |

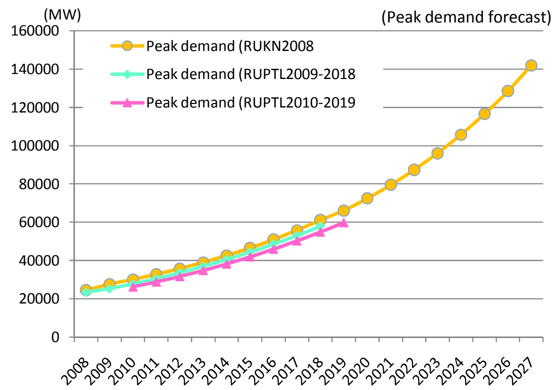
Source : JICA Study Team based on RUKN 2008 and RUPTL 2009-2018, 2010-2019

(1) Nation-wide electricity demand

Owing to assuming high economic growth and large energy elasticity, future demand is forecasted relatively high in RUKN. RUKN predicted that energy demand would be 2.4 fold in 2018, and 5.8 fold in 2027, of the demand in 2008. RUKN and RUPTLs made demand forecast by accumulating the regional demand values in principle. Looking at the future demand in total Indonesia illustrated in Figure 3.2.1, those of RUKN and RUPTLs shaped quite similar. However, RUKN forecasted much larger demands in Jamali and vice versa in outer Jamali, as mentioned in the following. A look at the power demand forecasts in RUPTL 2009 - 2018 and RUPTL 2010 - 2019 reveals that, as compared to the former, the latter foresees a lower GDP elasticity in the Jamali region and a higher GDP elasticity in the outside island region, where a substantial increase in demand is expected. This outlook can also be discerned from the increasing number of customers waiting for connection in the outside islands and the fact that economic growth in areas that have been without electrical power is going to be supported by the firm increase in the power demand along with improvement of the power infrastructure through system interconnection.




(a) Energy demand




(b) Peak load

Source : JICA Study Team based on RUKN2008, RUPTL2009-2018 and 2010-2019

**Figure 3.2.1 Nation-wide Demand Forecast**

(2) Region-wise demand forecast

To determine the future demand condition and to evaluate how much the hydropower candidates can contribute, firstly we have to study demand forecast in each region.

Following are comparisons among previous demand forecasting data in each region. Specifically, we compare several RUPTL's evidences with RUKN2008's and with JICA Study's, which were conducted about Jamali, Sumatra and Sulawesi.

Jamali

The future demand values of RUKN 2008, RUPTL 2009-2018, 2010-2019 and JICA study conducted in 2008 are shown in Figure 3.2.2 , Figure 3.2.3 and Figure 3.2.4 for comparison. In RUKN, the future demand values were impressively boosted compared with other forecasted results. The highest values (high case taking “waiting list” into consideration) in JICA study which are almost the same as those of RUPTL, are still much lower than those of RUKN. An average growth rate of the long-term electric power demand for Jamali region is expected at 10.1% annually in RUKN2008, which is much larger than the forecast value, 6.5% in JICA report. The JICA study team for the study on optimal electric power development in Java-Madura-Bali in the Republic of Indonesia (JICA Jamali study team) pointed out in the report that the discrepancy of future demands was brought mainly by the difference of the GDP elasticity. While the GDP growth rate for coming 20 years is almost the same at 6.1 percent as at 6.0 percent in JICA report, the GDP elasticity is 1.64 much higher than around 1.1 to 1.2 in JICA report. This is not in line with the national target of one[2] in the future articulated in the National Energy Policy and other governmental documents stated in the previous chapter. MEMR explains the difference results from the waiting list shown in Table 3.1.23. The materialized

[2] Exactly, this value is energy elasticity, not electricity elasticity mentioned here.

demand does not reflect the underlying actual demand due to the constrained power supply.

Generally speaking, government authorities and responsible business entities are liable to overestimate future demand values which are the most important fundamentals of power development planning, so as to hedge the delay of project installations as is often the case. As far as the evidences of medium term demand forecast represent, however, each value could be taken consistent (Figure 3.2.3).

In this study, demand forecast itself is out of scope, and appropriate development of hydropower generation in total generation development plan is main concern, so that the Study Team won't examine the existing demand forecast results.

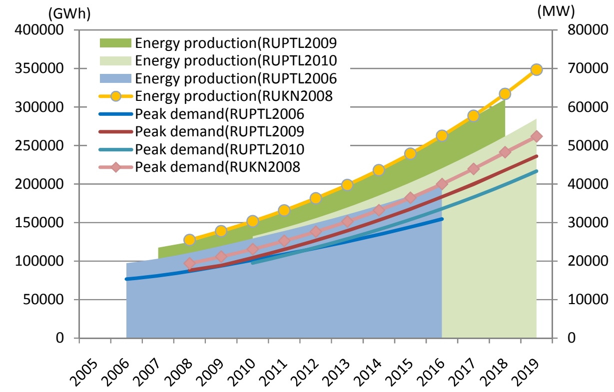
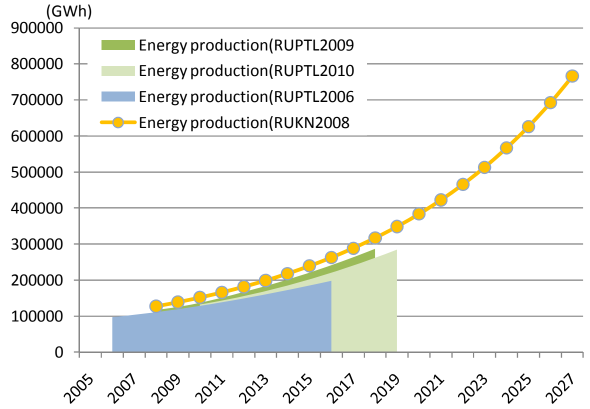
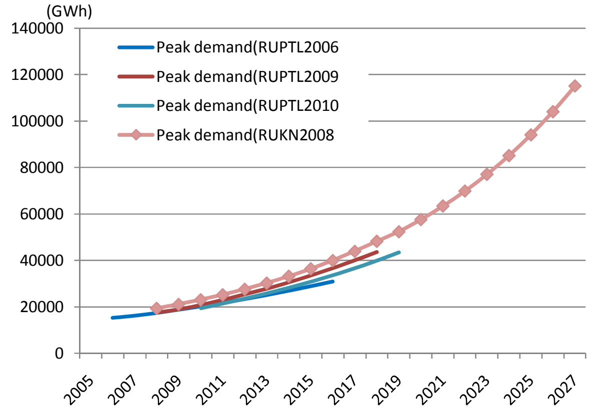



**Figure 3.2.2 Transition of demand forecast (Java-Madura-Bali System)**

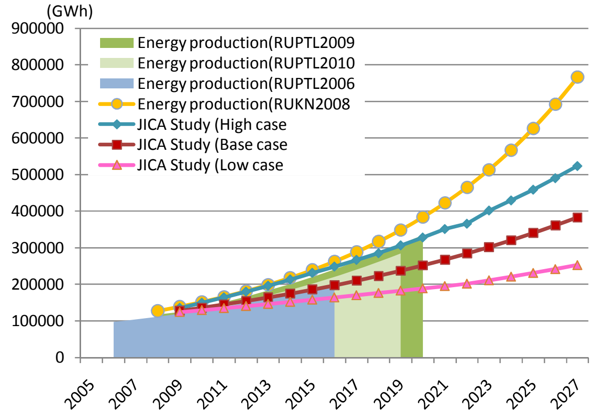



Energy production

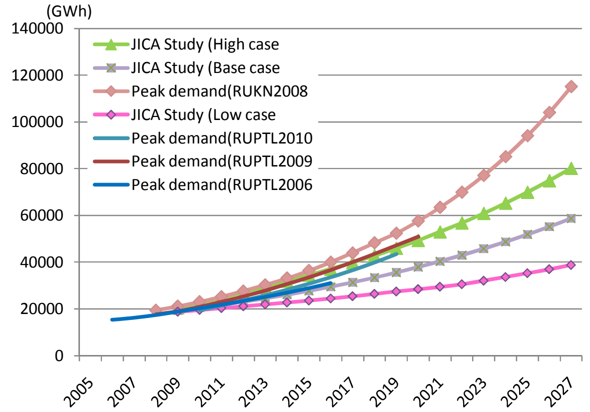



Peak demand

**Figure 3.2.3 Comparison among RUPTLs and RUKN (Java-Madura-Bali System)**




Energy production




Peak demand

**Figure 3.2.4 Comparison among Evidences and JICA Study (Java-Madura-Bali System)**

Sumatra

For Sumatera, JICA conducted a master plan study in 2005 including demand forecast, which results are also illustrated as compared with the results of RUKN and RUPTLs in Figure 3.2.6 and Figure 3.2.7.

RUPTLs and RUKN forecasted similar demand growth while JICA study estimated lower growth as base case. This is because the JICA Study was implemented in 2005, and its demand forecast does not reflect the prosperity in more recent years.

For reference purposes, it may be noted that the "high case" forecast figures in the JICA Study, which approximate those of the RUKN forecast, envision rates of 7.2 percent for the average annual increase in consumption in the northern Sumatra system and a corresponding 7.7 percent in the southwestern Sumatra system. The corresponding actual figures in PLN Statistics 2006 - 2009 are 7.9 and 8.8 percent in the respective systems based on an identical definition. The actual figures in each case are slightly higher. Given this burgeoning demand situation, there appears to be a need for revision and comparison of future demand forecasts, including the RUKN figures, by a third party.

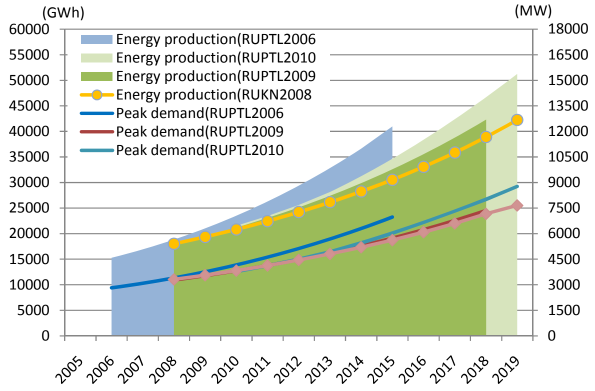
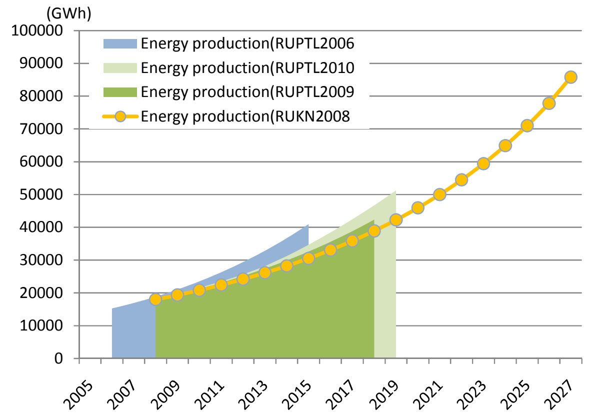
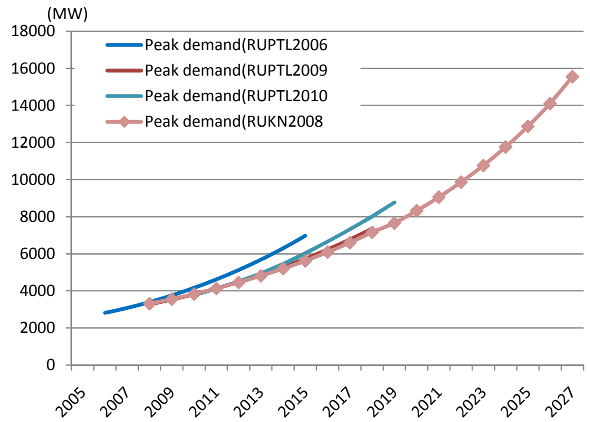



**Figure 3.2.5 Transition of demand forecast (Sumatra system)**

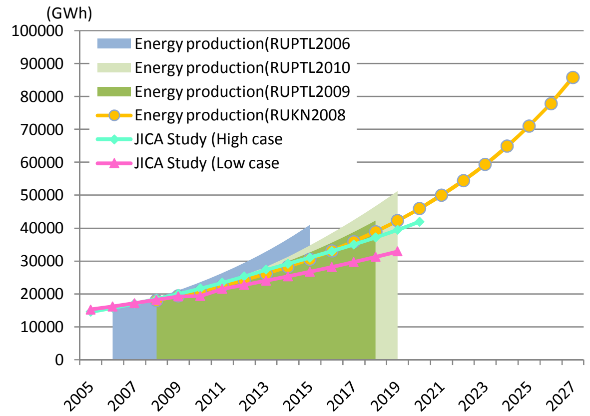



Energy production

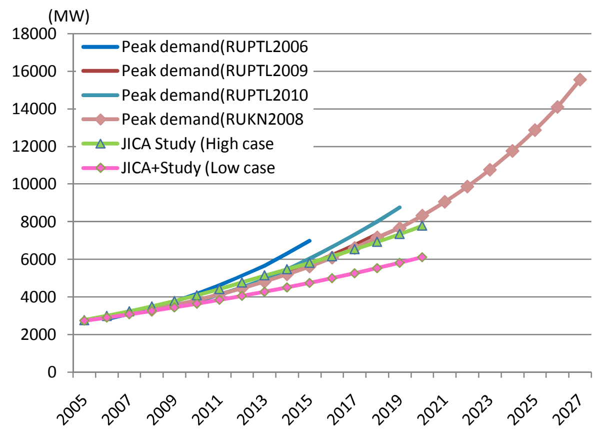



Peak demand

**Figure 3.2.6 Comparison among RUPTLs and RUKN (Sumatra System)**




Energy production




Peak demand

**Figure 3.2.7 Comparison among evidences and JICA Study (Sumatra System)**

Sulawesi

For Sulawesi, JICA conducted a master plan study in 2008 including demand forecast. In that study, some discussion on the demand forecast was seen, which was caused by the estimation of suppressed demand, waiting list and GDP elasticity as was the case with Jamali region. RUPTL forecasted the highest demand and 1.5 times higher than RUKN in 2018. As was mentioned in the former JICA Study, this suggests a possibility that the gap between two sets of forecast figures reflects differences deriving from the forecast approach applied by each.

In the former JICA Study, the demand forecast utilized the GRDP as the major indicator. In addition, the Study presented two sets of forecast figures (base case and high case) based on the current status of the potential demand represented by load shedding and the waiting list. As shown in Figure 3.2.10, while the figures for generating-end energy output in RUPTL trace basically the same trend as in the high case of the JICA Study, the RUPTL figures for peak power are still higher. The major factor behind this divergence is the different outlooks on future load factor.

The Study Team examined the forecast figures in RUKN, RUPTL, and the former JICA Study (for generating-end energy output and peak power) in terms of systems (see Figure 3.2.11 and Figure 3.2.12).

It can be seen that, although both the RUKN and RUPTL forecast figures follow the roughly the same trend in the case of the northern system (Suluttenggo), there is a big gap between the two in that of the southern system (Sulselrabar). More specifically, in 2019, there is a discrepancy of more than 40 percent in respect of both the electrical energy and peak power between RUKN 2008 and RUPTL 2010-2019 in the case of the Sulselrabar system. The emergence of a gap in excess of the reserve margin is undesirable as it may invite a lack of conformance in power development plans. As such, there is a need for revision of the RUKN forecast figures.

In connection with the peak power forecast figures, Table 3.2.2 notes the estimates of load factor in each forecast. It should be noted that there is a big difference between the latest and the previous RUPTL editions in respect of load factor estimates. The following factors are conceivable causes.

- ✓ Excessive posting to assure reserve capacity
- ✓ Influence of customers waiting for connection and the time of connection of pure captive power
- ✓ Assessment of effective DSM and SSM
- ✓ Close examination of the estimated load curve at the time of system interconnection

Estimation of load factors likewise requires full examination and assessment because of the influence on the power generation capacity required.

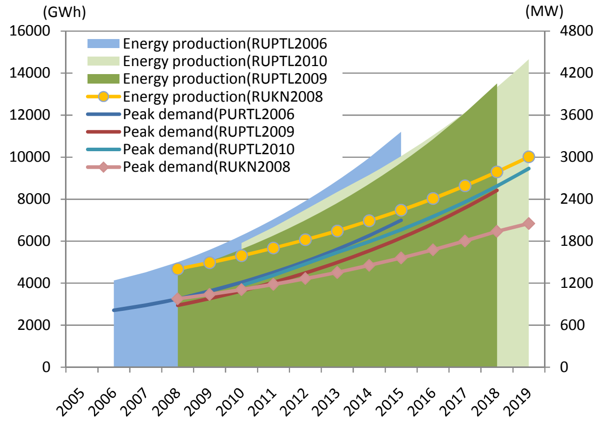
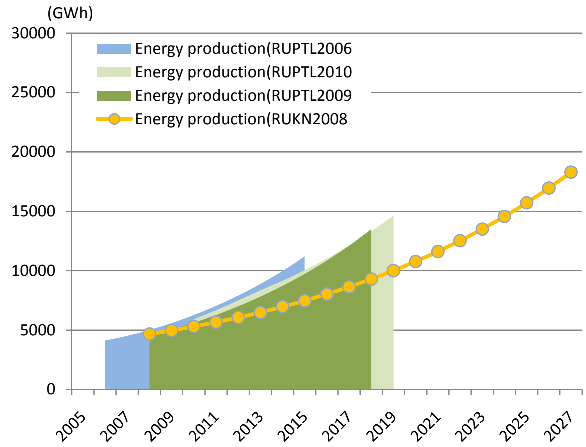
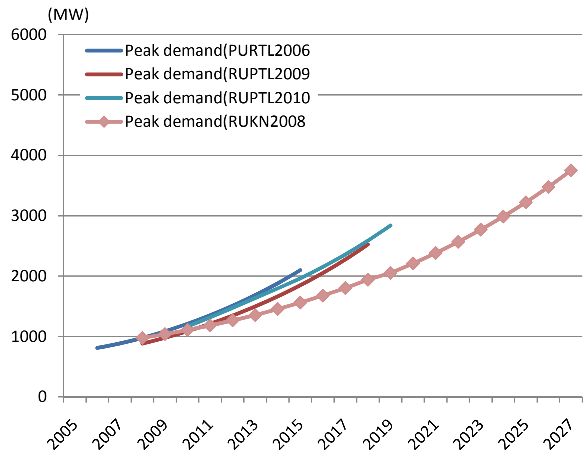



**Figure 3.2.8 Transition of demand forecast (Sulawesi System)**

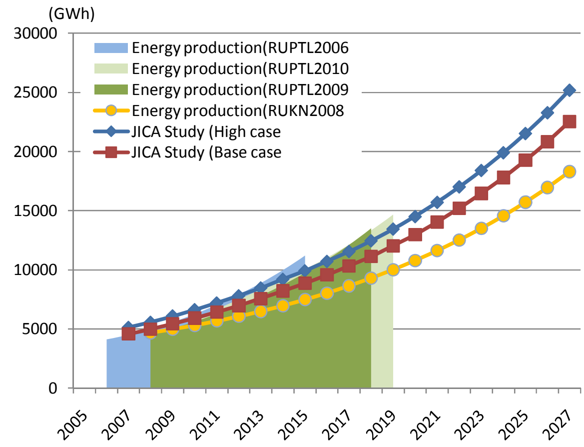



Energy production

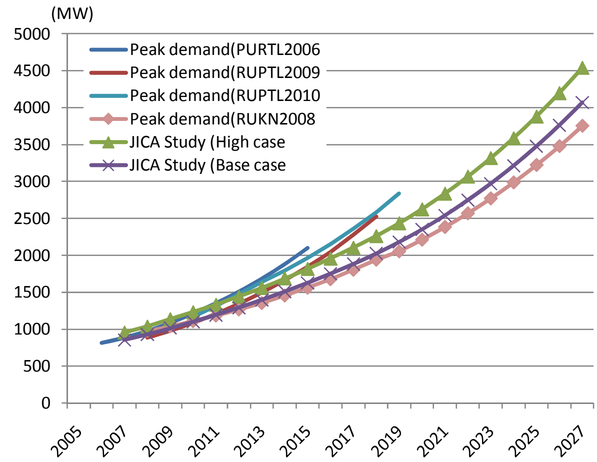



Peak demand

**Figure 3.2.9 Comparison among RUPTLs and RUKN (Sulawesi system)**




Energy production




Peak demand

**Figure 3.2.10 Comparison among evidences and JICA Study (Sulawesi System)**

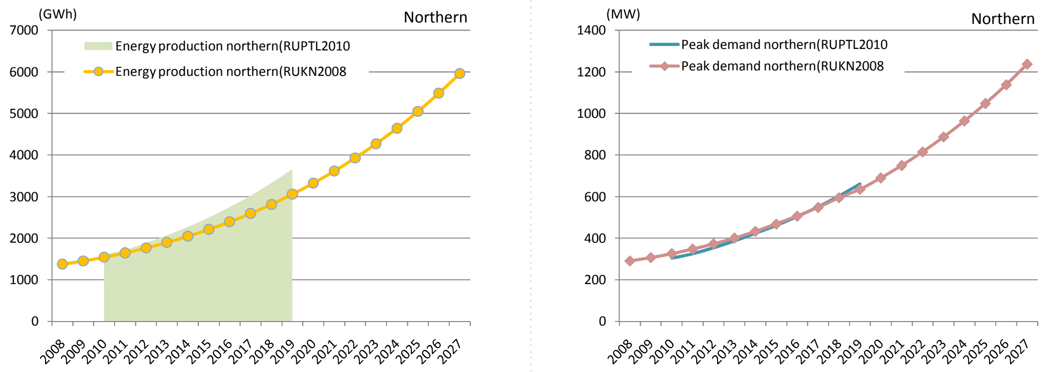



**Figure 3.2.11 Comparison between RUKN2008 and RUPTL2010 in Northern Sulawesi**

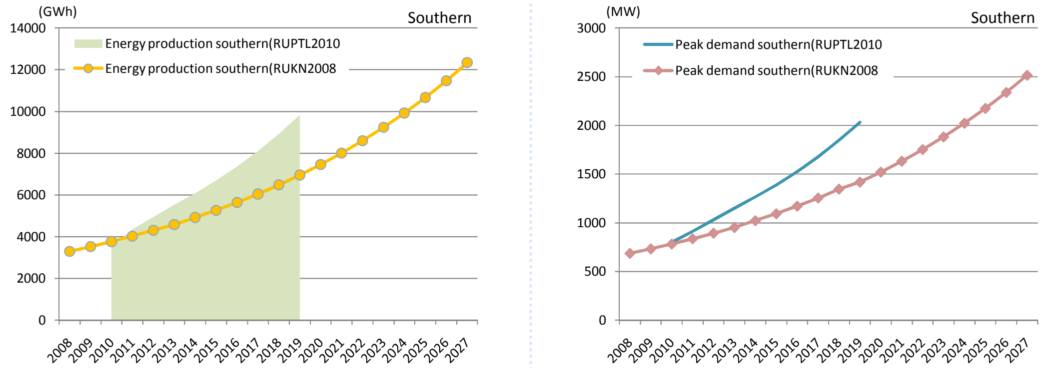



**Figure 3.2.12 Comparison between RUKN2008 and RUPTL2010 in Southern Sulawesi**

**Table 3.2.2 Load Factor Comparison among evidences and JICA Study (Sulawesi)**

| Northern area | | | | Year | Southern area | | | |
|---|---|---|---|---|---|---|---|---|
| JICA Study | RUPTL 2009-2018 | RUPTL 2010-2019 | RUKN 2008 | | JICA Study | RUPTL 2009-2018 | RUPTL 2010-2019 | RUKN 2008 |
| **52.2(*** | | | | **2007** | **36.0(*** | | | |
| **68.6(*** | | | | **2008** | **67.9(*** | | | |
| **54.8(*** | | | | **2009** | **65.1(*** | | | |
| 56.4 | 54.2 | 60.0(** | 54 | **2010** | 63.9 | 64.3 | 50.3 | 55 |
| 56.3 | 57.4 | 62.9(** | 54 | **2018** | 63.6 | 65.3 | 55.1 | 55 |
| 58.8 | | 63.3(** | 55 | **2019** | 65.2 | | 55.2 | 56 |
| 59.8 | | | 55 | **2027** | 65.2 | | | 56 |

*) Record **) Not considered diversity factor

Souce) JICA Study team based on PLN Statistics 2007, 2008, 2009, RUKN2008, RUPTL2010-2019 and Optimal Electric Power Development in Sulawesi(2008, JICA Study).

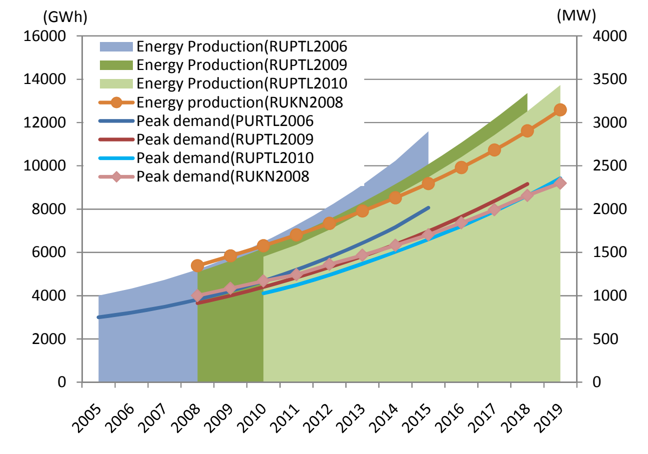
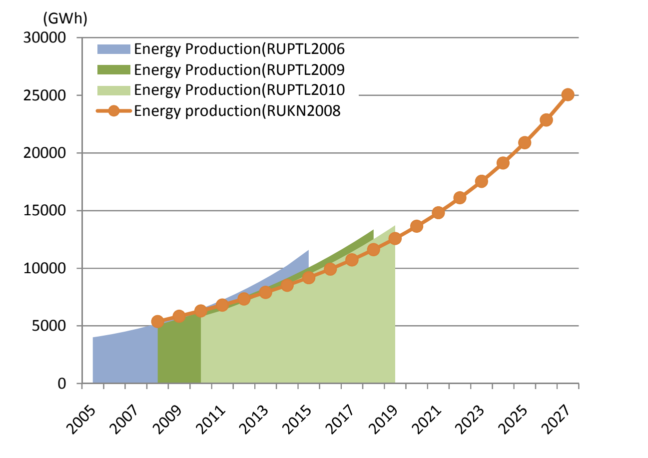
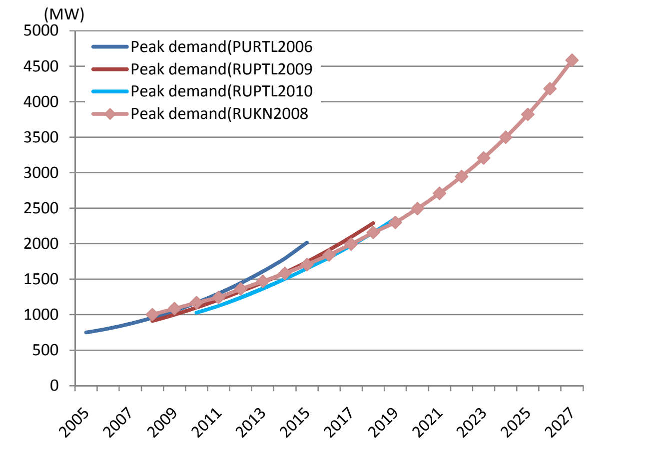



**Figure 3.2.13 Transition of demand forecast (Kalimantan System)**




Energy production




Peak demand

**Figure 3.2.14 Comparison among RUPTLs and RUKN (Kalimantan System)**

Kalimantan

The demand forecast figures in RUPTL are revised slightly on a yearly basis, and exhibit a trend of convergence toward the figures for forecast demand in RUKN 2008. In the same way, the RUPTL forecast consistently predicts an expansion of the demand over the years, and is apparently prepared merely by revision based on the actual demand in the base year. Considering this point, the RUKN 2008 demand forecast merits a certain positive evaluation.

IBT (NTT, NTB, Maluku, Papua)

Figure 3.2.15 - Figure 3.2.22 compare demand forecasts for NTT, NTB, Maluku, and Papua. In Indonesia Bagian Timur (IBT), there is a substantial gap between RUKN 2008 and RUPTL 2010-2019 for all islands except Maluku. In respect of generating-end output in 2019, the size of this gap is 46 percent for NTB, 56 percent for NTT, 30 percent for Papua, and 16 percent for Maluku respectively. These levels cannot be tolerated with a reserve margin target of 40 percent.

The following section summarizes the RUKN 2008 forecast and RUPTL forecast in each region.

- The RUPTL forecast for electrical energy in NTB is premised on a demand that is higher than the RUKN 2008 electrical energy forecast. The demand forecast in RUPTL was revised upward in the 2009-2018 edition. The RUPTL 2010-2019 edition basically follows the RUPTL 2009 - 2018 edition.
- The RUPTL forecast for electrical energy in NTT is premised on a demand that is higher than the RUKN 2008 electrical energy forecast. The demand forecast in RUPTL was revised upward in the 2009-2018 edition, and the 2010-2019 edition reflects a slight upward revision against the 2009-2018 edition.
- The RUPTL forecast for electrical energy in Maluku is premised on a demand that is slightly higher than the RUKN 2008 electrical energy forecast. The demand forecast in RUPTL is steadily being revised downward somewhat by the year, and is converging toward the RUKN 2008 figures.
- The latest RUPTL forecast for electrical energy in Papua is premised on a demand that is higher than the RUKN 2008 electrical energy forecast. The demand forecast in RUPTL was revised upward in the 2010 edition.
- In each region, the latest RUPTL peak demand forecast is higher than the RUKN 2008 peak demand forecast.

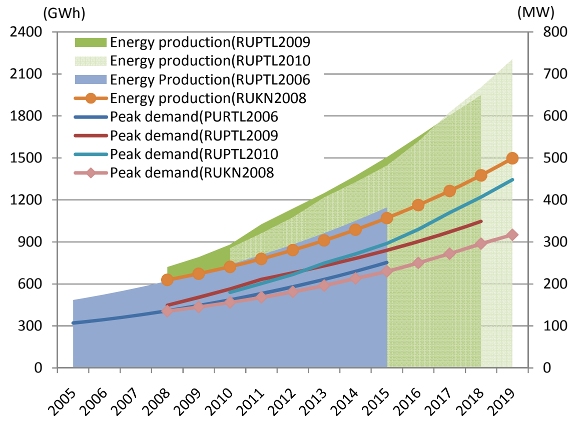



**Figure 3.2.15 Transition of demand forecast (NTB)**

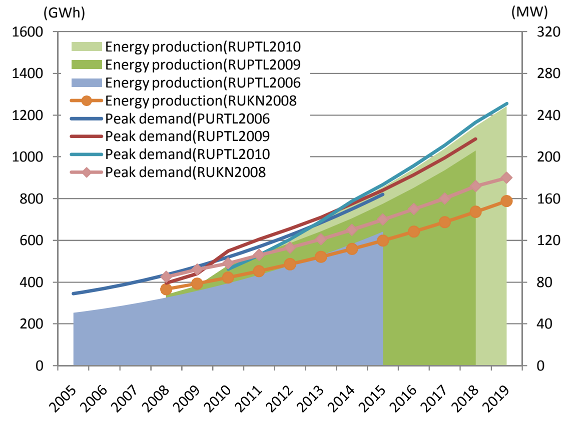
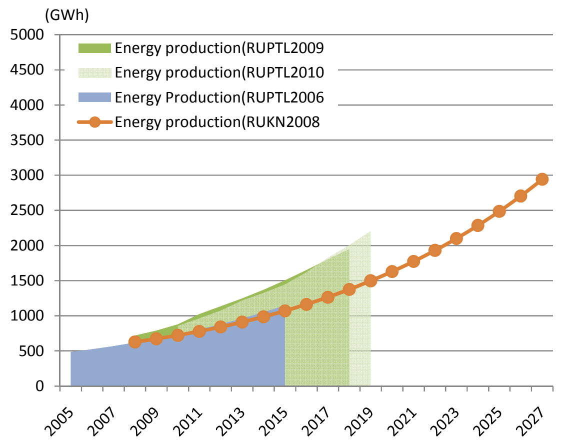
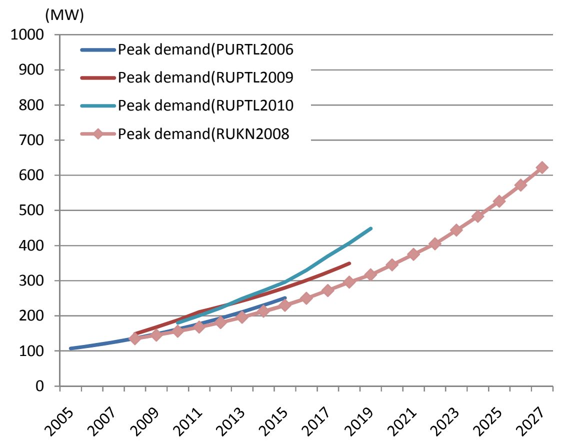



**Figure 3.2.16 Transition of demand forecast (NTT)**

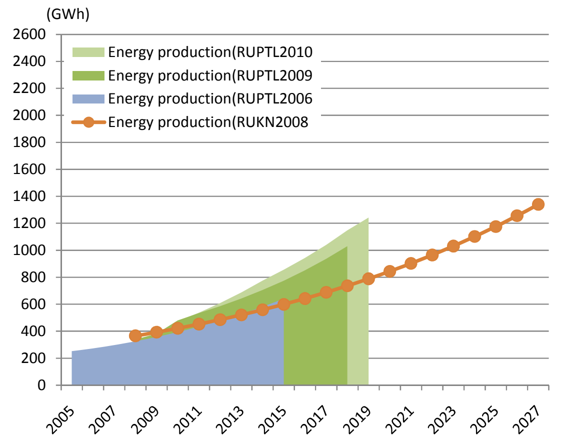



Energy production

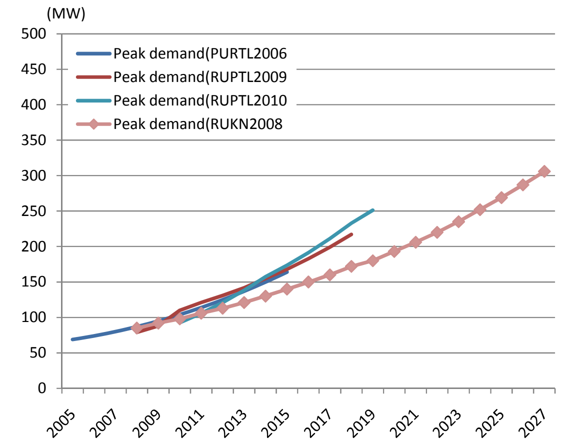



Peak demand

**Figure 3.2.17 Comparison among Evidences (NTB)**

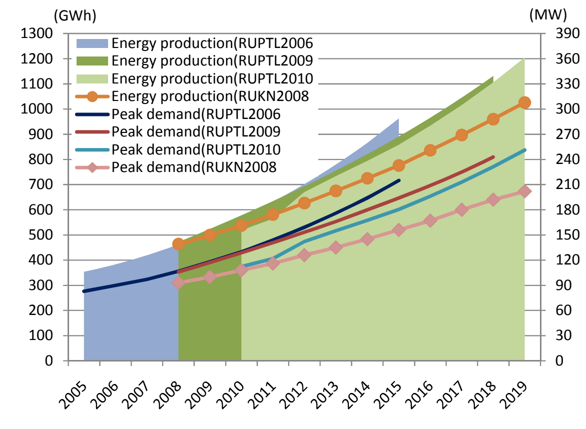



Energy production




Peak demand

**Figure 3.2.18 Comparison among Evidences (NTT)**



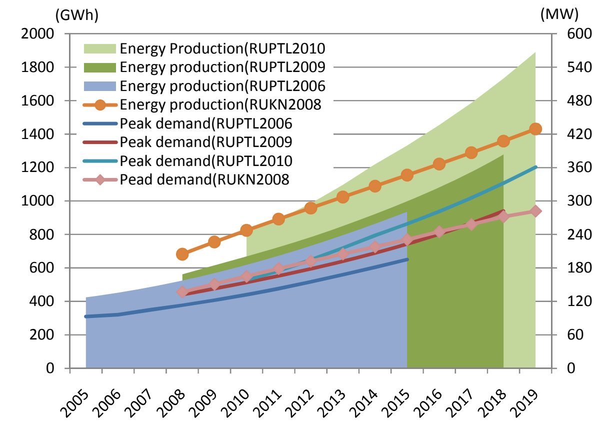
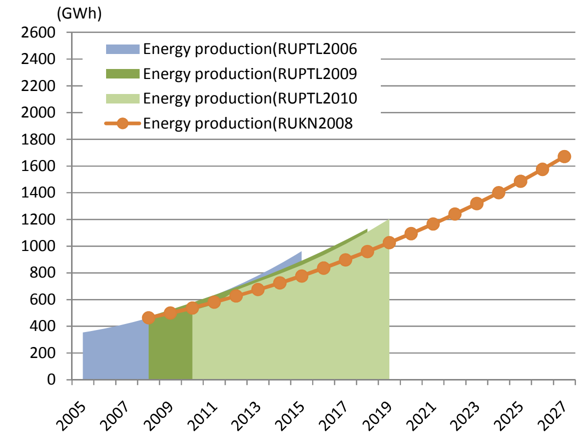
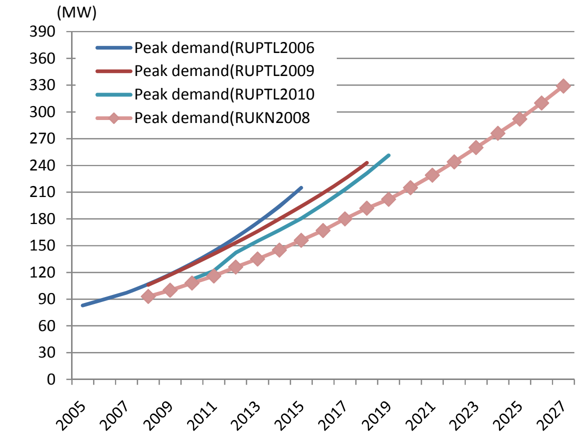




**Figure 3.2.19 Transition of demand forecast (Maluku)**

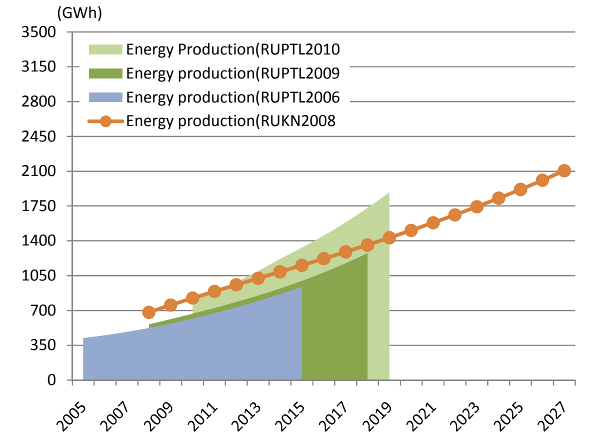
**Figure 3.2.20 Transition of demand forecast(Papua)**



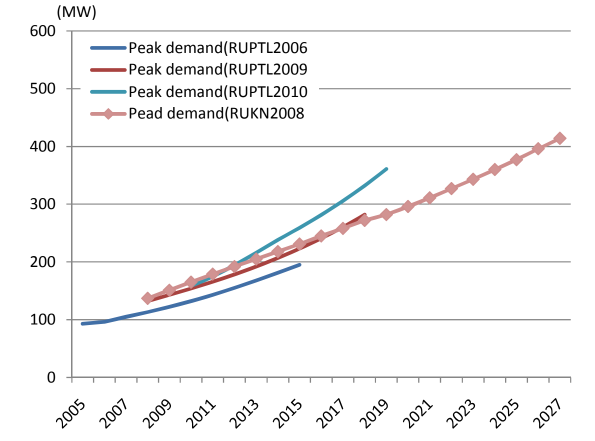

Energy production




Peak demand




Energy production




Peak demand

**Figure 3.2.21 Comparison among Evidences (Maluku)**

**Figure 3.2.22 Comparison among Evidences (Papua)**

In IBT, the systems are on a small scale and have lower power sales and peak power than the four major island systems (Jamali, Sulawesi, and Kalimantan). Therefore, a slight change in forecast sensitivity is apt to result in major changes in the forecast figures. In addition, as shown in Table 3.2.3, it cannot be denied that the available generation capacity has been steadily declining, and that the situation is critical for the supply-demand balance. As related above, with a view to securing a sufficient supply capability as well, it would make sense to estimate the demand on the high side and prepare firm supply plans for it.

At the same time, there are certain facts that go beyond the level of high demand forecasts. In particular, the RUPTL forecast figures are generally higher than the RUKN ones because of a difference in the growth rate forecast deriving from the strong increase in the power demand in recent years. As shown in Table 3.2.3, the increase in the power demand in recent years has far outstripped the growth rate forecast in RUKN 2008. This actual increase is driving up the demand forecast figures.

As for the assessment by region, the forecasts for the other regions except for Maluku are higher than the RUKN forecasts mainly because of the low electrification rates. As compared to the other regions, Maluku has a much higher electrification rate and also exhibits a fairly high figure for kWh sold per capita of population. In the other regions, the electrification rate is below 30 percent, and a steep rise in the residential demand acts as a favorable factor. As indicated by the mean E figure in Table 3.2.3 (A / (D x 8760) x 100 (%)), the trend has been flat over the last four years in NTT and Maluku but steadily rising in NTB and Papua. In IBT, the available generation capacity is shrinking in each case, as shown by the figures for rated capacity in the table, and this indicates exposure to the risk of tighter supply. The increase in the E value in NTB and Papua under a situation of uniform risk of supply tightening has a big impact on the projection for demand increase.

Another factor is the figure for the latent demand indicated by the waiting list. Generally, there is an approximately 10-percent component of customers waiting for connection and supply. This fact is not in conflict with adding a certain margin for upward revision to the demand forecast.

In regard to the peak power forecast, Table 3.2.4 presents information concerning load factors. The high load factors in recent years derive from a shortage of peak power supply in the situation of shrinking available generation capacity, and do not serve as a reference for higher peak power. The estimate of load factors in the area of 55 percent reflects the standard thinking of provision for margin in the power demand in this region, where the residential demand accounts for the majority, and is not necessarily a figure to be negated.

**Table 3.2.3 Records and parameters concerning IBT systems**

| Items \ Regions | NTB | | | | NTT | | | | Maluku | | | | Papua | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2006 | 2007 | 2008 | 2009 | 2006 | 2007 | 2008 | 2009 | 2006 | 2007 | 2008 | 2009 |
| Gene.-end energy(GWh) < A > | 550 | 615 | 678 | 752 | 306 | 342 | 366 | 417 | 375 | 429 | 448 | 468 | 536 | 595 | 669 | 731 |
| Incr. volume(GWh) < B > | - | 65 | 63 | 74 | - | 36 | 24 | 51 | - | 54 | 19 | 20 | - | 59 | 74 | 62 |
| Growth rate (%) < C = B/A> | | (‘06-‘07) 11.9 | (‘07-‘08) 10.3 | (‘08-‘09) 10.8 | | (‘06-‘07) 11.8 | (‘07-‘08) 7.0 | (‘08-‘09) 14.1 | | (‘06-‘07) 14.3 | (‘07-‘08) 4.5 | (‘08-‘09) 4.4 | | (‘06-‘07) 11.1 | (‘07-‘08) 12.4 | (‘08-‘09) 9.3 |
| Ave. growth rate RUPTL2010 | 11.1 | | | | 11.3 | | | | 9.86 | | | | 9.86 | | | |
| Ave. growth rate RUKN2008 | 8.33 | | | | 7.21 | | | | 7.08 | | | | 6.53 | | | |
| Electrification ratio(%) | 27.8 | 29.0 | 29.2 | 29.3 | 21.8 | 21.3 | 22.5 | 22.8 | 51.6 | 52.1 | 55.0 | 56.3 | 27.9 | 27.5 | 27.1 | 27.9 |
| kWh sold/Capita (kWh) | 119.3 | 133.0 | 142.5 | 155.4 | 64.3 | 70.6 | 74.7 | 82.8 | 155.7 | 172.6 | 176.5 | 182.7 | 180.1 | 194.4 | 212.9 | 232.8 |
| Total contracted(MVA) <D > | 288.65 | 306.05 | 324.29 | 343.41 | 215.44 | 227.2 | 256.60 | 266.58 | 230.47 | 244.82 | 267.75 | 283.13 | 289.88 | 308.33 | 327.40 | 343.89 |
| A/(D×8760)×100 (%) <E> | 21.8 | 22.9 | 23.9 | 25.0 | 16.2 | 17.1 | 16.3 | 17.9 | 18.6 | 20.0 | 19.1 | 18.9 | 21.1 | 22.1 | 23.3 | 24.3 |
| Rated Capacity(MVA) | 110.58 | 111.63 | 98.36 | 97.88 | 73.76 | 80.24 | 78.25 | 73.40 | 123.38 | 108.38 | 93.21 | 92.05 | 109.89 | 99.39 | 92.99 | 93.49 |
| Waiting list(MVA) | 80.112 | 99.092 | 116.11 | 129.85 | 21.771 | 28.697 | 18.235 | 24.840 | 1.229 | 2.556 | 8.275 | 29.775 | 19.502 | 42.949 | 38.687 | 43.640 |
| Pure Captive (MVA) | 11.257 | 11.257 | 11.257 | 11.257 | 2.018 | 2.626 | 2.626 | 2.533 | - | - | - | 30.763 | - | - | - | - |
| Reserve Captive(MVA) | 15.038 | 15.038 | 25.606 | 25.606 | 7.867 | 8.017 | 9.077 | 9.378 | - | 4.825 | 16.940 | - | - | - | - | - |

Source : Made by JICA Study Team based on PLN Statistics 2006,2007,2008,2009, RUKN 2008, and RUPTL2010-2019

**Table 3.2.4 Load Factor records, and predictions in RUKN2008 and RUPTL2010-2019**

| Regions | 2007 | 2008 | 2009 | Items | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NTB | **72.8** | **87.3** | **64.8** | RUPTL2010 | 54.3 | 54.8 | 55.2 | 55.8 | 55.8 | 55.7 | 56.0 | 56.4 | 56.3 | 56.2 |
| | | | | RUKN2008 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 54 |
| NTT | **53.1** | **79.6** | **56.7** | RUPTL2010 | 58.5 | 58.0 | 57.4 | 56.8 | 56.2 | 56.2 | 56.2 | 56.2 | 56.2 | 56.5 |
| | | | | RUKN2008 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 50 |
| Maluku | **58.3** | **68.8** | **49.6** | RUPTL2010 | 53.0 | 53.2 | 54.0 | 54.3 | 54.3 | 54.5 | 54.6 | 54.6 | 54.8 | 54.9 |
| | | | | RUKN2008 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 58 |
| Papua | **55.0** | **71.3** | **64.9** | RUPTL2010 | 54.8 | 54.5 | 54.6 | 54.6 | 54.8 | 54.9 | 55.0 | 55.1 | 55.3 | 55.4 |
| | | | | RUKN2008 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 58 |

Source) JICA Study Team based on PLN Statistics 2007, 2008, 2009, RUKN 2008 and RUPTL 2010-2019

(3) Decision of Demand Forecasting Indicator

The RUKN 2008 forecast is the most applicable as a demand forecast for the years leading up to 2027 and thus shall be used as the basis to formulate the hydropower development master plan in this Study.

Meanwhile where a significant gap with other forecast figures is found in the review presented above and there is a certain justification for the other figures, these other figures shall be also referred for the purpose of comparative study.

From the foregoing review, it may be concluded that the there is a wide gap between RUKN 2008 and RUPTL, and especially the latest edition (RUPTL 2010-2019), as regards the demand forecasts in the Sulawesi (properly speaking, Sulselrabar), NTB, NTT, and Papua regions.

It was consequently decided to obtain figures for the prospective demand up to 2027 in these four regions by a simple calculation. The calculation is grounded in linear increase in the demand in each regional system shown in RUPTL 2010-2019 over the period beginning in 2020 by application of the reasonable value for the demand increase rate shown in RUPTL 2010 - 2019. In the years beginning in 2020, the demand increase rate is generally anticipated to follow a trend of moderate decline. For this reason, linear increase based on use of the reasonable value in calculation of the prospective demand in the period in question would also make sense for the purpose of preventing an excessively low demand forecast. It should also be noted that the peak power calculation ignored the diversity factor and was made by adding up the peak power figures in each system.

The following section presents the individual results in each region.

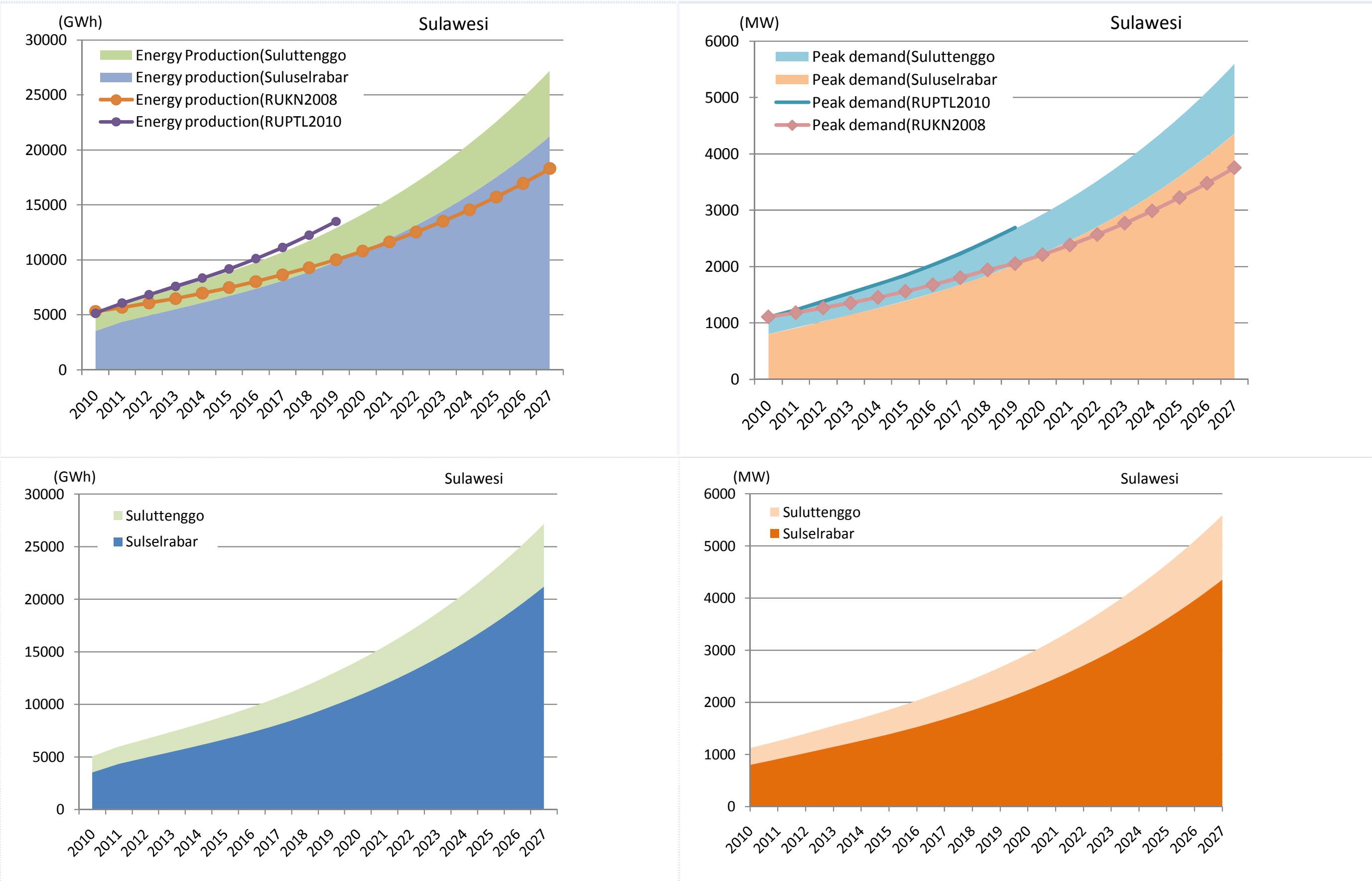



**Figure 3.2.23 Individual examination concerning regional demand forecast (Sulawesi)**

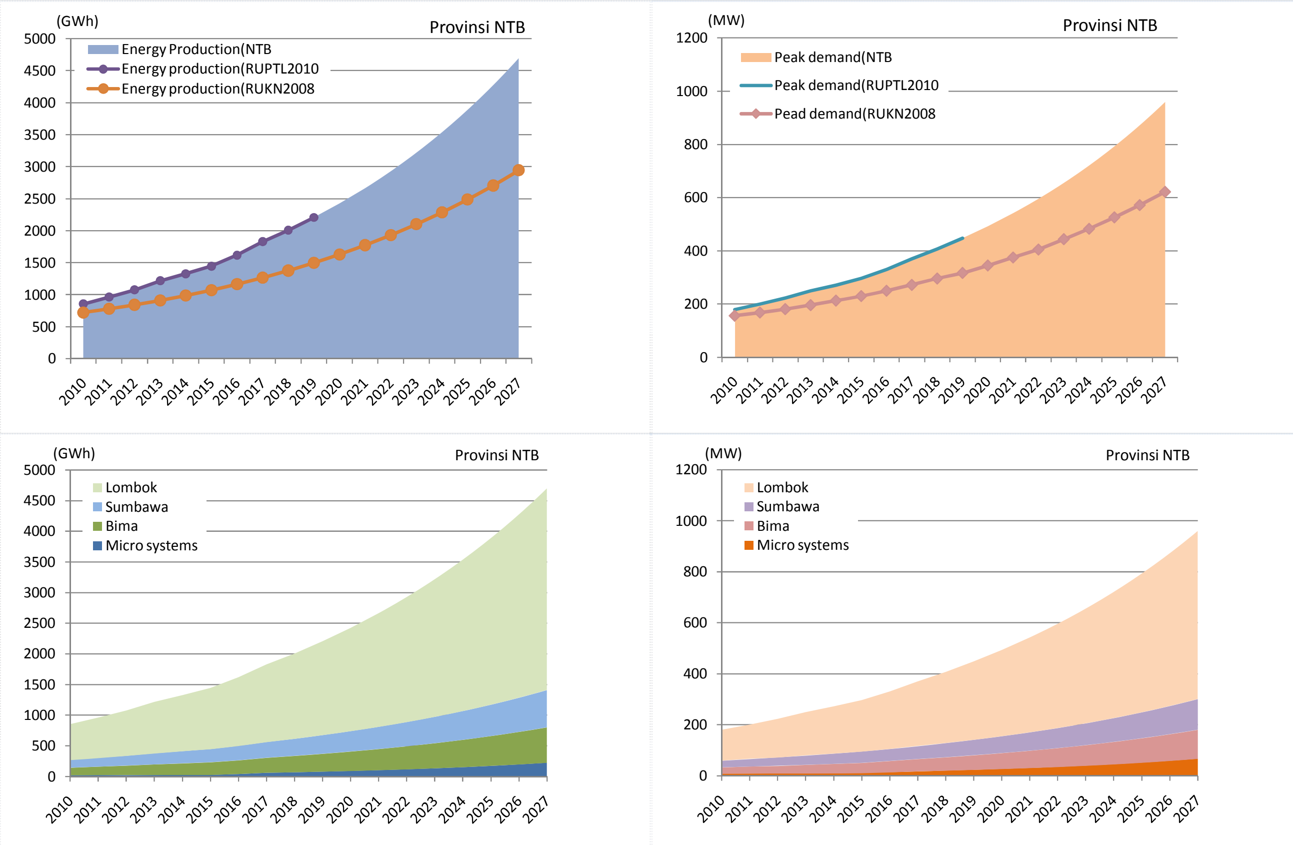



**Figure 3.2.24 Individual examination concerning regional demand forecast (NTB)**

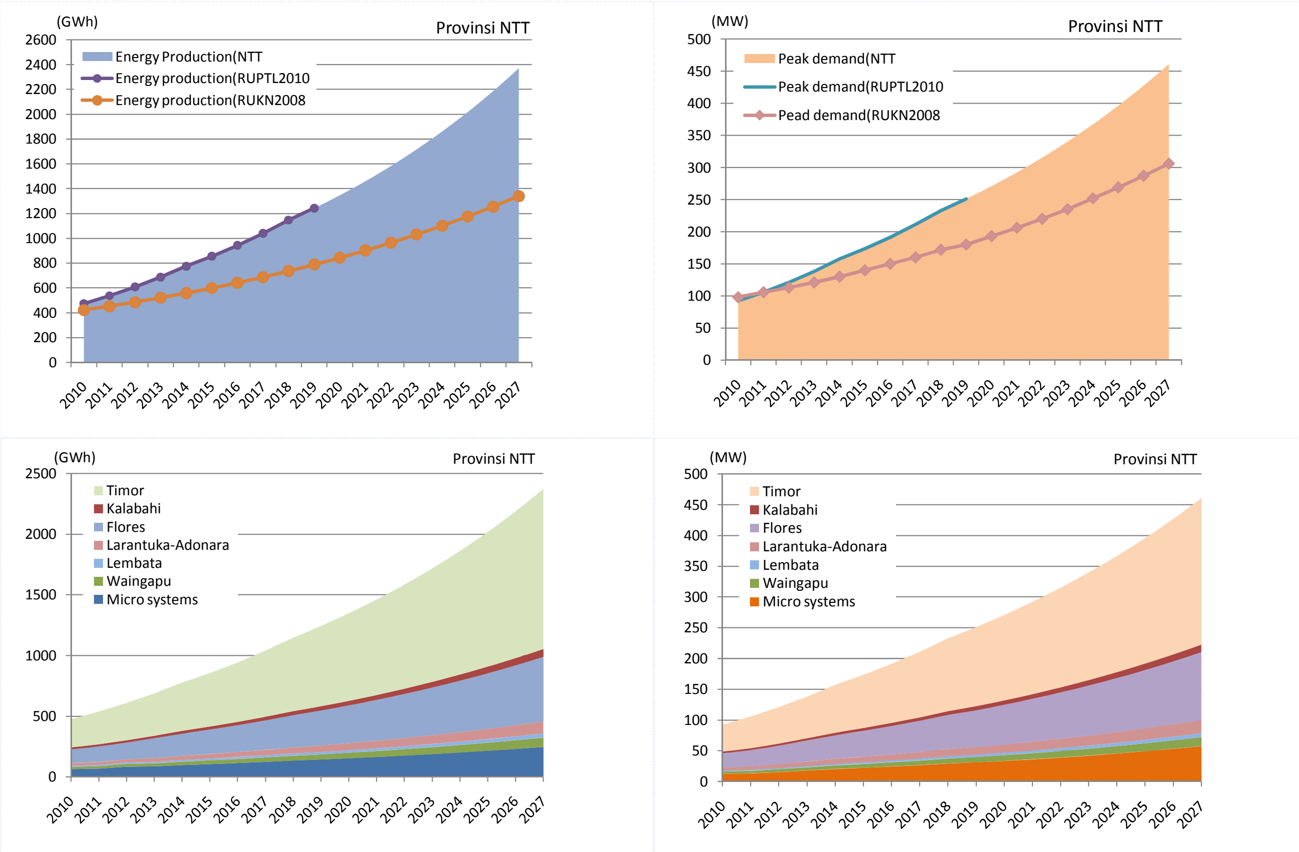



**Figure 3.2.25 Individual examination concerning regional demand forecast (NTT)**

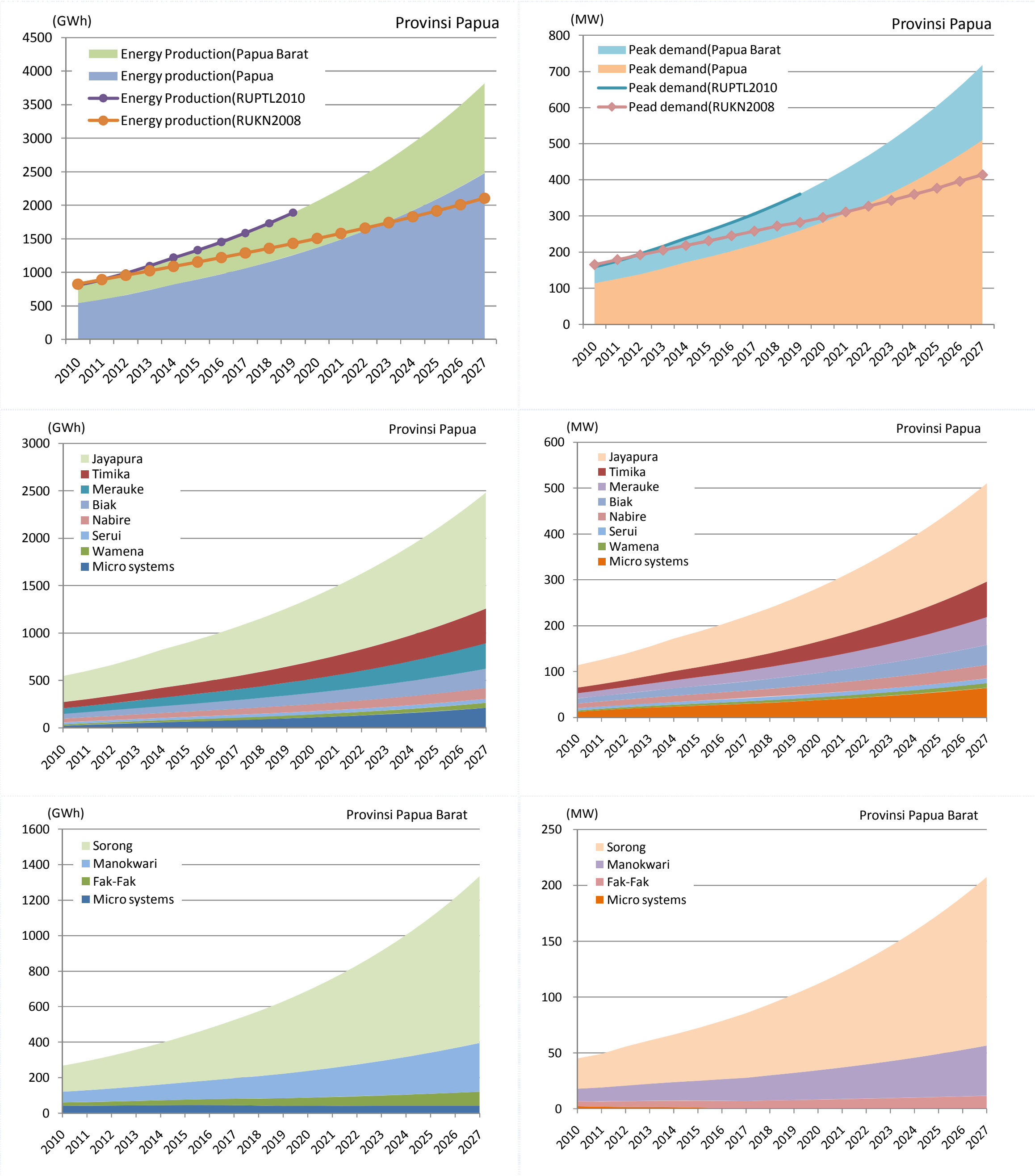



**Figure 3.2.26 Individual examination concerning regional demand forecast (Papua/Papua Barat)**

Table below shows the indicators that can be applied in the Study based on aforementioned individual examinations.

**Table 3.2.5 Future demand indicator**

| Demand / Items | Applied demand forecast | Demand in 2027 for measure | | |
|---|---|---|---|---|
| | | Energy production (GWh) | Peak demand (MW) | Energy sales (GWh) |
| Java-Madura-Bali | RUKN2008 | 766,300 | 115,102 | 684,197 |
| Sumatra | RUKN2008 | 85,813 | 15,549 | 76,619 |
| Sulawesi | Northern “Sulutenggo” : RUKN2008 | 5,959 | 1,237 | 5,297 |
| | Southern “Sulselrabar” : RUKN2008<br>(Reference value assembled RUPTL) | 12,341<br>(21,223) | 2,516<br>(4,358) | 10,912 |
| Kalimantan | RUKN2008 | 25,059 | 4,584 | 21,840 |
| Maluku | RUKN2008 | 1,671 | 329 | 1,526 |
| NTB | RUKN2008<br>(Reference value assembled RUPTL) | 2,943<br>(4,696) | 622<br>(959) | 2,628 |
| NTT | RUKN2008<br>(Reference value assembled RUPTL) | 1,340<br>(2,372) | 306<br>(461) | 1,230 |
| Papua | RUKN2008<br>(Reference value assembled RUPTL) | 2,106<br>(3,819) | 414<br>(736) | 1,890 |

## Table 3.2.6 Estimation of future demand for Sulselrabar

| **Sulselrabar** | ***2010*** | ***2011*** | ***2012*** | ***2013*** | ***2014*** | ***2015*** | ***2016*** | ***2017*** | ***2018*** | ***2019*** | ***2020*** | ***2021*** | ***2022*** | ***2023*** | ***2024*** | ***2025*** | ***2026*** | ***2027*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUPTL and estimation | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 3532.9 | 4352.6 | 4935.4 | 5523.2 | 6075.2 | 6684.5 | 7457.2 | 8100.2 | 8921.3 | 9828.8 | 10821.5 | 11914.5 | 13117.8 | 14442.8 | 15901.5 | 17507.5 | 19275.8 | 21222.6 |
| Growth (%) | | ***23.2*** | ***13.4*** | ***11.9*** | ***10.0*** | ***10.0*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.2*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.1*** | ***10.1*** |
| Demand (MW) | 799.8 | 910.4 | 1029.4 | 1149.9 | 1263.5 | 1388.6 | 1527.0 | 1679.5 | 1847.7 | 2033.2 | 2236.5 | 2460.2 | 2706.2 | 2976.8 | 3274.5 | 3601.9 | 3962.1 | 4358.3 |
| Growth (%) | | ***13.8*** | ***13.1*** | ***11.7*** | ***9.9*** | ***9.9*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** |

## Table 3.2.7 Estimation of future demand for Papua province

| P. Papua | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUPTL and estimation | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 545.1 | 600.6 | 633.5 | 739.6 | 824.9 | 897.7 | 976.9 | 1063.3 | 1158.2 | 1261.9 | 1372.7 | 1493.5 | 1625.1 | 1768.5 | 1924.7 | 2095.1 | 2280.7 | 2483.0 |
| Growth (%) | 9.2 | 9.5 | 10.3 | 10.3 | 8.1 | 8.1 | 8.1 | 8.1 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8,.1 | 8.2 |
| Demand (MW) | 113.6 | 125.9 | 138.8 | 154.5 | 171.9 | 186.7 | 202.7 | 220.1 | 239.1 | 260.0 | 282.7 | 307.5 | 334.5 | 363.9 | 396.0 | 431.0 | 469.2 | 510.9 |
| Growth (%) | 9.8 | 9.3 | 1.2 | 10.1 | 7.9 | 7.9 | 7.9 | 7.9 | 8.0 | 8.0 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.2 |
| Jayapura | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 272.3 | 295.9 | 323.5 | 360.3 | 401.5 | 437.1 | 475.9 | 518.2 | 564.3 | 614.7 | 670.0 | 730.3 | 796.1 | 867.7 | 945.8 | 1030.9 | 1123.7 | 1224.83 |
| Growth (%) | | 8.7 | 9.3 | 11.4 | 11.4 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 |
| Demnd (MW) | 48.7 | 52.8 | 57.6 | 63.9 | 71.1 | 77.2 | 83.9 | 91.1 | 99.9 | 107.6 | 117.3 | 127.8 | 139.4 | 151.9 | 165.6 | 180.5 | 196.7 | 214.4 |
| Growth (%) | | 8.4 | 9.1 | 10.9 | 11.3 | 8.6 | 8.7 | 8.6 | 8.7 | 8.7 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 |
| Wamena | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 14.9 | 16.0 | 17.3 | 19.0 | 20.9 | 22.5 | 24.2 | 26.1 | 28.0 | 30.2 | 32.3 | 34.6 | 37.0 | 40.0 | 42.4 | 45.3 | 48.5 | 51.9 |
| Growth (%) | | 7.4 | 8.1 | 9.8 | 10.0 | 7.7 | 7.6 | 7.9 | 7.3 | 7.9 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Demand (MW) | 2.9 | 3.1 | 3.4 | 3.7 | 4.1 | 4.4 | 4.7 | 5.1 | 5.5 | 5.9 | 6.3 | 6.8 | 7.2 | 7.7 | 8.3 | 8.9 | 9.5 | 10.1 |
| Growth (%) | | 6.9 | 9.7 | 8.8 | 10.8 | 7.3 | 6.8 | 8.5 | 7.8 | 7.3 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Biak | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 52.0 | 56.2 | 61.0 | 67.4 | 74.6 | 80.7 | 87.2 | 94.3 | 102.0 | 110.3 | 119.1 | 128.7 | 139.0 | 150.1 | 162.1 | 175.0 | 189.0 | 204.2 |
| Growth (%) | | 8.1 | 8.5 | 10.5 | 10.7 | 8.2 | 8.1 | 8.1 | 8.2 | 8.1 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Demand (MW) | 11.3 | 12.1 | 13.1 | 14.5 | 16.0 | 17.3 | 18.6 | 20.1 | 21.7 | 23.4 | 25.3 | 27.3 | 29.5 | 31.8 | 34.4 | 37.1 | 40.1 | 43.3 |
| Growth (%) | | 7.1 | 8.3 | 10.7 | 10.3 | 8.1 | 7.5 | 8.1 | 7.9 | 7.8 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Serui | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 20.0 | 20.9 | 21.9 | 23.4 | 25.0 | 26.1 | 27.3 | 28.5 | 29.8 | 31.2 | 32.5 | 33.75 | 35.1 | 36.5 | 38.0 | 39.5 | 41.1 | 42.7 |
| Growth (%) | | 4.5 | 4.8 | 6.9 | 6.8 | 4.4 | 4.6 | 4.4 | 4.6 | 4.7 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Demand (MW) | 4.8 | 5.0 | 5.3 | 5.6 | 6.0 | 6.3 | 6.6 | 6.9 | 7.3 | 7.6 | 7.9 | 8.2 | 8.6 | 8.9 | 9.3 | 9.6 | 10.0 | 10.4 |
| Growth (%) | | 4.2 | 6.0 | 5.7 | 7.1 | 5.0 | 4.8 | 4.6 | 5.8 | 4.1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Merauke | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 60.7 | 66.0 | 72.0 | 80.1 | 89.2 | 97.0 | 105.5 | 114.7 | 124.8 | 135.8 | 148.0 | 161.3 | 175.9 | 191.7 | 209.0 | 227.8 | 248.3 | 270.6 |
| Growth (%) | 8.7 | 9.1 | 11.3 | 11.4 | 8.7 | 8.8 | 8.7 | 8.8 | 8,8 | 8.8 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 |
| Demand (MW) | 11.5 | 12.6 | 14.0 | 15.7 | 17.7 | 19.5 | 21.4 | 23.6 | 26.0 | 28.6 | 31.5 | 34.6 | 38.1 | 41.9 | 46.1 | 50.7 | 55.7 | 61.3 |
| Growth (%) | | 9.6 | 11.1 | 12.1 | 12.7 | 10.2 | 8.7 | 10.3 | 10.2 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Nabire | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 39.3 | 41.7 | 44.5 | 48.4 | 52.7 | 56.0 | 59.5 | 63.2 | 67.2 | 71.5 | 75.8 | 80.3 | 85.2 | 90.3 | 95.7 | 101.4 | 107.5 | 114.0 |
| Growth (%) | | 6.1 | 6.7 | 8.8 | 8.9 | 6.3 | 6.3 | 6.2 | 6.3 | 6.4 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Demand (MW) | 10.0 | 10.7 | 11.4 | 12.4 | 13.5 | 14.4 | 15.3 | 16.3 | 17.3 | 18.5 | 19.6 | 20.8 | 22.0 | 23.4 | 24.8 | 26.3 | 27.8 | 29.5 |
| Growth (%) | | 7.0 | 6.5 | 8.8 | 8.9 | 6.7 | 6.3 | 6.5 | 6.1 | 6.9 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Timika | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 64.6 | 71.4 | 79.4 | 90.0 | 102.0 | 112.9 | 125.0 | 138.5 | 153.4 | 170.0 | 197.0 | 205.7 | 226.3 | 248.9 | 273.8 | 301.2 | 331.3 | 364.4 |
| Growth (%) | | 10.5 | 11.2 | 13.4 | 13.3 | 10.7 | 10.7 | 10.8 | 10.8 | 10.8 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Demand (MW) | 12.3 | 13.7 | 15.3 | 17.4 | 19.8 | 22.0 | 24.5 | 27.2 | 30.2 | 33.6 | 37.3 | 41.4 | 45.95 | 51.0 | 56.6 | 62.9 | 69.8 | 77.4 |
| Growth (%) | | 11.4 | 11.7 | 13.7 | 13.8 | 11.1 | 11.4 | 11.0 | 11.0 | 11.3 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Micro sys. | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 21.3 | 32.5 | 43.9 | 51.0 | 59.0 | 65.4 | 72.3 | 79.8 | 88.7 | 98.2 | 108.0 | 118.8 | 130.7 | 143.8 | 158.2 | 174.0 | 191.4 | 210.5 |
| Growth (%) | | 52.6 | 35.1 | 16.2 | 15.7 | 10.9 | 10.6 | 10.4 | 11.2 | 10.7 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Demand (MW) | 12.1 | 15.9 | 18.7 | 21.3 | 23.7 | 25.6 | 27.7 | 29.8 | 32.1 | 34.8 | 37.6 | 40.6 | 43.8 | 47.4 | 51.1 | 55.2 | 59.6 | 64.4 |
| Growth (%) | | 31.4 | 17.6 | 13.8 | 11.3 | 8.0 | 8.2 | 7.6 | 7.7 | 8.4 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |

## Table 3.2.8 Estimation of future demand for West Papua province

| P. Papua Barat | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUPTL and estimation | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 266.3 | 291.7 | 322.2 | 356.7 | 394.9 | 434.6 | 477.2 | 523.4 | 574.0 | 628.8 | 690.4 | 757.5 | 831.7 | 913.5 | 1003.9 | 1103.8 | 1214.1 | 1336.0 |
| Growth (%) | | 9.5 | 10.5 | 10.7 | 10.1 | 9.8 | 9.7 | 9.7 | 9.6 | 9.6 | 9.8 | 9.7 | 9.8 | 9.8 | 9.9 | 10.0 | 10.0 | 10.0 |
| Demand (MW) | 45.2 | 49.3 | 55.7 | 61.3 | 66.5 | 72.2 | 78.6 | 85.4 | 92.9 | 100.9 | 111.9 | 122.1 | 133.3 | 145.6 | 159.0 | 173.7 | 189.8 | 207.3 |
| Growth (%) | | 9.1 | 13.0 | 10.1 | 8.5 | 8.6 | 8.9 | 8.7 | 8.8 | 8.6 | 10.9 | 9.2 | 9.2 | 9.2 | 9.2 | 9.3 | 9.3 | 9.3 |
| Sorong | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 146.7 | 164.2 | 185.3 | 208.2 | 234.1 | 262.3 | 293.4 | 327.8 | 365.9 | 408.0 | 452.9 | 502.7 | 558.0 | 619.4 | 687.5 | 763.1 | 847.1 | 940.3 |
| Growth (%) | | 12.0 | 12.9 | 12.4 | 12.4 | 12.1 | 11.9 | 11.7 | 11.6 | 11.5 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Demnd (MW) | 27.1 | 30.2 | 34.8 | 38.8 | 42.7 | 47.1 | 52.1 | 57.7 | 63.7 | 70.3 | 77.3 | 85.1 | 93.6 | 102.9 | 113.2 | 124.5 | 137.0 | 150.7 |
| Growth (%) | | 11.4 | 15.2 | 11.5 | 10.1 | 10.3 | 10.6 | 10.8 | 10.4 | 10.4 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Manokwari | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 60.2 | 66.0 | 73.0 | 80.2 | 88.3 | 96.9 | 106.1 | 116.1 | 126.9 | 138.5 | 151.0 | 164.6 | 179.4 | 195.5 | 213.0 | 232.3 | 253.2 | 276.0 |
| Growth (%) | | 9.6 | 10.6 | 9.9 | 10.1 | 9.7 | 9.5 | 9.4 | 9.3 | 9.1 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 | 9.0 |
| Demand (MW) | 11.4 | 12.5 | 14.0 | 15.3 | 16.5 | 17.8 | 19.3 | 20.8 | 22.5 | 24.3 | 26.2 | 28.3 | 30.6 | 33.1 | 35.7 | 38.6 | 41.6 | 45.0 |
| Growth (%) | | 9.7 | 12.0 | 9.3 | 7.8 | 7.9 | 8.4 | 7.8 | 8.2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Fak-Fak | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 19.0 | 20.8 | 23.0 | 25.2 | 27.7 | 30.4 | 33.2 | 36.3 | 39.6 | 43.1 | 46.6 | 50.3 | 54.3 | 58.6 | 63.3 | 68.4 | 73.9 | 79.8 |
| Growth (%) | | 9.5 | 10.6 | 9.6 | 9.9 | 9.8 | 9.2 | 9.3 | 9.1 | 8.8 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Demand (MW) | 4.4 | 4.7 | 5.2 | 5.6 | 5.9 | 6.2 | 6.6 | 7.0 | 7.5 | 7.9 | 8.3 | 8.7 | 9.2 | 9.6 | 10.1 | 10.6 | 11.1 | 11.7 |
| Growth (%) | | 6.8 | 10.6 | 7.7 | 5.4 | 5.1 | 6.5 | 6.1 | 7.1 | 5.3 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Micro sys. | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 40.4 | 40.7 | 40.9 | 43.1 | 44.8 | 45.0 | 44.5 | 43.2 | 41.6 | 39.2 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 |
| Growth (%) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Demand (MW) | 2.3 | 1.9 | 1.7 | 1.6 | 1.4 | 1.1 | 0.6 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Growth (%) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## Table 3.2.9 Estimation of future demand for NTB province

| P. NTB | *2010* | *2011* | *2012* | *2013* | *2014* | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* | *2024* | *2025* | *2026* | *2027* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUPTL and estimation | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 856 | 962 | 1075.9 | 1218.3 | 1326.7 | 1445.9 | 1618.7 | 1827.4 | 2006.8 | 2206.7 | 2424.5 | 2664.0 | 2927.4 | 3217.1 | 3535.6 | 3886.0 | 4271.5 | 4695.5 |
| Growth (%) | | ***12.4*** | ***11.8*** | ***13.2*** | ***8.9*** | ***9.0*** | ***12.0*** | ***12.9*** | ***9.8*** | ***10.0*** | ***9.9*** | ***9.9*** | ***9.9*** | ***9.9*** | ***9.9*** | ***9.9*** | ***9.9*** | ***9.9*** |
| Demand (MW) | 179.9 | 200.5 | 222.6 | 249.2 | 271.6 | 296.2 | 330.0 | 369.9 | 406.9 | 448.1 | 492.7 | 541.7 | 595.7 | 655.2 | 720.6 | 792.7 | 872.0 | 959.4 |
| Growth (%) | | ***11.5*** | ***11.0*** | ***12.0*** | ***9.0*** | ***9.1*** | ***11.4*** | ***12.1*** | ***10.0*** | ***10.1*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** |
| Lombok | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 586..6 | 658.5 | 741.3 | 839.7 | 915.3 | 999.0 | 1120.1 | 1266.4 | 1392.1 | 1532.4 | 1685.6 | 1854.2 | 2039.6 | 2243.6 | 2468.0 | 2714.7 | 2986.2 | 3284.8 |
| Growth (%) | | ***12.3*** | ***12.5*** | ***13.3*** | ***9.0*** | ***9.1*** | ***12.1*** | ***13.1*** | ***9.9*** | ***10.1*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** |
| Demnd (MW) | 120.7 | 134.3 | 151.5 | 169.6 | 185.0 | 202.0 | 225.5 | 253.2 | 278.8 | 307.3 | 338.0 | 371.8 | 409.0 | 450.0 | 494.9 | 544.4 | 598.8 | 658.7 |
| Growth (%) | | ***11.3*** | ***12.8*** | ***12.0*** | ***9.1*** | ***9.2*** | ***11.6*** | ***12.3*** | ***10.1*** | ***10.2*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** | ***10.0*** |
| Sumbawa | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 128.2 | 144.0 | 160.7 | 182.0 | 198.4 | 216.5 | 236.0 | 257.2 | 280.4 | 305.6 | 333.1 | 363.1 | 395.8 | 431.4 | 470.2 | 512.5 | 558.7 | 608.9 |
| Growth (%) | | ***12.3*** | ***11.6*** | ***13.3*** | ***9.0*** | ***9.1*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** |
| Demand (MW) | 26.3 | 29.2 | 3.4 | 36.3 | 39.6 | 43.3 | 46.4 | 50.6 | 55.2 | 60.1 | 65.6 | 71.5 | 77.9 | 84.9 | 92.6 | 100.9 | 110.0 | 119.9 |
| Growth (%) | | ***11.0*** | ***11.0*** | ***12.0*** | ***9.1*** | ***9.3*** | ***7.3*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** |
| Bima | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 121.9 | 136.9 | 152.8 | 173.1 | 188.6 | 205.9 | 224.4 | 244.6 | 266.6 | 290.6 | 316.8 | 345.3 | 376.4 | 410.3 | 447.2 | 487.4 | 531.3 | 579.1 |
| Growth (%) | | ***12.3*** | ***11.6*** | ***13.3*** | ***9.0*** | ***9.2*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** |
| Demand (MW) | 24.5 | 27.3 | 30.2 | 33.9 | 26.9 | 40.3 | 44.2 | 48.1 | 52.5 | 57.2 | 62.4 | 68.0 | 74.1 | 80.8 | 88.0 | 95.9 | 104.6 | 114.0 |
| Growth (%) | | ***11.4*** | ***10.6*** | ***12.3*** | ***8.9*** | ***9.2*** | ***9.6*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.0*** | ***9.;0*** | ***9.0*** | ***9.0*** |
| Micro sys. | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 19.3 | 22.6 | 21.1 | 23.5 | 24.4 | 24.5 | 38.2 | 59.2 | 67.7 | 78.1 | 89.0 | 101.4 | 115.6 | 131.8 | 150.3 | 171.3 | 195.3 | 222.6 |
| Growth (%) | - | - | - | - | - | - | - | - | ***14.4*** | ***15.3*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** |
| Demand (MW) | 8.4 | 9.7 | 8.5 | 9.4 | 10.1 | 10.6 | 13.9 | 17.9 | 20.4 | 23.5 | 26.7 | 30.5 | 34.7 | 39.6 | 45.1 | 51.5 | 58.7 | 66.9 |
| Growth (%) | - | - | - | - | - | - | - | - | ***14.0*** | ***14.7*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** | ***14.0*** |

## Table 3.2.10 Estimation of future demand for NTT province

| P. NTT | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUPTL and estimation | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 474.3 | 537.8 | 608.7 | 687.4 | 775.7 | 855.2 | 943 | 1039.9 | 1147.5 | 1242.7 | 1347.1 | 1460.3 | 1583.2 | 1716.4 | 1860.9 | 2017.7 | 2187.7 | 2372.2 |
| Growth (%) | | *13.4* | *13.2* | *12.9* | *12.9* | *10.3* | *10.3* | *10.3* | *10.3* | *8.3* | *8.4* | *8.4* | *8.4* | *8.4* | *8.4* | *8.4* | *8.4* | *8.4* |
| Demand (MW) | 92.5 | 105.9 | 121.1 | 138.2 | 157.5 | 173.6 | 191.5 | 211.1 | 233.0 | 251.1 | 270.9 | 292.3 | 315.3 | 340.2 | 367.0 | 396.0 | 427.3 | 461.0 |
| Growth (%) | | *14.5* | *14.3* | *14.1* | *14.0* | *10.2* | *10.3* | *10.2* | *10.4* | *7.8* | *7.9* | *7.9* | *7.9* | *7.9* | *7.9* | *7.9* | *7.9* | *7.9* |
| Timor | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 231.7 | 269.7 | 306.8 | 348.6 | 396.4 | 440.5 | 489.7 | 544.5 | 605.5 | 661.0 | 720.5 | 785.3 | 856.0 | 933.1 | 1017.0 | 1108.6 | 1208.3 | 1317.1 |
| Growth (%) | | *16.4* | *13.8* | *13.7* | *13.7* | *11.1* | *11.2* | *11.2* | *11.2* | *9.2* | *9.0* | *9.0* | *9.0* | *9.0* | *9.0* | *9.0* | *9.0* | *9.0* |
| Demnd (MW) | 43.6 | 51.6 | 59.2 | 67.9 | 77.9 | 86.5 | 96.0 | 106.7 | 118.6 | 128.7 | 139.0 | 150.1 | 162.1 | 175.1 | 189.1 | 204.2 | 220.6 | 238.2 |
| Growth (%) | | *18.3* | *14.8* | *14.7* | *14.7* | *11.0* | *11.0* | *11.2* | *11.2* | *8.5* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Kalabahi | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 14.9 | 16.7 | 18.6 | 20.8 | 23.2 | 25.2 | 27.5 | 30.0 | 32.7 | 35.0 | 37.8 | 40.8 | 44.1 | 47.6 | 51.4 | 55.5 | 60.0 | 64.8 |
| Growth (%) | | *12.1* | *11.4* | *11.8* | *11.5* | *8.6* | *9.1* | *9.1* | *9.0* | *7.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Demnd (MW) | 2.7 | 3.1 | 3.5 | 3.9 | 4.4 | 4.8 | 5.2 | 5.7 | 6.2 | 6.6 | 7.1 | 7.7 | 8.3 | 9.0 | 9.7 | 10.5 | 11.3 | 12.2 |
| Growth (%) | | *14.8* | *12.9* | *11.4* | *12.8* | *9.1* | *8.3* | *9.6* | *8.8* | *6.5* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Flores | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 115.3 | 129.6 | 139.3 | 163.4 | 183.5 | 201.5 | 221.3 | 243.2 | 267.3 | 288.5 | 311.6 | 335.5 | 363.4 | 392.5 | 423.9 | 4567.8 | 494.4 | 534.0 |
| Growth (%) | | *12.4* | *7.5* | *17.3* | *12.3* | *9.8* | *9.8* | *9.9* | *9.9* | *7.9* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Demnd (MW) | 23.3 | 26.4 | 29.9 | 33.9 | 38.3 | 42.0 | 46.1 | 50.6 | 55.5 | 59.8 | 64.6 | 69.8 | 75.3 | 81.4 | 87.9 | 94.9 | 102.5 | 110.7 |
| Growth (%) | | *13.3* | *13.3* | *13.4* | *13.0* | *9.7* | *9.8* | *9.8* | *9.8* | *7.8* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Larantuka – Adonara | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 21.4 | 24.1 | 27.1 | 30.4 | 34.2 | 37.5 | 41.2 | 45.2 | 49.6 | 53.5 | 57.8 | 62.4 | 67.4 | 72.8 | 78.6 | 84.9 | 91.7 | 99.0 |
| Growth (%) | | *12.6* | *12.5* | *12.2* | *12.5* | *9.7* | *9.9* | *9.7* | *9.7* | *7.9* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Demnd (MW) | 5.0 | 5.6 | 6.4 | 7.2 | 8.2 | 8.9 | 9.8 | 10.7 | 11.7 | 12.5 | 13.4 | 14.3 | 15.3 | 16.4 | 17.5 | 18.8 | 20.1 | 21.5 |
| Growth (%) | | *12.0* | *14.3* | *12.5* | *13.9* | *8.5* | *10.1* | *9.2* | *9.4* | *6.8* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* |
| Lembata | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 8.5 | 9.4 | 10.5 | 11.6 | 12.9 | 14.0 | 15.1 | 16.4 | 17.8 | 19.0 | 20.3 | 21.8 | 23.3 | 24.9 | 26.7 | 28.5 | 30.5 | 32.7 |
| Growth (%) | | *10.6* | *11.7* | *10.5* | *11.2* | *8.5* | *7.9* | *8.6* | *8.5* | *6.7* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* |
| Demand (MW) | 1.7 | 1.9 | 2.1 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.6 | 3.9 | 4.1 | 4.4 | 4.6 | 4.9 | 5.2 | 5.5 | 5.9 | 6.2 |
| Growth (%) | | *11.8* | *10.5* | *14.3* | *8.3* | *11.5* | *6.9* | *9.7* | *5.9* | *8.3* | *6.0* | *6.0* | *6.0* | *6.0* | *6.0* | *6.0* | *6.0* | *6.0* |
| Waingapu | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 18.1 | 20.3 | 22.6 | 25.2 | 28.1 | 30.6 | 33.3 | 36.3 | 39.6 | 42.4 | 45.8 | 49.5 | 53.4 | 57.7 | 62.3 | 67.3 | 72.7 | 78.5 |
| Growth (%) | | *12.2* | *11.3* | *11.5* | *11.5* | *8.9* | *8.8* | *9.0* | *9.1* | *7.1* | *8.0* | *8.0* | *8.0* | *8,.0* | *8.0* | *8.0* | *8.0* | *8.0* |
| Demand (MW) | 3.5 | 4.0 | 4.5 | 5.0 | 5.7 | 6.2 | 6.7 | 7.3 | 8.0 | 8.5 | 9.1 | 9.7 | 10.4 | 11.1 | 11.9 | 12.8 | 13.7 | 14.6 |
| Growth (%) | | *14.3* | *12.5* | *11.1* | *14.0* | *8.7* | *8.1* | *9.0* | *9.6* | *6.3* | *7.0* | *7.0* | *7.0* | *7.0* | *7,.0* | *7.0* | *7.0* | *7.0* |
| Micro sys. | | | | | | | | | | | | | | | | | | |
| Production (GWh) | 64.4 | 68.0 | 83.9 | 87.4 | 97.4 | 105.9 | 114.9 | 124.3 | 135 | 143.3 | 153.3 | 164.1 | 175.6 | 187.8 | 201.0 | 215.1 | 230.1 | 246.2 |
| Growth (%) | | *5.7* | *23.2* | *4.2* | *11.5* | *8.7* | *8.5* | *8.2* | *8.6* | *6.2* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* | *7.0* |
| Demand (MW) | 12.7 | 13.3 | 15.5 | 17.9 | 20.4 | 22.3 | 24.6 | 26.7 | 29.4 | 31.1 | 33.6 | 36.3 | 39.2 | 42.3 | 45.7 | 49.4. | 53.3 | 57.6 |
| Growth (%) | | *4.9* | *16.3* | *15.4* | *14.0* | *9.3* | *10.3* | *8.5* | *10.1* | *5.8* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* | *8.0* |

## 3.2.3 GENERATION DEVELOPMENT PLAN

### (1) Primary Energy mix for power generation

The primary energy mix for power generation is indicated in RUKN as Table 3.2.11. Oil currently composing 26 percent of total primary energy will be reduced drastically to 2 percent from 2009 to 2011. Compensating the reduction of oil, coal will be increased to 66 percent in 2011 after completing the Fast Track Program I, and keep 60 percent range by the implementation of the Fast Track Program II and other projects. Geothermal will also jump from the current 5 percent to 10 percent range in 2014 when the Fast Track Program II projects are completed. Gas will keep the current level of the latter half of 10 percent range, and hydro will be on the gradual decrease.

**Table 3.2.11 Composition of Primary Energy for Power Generation**

(%)

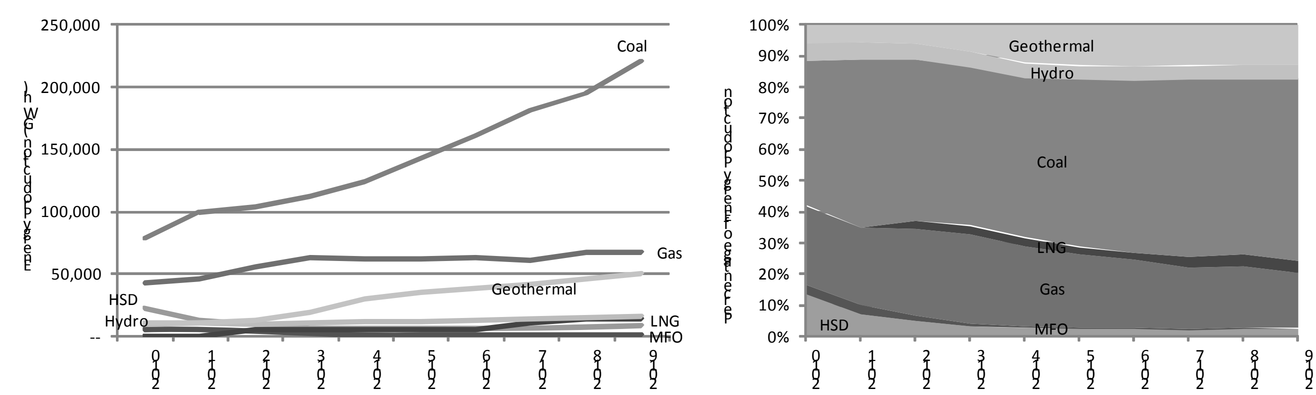
| Primary Energy | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | 45 | 48 | 62 | 66 | 65 | 64 | 64 | 65 | 64 | 64 | 63 |
| Oil | 26 | 19 | 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Geothermal | 5 | 5 | 5 | 6 | 8 | 9 | 10 | 11 | 10 | 11 | 12 |
| Gas*) | 17 | 21 | 21 | 19 | 19 | 19 | 18 | 16 | 18 | 17 | 17 |
| Hydropower | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |

*) Including LNG which will be utilized from the year 2015.

Source: RUKN 2008.

RUPTL also presented the future energy mix for power generation in percentage almost same as the values of RUKN, but more specifically in energy values as illustrated in Figure 3.2.27.

Figure 3.2.27 (a) describes the future picture of energy production more clearly. Coal will keep 60 percent range after 2012 as stated above, but the value itself will jump by more than triple from 66 TWh in 2008 to 229 TWh in 2018. With the significant reduction of oil in actual energy, energy productions by other sources present moderate growth.




(a) Energy production by fuel (b) Percentage of energy production

Source: Assembled by JICA Study Team based on RUPTL.

**Figure 3.2.27 Energy Production by Type of Fuel**

(2) INFRASTRUCTURE SUMMIT

The Government of Indonesia held a meeting inviting leaders of worldwide economic circles in January 2005, in order to promote infrastructure building. In this meeting, aka “Infrastructure Summit”, the government disclosed that total of 145 billion dollars investment in infrastructure building would be required during 2005 – 2009 to achieve 6.6 percent of annual growth, among which 24 billion dollars (17 percent) would be disbursed by the state budget, 30 billion (21 percent) by the domestic money market, 9 billion (6 percent) by the foreign aid, and the rest of 81 billion (54 percent) would be covered by domestic and overseas private investment. At the same time, 91 private infrastructure projects were presented including 12 power projects. In October of the same year, eight IPP projects shown in Table 3.2.12 were officially solicited, and some of them like Cirebon and Paiton expansion are in the development stage. However, others are still under preparation stage, and listed in the power develop plan of RUPTL.

**Table 3.2.12 IPP Projects Announced in Infrastructure Summit 2005**

| No | Project | Location | Capacity (MW) | Investment (mil.US$) | COD |
|---|---|---|---|---|---|
| 1 | PLTU Cirebon | Java Barat | 1×600 | 600 | 2010 |
| 2 | PLTGU Pasuruan | Java Timur | 1×500 | 555 | 2011 |
| 3 | PLTU Java Tengah | Java Tengah | 2×600 | 1,311 | 2011 |
| 4 | PLTU Paiton 3 -4 | Java Timur | 2×400 | 889 | 2012 |
| 5 | PLTU Bali Timur | Bali | 2×100 | 200 | Sep-08 |
| 6 | PLTU Sumut | Sumatera Utara | 2×100 | 200 | 2010 |
| 7 | PLTU Sulut | Sulawesi Utara | 2×25 | 50 | 2010 |
| 8 | PLTU Kaltim | Kalimantan Timur | 2×60 | 120 | 2010 |

Source: JICA Study Team

(3) Fast track program

As stated in the previous chapter, two fast track programs (FTPs) were issued as Presidential Regulations indicating the specific generation projects. The projects nominated in the first Fast Track Program issued in 2006 are indicated in Table 3.2.13. Originally, all of the projects should have been completed by 2010, among which Indramayu, Rembang and Labuhan will be synchronized to the Java Bali system, and others are still under preparation or development stage. The projects in the Fast Track Program I have already been taken into account in RUPTL.

**Table 3.2.13 Project List on the First Fast Track Program**

| No. | | Project | Location | Capacity (MW) | | | | | Year of Commission |
|---|---|---|---|---|---|---|---|---|---|
| 1 | PLTU 2 | Labuan | Banten | 2 | x | 315 | = | 630 | 2009-2010 |
| 2 | PLTU | Indramayu | Jabar Utara | 3 | x | 330 | = | 990 | 2010 |
| 3 | PLTU 1 | Suralaya Unit 8 | Banten | 1 | x | 625 | = | 625 | 2010 |
| 4 | PLTU 3 | Lontar | Banten | 3 | x | 315 | = | 945 | 2010-2011 |
| 5 | PLTU | Pelabuhan Ratu | Jabar Selatan | 3 | x | 350 | = | 1,050 | 2011 |
| 6 | PLTU 1 | Rembang | Jateng | 2 | x | 315 | = | 630 | 2010 |
| 7 | PLTU 2 | Adipala | Jateng | 1 | x | 600 | = | 600 | 2014 |
| 8 | PLTU 1 | Pacitan | Jatim | 2 | x | 315 | = | 630 | 2010-2011 |
| 9 | PLTU 2 | Paiton Unit 9 | Jatim | 1 | x | 660 | = | 660 | 2010 |
| 10 | PLTU 3 | Tanjung Awar-awar | Jatim | 2 | x | 300 | = | 600 | 2013 |
| | | **(subtotal Java-Madura-Bali)** | | | | | | **7,360** | 78.1% |
| 11 | PLTU | Meulaboh | NAD | 2 | x | 110 | = | 220 | 2012 |
| 12 | PLTU 2 | Pangkalan Susu | Sumut | 2 | x | 220 | = | 440 | 2011-2012 |
| 13 | PLTU 1 | Beng-kalis | Riau | 2 | x | 7 | = | 14 | 2012 |
| 14 | PLTU 2 | Selat Panjang | Riau | 5 | x | 5 | = | 25 | 2012 |
| 15 | PLTU | Tanjung Balai | Kepri | 2 | x | 7 | = | 14 | 2010 |
| 16 | PLTU 4 | Belitung | Babel | 2 | x | 16.5 | = | 33 | 2011 |
| 17 | PLTU 3 | Air Anyer | Babel | 2 | x | 30 | = | 60 | 2010-2011 |
| 18 | PLTU | Teluk Sirih | Sumbar | 2 | x | 112 | = | 224 | 2011-2012 |
| 19 | PLTU | Tarahan Baru | Lampung | 2 | x | 110 | = | 220 | 2011-2012 |
| | | **(subtotal Sumatra)** | | | | | | **1,250** | 13.3% |
| 20 | PLTU 1 | Parit Baru | Kalbar | 2 | x | 50 | = | 100 | 2012 |
| 21 | PLTU 2 | Pantai Kura-Kura | Kalbar | 2 | x | 27.5 | = | 55 | 2012 |
| 22 | PLTU 1 | Pulang Pisau | Kalteng | 2 | x | 60 | = | 120 | Retender |
| 23 | PLTU | Asam-Asam | Kalsel | 2 | x | 65 | = | 130 | 2011 |
| | | **(subtotal Kalimantan)** | | | | | | **405** | 4.3% |
| 24 | PLTU 2 | Amurang | Sulut | 2 | x | 25 | = | 50 | 2010-2011 |
| 25 | PLTU | Gorontalo | Gorontalo | 2 | x | 25 | = | 50 | 2011 |
| 26 | PLTU | Kendari | Sulteng | 2 | x | 10 | = | 20 | 2010 |
| 27 | PLTU | Barru | Sulsel | 2 | x | 50 | = | 100 | 2011 |
| | | **(subtotal Sulawesi)** | | | | | | **220** | 2.3% |
| 28 | PLTU | Ambon | Maluku | 2 | x | 15 | = | 30 | Retender |
| 29 | PLTU | Tidore | Maluku Utara | 2 | x | 7 | = | 14 | 2011 |
| | | **(subtotal Maluku)** | | | | | | **44** | 0.5% |
| 30 | PLTU 2 | Jayapura | Papua | 2 | x | 10 | = | 20 | 2011 |
| 31 | PLTU 1 | Timika | Papua | 2 | x | 7 | = | 14 | Retender |
| | | **(subtotal Papua)** | | | | | | **34** | 0.4% |
| 32 | PLTU 2 | Lombok | NTB | 2 | x | 25 | = | 50 | 2011 |
| 33 | PLTU 1 | Bima | NTB | 2 | x | 10 | = | 20 | 2011 |
| | | **(subtotal NTB)** | | | | | | **70** | 0.7% |
| 34 | PLTU 1 | Ende | NTT | 2 | x | 7 | = | 14 | 2010 |
| 35 | PLTU 2 | Kupang | NTT | 2 | x | 15 | = | 30 | 2011 |
| | | **(subtotal NTT)** | | | | | | **44** | 0.5% |
| | | **Total Indonesia** | | | | | | **9,427** | **100.0%** |

Source: RUPTL 2010-2019.

The generation projects listed in the Fast Track Program II were announced in the Ministerial Regulation (Permen ESDM No. 2/2010) along with transmission projects. All of those projects are not brand-new, but some of them are well known such as Upper Cisokan Pumped Storage, Asahan III, Muara Tawar Add-on etc. This is why some of the projects in the Fast Track Program II were already taken into account in RUPTL 2009-2018. However, some of geothermal projects are not appeared in RUPTL. Therefore, RUPTL should be revised conforming to the Fast Track Program II, and also considered in this Study. The projects listed in the Fast Track Program II are shown in Table 3.2.14 and Table 3.2.15

**Table 3.2.14 Fast Track Program II Projects to Be Implemented by PLN**

| Region | | Type | Project | COD 2011 | COD 2012 | COD 2013 | COD 2014 | Capacity (MW) |
|---|---|---|---|---|---|---|---|---|
| **Java** | -- | PLTA | Upper Cisokan PS | | | | 1,000 | 1,000 |
| | | PLTGU | Muara Tawar Add-on 2,3,4 | 150 | | 1,050 | | 1,200 |
| | | PLTP | Tangkuban Perahu 1 | | | 55 | 55 | 110 |
| | | | Ijen | | | | 110 | 110 |
| | | | Iyang Argopuro | | | | 55 | 55 |
| | | | Kamojang | | | 60 | 40 | 100 |
| | | | Wilis/Ngebel | | | 55 | 110 | 165 |
| | | PLTU | Indramayu Baru | | | | 1,000 | 1,000 |
| | **Total Java** | | | **150** | **--** | **1,220** | **2,370** | **3,740** |
| **Sumatera** | Sumbagsel | PLTP | Hululais | | | 55 | 55 | 110 |
| | | PLTP | Sungai Penuh | | | 55 | 55 | 110 |
| | Sumbagut | PLTA | Asahan III | | | 174 | | 174 |
| | | PLTU | Pangkalan Susu Baru | | | 200 | 200 | 400 |
| | **Total Sumatera** | | | **--** | **--** | **484** | **310** | **794** |
| **Kalimantan** | Kalbar | PLTU | Parit Baru (Loan China) | | | | 100 | 100 |
| | Kalselteng | PLTU | Kotabaru | | 14 | | | 14 |
| | | | Sampit | | | | 50 | 50 |
| | Kaltim | PLTG | Kaltim Baru | | 100 | | | 100 |
| | **Total Kalimantan** | | | **--** | **114** | **--** | **150** | **264** |
| **Sulawesi** | Sulselrabar | PLTU | Takalar - Eks Spanyol | | | | 200 | 200 |
| | Suluttenggo | PLTP | Kotamobagu II | | | | 40 | 40 |
| | | | Kotamobagu I | | | | 40 | 40 |
| | **Total Sulawesi** | | | **--** | **--** | **--** | **280** | **280** |
| **Maluku** | Maluku | PLTP | Tulehu | | | 20 | | 20 |
| **NTB** | NTB | PLTP | Sembalun | | | 20 | | 20 |
| | **Total PLN** | | | **150** | **114** | **1,744** | **3,110** | **5,118** |

Source: PLN.

### Table 3.2.15 Fast Track Program II Projects to Be Implemented by IPP

| Region | | Type | Project | COD 2011 | COD 2012 | COD 2013 | COD 2014 | Capacity (MW) |
|---|---|---|---|---|---|---|---|---|
| **Java** | -- | PLTP | Cisolok-Cisukarame | | | | 50 | 50 |
| | | | Darajat | | 55 | 55 | | 110 |
| | | | Dieng | | | 55 | 60 | 115 |
| | | | Karaha Bodas | | | 30 | 110 | 140 |
| | | | Patuha | | | 120 | 60 | 180 |
| | | | Salak | | | 40 | | 40 |
| | | | Tampomas | | | | 45 | 45 |
| | | | Ungaran | | | | 55 | 55 |
| | | | Wayang Windu | | 120 | | 120 | 240 |
| | | | Cibuni | | | | 10 | 10 |
| | | | Tangkuban Perahu 2 | | | | 60 | 60 |
| | | | Baturaden | | | | 220 | 220 |
| | | | Guci | | | | 55 | 55 |
| | | | Rawa Dano | | | | 110 | 110 |
| | | PLTU | Bali Timur | | | 200 | | 200 |
| | | | Madura | | | | 400 | 400 |
| | **Total Java** | | | **--** | **175** | **500** | **1,355** | **2,030** |
| **Sumatera** | Sumbagsel | PLTA | Simpang Aur | | | | 30 | 30 |
| | | PLTP | Ulubelu #3 | | | 55 | | 55 |
| | | | Ulubelu #4 | | | | 55 | 55 |
| | | | Lumut Balai | | | 110 | 110 | 220 |
| | | | Rajabasa | | | 110 | 110 | 220 |
| | | | Muara Laboh | | | | 220 | 220 |
| | | | Rantau Dadap | | | | 220 | 220 |
| | Sumbagut | PLTP | Sarulla 1 | | | 220 | 110 | 330 |
| | | | Seulawah | | | | 55 | 55 |
| | | | Sarulla 2 | | | | 110 | 110 |
| | | | Sorik Merapi | | | | 55 | 55 |
| | NAD | PLTP | Jaboi | | | 7 | | 7 |
| | | PLTU | Sabang | | | | 8 | 8 |
| | Babel | PLTU | Bangka Baru I | | | | 60 | 60 |
| | Riau | PLTU | Tanjung Batu | | 8 | | | 8 |
| | | | Tj. Balai Karimum II | | | | 20 | 20 |
| | | | Tanjung Pinang II | | | | 30 | 30 |
| | Sumut | PLTU | Nias | | | 14 | | 14 |
| | **Total Sumatera** | | | -- | 8 | 516 | 1,193 | 1,717 |
| **Kalimantan** | Kalbar | PLTU | Putussibau | | | | 8 | 8 |
| | | | Ketapang | | | 20 | | 20 |
| | Kalselteng | PLTGU | Bangkanai | | | 120 | | 120 |
| | | PLTU | Kalsel Baru 1 | | | 100 | 100 | 200 |
| | Kaltim | PLTU | Petung | | | 14 | | 14 |
| | | | Kaltim Baru II | | | | 200 | 200 |
| | | | Melak | | | 7 | 7 | 14 |
| | | | Nunukan | | | 14 | | 14 |
| | **Total Kalimantan** | | | **--** | **--** | **275** | **315** | **590** |
| **Sulawesi** | Sulselrabar | PLTGU | Sulteng Baru | | | 120 | 120 | 240 |
| | | PLTP | Mangolo | | | 5 | 5 | 10 |
| | | PLTU | Selayar | | | | 8 | 8 |
| | | | Kolaka | | 20 | | | 20 |
| | | | Bau-Bau | | | 20 | | 20 |
| | | | Mamuju | | | | 14 | 14 |
| | | | Kendari Baru I | | | 50 | | 50 |
| | Suluttenggo | PLTP | Bora | | | | 5 | 5 |
| | | | Merana/Masaingi | | | | 20 | 20 |
| | | | Lahendong V | | | 20 | | 20 |
| | | | Lahendong VI | | | 20 | | 20 |
| | | PLTU | Tahuna | | 8 | | | 8 |
| | | | Moutong | | 8 | | | 8 |

| Region | | Type | Project | COD 2011 | COD 2012 | COD 2013 | COD 2014 | Capacity (MW) |
|---|---|---|---|---|---|---|---|---|
| | | | Luwuk | | 20 | | | 20 |
| | **Total Sulawesi** | | | **--** | **56** | **235** | **172** | **463** |
| **Maluku** | -- | PLTP | Songa Wayaua | | | | 5 | 5 |
| | | | Jailolo | | | | 10 | 10 |
| | | PLTU | Masohi | | | | 8 | 8 |
| | | | Tual | | | 8 | | 8 |
| | | | Tobelo | | | 8 | | 8 |
| | | | Tidore Baru | | | | 14 | 14 |
| | **Total Maluku** | | | **--** | **--** | **16** | **37** | **53** |
| **NTB** | -- | PLTP | Huu | | | | 20 | 20 |
| | | PLTU | Sumbawa Baru I | | 10 | 10 | | 20 |
| | **Total NTB** | | | **--** | **10** | **10** | **20** | **40** |
| **NTT** | -- | PLTP | Sukoria | | | | 5 | 5 |
| | | | Atadei | | | | 5 | 5 |
| | | PLTU | Larantuka | | | | 8 | 8 |
| | | | Waingapu | | | | 8 | 8 |
| | **Total NTT** | | | **--** | **--** | **--** | **26** | **26** |
| **Papua** | -- | PLTU | Nabire | | | 14 | | 14 |
| | | | Andai | | 7 | 7 | | 14 |
| | | | Merauke | | 7 | 7 | | 14 |
| | | | Biak | | | 7 | 7 | 14 |
| | | | Sorong | | | 15 | 15 | 30 |
| | | | Jayapura | | | 30 | | 30 |
| | **Total Papua** | | | **--** | **14** | **80** | **22** | **116** |
| **Total Private** | | | | **--** | **263** | **1,632** | **3,140** | **5,035** |

Source: PLN.

(4) Generation development plan in RUPTL

RUPTL explicitly listed the all generation projects including both PLN’s own and IPPs up to 2019. Table 3.2.16 shows the summary of additional generation capacity up to 2019.

In addition to the high demand growth, RUPTL secured high reserve margin; 30 percent in Java-Bali system and 40 percent in outside of Java-Bali, considering delays of planned projects (project slippage).

In this way, Indonesia is supposed to have 55,485 MW of additional generation capacity for the coming 10 years which is almost double of the existing capacity.

**Table 3.2.16 Generation Capacity to Be Developed up to 2019**

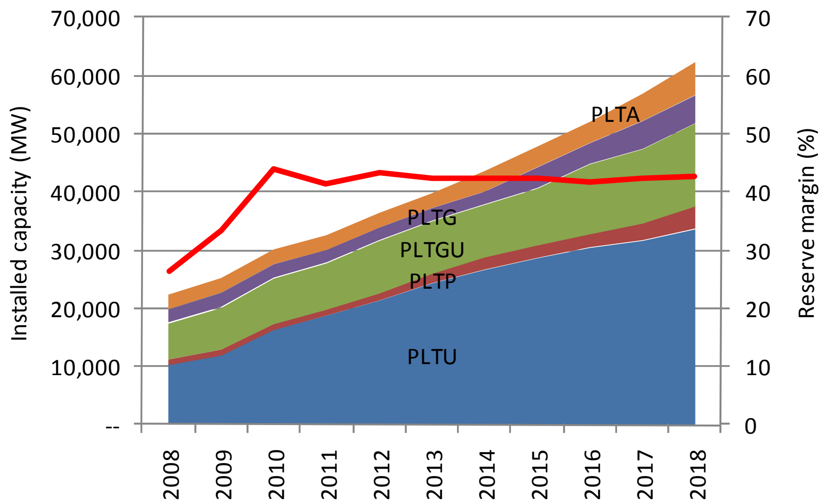
(unit: MW)

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PLN** | | | | | | | | | | | |
| PLTU | 3,291 | 4,090 | 834 | 1,479 | 2,203 | 110 | 1,200 | 200 | 7 | 3,007 | 16,421 |
| PLTP | 10 | 55 | 78 | 143 | 203 | 20 | 23 | 3 | 20 | 20 | 575 |
| PLTGU | 194 | 820 | 393 | 350 | 240 | -- | 700 | 1,500 | 2,250 | -- | 6,447 |
| PLTG | 105 | -- | 225 | 50 | -- | 65 | 235 | 800 | 1,065 | 1,280 | 3,825 |
| PLTD | 11 | 14 | 12 | 48 | 44 | 42 | 34 | 16 | 33 | 50 | 303 |
| PLTM | 14 | 6 | 6 | 14 | 8 | 4 | 5 | 8 | 1 | -- | 66 |
| PLTA | -- | -- | 10 | 300 | 1,000 | 65 | 103 | 715 | 1,311 | 818 | 4,321 |
| **Total** | **3,625** | **4,985** | **1,558** | **2,384** | **3,698** | **306** | **2,299** | **3,242** | **4,686** | **5,175** | **31,958** |
| **IPP** | | | | | | | | | | | |
| PLTU | 26 | 891 | 2,649 | 1,703 | 2,212 | 2,160 | 2,550 | 1,930 | 1,410 | 745 | 16,276 |
| PLTP | -- | 3 | 178 | 857 | 2,450 | 50 | 330 | 392 | 510 | 645 | 5,415 |
| PLTGU | 290 | 110 | 30 | -- | 120 | -- | -- | -- | -- | -- | 550 |
| PLTG | 10 | 10 | 80 | -- | -- | -- | -- | -- | -- | -- | 100 |
| PLTD | -- | 22 | -- | -- | -- | -- | -- | -- | -- | -- | 22 |
| PLTM | 25 | 31 | 91 | 42 | 6 | 2 | 1 | 1 | 1 | -- | 201 |
| PLTA | 180 | 195 | -- | -- | 157 | 90 | 310 | 30 | -- | -- | 962 |
| **Total** | **531** | **1,262** | **3,028** | **2,601** | **4,945** | **2,302** | **3,191** | **2,353** | **1,921** | **1,390** | **23,252** |
| **PLN+IPP** | | | | | | | | | | | |
| PLTU | 3,317 | 4,981 | 3,483 | 3,182 | 4,415 | 2,270 | 3,750 | 2,130 | 1,417 | 3,752 | 32,697 |
| PLTP | 10 | 58 | 256 | 1,000 | 2,653 | 70 | 353 | 395 | 530 | 665 | 5,990 |
| PLTGU | 484 | 930 | 423 | 350 | 360 | -- | 700 | 1,500 | 2,250 | -- | 6,997 |
| PLTG | 115 | 10 | 305 | 50 | -- | 65 | 235 | 800 | 1,065 | 1,280 | 3,925 |
| PLTD | 11 | 36 | 12 | 48 | 44 | 42 | 34 | 16 | 33 | 50 | 326 |
| PLTM | 39 | 37 | 97 | 56 | 14 | 6 | 6 | 9 | 2 | -- | 266 |
| PLTA | 180 | 195 | 10 | 300 | 1,157 | 155 | 413 | 745 | 1,311 | 818 | 5,284 |
| **Total** | **4,156** | **6,247** | **4,586** | **4,986** | **8,643** | **2,608** | **5,491** | **5,595** | **6,608** | **6,565** | **55,485** |

Source: RUPTL 2010-2019.

i) Java-Madura-Bali

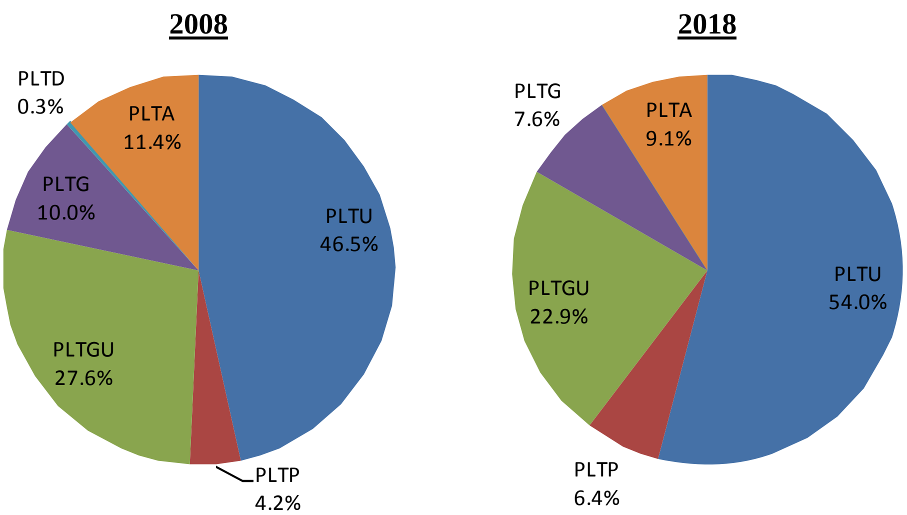
In Jamali system, the installed capacity will increase from the current 22,300 MW to 62,280 MW in 2018. In addition to the high demand growth 9.5 percent (which brings about 140 percent growth at 10 years compound), over 40 percent of reserve margin as indicated in Figure 3.2.28, requires more generation capacity. By generation type, PLTU especially fueled by coal will treble in 10 years, thanks to the fast track programs and other projects. Other generation, PLTP, PLTGU, PLTG and PLTA will also increase but at lower ratio, so that only PLTU will increase the composition for total generation capacity by 7.5 points in 2018, as illustrated in Figure 3.2.29.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.28 Generation Development Plan in Jamali**

The capacity of renewable energy sources, geothermal and hydro will make up 15.5 percent of total capacity including pumped storage hydro.

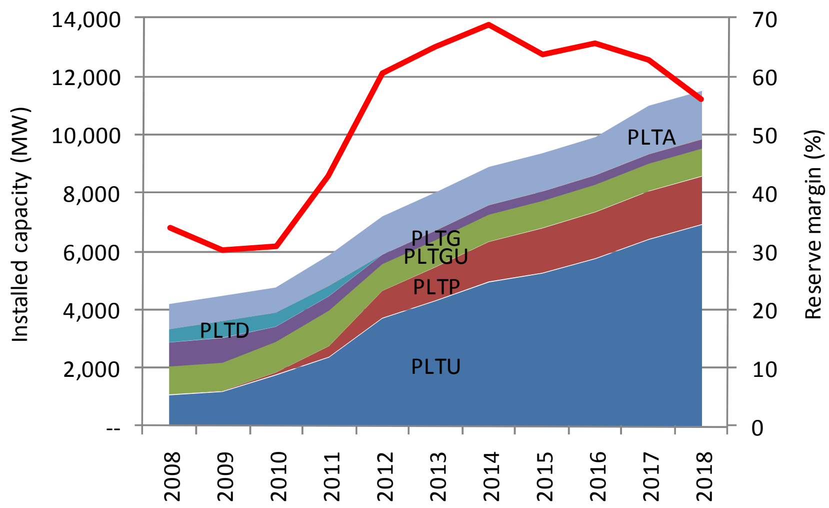



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.29 Generation Composition in Jamali**

ii) Sumatera

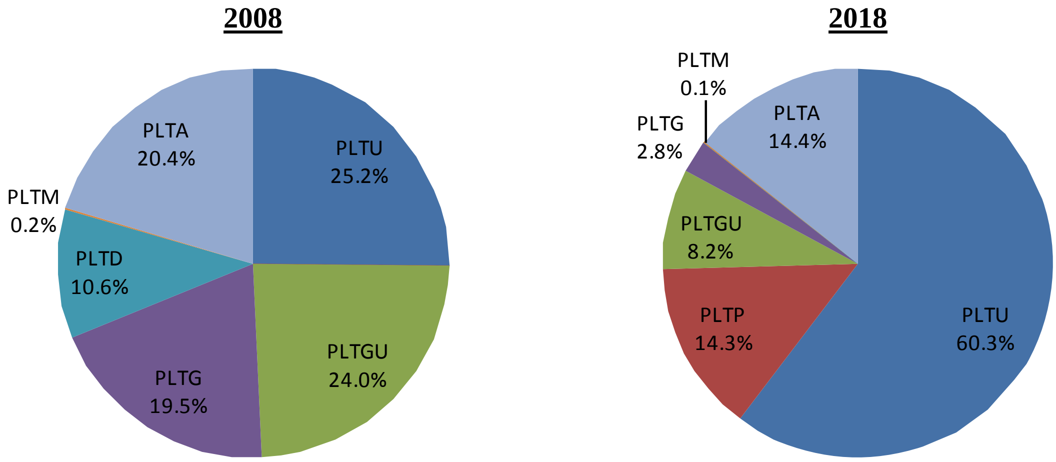
In Sumatera also, PLTU will drastically increase in the coming 10 years. The current 1,060 MW will jump to 6,924 MW in 2018. PLTP will appear after 2010 while PLTD will disappear in 2012. The reserve margin will keep high level far exceeding the target of 40 percent.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.30 Generation Development Plan in Sumatera**

At the end of the period of RUPTL, PLTU will make up 60 percent of total generation capacity. The renewable energy composition will make up 28.8 percent of which hydro will make up 14.5 percent and geothermal 14.3 percent.

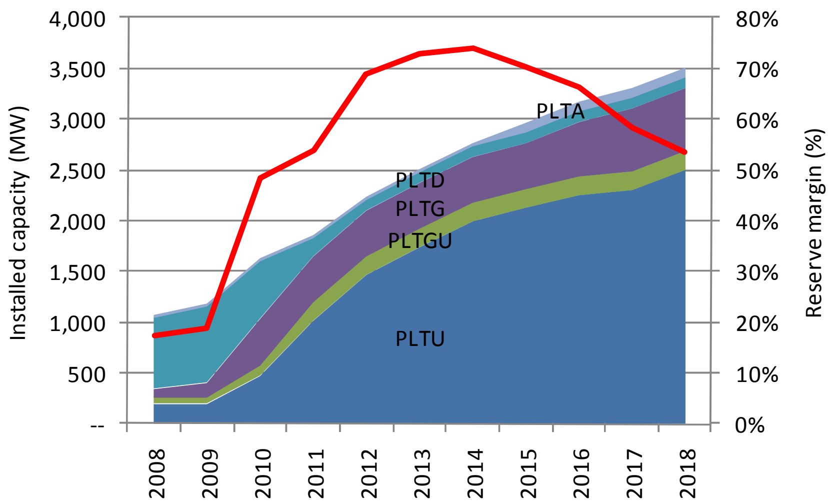



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.31 Generation Composition in Sumatera**

iii) Kalimantan

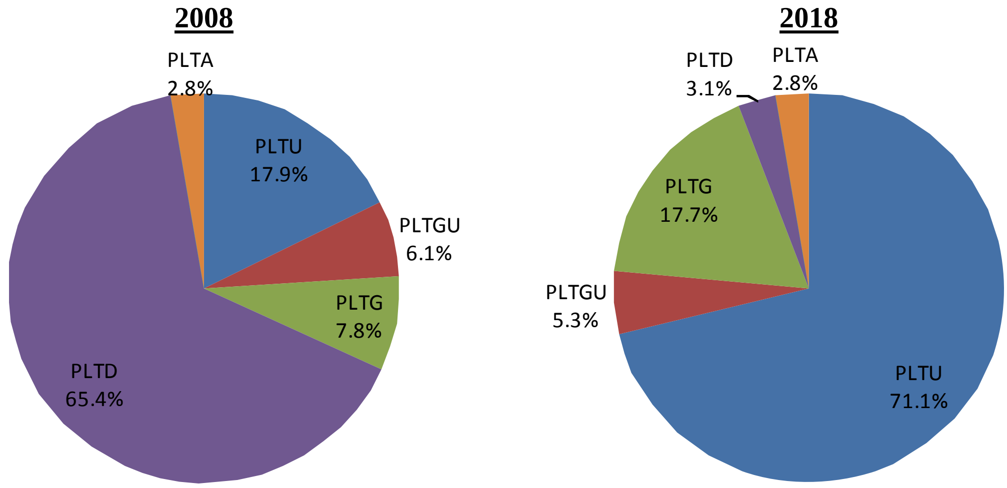
In Kalimantan, currently 702 MW or two-thirds of total generation is diesel generation (PLTD), which will be gradually decreased to 110 MW in 2018. On behalf of PLTD, PLTU will be increased to 2,500 MW in 2018. The reserve margin will also keep high level after 2010.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.32 Generation Development Plan in Kalimantan**

The renewable energy source available in Kalimantan is only hydro which will make up just 2.8 percent of total capacity in 2018, and others will be fossil fueled.

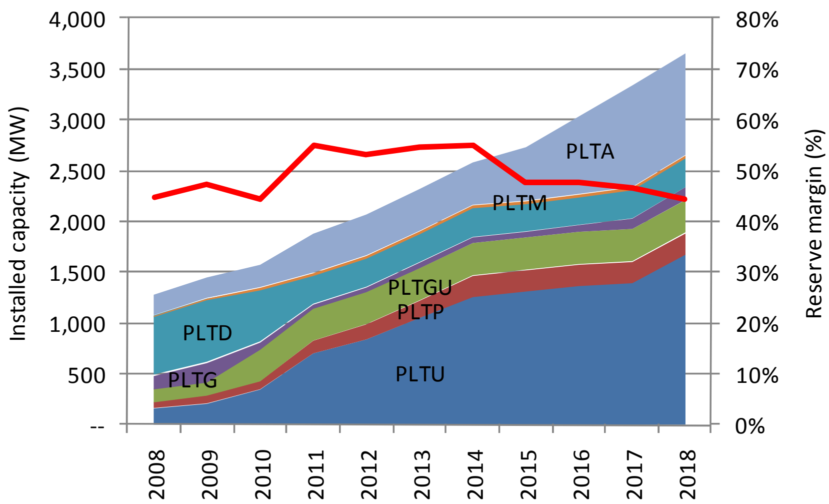



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.33 Generation Composition in Kalimantan**

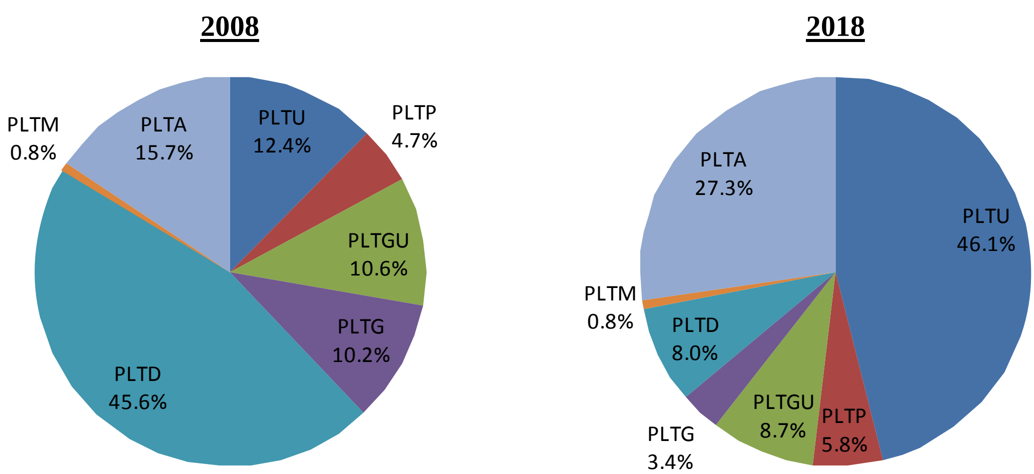
iv) Sulawesi

As well as other regions, PLTU will be increased in Sulawesi. Even though the capacity of diesel generation is decreased, it will remain at 8.0 percent in 2018. Hydropower generation is expected to remarkably increase owing to the big projects, Bakaru II (126 MW), Bonto Batu (100 MW), Poko (234 MW), Poso (145 MW) and Malea (90 MW). In 2018, the renewable energy generation capacity will make up nearly one-third of total.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.34 Generation Development Plan in Sulawesi**

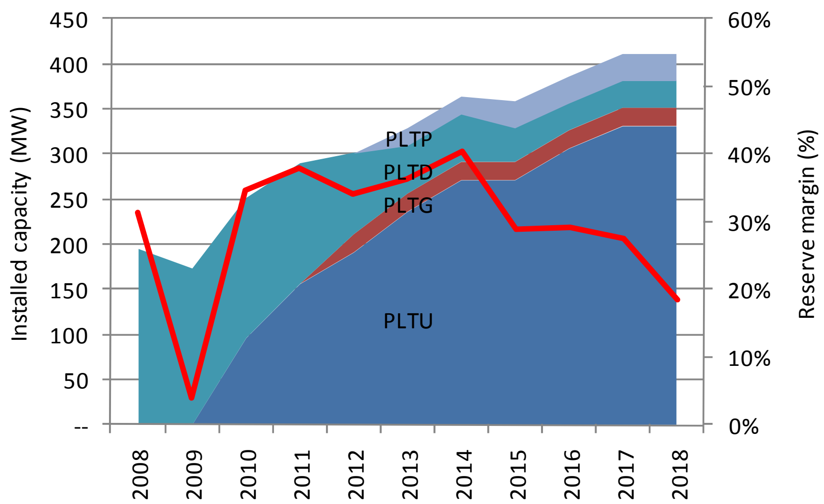



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.35 Generation Composition in Sulawesi**

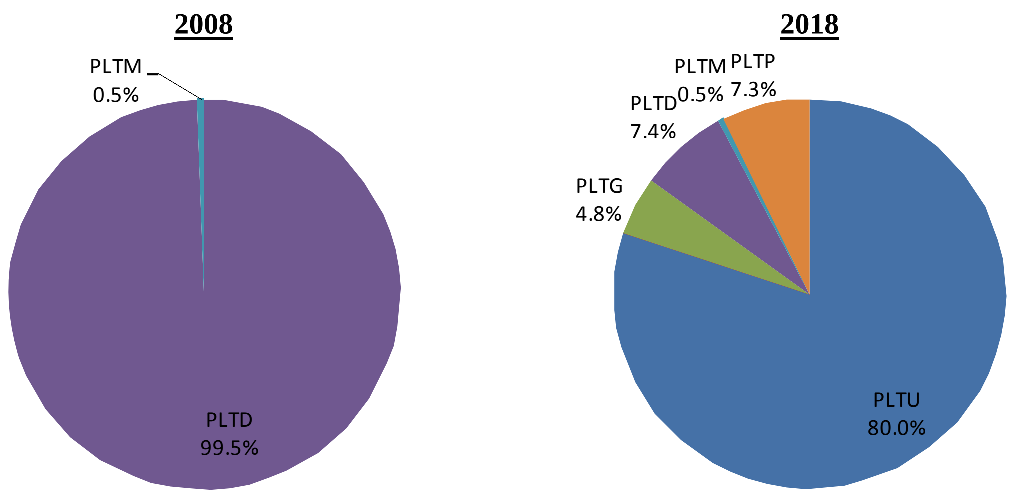
v) NTB

In this region, currently the percentage of diesel generation is nearly 100 percent as well as in other eastern Indonesian regions. Small scale coal thermal will be introduced after 2009, and diesel generation will be gradually abondoned. In this region, reserve margin will not reach the target of 40 percent in 2018. The renewable energy generation capacity will be 7.8 percent in 2018 of which most of them are geothermal.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.36 Generation Development Plan in NTB**

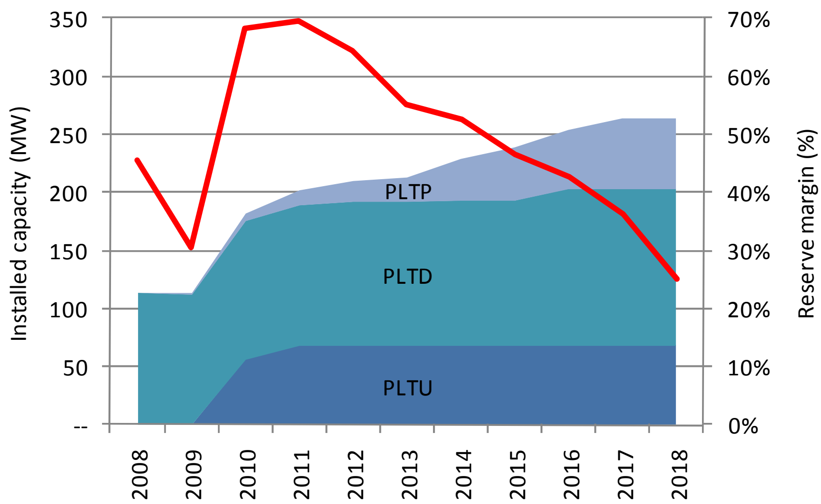



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.37 Generation Composition in NTB**

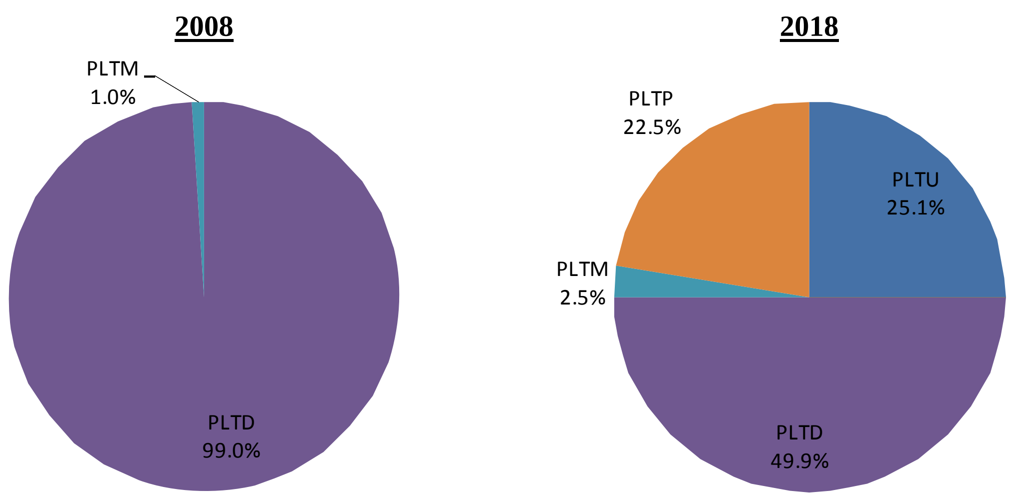
vi) NTT

In NTT, demand centers or grids are dispersed, diesel generation will keep stable position in spite of introduction of small coal thermal generation (PLTU) after 2009. The reserve margin will miss the target of 40 percent by 15 percent. 61 MW of PLTP will be developed in the coming 10 years. At the end of the period, the percentage of PLTD will drop to 50 percent while the renewable energy capacity will consist of a quarter of total.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.38 Generation Development Plan in NTT**

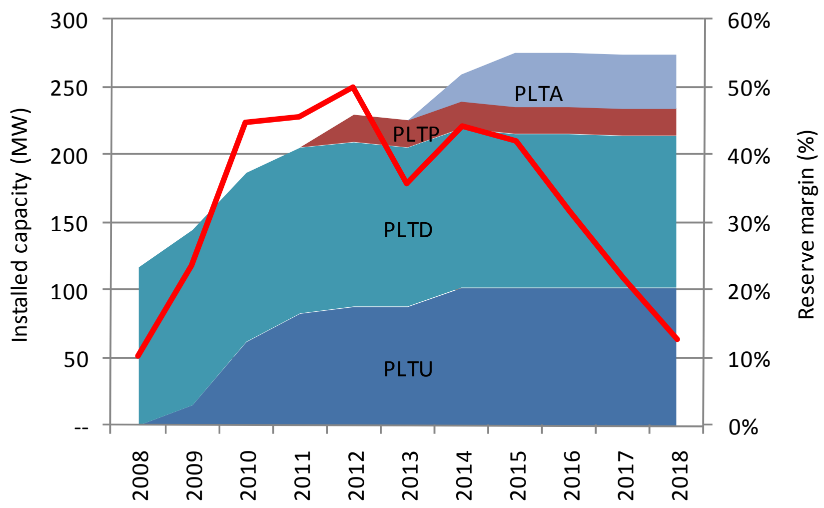



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.39 Generation Composition in NTT**

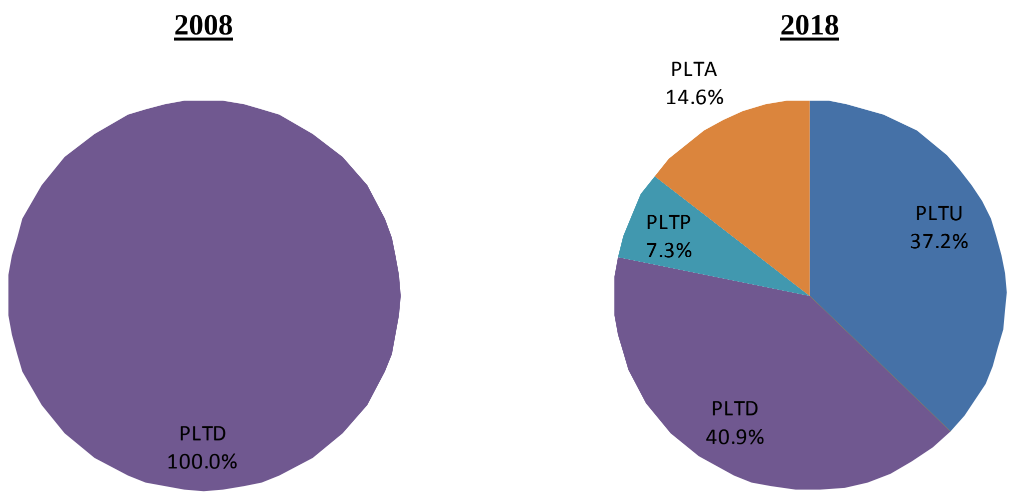
vii) Maluku

As well as NTT, PLTD will contribute stable amount in Maluku. PLTU will be introduced after 2009. PLTP Tulehu will be added to the system in 2012 and PLTA Isal will be developed in 2014. However, reserve margin will miss the target largely in 2018.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.40 Generation Development Plan in Maluku**

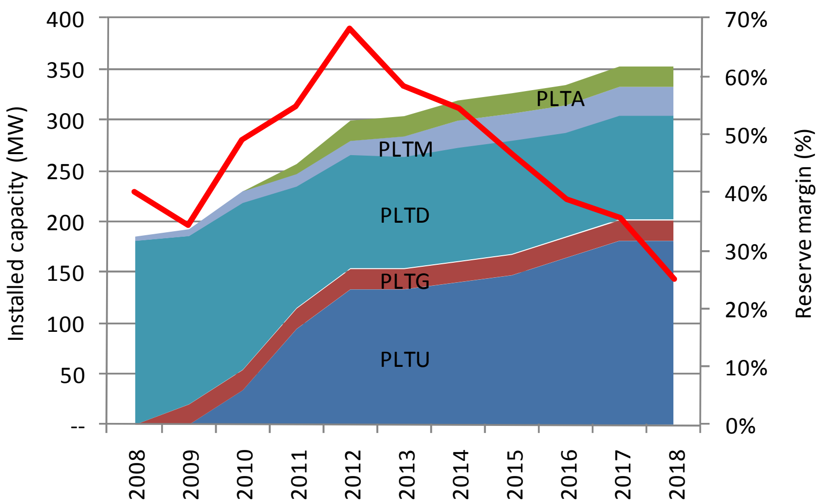



Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.41 Generation Composition in Maluku**

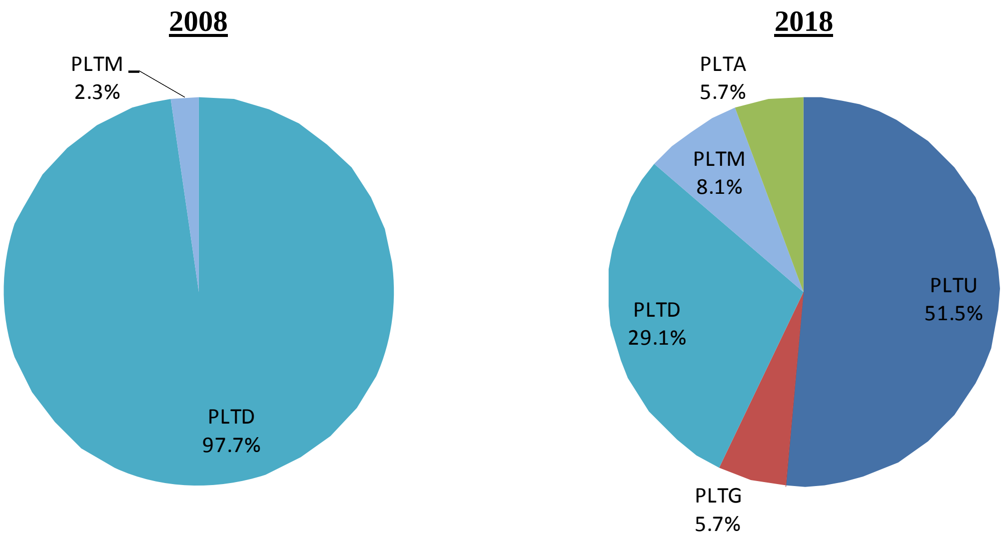
viii) Papua

In spite of its large hydro potential, there will be only one hydro project planned in Jayapura system. 10 to 20 MW class PLTU will be introduced in relatively larger systems such as Jayapura, Sorong, Merauke, and Timika, while small scale hydro (PLTM) will be planned in smaller systems. In this region, the reserve margin will also miss the target in 2018.




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.42 Generation Development Plan in Papua**




Source: JICA Study Team based on RUPTL 2009-2018.

**Figure 3.2.43 Generation Composition in Papua**

# 3.3 TRANSMISSION DEVELPOMENT PLAN

## 3.3.1 TRENDS OF TRANSMISSION FACILITIES

### (1) Jamali System

The following are the trends of transmission line length and transformer facility capacity.

**Table 3.3.1 Trends of transmission line length (Jamali System)**

(×1000kms)

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| **500kV** | 3.53 | 3.58 | 3.58 | 5.05 | 5.05 | 5.09 | 5.11 |
| **150kV** | 11.06 | 11.23 | 11.23 | 11.27 | 11.61 | 11.85 | 11.97 |
| **70kV** | 3.76 | 3.77 | 3.77 | 3.66 | 3.58 | 3.61 | 3.61 |

Source：RUPTL 2009-2018, and 2010-2019

**Table 3.3.2 Trends of transformer capacity (Jamali System)**

(GVA)

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| **500/150kV** | 15.50 | 15.50 | 15.50 | 17.00 | 17.00 | 17.00 | 18.50 |
| **150/20kV** | 23.09 | 23.83 | 24.47 | 25.30 | 26.07 | 26.15 | 27.08 |
| **150/70kV** | 3.44 | 3.40 | 3.58 | 3.58 | 3.61 | 4.01 | 4.66 |
| **70/20kV** | 2.93 | 2.99 | 2.79 | 2.88 | 2.80 | 2.75 | 2.74 |

Source: JICA Study Team based onRUPTL2009-2018, and 2010-2019, PLN Statistics 2008, and 2009

The 500kV southern route was constructed to heighten reliability of the extra high voltage trunk system transmission lines for the chronically heavy flow from east to west. This has assured the transmission capacity in the 500kV trunk system, which, in turn, has increased the capacity of 150/20 kV transformer facilities. Because the capacity of 70/20kV transformer facilities shows a basically constant trend, it can be seen that reinforcement of the load system to meet the increasing demand is being accompanied by a shift from a 70kV to a 150kV load system.

While a switch to thicker cable for transmission lines does not appear in the table, it can at least be stated that, although the growing demand is being supplied within the framework of the current transmission capacity, reinforcement of 150kV transmission lines (in load systems) is likely to become a task.

As shown in the table below, the hydropower sources in the Jamali system are each connected to sub-150kV load systems. The pumped storage power sources are planned to be connected to 500kV systems, and the transmission lines are constructed at comparatively close distances in each case.

| Region | Name | COD | Ins. Cap. (MW) |
|---|---|---|---|
| East Java | Kalikonto | 2016 | 62 |
| East Java | Kesamben | 2017 | 37 |
| West Java | Rajamandala | 2014 | 47 |
| West Java | Jatigede | 2014 | 110 |

Source : RUPTL 2010-2019

| Region | Name | COD | Ins. Cap. (MW) | Access |
|---|---|---|---|---|
| West Java | Upper Cisokan | 2014 | 1000 | 500kV system(60kms 2014) |
| Central Java | Matenggeng | 2017 | 443 | 500kV system (20kms 2017) |
| Central Java | Matenggeng | 2018 | 443 | Ditto. |
| East Java | Grindulu | 2018 | 500 | 500kV system (40kms 2018) |
| East Java | Grindulu | 2019 | 500 | Ditto. |

Source : RUPTL 2010-2019

(2) Outer Island Systems

Table 3.3.3 and Table 3.3.4 show the trend of transformer capacity and transmission line length in recent years in outer islands, and particularly Sumatra, Kalimantan, and Sulawesi.

In the Sumatra and Sulawesi systems, there was an approximately two-fold increase in 150kV transmission lines, which are the major load-type transmission lines, over the six-year period shown in the table. The corresponding increase in Kalimantan system was about 1.5-fold. These facilities are therefore increasing dramatically.

There has been a similar increase in capacity of load-type transformer facilities. This capacity has been rapidly growing at annual rates averaging 6.5 percent in the Sulawesi system and 7.8 percent in the Kalimantan system as compared to 2.5 percent in the Sumatra system, which is the same as in the Jamali system. This is because, although the facility capacity is increasing in correspondence with the demand in the Sumatra system, which has a comparatively full assortment of power delivery (transformation and distribution) facilities, delivery facilities in the Sulawesi and Kalimantan systems are still in the developing phase.

In contrast, delivery facilities have not been formed (into a grid) in NTB, NTT, and Papua.

**Table 3.3.3 Trends of transmission line length (major outer island systems)**

(kms)

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| **Sumatra** | | | | | | | |
| **275kV** | - | - | - | - | 781 | 781 | 781 |
| **150kV** | 4361 | 4361 | 4361 | 8521 | 7739 | 8423 | 8211 |
| **70kV** | 310 | 310 | 310 | 310 | 334 | 334 | 334 |
| **Sulawesi** | | | | | | | |
| **150kV** | 1044 | 1044 | 1044 | 1769 | 1839 | 1957 | 1957 |
| **70kV** | 420 | 420 | 420 | 505 | 505 | 505 | 519 |
| **Kalimantan** | | | | | | | |
| **150kV** | 1054 | 1120 | 1120 | 1264 | 1305 | 1429 | 1429 |
| **70kV** | 123 | 123 | 123 | 123 | 123 | 123 | 123 |

Source: RUPTL 2009-2018, and 2010-2019

**Table 3.3.4 Trends of transformer capacity (major outer island systems)**

(MVA)

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| **Sumatra** | | | | | | | |
| **275/150kV** | 80 | 80 | 80 | 160 | 160 | 160 | 160 |
| **150/20kV** | 4440 | 5101 | 4390 | 4419 | 4474 | 4804 | 5140 |
| **70/20kV** | 295 | 360 | 355 | 360 | 360 | 360 | 375 |
| **Sulawesi** | | | | | | | |
| **150/20kV** | 664 | 723 | 813 | 923 | 1045 | 1074 | 1074 |
| **70/20kV** | 486 | 486 | 490 | 532 | 546 | 606 | 606 |
| **Kalimantan** | | | | | | | |
| **150/20kV** | 824 | 884 | 934 | 1094 | 1174 | 1174 | 1383 |
| **70/20kV** | 157 | 157 | 157 | 157 | 157 | 157 | 157 |

Source：RUPTL2009-2018, and 2010-2019

## 3.3.2 CURRENNT TRANSMISSION DEVELOPMENT PLAN

Along with the burgeoning increase in the power demand and the large-scale input of power sources in the first and second phases of the Fast Track Program (FTP) to meet the demand, the plans for distribution facility development contain the development of power source lines related to system interconnections for new power sources. There are also plans for expansion and improvement of existing delivery facilities, and construction of additional facilities, to cope with the rapidly growing demand.

(1) Jamali System

The table below shows the plans for transmission line development, transformer reinforcement, and generation development in the Jamali system.

**Table 3.3.5 Transmission line development plan (Jamali System)**

(kms)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500kV AC | 87 | 1 | 436 | 86 | 1218 | 432 | 106 | 28 | 64 | 40 | 2498 |
| 500kV DC | | | | | | | 300 | | | | 300 |
| 150kV | 1930 | 1613 | 1536 | 801 | 458 | 587 | 354 | 410 | 76 | 300 | 8064 |
| 70kV | 114 | | 11 | | | | | | | | 125 |
| Yearly total | 2130 | 1614 | 1983 | 887 | 1676 | 1019 | 760 | 438 | 140 | 340 | 10987 |

Source: RUPTL2010-2019.

**Table 3.3.6 Reference between transformer development and generation development plans (Jamali System)**

| | As of 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Peak demand (MW) | 17211 | 19486 | 21379 | 23541 | 25804 | 28194 | 30797 | 33579 | 36608 | 39881 | 43367 |
| Gene. Capacity (MW) | 22906 | 26140 | 30169 | 32926 | 34851 | 40448 | 41478 | 46320 | 49230 | 53947 | 58617 |
| 500/150kV(GVA) | 18.50 | 21.5 | 24.83 | 29.33 | 30.83 | 36.33 | 39.33 | 43.83 | 45.33 | 46.83 | 47.83 |
| 150/20kV(GVA) | 27.08 | 30.17 | 37.21 | 43.96 | 48.55 | 51.58 | 54.82 | 58.81 | 63.97 | 67.78 | 74.50 |
| 150/70kV(GVA) | 4.66 | 4.92 | 5.22 | 5.31 | 5.31 | 5.31 | 5.31 | 5.31 | 5.31 | 5.31 | 5.31 |
| 70/20kV(GVA) | 2.74 | 2.88 | 2.91 | 3.22 | 3.25 | 3.40 | 3.51 | 3.60 | 3.78 | 3.81 | 3.87 |

Note: Not considered assumption of retired transformers

Source: JICA Study Team based on RUPTL2010-2019.

The expansion of 500kV transmission lines derives mainly from the large-scale power source lines based on the FTP, system reinforcement in the Jabotabek area, which is a major consumption center, and system interconnection based on the direct-current transmission lines from Sumatra. The plans for the load system envision a four-fold increase in 150kV transmission lines relative to 2010 in 2019. Such lines occupy about 80 percent of all planned transmission line construction. The corresponding increase in capacity of load-system’s transformer facilities is 2.5-fold.

(2) Outer Island Systems

Following is the plans for transmission line development and transformer reinforcement in outside island systems.

The total length of transmission lines planned for construction reaches 32,700 km, or about three times as many as in the Jamali system. Of this total, sub-150kV transmission lines account for about 24,000 km or 74 percent. On outside islands other than Sumatra, 150kV systems are positioned as trunk systems, not load systems. In light of this point, it may be said that the plans for transmission line construction over the next ten years amount to a phase of large-scale system development.

A check of the plans for transformer reinforcement reveals that the installed capacity of load system transformer facilities in 2019 will be about four times as high as in 2009, and about the same as in the Jamali system in 2009. In other words, the outer island systems are following the lead of the Jamali system with a time lag of about ten years.

With the exception of Asahan I in the Sumatra system, the plans for hydropower plants construction are all premised on connection to a sub-150kV load system in view of facility capacity. This is to say that these systems will play the role of supplying base power in the vicinity of hydropower sources (in some cases, there is also the possibility of operation to raise the peak with a regulating reservoir).

**Table 3.3.7 Transmission line development plan (Outer island systems)**

(kms)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sumatra** | | | | | | | | | | | **16929 kms** |
| **500kV AC** | | | | | | | 500 | | 1390 | | **1890** |
| **500kV DC** | | | | | | | 800 | | | | **800** |
| **250kV DC** | | | | | | 462 | | | | | **462** |
| **275kV AC** | 16 | 638 | 1182 | 332 | 970 | 980 | 432 | | | | **4550** |
| **150kV** | 465 | 2396 | 1792 | 1610 | 908 | 471 | 311 | 243 | 229 | 270 | **8695** |
| **70kV** | 122 | 50 | 360 | | | | | | | | **532** |
| **Sulawesi** | | | | | | | | | | | **6068 kms** |
| **275kV** | | 512 | | 360 | | | | | | | **872** |
| **150kV** | 551.2 | 1142 | 353 | 1180 | 334 | 502 | 62 | 764 | 84 | 170 | **5142** |
| **70kV** | 24 | | | | | | | | 30 | | **54** |
| **Kalimantan** | | | | | | | | | | | **7000 kms** |
| **275kV** | | | 180 | | | | | | | | **180** |
| **150kV** | 244 | 1106 | 2291 | 1128 | 270 | 640 | 947 | 138 | 56 | | **6820** |
| **NTB** | | | | | | | | | | | **1010 kms** |
| **150kV** | 180.4 | | 108 | 60 | | | 283.8 | | | | **632** |
| **70kV** | 144 | 112.6 | | 60.8 | 60.8 | | | | | | **378** |
| **NTT** | | | | | | | | | | | **620 kms** |
| **70kV** | | 294 | | | 326 | | | | | | **620** |
| **Maluku** | | | | | | | | | | | **692 kms** |
| **150kV** | | | | | | | | 464 | | | **464** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **70kV** | | | 60 | 40 | 128 | | | | | | **228** |
| **Papua** | | | | | | | | | | | **490 kms** |
| **70kV** | | | 430 | | 60 | | | | | | **490** |
| **Total** | | | | | | | | | | | |
| **500kV AC** | | | | | | | 500 | | 1390 | | **1890** |
| **500kV DC** | | | | | | | 800 | | | | **800** |
| **250kV DC** | | | | | | 462 | | | | | **462** |
| **275kV AC** | 16 | 1150 | 1182 | 692 | 970 | 980 | 432 | | | | **5422** |
| **150kV** | 1440.6 | 4644 | 4544 | 3978 | 1512 | 1613 | 1603.8 | 1609 | 369 | 440 | **21753** |
| **70kV** | 290 | 456.6 | 850 | 100.8 | 574.8 | | | | 30 | | **2272** |
| **Yealy total** | 1747 | 6250.6 | 6576 | 4770.8 | 3056.8 | 3055 | 3315.8 | 1609 | 1789 | 440 | **32630** |

Source: JICA Study Team based on RUPTL2010-2019.

**Table 3.3.8 Transformer development plan (Outer island systems)**

| | As of 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500/275kV(GVA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |
| 500/150 kV(GVA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 500DC(GVA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 |
| 275/150kV(GVA) | 0.16 | 0.41 | 1.91 | 5.41 | 6.41 | 8.29 | 8.79 | 10.04 | 10.04 | 10.04 | 10.04 |
| 250kVDC(GVA) | 0 | 0 | 0 | 0 | 0 | 0 | 0.60 | 1.20 | 1.80 | 2.40 | 3.00 |
| 150/20kV(GVA) | 5.93 | 7.49 | 10.16 | 11.78 | 13.32 | 14.90 | 16.21 | 17.58 | 19.26 | 20.93 | 22.48 |
| 150/70kV(GVA) | | | 0.06 | 0.12 | 0.18 | 0.18 | 0.24 | 0.30 | 0.36 | 0.36 | 0.36 |
| 70/20kV(GVA) | 0.94 | 1.02 | 1.37 | 1.62 | 1.70 | 1.79 | 1.90 | 2.01 | 2.20 | 2.33 | 2.41 |

Note: Not considered assumption of retired transformers

Source: JICA Study Team based on RUPTL2010-2019.

The following outlines the transmission facility plans for systems on outer islands

i) Sumatra System

It was decided to abandon the idea of conducting 150kV interconnections in the Sumatra system due to problems regarding the degree of stability. There are plans to build 275-kV interconnections to serve the whole island in 2012. In addition, the transmission capacity is to be expanded by adding a northern route in 2015 in the 275kV system.

Of particular note in RUPLT 2010 - 2019 are the plans for construction of a transmission line for interconnection with the Malay peninsula using 250kV DC cable in 2015 and input of a 500kV trunk transmission system in anticipation of demand growth in 2018 in addition to the existing plan for construction of a 500kV DC interconnection between Sumatra and Java.

In connection with formation of the 275kV trunk system to cover the whole island, in advance of the aforementioned plans, the schedule for 2011 contains construction of a 275kV system in the vicinity of Medan, inclusive of the PLTU Pangkalan Susu power line, to meet the demand in the northern Sumatra system. The only hydropower plant connected to an extra high voltage system (with a voltage of at least 275 kV) is Asahan l (180 MW, 2010), which lies in North Sumatra Province. All other hydropower source candidates are connected to load systems with voltages of no more than 150 kV.

ii) Sulawesi System

In addition to system expansion through input of new power sources, there are plans for construction of the first 275kV trunk transmission line in the Sulawesi system in 2011 (for interconnection between the central and southern Sulawesi systems along with the start of operation by PLTA Poso) and extension of the same to PLTGU Donggi Serono, which is to be built in central Sulawesi, in 2013.

In addition, the currently isolated (mutually unconnected) systems in southwestern Sulawesi are to be connected with the southern Sulawesi system by means of 150kV transmission lines in 2013, in step with the coal-fired power lines to be placed into operation in the FTP.

In northern Sulawesi, there are plans for interconnection of the Sulawesi Utara and Golontaro systems in 2012.

As indicated by the above, the Sulawesi systems in the northern and southern parts of the island are being consolidated. (Plans call for construction of the Sulawesi Tengah-Sulselbar interconnection along with the placement of PLTA Poso into service in 2011 and interconnection with the Sultra system in 2013.)

iii) Kalimantan System

Plans envision construction of a 275kV international interconnection with the Malaysian province of Sarawak to improve the power quality in the Kalbar system in 2012, interconnection of the Kaltim (Mahakam) system and Kalselteng (Balito) system (in central and southern Kalimantan) in 2011, interconnection between GI Ketapang and GI Pangkaranbun by a 150kV transmission line in 2016, and interconnection of GI Kota Baru 2 and GI Kuala Kunun by a 150kV transmission line for full interconnected operation of the Kalbar and Kalselteng systems in 2020. With the execution of these plans, all of the systems on Kalimantan will be interconnected.

iv) NTB System

The Lombok system, which is a major one, is converted into a 150kV system along with the start of PLTU operation in 2010. The Sumbawa and Bima systems on the island of Sumbawa are to be reinforced with input of a 70kV system along with power source input. There are additional plans for interconnection of the Bima and Sumbawa Besar systems with 150kV transmission lines to form a system in 2016.

v) NTT System

On the island of Flores, isolated systems are to be consolidated by means of 70kV transmission lines. Along with the start of PLTU operation as part of the FTP I, 70kV power lines are to be constructed for linkage with Ende and Maumere. Plans also include consolidation of the Bajawa and Ruteng systems in the western part of the island in 2014 and extension of the grid to Labuhan Bajo on the western end, for a total length of 190 km. Consolidation of isolated systems with 70kV transmission lines is also under way on the island of Timor. There are plans for linkage of all communities from Kupang, the major city, to Soe in the interior, and the key interior cities of Atambua and Kefamenanu, with 70kV transmission lines in 2011, and linkage of Soe and Kefamenanu with 70kV transmission lines in 2014. As a result, the Timor system will be interconnected by 70kV transmission lines with a total length of more than 120 km. As for other isolated systems, plans envision active consolidation by means of 20kV distribution systems.

vi) Maluku System

In Maluku Province, there are plans for construction of a 150kV interconnection between the islands of Ambon and Seram, for delivery of power to the former, which is a major consumption center. In 2012, a 70kV system accommodating the start of PLTU operation in the FTP I is to be constructed in the Ambon system. This is to be followed in 2017 by a voltage uprating to 150kV in the system using a 150kV undersea cable from Seram to Ambon along with the development of PLTA Isal on Seram.

In North Maluku Province, there are plans to construct a 64km, 70kV system extending from PLTP Jailolo on the island of Halmahera to the island of Ternate, a major demand center, with some use of undersea cable.

Other isolated systems are to be interconnected through 20kV distribution systems.

vii) Papua System

The only systems in Papua Province at present are isolated 20kV distribution systems. There are plans for input of 70kV systems in the Jayapura and Timika systems in 2012 respectively as interconnections with the power lines of the small-capacity coal-fired plant to be constructed by FTPI and the 20kV distribution systems in cities. A 70kV power line is also planned in connection with PLTA Genyem, which is to be placed into operation in 2012. Its power will be shared with the Jayapura system.

In West Papua Province, there are plans for input of a 70kV system in the Sorong system, which has the biggest demand, in step with the start of PLTU operation as a part of the FTP II in 2014.

# CHAPTER 4 HYDROPOWER POTENTIALS

## 4.1 GENERAL

This Study covers the hydropower potential sites in the list provided by MEMR and PLN (refer to Minutes of Meeting on 2nd March, 2009). The list is composed of the followings:

- Projects which passed 3rd screening in HPPS2;
- Pumped storage projects in Java screened in HPPS2;
- Projects of 5-10 MW class screened in HPPS2; and;
- Projects for which detailed design, feasibility study and pre-feasibility study have been finished.

Besides the above projects, 1) modification of reservoir scheme to run-of-river scheme, 2) expansion of the existing power plants and 3) pumped storage project in Sumatra are additionally examined.

## 4.2 PROJECTS PASSED 3RD SCREENING IN HPPS2

In HPPS (1983), 1,275 hydropower potential schemes were identified. Out of the said potential, 363 schemes passed the 1st screening of HPPS as relatively higher promising schemes. Furthermore, 125 schemes were selected as the most promising potentials which were composed of 85 reservoir type schemes and 40 run-of-river schemes.

When HPPS2 (1999) was conducted, 55 schemes among the said 363 schemes had already proceeded to subsequent stages such as pre feasibility study, feasibility study, detailed design, under construction or completed.

HPPS2 cancelled 38 schemes and newly added 67 schemes. As a result, HPPS2 identified 1,249 potential schemes, which did not include the said number of schemes which had already proceeded to the subsequent stages.

Out of the 1,249 identified schemes, 338 schemes passed the 1st screening of HPPS2 as relatively higher promising schemes.

Furthermore, the 2nd screening from aspects of environmental impacts, geology and small installed capacity was carried out in HPPS2, and as a result 247 schemes passed the 2nd screening. Criteria for the 2nd screening adopted in HPPS2 were as follows.

- Reservoir type development schemes of which reservoir will submerge the conservation forest is dropped in the environmental screening, except the case that the submerged area is less than 10 ha.

- Schemes requiring resettlement beyond 1,000 households are ruled out in the environmental screening.
- Reservoir type development schemes situated within the Great Sumatra Fault Zone or the Palu Fault Zone are ruled out in the geological screening.
- Installed capacity less than 10.0MW was considered to be too small to be taken up in HPPS2.

The 3rd screening was made on these 247 schemes based on the economic viability which were re-evaluated through preliminary design and estimated work quantities of major works and updated unit cost. As a result, 115 schemes in total (excluding one scheme in East Timur) were selected in the 3rd screening of HPPS2 as the most promising potentials which were composed of 35 reservoir type schemes, 78 run-of-river type schemes, 1 run-of river type with a low head dam scheme, and 1 lake outlet type scheme.

List of the schemes which passed the 3rd screening of HPPS2 is given in Table 4.2.1.

**Table 4.2.1 List of Schemes which Passed 3rd Screening of HPPS2**

| No. | ID No. | Name | Province | Type | Installed Capacity (MW) | Annual Energy (GWh) |
|---|---|---|---|---|---|---|
| 1 | 1-190-13 | Mamas-2 | NAD | ROR | 51.0 | 327.7 |
| 2 | 1-192-04 | Jambo Papeun-3 | NAD | ROR | 25.4 | 206.1 |
| 3 | 1-204-05 | Woyla-2 | NAD | RES | 242.1 | 664.6 |
| 4 | 1-190-11 | Ketambe-2 | NAD | ROR | 19.4 | 124.9 |
| 5 | 1-205-09 | Teunom-2 | NAD | RES | 230.0 | 595.3 |
| 6 | 1-192-03 | Kluet-1 | NAD | ROR | 40.6 | 231.9 |
| 7 | 1-202-06 | Meulaboh-5 | NAD | ROR | 43.0 | 271.1 |
| 8 | 1-192-07 | Kluet-3 | NAD | ROR | 23.8 | 194.0 |
| 9 | 1-027-14 | Ramasan-1 | NAD | RES | 119.0 | 291.9 |
| 10 | 1-192-08 | Sibubung-1 | NAD | ROR | 32.4 | 207.3 |
| 11 | 1-201-03 | Seunangan-3 | NAD | ROR | 31.2 | 179.3 |
| 12 | 1-198-05 | Teripa-4 | NAD | RES | 184.8 | 503.6 |
| 13 | 1-205-10 | Teunom-3 | NAD | RES | 102.0 | 303.2 |
| 14 | 1-202-02 | Meulaboh-2 | NAD | ROR | 37.0 | 212.5 |
| 15 | 1-192-10 | Sibubung-3 | NAD | ROR | 22.6 | 144.9 |
| 16 | 1-186-01 | Sirahar | North Sumatra | ROR | 35.4 | 228.3 |
| 17 | 1-190-33 | Ordi-1 | North Sumatra | ROR | 40.8 | 263.0 |
| 18 | 1-190-40 | Simanggo-1 | North Sumatra | ROR | 44.4 | 285.8 |
| 19 | 1-190-21 | Renun-3 | North Sumatra | ROR | 19.8 | 127.8 |
| 20 | 1-190-32 | Kumbih-3 | North Sumatra | ROR | 41.8 | 269.6 |
| 21 | 1-190-41 | Simanggo-2 | North Sumatra | ROR | 59.0 | 366.9 |
| 22 | 1-183-01 | Raisan-1 | North Sumatra | ROR | 26.2 | 167.9 |
| 23 | 1-190-26 | Gunung-2 | North Sumatra | ROR | 22.6 | 145.3 |
| 24 | 1-178-03 | Toru-2 | North Sumatra | ROR | 33.6 | 237.1 |
| 25 | 1-190-24 | Renun-6 | North Sumatra | ROR | 22.4 | 144.8 |
| 26 | 1-184-05 | Sibundong-4 | North Sumatra | ROR | 31.6 | 203.6 |
| 27 | 1-190-34 | Ordi-2 | North Sumatra | ROR | 26.8 | 172.8 |
| 28 | 1-190-37 | Ordi-5 | North Sumatra | ROR | 26.8 | 173.7 |
| 29 | 1-055-02 | Bila-2 | North Sumatra | ROR | 42.0 | 300.6 |
| 30 | 1-190-35 | Ordi-3 | North Sumatra | ROR | 18.4 | 119.1 |
| 31 | 1-053-01 | Silau-1 | North Sumatra | ROR | 52.3 | 147.9 |
| 32 | 1-190-22 | Renun-4 | North Sumatra | ROR | 53.6 | 134.5 |
| 33 | 1-190-38 | Siria | North Sumatra | ROR | 43.9 | 105.8 |

| No. | ID No. | Name | Province | Type | Installed Capacity (MW) | Annual Energy (GWh) |
|---|---|---|---|---|---|---|
| 34 | 1-178-07 | Toru-3 | North Sumatra | RES | 322.7 | 516.1 |
| 35 | 1-071-12 | Sangir | West Sumatra | ROR | 41.8 | 331.7 |
| 36 | 1-066-03 | Sinamar-2 | West Sumatra | ROR | 25.6 | 217.1 |
| 37 | 1-147-03 | Air Tuik | West Sumatra | ROR | 24.8 | 161.4 |
| 38 | 1-145-01 | Sirantih-1 | West Sumatra | ROR | 18.3 | 153.3 |
| 39 | 1-071-11 | Batang Hari-4 | West Sumatra | RES | 216.0 | 544.9 |
| 40 | 1-147-01 | Taratak Tumpatih-1 | West Sumatra | ROR | 29.6 | 192.6 |
| 41 | 1-066-02 | Sinamar-1 | West Sumatra | ROR | 36.6 | 254.9 |
| 42 | 1-163-02 | Masang-2 | West Sumatra | ROR | 39.6 | 256.1 |
| 43 | 1-071-01 | Gumanti-1 | West Sumatra | ROR | 15.8 | 85.4 |
| 44 | 1-155-01 | Anai-1 | West Sumatra | ROR | 19.1 | 109.2 |
| 45 | 1-163-03 | Masang-3 | West Sumatra | RES | 192.0 | 473.0 |
| 46 | 1-066-16 | Kuantan-2 | West Sumatra | RES | 272.4 | 734.1 |
| 47 | 1-058-08 | Rokan Kiri-1 | West Sumatra | RES | 183.0 | 431.9 |
| 48 | 1-115-01 | Mauna-1 | Bengkulu | ROR | 103.0 | 814.0 |
| 49 | 1-136-02 | Langkup-2 | Bengkulu | ROR | 82.8 | 700.5 |
| 50 | 1-071-33 | Merangin-4 | Jambi | RES | 182.0 | 491.9 |
| 51 | 1-113-02 | Padang Guci-2 | Bengkulu | ROR | 21.0 | 145.1 |
| 52 | 1-074-17 | Endikat-2 | South Sumatra | ROR | 22.0 | 179.8 |
| 53 | 1-082-07 | Semung-3 | Lampung | ROR | 20.8 | 146.9 |
| 54 | 1-106-02 | Menula-2 | Bengkulu | ROR | 26.8 | 152.2 |
| 55 | 1-071-17 | Tebo-2 | Lampung | ROR | 24.4 | 188.7 |
| 56 | 3-043-52 | Melawi-9 | West Kalimantan | RES | 590.4 | 1,324.8 |
| 57 | 3-043-20 | Mandai-5 | Central Kalimantan | RES | 140.7 | 351.8 |
| 58 | 3-014-06 | Boh-2 | East Kalimantan | RES | 1,119.6 | 3,299.2 |
| 59 | 3-010-01 | Kelai-1 | East Kalimantan | RES | 952.8 | 2,106.4 |
| 60 | 3-004-20 | Sesayap-20 | East Kalimantan | RES | 949.2 | 2,633.3 |
| 61 | 3-004-11 | Sesayap-11 | East Kalimantan | RES | 624.0 | 2,035.3 |
| 62 | 3-003-03 | Sembakung-3 | East Kalimantan | RES | 572.4 | 1,268.3 |
| 63 | 3-004-15 | Sesayap-15 | East Kalimantan | RES | 313.2 | 956.7 |
| 64 | 3-014-13 | Telen | East Kalimantan | RES | 193.2 | 544.4 |
| 65 | 4-026-03 | Poso-2 | Central Sulawesi | ROR | 132.8 | 1,125.4 |
| 66 | 4-026-02 | Poso-1 | Central Sulawesi | ROR | 204.0 | 1,341.0 |
| 67 | 4-106-07 | Lariang-7 | Central Sulawesi | RES | 618.0 | 1,489.6 |
| 68 | 4-106-06 | Lariang-6 | Central Sulawesi | RES | 209.4 | 616.2 |
| 69 | 4-003-04 | Bone-3 | Gorontalo | ROR | 20.4 | 148.3 |
| 70 | 4-030-02 | Bongka-2 | Central Sulawesi | RES | 187.2 | 451.3 |
| 71 | 4-038-01 | Solato | Central Sulawesi | ROR | 26.6 | 176.1 |
| 72 | 4-106-08 | Lariang-8 | Central Sulawesi | ROR | 12.8 | 85.4 |
| 73 | 4-100-03 | Karama-2 | West Sulawesi | RES | 762.3 | 1,796.1 |
| 74 | 4-055-01 | Tamboli | South East Sulawesi | ROR | 20.8 | 150.1 |
| 75 | 4-100-01 | Karama-1 | West Sulawesi | RES | 800.0 | 2,147.1 |
| 76 | 4-095-06 | Masuni | West Sulawesi | RES | 400.2 | 930.2 |
| 77 | 4-073-04 | Mong | South Sulawesi | RES | 255.6 | 618.9 |
| 78 | 4-093-13 | Bonto Batu | South Sulawesi | RES | 228.3 | 560.2 |
| 79 | 4-056-01 | Watunohu-1 | South East Sulawesi | ROR | 57.0 | 309.0 |
| 80 | 4-047-01 | Lalindu-1 | South East Sulawesi | RES | 193.6 | 544.1 |
| 81 | 4-057-03 | Pongkeru-3 | South East Sulawesi | RES | 227.6 | 556.6 |
| 82 | 14-002-02 | Mala-2 | Maluku | ROR | 30.4 | 209.0 |
| 83 | 14-002-01 | Mala-1 | Maluku | RES | 27.8 | 65.4 |
| 84 | 14-012-01 | Tala | Maluku | RES | 51.4 | 122.7 |
| 85 | 13-004-01 | Tina | Maluku | ROR | 22.8 | 156.7 |
| 86 | 5-042-02 | Warasai | West Irian Jaya | ROR | 231.9 | 1,314.0 |
| 87 | 5-013-06 | Jawee-4 | West Irian Jaya | ROR | 152.6 | 1,308.6 |
| 88 | 5-043-07 | Derewo-7 | West Irian Jaya | ROR | 148.8 | 1,180.5 |
| 89 | 5-013-05 | Jawee-3 | West Irian Jaya | ROR | 147.2 | 1,163.6 |
| 90 | 5-013-07 | Endere-1 | West Irian Jaya | ROR | 144.8 | 1,033.5 |
| 91 | 5-013-08 | Endere-2 | West Irian Jaya | ROR | 87.0 | 727.8 |
| 92 | 5-043-06 | Derewo-6 | West Irian Jaya | ROR | 170.0 | 1,128.4 |
| 93 | 5-013-04 | Jawee-2 | West Irian Jaya | ROR | 94.2 | 755.9 |
| 94 | 5-006-08 | Baliem-7 | Papua | ROR | 97.8 | 834.7 |

| No. | ID No. | Name | Province | Type | Installed Capacity (MW) | Annual Energy (GWh) |
|---|---|---|---|---|---|---|
| 95 | 5-006-06 | Baliem-5 | Papua | ROR | 189.2 | 1,401.4 |
| 96 | 5-036-12 | Waryori-4 | West Irian Jaya | ROR | 94.2 | 598.8 |
| 97 | 5-042-01 | Ulawa | West Irian Jaya | ROR | 34.6 | 194.6 |
| 98 | 5-037-91 | Gita/Ransiki-1 | West Irian Jaya | LOT | 56.2 | 136.2 |
| 99 | 5-006-07 | Baliem-6 | West Irian Jaya | ROR | 88.2 | 754.2 |
| 100 | 5-032-03 | Kladuk-2 | West Irian Jaya | RES | 229.0 | 567.4 |
| 101 | 5-015-05 | Titinima-3 | West Irian Jaya | ROR | 55.6 | 402.2 |
| 102 | 5-020-01 | Maredrer | West Irian Jaya | ROR | 8.7 | 62.4 |
| 103 | 5-026-01 | Muturi-1 | West Irian Jaya | ROR | 45.8 | 288.3 |
| 104 | 5-043-09 | Siewa-1 | West Irian Jaya | ROR | 58.4 | 330.5 |
| 105 | 5-006-09 | Baliem-8 | Papua | ROR | 138.4 | 1,007.0 |
| 106 | 9-011-01 | Parainglala | West Nusa Tenggara | ROR | 14.9 | 85.6 |
| *107* | | *Be Lulic-1* | *East Timur* | | | |
| 108 | 9-012-01 | Watupanggantu | West Nusa Tenggara | ROR | 7.1 | 40.5 |
| 109 | 9-001-01 | Karendi-1 | West Nusa Tenggara | RES | 21.4 | 49.5 |
| 110 | 7-015-01 | Teldewaja | Bali | ROR | 7.0 | 44.2 |
| 111 | 9-005-02 | Kambera-2 | West Nusa Tenggara | RES | 65.4 | 154.0 |
| 112 | 10-003-02 | Wai Ranjang | West Nusa Tenggara | ROR | 9.3 | 53.1 |
| 113 | 2-057-17 | Kesamben | East Java | LHD | 16.7 | 99.0 |
| 114 | 2-050-01 | Rowopening | Central Java | ROR | 19.6 | 138.4 |
| 115 | 2-108-01 | Cibareno-1 | Banten | ROR | 17.5 | 117.0 |
| 116 | 2-207-01 | Cimandiri-1 | West Java | ROR | 24.4 | 167.5 |

Note: ROR = Run-of-river type, RES = Reservoir type, LOT = Lake outlet type, LHD = Run-of-river type with low head dam, NAD = Nanggroe Aceh Darussalam Province.

Source: HPPS2 (1999).

The above table indicates some characteristics of hydropower potentials Indonesia as follows:

- With respect of numbers of schemes, almost half of the all (55 among 115) are located in Sumatra. Among the schemes in Sumatra, more than half (34 among 55) are located in NAD or North Sumatra.
- Most of the schemes in Sumatra (44 among 55) are formulated as run-of-river type of which installed capacity varies 10~40 MW.
- All schemes in Kalimantan are formulated as reservoir type of large scale (several hundreds MW) , for a reason that the areas are covered mostly with gentle topography.
- Sulawesi is characterized with abundant potential for run-of-river type development in the Poso river and also reservoir type development in West Sulawesi.
- West Irian Jaya and Papua have abundant potential for run-of-river type development of which installed capacity are significantly large. Those potentials may be developed in case large power demand such as mining purpose are reasonably expected.
- Only few projects are identified in Java.

Out of 115 schemes which passed the 3rd screening of HPPS2 as seen in Table 4.1.1., the following 7 schemes in total have proceeded to subsequent stages after HPPS2 completed.

- Pre-F/S : Masang-3, Tamboli, Tala, Tina, Kambera-2, Wai Ranjang

- F/S : Kesamben

## 4.3 PUMPED STORAGE PROJECTS IN JAVA SCREENED IN HPPS2

In HPPS2, 58 pumped storage schemes in total were identified including the Upper Cisokan for which F/S was completed at that time and the Cijulang-2 (or Matenggeng) for which Pre-F/S was completed as well.

Screening from aspects of required catchment area, maximum head, distribution of power demand and economic viability was carried out in HPPS2, and as a result 10 schemes passed the screening.

List of the pumped storage schemes which passed the screening in HPPS2 is seen in Table 4.3.1.

**Table 4.3.1 List of Screened Pumped Storage Schemes in HPPS2**

| No. | ID No. | Name | Province | Installed Capacity (MW) | Catchment Area ($km^2$) | Max. Gross Head (m) |
|---|---|---|---|---|---|---|
| 1 | 02-092-72-11 | Cijulang-P/S-2 | West Java | 1,000 | 240 | 484 |
| 2 | 02-103-71-11 | Cibuni-P/S-1 | West Java | 1,000 | 80 | 467 |
| 3 | 02-016-72-11 | Upper Cisokan P/S | West Java | 1,000 | 366 | 296 |
| 4 | 02-108-72-11 | Cibareno-P/S-2 | West Java | 1,000 | 122 | 500 |
| 5 | 02-107-71-11 | Cikalong-P/S | West Java | 1,000 | 24 | 497 |
| 6 | 02-050-71-11 | Klegung-P/S | Central Java | 1,000 | 269 | 543 |
| 7 | 02-090-76-11 | Dolok-P/S | Central Java | 1,000 | 18 | 470 |
| 8 | 02-090-71-11 | Laban-P/S | Central Java | 1,000 | 35 | 399 |
| 9 | 02-080-73-11 | Grindulu-P/S-3 | East Java | 1,000 | 236 | 444 |
| 10 | 02-057-71-12 | K. Konto-P/S | East Java | 1,000 | 239 | 512 |

Source: HPPS2 (1999)

The Upper Cisokan has proceeded to construction stage after HPPS2 completed.

## 4.4 PROJECTS OF 5-10MW CLASS SCREENED IN HPPS2

Schemes of less than 10.0MW installed capacity were considered to be too small to be taken up in HPPS2 and thus discarded in the 2rd screening of HPPS2. List of the 5-10MW class schemes which passed the 1st screening but were dropped in the 2nd screening of HPPS2 is seen in Table 4.4.1.

**Table 4.4.1 List of Schemes of 5-10MW Class Screened in HPPS2**

| No. | ID No. | Name | Province | Type | Installed Capacity (MW) |
|---|---|---|---|---|---|
| 1 | 01-019-05-2 | Baleg | NAD | ROR | 8.7 |
| 2 | 01-190-04-2 | Pantan Dadalu-1 | NAD | ROR | 7.3 |
| 3 | 01-027-01-2 | Jambuaye-1 | NAD | ROR | 7.2 |
| 4 | 01-190-29-2 | Puncu | NAD | ROR | 4.2 |
| 5 | 01-190-25-2 | Gunung-1 | North Sumatra | ROR | 8.0 |
| 6 | 01-184-01-2 | Sibundong-1 | North Sumatra | ROR | 9.9 |
| 7 | 01-184-02-2 | Sibundong-2 | North Sumatra | ROR | 9.7 |
| 8 | 01-040-09-2 | Berkail-2 | North Sumatra | ROR | 7.1 |
| 9 | 01-066-15-3 | Kuantan-1 | West Sumatra | LHD | 7.0 |

| No. | ID No. | Name | Province | Type | Installed Capacity (MW) |
|---|---|---|---|---|---|
| 10 | 01-066-08-2 | Lawas/Suo | West Sumatra | ROR | 3.5 |
| 11 | 01-168-01-2 | Bangis | West Sumatra | ROR | 7.2 |
| 12 | 01-077-03-3 | Besai-2 | Lampung | LHD | 6.8 |
| 13 | 01-125-02-2 | Nokan-2 | Bengkulu | ROR | 7.2 |
| 14 | 01-111-04-2 | Mantai | Bengkulu | ROR | 9.7 |
| 15 | 01-109-01-2 | Sanbat Kiri | Bengkulu | ROR | 8.3 |
| 16 | 02-057-04-3 | Tambak Sari | East Java | LHD | 9.7 |
| 17 | 02-057-06-3 | Blobo | East Java | LHD | 8.3 |
| 18 | 02-059-01-2 | Baung | East Java | ROR | 7.0 |
| 19 | 02-057-05-3 | Lumbang Sari | East Java | LHD | 3.3 |
| 20 | 02-065-01-2 | Wanasari | East Java | ROR | 3.4 |
| 21 | 02-057-23-2 | Upper Konto-2 | East Java | ROR | 3.6 |
| 22 | 02-057-10-1 | Lesti-3 | East Java | RES | 6.6 |
| 23 | 02-044-01-2 | Curug Sewu-1 | Central Java | ROR | 5.2 |
| 24 | 02-083-03-2 | Bogowonto-2 | Central Java | ROR | 5.1 |
| 25 | 02-083-04-2 | Bogowonto-3 | Central Java | ROR | 5.8 |
| 26 | 02-106-01-2 | Ciletuh | West Java | ROR | 8.9 |
| 27 | 02-104-01-2 | Cikaso-1 | West Java | ROR | 9.7 |
| 28 | 02-103-02-2 | Cibuni-2 | West Java | ROR | 6.8 |
| 29 | 04-040-11-2 | Sumara | Central Sulawesi | ROR | 8.2 |
| 30 | 04-128-04-2 | Sawangan | North Sulawesi | ROR | 9.0 |
| 31 | 04-125-02-2 | Poigar-1 | North Sulawesi | ROR | 6.4 |
| 32 | 04-093-11-2 | Mataalo-1 | South Sulawesi | ROR | 8.7 |
| 33 | 07-009-02-2 | Daya-2 | Bali | ROR | 4.3 |

Note: ROR = Run-of-river type, RES = Reservoir type, LOT = Lake outlet type, LHD = Run-of-river type with low head dam, NAD = Nanggroe Aceh Darussalam Province.

Source: HPPS2 (1999)

Among the above, the following two projects are further examined as their installed capacities can be increased to more than 10MW.

- Besai-2 is currently under study by PLN for re-formulation to 44 MW scale as Besai-1 is already completed as the peak power generating plant at the immediate upstream of Besai-2.
- Pre FS of Sawangan was completed in 1999 and the scheme was re-formulated with a scale of 16 MW.

## 4.5 PROJECTS FINISHED FOR DD, F/S OR PRE F/S

As aforementioned, 55 schemes among the potentials identified in HPPS had already proceeded to subsequent stages when HPPS2 was conducted. Furthermore, aside from the identified schemes in HPPS, 31 schemes had also proceeded to stages such as pre feasibility study, feasibility study, detailed design, under construction or completed. Adding 22 hydropower plants which already existed as of HPPS, a total of 108 schemes were identified in HPPS2 as planned and existing schemes.

List of the planned conventional schemes as of HPPS2, with current status of respective scheme as of 2010, are seen in Table 4.5.1.

## Table 4.5.1 List of Planned Schemes as of HPPS2 with Current Status

| No. | Name | Province | Type | Installed Capacity (MW) | Annual Energy (GWh) | Status in HPPS2 (1999) | Current Status (2010) |
|---|---|---|---|---|---|---|---|
| - | Sipansihaporas-1 | North Sumatra | RES | 33 | 135 | DD | Completed |
| - | Sipansihaporas-2 | North Sumatra | ROR | 17 | 69 | DD | Completed |
| - | Asahan-1 | North Sumatra | LHD | 180 | 1,360 | DD | On-going |
| - | Asahan-3 | North Sumatra | ROR | 174 | 1,477 | DD | On-going |
| 1 | Merangin-2 | Jambi | ROR | 350 | 1,465 | DD | DD |
| 2 | Tampur-1 | NAD | RES | 428 | 1,214 | FS | FS |
| 3 | Jambu Aye-8 | NAD | RES | 160 | 650 | FS | FS |
| 4 | Wampu | North Sumatra | ROR | 84 | 475 | FS | FS |
| 5 | Ketaun-1 | Bengkulu | RES | 84 | 308 | FS | FS |
| 6 | Ranau | South Sumatra | LOT | 60 | 146 | FS | FS |
| 7 | Teunom-1 | NAD | RES | 24 | 212 | Pre FS | Pre FS |
| 8 | Aceh-2 | NAD | RES | 7 | 64 | Pre FS | Pre FS |
| 9 | Peusangan-4 | NAD | ROR | 31 | 234 | Pre FS | FS |
| 10 | Lawe Alas-4 | NAD | RES | 322 | 1,549 | Pre FS | Pre FS |
| 11 | Toru-1 | North Sumatra | ROR | 38 | 308 | Pre FS | Pre FS |
| 12 | Merangin-5 | Jambi | RES | 24 | 197 | Pre FS | Pre FS |
| 13 | Bayang-1 | West Sumatra | ROR | 13 | 71 | Pre FS | Pre FS |
| 14 | Bayang-2 | West Sumatra | ROR | 31 | 203 | Pre FS | Pre FS |
| 15 | Lematang-4 | South Sumatra | RES | 12 | 107 | Pre FS | Pre FS |
| 16 | Lasolo | Central Sulawesi | ROR | 100 | 770 | FS | FS |
| 17 | Palu-3 | Central Sulawesi | LOT | 75 | 510 | FS | FS |
| 18 | Bakaru (2nd) | South Sulawesi | ROR | 126 | 471 | FS | DD |
| 19 | Poko | South Sulawesi | RES | 233 | 760 | FS | FS |
| 20 | Malea | South Sulawesi | ROR | 182 | 1,477 | FS | FS |
| 21 | Konaweha-3 | Central Sulawesi | RES | 24 | 116 | Pre FS | Pre FS |
| 22 | Poigar-2 | North Sulawesi | ROR | 25 | 149 | Pre FS | DD |
| 23 | Poigar-3 | North Sulawesi | ROR | 14 | 99 | Pre FS | Pre FS |
| 24 | Batu | South Sulawesi | RES | 271 | 1,740 | Pre FS | Pre FS |
| 25 | Maung | Central Java | RES | 360 | 535 | DD | DD |
| 26 | Rajamandala | West Java | ROR | 58 | 216 | DD | DD |
| 27 | Jatigede | Wesy Java | RES | 175 | 777 | DD | DD |
| 28 | Cibuni-3 | West Java | RES | 172 | 568 | FS | FS |
| 29 | Cipasang | West Java | RES | 400 | 751 | FS | FS |
| 30 | Cimandiri-3 | West Java | RES | 238 | 600 | FS | FS |
| 31 | Gintung | Central Java | RES | 19 | 81 | Pre FS | Pre FS |
| 32 | Rawalo-1 | Central Java | LHD | 0.6 | 5 | Pre FS | Pre FS |
| 33 | Cibuni-4 | West Java | RES | 71 | 207 | Pre FS | Pre FS |
| 34 | Cikaso-3 | West Java | RES | 30 | 189 | Pre FS | Pre FS |
| 35 | Grindulu-2 | East Java | RES | 16 | 51 | Pre FS | Pre FS |
| 36 | Riam Kiwa | South Kalimantan | RES | 42 | 152 | DD | DD |
| 37 | Pade Kembayung | West Kalimantan | RES | 30 | 235 | FS | FS |
| 38 | Kusan-3 | South Kalimanatan | RES | 68 | 101 | FS | DD |
| 39 | Amandit-2 | South Kalimantan | RES | 2.5 | 20 | Pre FS | Pre FS |
| 40 | Kelai-2 | East Kalimantan | RES | 168 | 1,103 | Pre FS | FS |
| 41 | Kayan-2 | East Kalimantan | RES | 500 | 3,833 | Pre FS | Pre FS |
| 42 | Pinoh | West Kalimantan | RES | 198 | 1,375 | Pre FS | Pre FS |
| 43 | Silat | West Kalimanatan | RES | 29 | 130 | Pre FS | Pre FS |
| 44 | Ayung-1 | Bali | ROR | 23 | 88 | FS | FS |
| 45 | Ayung-2 | Bali | ROR | 19 | 52 | FS | FS |
| 46 | Ayung-3 | Bali | LHD | 1.8 | 12 | FS | FS |
| 47 | Beburung | West Nusa Tenggara | ROR | 22 | 91 | FS | FS |
| 48 | Putih-1 | West Nusa Tenggara | ROR | 5.6 | 29 | FS | FS |
| 49 | Putih-2 | West Nusa Tenggara | ROR | 4.1 | 22 | FS | FS |
| 50 | Putih-3 | West Nusa Tenggara | ROR | 6.1 | 32 | FS | FS |
| 51 | Isal-2 | Maluku | RES | 60 | 447 | FS | FS |
| 52 | Lamo-1 | Maluku | RES | 5.7 | 25 | Pre FS | Pre FS |
| 53 | Warsamson | West Irian Jaya | RES | 49 | 248 | FS | FS |
| 54 | Genyem | Papua | ROR | 23 | 68 | FS | On-going |

Notes: 1) ROR = Run-of-river type, RES = Reservoir type, LOT = Lake outlet type, LHD = Run-of-river type with low head dam, NAD = Nanggroe Aceh Darussalam Province.

2) Status of Peusangan 1&2 (currently on-going) in HPPS2 was “On-going”.

Source: JICA Study Team based on HPPS2 (1999).

The followings are noted:

- More than half of the studied schemes were formulated as reservoir type development.
- The following projects are under process of implementation by IPP; Asahan 1, Wampu, Toru-1 (as PLTM), Malea, and Rajamandala.

## 4.6 ADDITIONAL SCHEMES EXAMINED IN THIS STUDY

(1) Modification of Reservoir Scheme to Run-of-River Scheme

Reservoir development type schemes which have steep river gradient (more than 1:50) in downstream stretch (from the dam site to tailrace) were selected in the Table 4.2.1 as the candidates for modification of reservoir type to run-of-river scheme. As the result, Bonto Batu was selected for further examination.

(2) Expansion of Existing Power Plants

Candidate schemes of expansion of the existing power plants are selected based on the hearing with PLN. As a result, the extension of Karangkates was selected for further examination.

(3) Pumped Storage Project in Sumatra

For reduction of environmental impact, plans which utilize natural lake or existing reservoir are considered. As a prospective site, the Lake Toba pumped storage scheme was selected for further study.

# CHAPTER 5 BASIC DATA FOR HYDROPOWER PLANNING

## 5.1 TOPOGRAPHY

(1) Availability in HPPS2 in 1999

Topographic maps with a scale of 1:50,000 which were published by BAKOSURTANAL (National Coordination Agency for Surveys and Mapping) or JANTOP were available in the following areas, and thus were used for site identification and evaluation of the schemes in HPPS2.

- Whole areas of Sumatra, Java-Bali and Sulawesi
- South Kalimantan Province, eastern part of Central Kalimantan Province, southern part of East Kalimantan Province and surrounding areas of the Landak river basin in West Kalimantan Province

Small areas of West Irian Jaya Province were covered with 1:100,000 topographic maps. Other areas except the above mentioned were covered with 1:250,000 topographic maps.

(2) Topographic Maps Available after HPPS2

New topographic maps as below have become available after HPPS2, which have been published by BAKOSURTANAL.

- Whole areas of Java-Bali, West and East Nusa Tenggara Province with a scale of 1:25,000
- Almost whole areas of Kalimantan with a scale of 1:50,000
- Almost whole areas of Papua Province with a scale of 1:100,000

(3) Collection of New Topographic Maps

Topographic maps which had been used in the previous HPPS2 in 1999 and submitted to the Survey Subdivision of the System Planning Division, PLN headquarter, were found missing. Therefore, collection of necessary topographic maps with a scale of 1:50,000 or 1:25,000 from BAKOSURTANAL was made by the Study Team.

Numbers of the topographic maps collected until the 2nd Field Survey from BAKOSURTANAL in the Study are as tabulated below.

**Table 5.1.1 Numbers of Collected Topographic Maps from BAKOSURTANAL**

| Province | Scale | Sheet | Province | Scale | Sheet |
|---|---|---|---|---|---|
| Nangroe Aceh Darussalam | 1:50,000 | 13 | East Kalimantan | 1:50,000 | 2 |
| North Sumatra | 1:50,000 | 15 | South Sulawesi | 1:50,000 | 5 |
| West Sumatra | 1:50,000 | 2 | Central Sulawesi | 1:50,000 | 7 |
| Bengkulu | 1:50,000 | 1 | West Sulawesi | 1:50,000 | 3 |
| Banten | 1:25,000 | 6 | Central Sulawesi | 1:50,000 | 4 |
| West Java | 1:25,000 | 20 | Gorontalo | 1:50,000 | 1 |
| Central Java | 1:25,000 | 13 | North Sulawesi | 1:50,000 | 2 |
| East Java | 1:25,000 | 19 | | | |
| | | | Total | | 113 |

Source: JICA Study Team

# 5.2 GEOLOGY AND SEISMICITY

## 5.2.1 DATA SOURCE

The primary geological data sources collected and used for hydropower project site assessment and hydropower development planning are as follows:

- Geological base maps used in HPPS2;
- Recently published geological maps;
- Seismic hazard zone maps published in 2005; and
- Previous investigation and study reports.

In addition, the collected geological data and information were listed in Volume III Supporting Report (1) Hydropower Development Master Plan.

(1) Geological base maps used in HPPS2

HPPS2 completed in 1999 collected the geological maps of the whole Indonesia with a scale of 1:250,000 from Pusat Penelitian dan Pengembangan Geologi (P3G) (Geological Research and Development Centre, Directorate General of Geology and Mineral Resources, Department of Mines and Energy). These maps were submitted to PLN. The digitized geological base maps prepared in HPPS2 are available for the identification of geology around project sites and basically used to identify the geology of each project site in this study.

(2) Recently published geological maps

Since HPPS2, the geological maps used in HPPS2 have recently been locally revised and republished with a scale of 1:250,000 or 1:100,000 by Geological Research and Development Centre, Directorate General of Geology and Mineral Resources, Department of Mines and Energy. These recently published geological maps, especially with a larger scale, were collected to confirm and check the geology of project sites by comparison with the geological base maps prepared in HPPS2.

(3) Seismic hazard zone maps published in 2005

Since the 2004 earthquake, the latest seismic hazard zone map was prepared in 2005 by Water Resource Development and Research Centre. The map was collected and used, together with the above-mentioned geological maps, to evaluate regional seismic activity.

(4) Previous investigation and study reports

The hydropower potential sites in this study included some existing and ongoing projects, of which detailed design, feasibility study and pre-feasibility.

These previous available study and geological investigation reports were collected to further check the geology of the subject project sites by comparison with the above-mentioned geological maps.

## 5.2.2 PRELIMINARY EVALUATION ON GEOLOGY AND SEISMICITY

(1) General

The second hydropower potential study (HPPS2) in 1996-99 performed an extensive assessment of undeveloped potential hydropower project sites over the whole country and resulted in the identification of 116 preferred project sites from the total 1,249 potential project sites. The HPPS2 mainly addressed the economical viability as well as socio-environmental and geological constraints.

The features of a hydropower project are generally site specific and mainly depend on the geology, topography, hydrology and seismic condition at the site. Especially the development cost of a hydropower project is greatly influenced by the geologic and seismic settings of project site as well as its accessibility. Accordingly, in order to prioritize the candidate hydropower development sites, the preliminary geological and seismic evaluations of these project sites were conducted to provide a geological and seismic basis for estimation of development costs.

The preliminary geological and seismic evaluations were mainly based on the review of published geological and seismic hazard zone maps as well as previous study reports. This section summarizes the regional geological features of each island and presents the method and results of preliminary geological and seismic evaluations.

(2) Preliminary geological evaluation

a) Previous evaluation methods

The nature, strength, thickness, dip, jointing and permeability of geological foundations at a hydropower project site are a set of often decisive factors in selection of the dam type and size. The most important aspect is the major and active faults, which greatly affect the safety of hydropower projects. Therefore, the geological screening criteria in the 2$^{nd}$ screening of HPPS2 were addressed below:

- Reservoir type development schemes situated within the Great Sumatera Fault Zone were ruled out; and

- Reservoir type development schemes situated within the Palu Fault Zone were ruled out.

Consequently, nine reservoir type development schemes with a larger dam within these fault zones were abandoned through HPPS2.

Subsequent to geological screening, based on review of regional geology in the whole Indonesia, the geology of potential hydropower development sites were preliminarily evaluated by means of geological zonation all over Indonesia, as shown in Table 5.2.1 below.

**Table 5.2.1 Geological Evaluation Criteria in HPPS2**

| Island | Geological zone | | DS | HRT | ST | PST | TRT | QA |
|---|---|---|---|---|---|---|---|---|
| Sumatra | A | Barisan Range Tertiary and older rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Barisan Range young volcanic products | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Lower hill zone out of Barisan Range | 3 | 3 | 2 | 3 | 2 | 2 |
| | D | Barisan Range Great Sumatra Fault zone | 3 | 3 | 3 | 3 | 3 | 3 |
| Java | A | Tertiary or older rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Quaternary volcanic products | 2 | 3 | 2 | 3 | 2 | 2 |
| | C | Alluvial plain or limestone | 3 | 3 | 3 | 3 | 2 | 2 |
| Kalimantan | A | Paleozoic/Mesozoic Mountain Range | 1 | 2 | 1 | 2 | 1 | 1 |
| | B | Tertiary rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | C | Plio-Pleistocene soft rocks | 2 | 3 | 2 | 3 | 2 | 3 |
| | D | Limestone/Holocene sediments | 3 | 3 | 3 | 3 | 2 | 3 |
| Sulawesi | A | Pre-Tertiary rocks/Intrusive rocks | 1 | 2 | 1 | 2 | 1 | 1 |
| | B | Paleogene to Miocene rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | C | Plio-Pleistocene rock or fault in older rock | 2 | 3 | 2 | 3 | 2 | 2 |
| | D | Palu fault/Limestone/Holocene sediments | 3 | 3 | 3 | 3 | 2 | 3 |
| Irian Jaya | A | Paleogene or older rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Neogene rocks | 2 | 3 | 2 | 3 | 2 | 2 |
| | C | Neogene rocks with large faults | 3 | 3 | 3 | 3 | 2 | 2 |
| | D | Quaternary sediments and limestone | 3 | 3 | 3 | 3 | 3 | 3 |
| Timor | A | Pre-Tertiary rocks in the eastern part | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Neogene and older rocks | 3 | 3 | 2 | 3 | 2 | 2 |
| | C | Quaternary and limestone | 3 | 3 | 3 | 3 | 3 | 3 |
| Sumba | A | Pre-Tertiary rocks | 2 | 2 | 2 | 3 | 1 | 2 |
| | B | Mio-Pliocene sedimentary rock | 2 | 3 | 2 | 3 | 2 | 2 |
| | C | Quaternary and limestone | 3 | 3 | 3 | 3 | 3 | 3 |
| Seram/Buru | A | Paleogene/older rocks | 1 | 2 | 2 | 2 | 1 | 2 |
| | A’ | Paleogene rocks with faults | 2 | 2 | 2 | 3 | 1 | 2 |
| | B | Mio-Pliocene merange | 3 | 3 | 3 | 3 | 2 | 2 |
| | C | Quaternary and limestone | 3 | 3 | 3 | 3 | 3 | 3 |
| Halmahera | A | Tertiary/older rocks/intrusives | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Quaternary volcanic products | 2 | 3 | 2 | 3 | 2 | 2 |
| | C | Alluvial plain or limestone | 3 | 3 | 3 | 3 | 2 | 2 |

Notes: 1) Evaluation criteria in Madura, Bali, Lombok, Sumbawa and Flores are the same as those in Java; 2) DS=Damsite, HRT=Headrace tunnel, ST=Surgetank, PST=Penstock tunnel, TRT=Tailrace tunnel, QA= Quarry access, RES=Reservoir type; 3) GSFZ = Great Sumatra Fault Zone, PFZ = Palu Fault Zone.

Source: HPPS2 (1999)

Each geological zone classified was assessed for its geotechnical suitability for the rockfill dam foundation, the headrace tunnel, the surge tank, the penstock tunnel, the open tailrace and the accessibility to quarry (haul distance), through the following three points system:

- Point 1: Very Good
- Point 2: Good
- Point 3: Acceptable (or Poor)

b) Present evaluation criteria

Preliminary geological evaluation criteria in this study are basically the same as those used in HPPS2 with a slight modification mainly in view of consistency and simplicity. Table 5.2.2 presents the general geological evaluation criteria in this study, while Table 5.2.3 gives the regional geological evaluation criteria for each island.

**Table 5.2.2 General Geological Evaluation Criteria in This Study**

| General geological zone | | DS | RES | HRT | ST | PST | TRT | QA | Geological class |
|---|---|---|---|---|---|---|---|---|---|
| **A** | Tertiary and Pre-Tertiary rocks or/and plutonic igneous rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 | Very Good |
| **B** | Quaternary volcanic rocks or/and Tertiary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 | Good |
| **C** | Quaternary sediments or limestone, rocks or sediments with major faults | 3 | 3 | 3 | 2 | 3 | 2 | 2 | Acceptable |

Note: Abbreviations are the same as those shown in Table 5.2.1 above.

**Table 5.2.3 Geological Evaluation Criteria by Island in This Study**

| Island | Geological zone | | DS | RES | HRT | ST | PST | TRT | QA |
|---|---|---|---|---|---|---|---|---|---|
| Sumatra | A | Barisan Range Tertiary or/and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Barisan Range Quaternary volcanic rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or rocks with GSFZ | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Java | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Quaternary volcanic rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Kalimantan | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary to Quaternary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Sulawesi | A | Tertiary and Pre-Tertiary rocks or plutonic igneous rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary to Quaternary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone or Rocks with PFZ | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Irian Jaya | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone or rocks with PFZ | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Timor | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sumba | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary soft rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Seram/Buru | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Tertiary soft rocks or rocks with faults | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| Halmahera | A | Tertiary and Pre-Tertiary rocks | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | B | Quaternary volcanic rocks | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| | C | Quaternary sediments or limestone | 3 | 3 | 3 | 2 | 3 | 2 | 2 |

Note: Abbreviations are the same as those shown in Table 5.2.1 above.
Source: JICA Study Team

As shown in Table 5.2.2, geological foundation materials are divided into three general categories or three geological zones. The three geological zones correlate respectively to three geological classes, as defined in HPPS2. Conceptually, for a given type and size of hydropower project, a potential project site with a geological class of Very Good was defined to be suitable for its construction without any additional engineering treatments; whereas a potential project site with a geological class of Good was defined to be suitable for its construction probably with a requirement of additional engineering treatment, thereby requiring a additional engineering cost. Comparatively a potential project site with a geological class of Acceptable will be much likely to require more additional engineering cost for construction of a similar type and size of hydropower project.

c) Preliminary geological evaluation results

According to the geological evaluation criteria shown in Table 5.2.3 above, the geology of each project site was evaluated and given in No. 2.2 of Supporting Report (1) Hydropower Development Master Plan and general geology of Indonesia is summarized in No. 2.3 of Supporting Report (1) Hydropower Development Master Plan.

As the result, it is judged that the geotechnical evaluations in HPPS2 for respective schemes are not substantially different from the updated evaluation in this Study. Therefore, substantial alteration to work quantities of major structures estimated in HPPS2 due to updated geological evaluation result is found not required for formulating the master plan.

(3) Seismic Zone Evaluation

Seismic analysis was carried out in order to estimate maximum earthquake acceleration to be used for structure design.

In this study, the expected acceleration due to the earthquake motion at project sites was calculated in accordance with the Indonesian standard in respect to the seismic design, that is, Indonesian Earthquake Zone Maps published by Water Resource Development and Research Center in 2005.

Figure 5.2.1 shows the relevant Indonesian Zone Maps, including two maps; one is based on the attenuation model proposed by Fukushima & Tanaka (1990), and the other on the attenuation model proposed by Joyner & Boore (1993). In this study, the earthquake acceleration was calculated by using

Fukushima & Tanaka model, which has been supposed to give conservative results. In addition, for comparative purpose, earthquake acceleration was also obtained by means of Joyner & Boore model.

In calculation with the maps, the earthquake acceleration value is calculated by the following equation:

$$a_d = Z \times a_c \times v$$

Where, $a_d$: corrected acceleration on the ground surface (gal)

$a_c$: basic earthquake acceleration (gal)

Z: zone correction coefficient

V: correction factor for type of foundation ground

In general, the following equation can be applied to convert the earthquake acceleration to the horizontal seismic coefficient:

$$k_h = R \times A_{\max} / 980$$

where, $k_h$: design horizontal seismic coefficient

R: conversion factor

$A_{max}$: earthquake acceleration (gal) = $a_d$

The maximum earthquake acceleration for each project site is estimated according to the following steps:

a) Firstly, each project site is categorized into different zone in accordance with the Zone Map, and then the zone correction coefficient, Z, is determined for each project site. In addition, higher zone correction coefficient is adopted for safe side, for example, if fallen into zone D, the zone correction coefficient of Z is taken to be 1.20.

b) Secondly, the corrected acceleration on the ground surface of “$a_d$” is given. 0.80 is applied for correction factor for type of foundation ground rock type “v” as rock foundation is generally assumed, and 0.289 g for 500 years is considered appropriate for the basic earthquake acceleration value “$a_c$” as water schemes are the civil structures that society requires the highest level of safety measures against the possible earthquake damages happening to the structures.

c) As for the conversion factor of “R”, it is regarded as 0.40 to 0.60 empirically, and as from the safety side 0.60 is taken.

d) Finally, earthquake acceleration value “$k_h$”is calculated by the above equations and the results are summarized and further categorized into 4 groups for safety purpose.

The zone maps, respective coefficient and the result of calculations are shown in Table 5.2.4 through Table 5.2.8.

**Table 5.2.4 Return Period and Basic Earthquake Acceleration**

| Return Period<br>T (Year) | Acceleration<br>$a_d$ (g) |
|---|---|
| 10 | 0.127 |
| 20 | 0.155 |
| 50 | 0.196 |
| 100 | 0.227 |
| 200 | 0.255 |
| 500 | 0.289 |
| 1,000 | 0.313 |
| 5,000 | 0.364 |
| 10,000 | 0.385 |

Source: Indonesian Earthquake Zone Maps by Water Resource Development and Research Center in 2005

**Table 5.2.5 Zone and Zone Coefficient**

| Zone | Zone Coefficient<br>Z |
|---|---|
| A | 0.0 – 0.3 |
| B | 0.3 – 0.6 |
| C | 0.6 – 0.9 |
| D | 0.9 – 1.2 |
| E | 1.2 – 1.4 |
| F | 1.4 – 1.6 |

Source: Indonesian Earthquake Zone Maps by Water Resource Development and Research Center in 2005

**Table 5.2.6 Foundation Type and Correction Factor**

| Foundation type | Dominant Period<br>Ts (sec) | | | Correction<br>v |
|---|---|---|---|---|
| Rock | | Ts < | 0.25 | 0.80 |
| Diluvium | 0.25 | < Ts < | 0.50 | 1.00 |
| Alluvium | 0.50 | < Ts < | 0.75 | 1.10 |
| Soft Alluvium | | Ts > | 0.75 | 1.20 |

Source: Indonesian Earthquake Zone Maps by Water Resource Development and Research Center in 2005

**Table 5.2.7 Earthquake Acceleration Calculated by Indonesian Earthquake Map**

| Zone | Earthquake acceleration value | Group |
|---|---|---|
| A | 0.04 | 0.10 |
| B | 0.08 | |
| C | 0.12 | 0.15 |
| D | 0.17 | 020 |
| E | 0.19 | |
| F | 0.22 | 0.25 |

Source: Indonesian Earthquake Zone Maps by Water Resource Development and Research Center in 2005

This study was conducted based on the Indonesian Earthquake Zone Maps published by Water Resource Development and Research Center as the latest Standard for the earthquake acceleration to be used for structure design. As a result, project sites are categorized mostly as D and E, which represent the Indonesian seismic activity situation.

The attenuation models applied in the maps have been issued on 1990 through 1993, and have not included the recent earthquakes in their empirical estimations. Thus this study has taken conservative figures for each coefficients estimation and has provided safe side evaluation.

**Table 5.2.8 Distribution of Earthquake Acceleration Zone Factor**

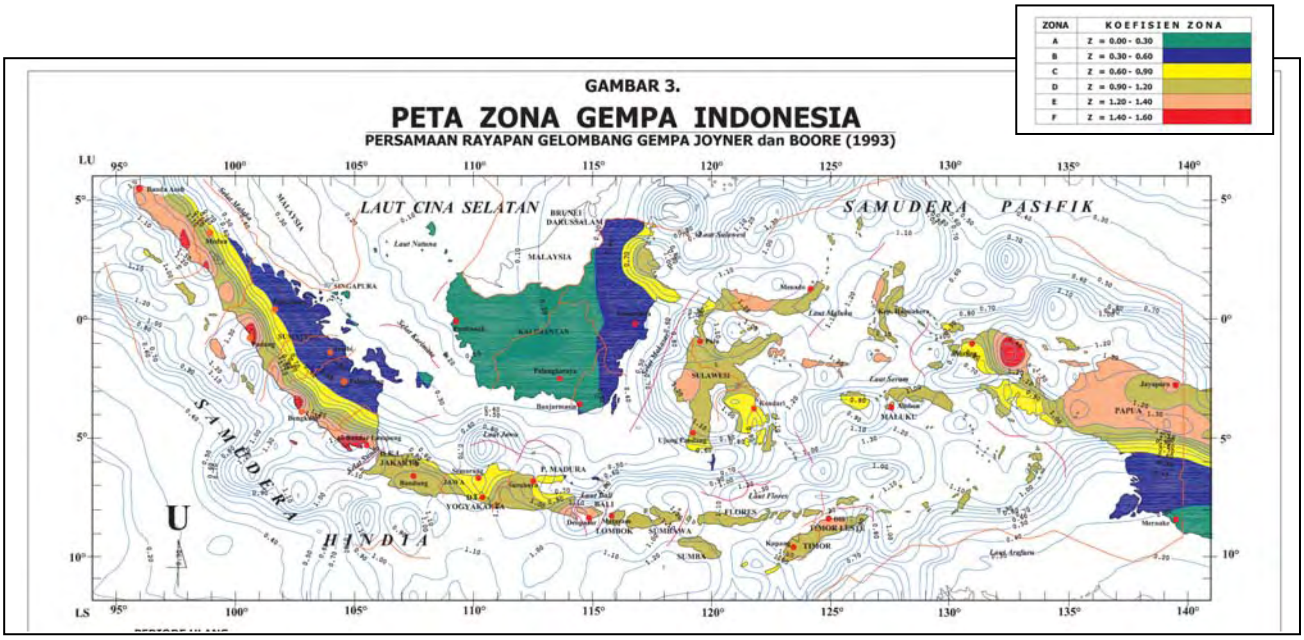
| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Fukushima & Tanaka (1990) | **14** | **4** | **19** | **109** | **94** | **14** |
| Sumatera | *0* | *0* | *3* | *24* | *64* | *11* |
| Java | *0* | *0* | *14* | *35* | *6* | *0* |
| Kalimantan | *14* | *3* | *1* | *0* | *0* | *0* |
| Sulawesi | *0* | *1* | *0* | *27* | *8* | *0* |
| Irian Jaya | *0* | *0* | *1* | *9* | *9* | *3* |
| Others | *0* | *0* | *0* | *14* | *7* | *0* |
| (cf) Joyner & Boore (1993) | **9** | **6** | **26** | **100** | **96** | **17** |

Taking into consideration the fact that there seems to be rather many earthquakes in Indonesia, the probability analysis for the attenuation characteristics of maximum earthquake motion should also be evaluated using the actual past earthquake data update (epicenters and magnitudes) in further stage. Furthermore the stability of the site should be verified using such as dynamic seismic analysis at the detailed design stage.

Actually there have been several earthquakes reported in Indonesia; large earthquakes beyond M9 on 26th Dec. 2004 in the areas of North Sumatra through Andaman Archipelago, followed by the earthquake on Mar. 2005 near Nias Island (Northwest Sumatra), the earthquake on July 2006 in Pangandalan (South of Java), the earthquake on Sep. 2007 in Bengkulu (Sumatra Northwest) have occurred along the Sunda Trench, and also the inland type earthquake occurred on May 2006 near Jogjakarta.

As seen on the Table 5.2.8, no significant differences are seen in the result of zoning of the earthquake accelerations for the potential project sites from the attenuation model proposed by Fukushima & Tanaka (1990) and by Joyner & Boore (1993). This is presumably due to the regionally biased distribution of the project sites such as that most of the project sites are located in the mountain areas like along western Barisan mountains in Sumatra Island, which mostly fall in high earthquake acceleration zone E.


**(a) Modified from Fukushima & Tanaka (1990)**




Source: Water Resource Development and research Centre (2005).

**(b) Modified from Joyner & Boore (1993)**

**Figure 5.2.1 Indonesian Earthquake Zone Maps**

# 5.3 HYDROLOGY

## 5.3.1 DATA SOURCE

(1) Runoff Data

1) Collected Data in HPPS2

There is difficulty for collecting long-term runoff data. In the former study as HPPS2, stations which had relatively long term runoff records were selected as the Key Stream Gauges. The runoff data of the key stream gauges was supplemented with supplemental stream gauges. 43 key stream gauges were selected in whole Indonesia. The data source is listed below.

- Research Institute for Water Resources Development under Ministry of Public Works (*Pusat Penelitian dan Pengembangan Sumber Daya Air*: PUSAIR, formerly DPMA): PUSAIR is in charge for data collection and data processing of runoff data in whole Indonesia, which is located in Bandung.

- PLN-LMK Observation Network: It is the observation network of rainfall, runoff and water level which was constructed by PLN, which is one of the counter parts of this study. PLN-LITBANG which is the research center of PLN is in charge of data collection and compilation.

- Project Reports: The runoff data collected from PUSAIR and PLN-LITBANG did not cover whole Indonesia. Existing hydrology reports on various hydropower and water resources development projects were collected to supplement the monthly runoff records especially in Kalimantan, Sulawesi and Irian Jaya where available runoff data were scarce and limited.

2) Data Collection

Runoff data of the key stream gauges which is recorded after HPPS2 is collected from PUSAIR and PLN-LITBANG in this study.

31 stations of the 43 key stream gauges have station ID of PUSAIR. Daily runoff records at 27 stations of 31 are collected.

5 stations of the 43 key stream gauges have station ID of PLN. Daily runoff records at 2 stations of 5 and daily water level records at 2 stations of 5 are collected. Data collection and compilation in PLN does not work effectively in recent years, after the responsibility of observation transferred to local branch of PLN from head office in 1993. It works only in West Java province and West Sumatra province.

9 stations of the 43 key stream gauges were collected from project reports in HPPS2.

Additional data at these stations cannot be collected and only data at surrounding stations is collected with cooperation of PLN-LITBANG.

3) Data Availability of Hydrological Data

There are forty three of the key stream gauges in whole Indonesia. Runoff data at 29 stations of 43 are collected in this study. The list of key stream gauges is shown in Table 5.3.1.

(2) Rainfall Data

1) Collected Data in HPPS2

In HPPS2, rainfall data were collected in/around basins of 20 stations of the 43 key stream gauges, and the basin mean rainfall was calculated with arithmetic mean. There were scarce rainfall data in/around the other 23 stations.

2) Data Availability of Hydrological Data

Additional rainfall data in/around basins of key stream gauges which is recorded after HPPS2 is collected from BMKG. Besides, rainfall data stored in Hydro-Inventory Database (HIDB) constructed in HPPS2 is collected. The list of stations is shown in Table 5.3.2 and Table 5.3.3. The data is attached in Volume III Supporting Report (1) Hydropower Development Master Plan..

## 5.3.2 PRELIMINARY EVALUATION ON LOW FLOW

(1) Low-flow Analysis

1) General Approach

In HPPS2, monthly runoff records at the key stream gauges were supplemented by monthly runoff records at surrounding stations, and then the data was extended to 30 years with Synthetic Flow Analysis. Non-dimensional runoff data was calculated from the extended runoff data. In each project scheme, a duration curve or a storage-draft curve could be estimated from non-dimensional runoff data with a catchment area and a basin mean rainfall.

In this study, lowflow of the key stream gauges is estimated with calculating the change of rate of runoff or rainfall from HPPS2 to the present.

2) Runoff Estimation

a) Monthly Mean Runoff Calculation

Monthly mean runoff is calculated in the following procedure, because the collected data in this study is on daily basis.

If there is only less than 15 daily runoff data in a month, then the monthly runoff is decided as missing. If there is more than 16 daily runoff data in a month, then the monthly runoff is calculated with averaging daily runoff records in the month..

b) Difference between lowflow in HPPS2 and additional lowflow in this study

The difference between lowflow in HPPS2 and additional lowflow in this study is estimated in the following equation.

$$Q = (Q_H * N_H + Q_A * N_A) / (N_H + N_A)$$

$$Rc = Q / Q_H - 1$$

where, $Q$ : Calculated runoff (m$^3$/s)

$Q_H$ : Annual mean runoff estimated in HPPS2 (m$^3$/s)

$Q_A$ : Annual mean runoff of collected runoff data in this study (m$^3$/s)

$N_H$ : Number of data in HPPS2

$N_A$ : Number of data collected in this study

$Rc$ : Rate of change

The result is listed in Table 5.3.4.

3) Rainfall Estimation

In the previous chapter, lowflow at 23 station of the 43 key stream gauges are estimated, however there is no runoff data at the other 20 stations. Then there are rainfall records at 7 stations of 20 stations, and lowflow were estimated with rainfall records.

Basin mean rainfalls are estimated with the following two methods in HPPS2.

- A basin mean rainfall is estimated with arithmetic mean method, if there are rainfall gauging stations in/around the basin.

- A basin mean rainfall is estimated with Isohyetal map, if there is no rainfall gauging station in/around the basin.

The changing rates of basin mean rainfalls at the key stream gauges are calculated here, where the basin mean rainfall is estimated with arithmetic mean method. The equation is shown in below.

$$R_i = (R_{iH} * N_{iH} + R_{iA} * N_{iA}) / (N_{iH} + N_{iA})$$

$$Rc_i = R_i / R_{iH} - 1$$

$$Rc = \sum_{i}^{n} Rc_i \Big/ n$$

where, $R_i$ : Calculated rainfall at station “i” (mm)

$R_{iH}$ : Annual rainfall in HPPS2 at station “i” (mm)

$R_{iA}$ : Annual rainfall calculated from collected data in this study at station “i” (mm)

$N_{iH}$ : Number of data in HPPS2 at station “i”

$N_{iA}$ : Number of data collected in this study at station “i”

$Rc_i$ : Rate of change at station “i”

$Rc$ : Rate of change

$n$ : Number of stations

4) Low flow Analysis

The results of lowflow analysis are shown in Table 5.3.5. The lowflow analysis with rainfall records is given by the following equation.

$$Q = Q_H \times (Rc + 1)$$

where, $Q$ : Calculated runoff ($m^3/s$)

$Q_H$ : Annual mean runoff estimated in HPPS2 ($m^3/s$)

$Rc$ : Rate of change

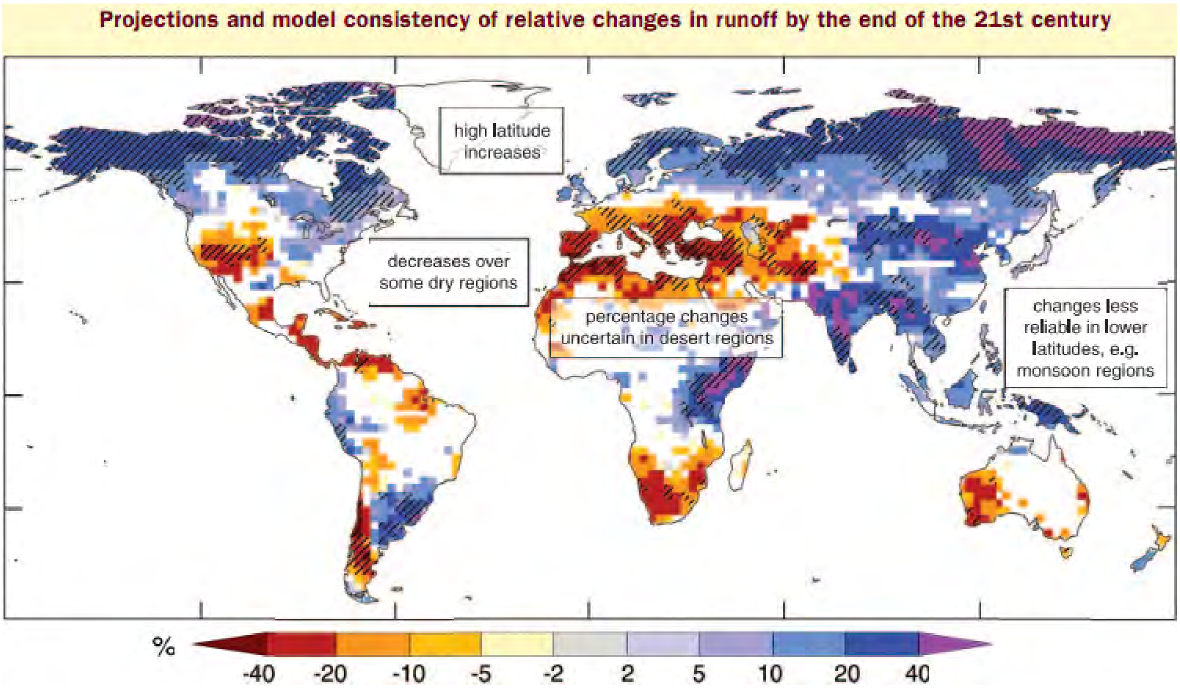
The rates of change vary between -10.8% and +7.7%. It is judged that in the most cases the rates are not substantially high, and thus substantial alteration to low flow and energy estimated in HPPS2 due to updated hydrological evaluation result is found not required for formulating the master plan.

(2) Prediction of Climate Change

The fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) has been published in 2007. AR4 prediction about rainfall and runoff is listed below.

- Heavy precipitation events frequency increases over most areas ‘very likely’.
- Area affected by drought increase ‘likely’.

Focusing runoff in Indonesia, it has been predicted that annual mean runoff slightly increase as following figure.




Source: IPCC AR4 SYR Figure3.5

# Table 5.3.1 List of Key Stream Gauges

| Key Stream Gauges on HPPS2 | | | | | | | | Follow up in 2010 | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Station Name | Gauge ID by HPPS2 | Gauge ID by DPMA | Gauge ID by PLN | River Basin | Province | Supplement of Missing Data | Availablity | Source |
| A. Sumatera | | | | | | | | | |
| 1 | Lhok Nibong | 01-027-01-01 | 01-027-00-02 | - | Kr. Jambu Aye | D.I. Aceh | Surrouding Stations | Available | PUSAIR |
| 2 | Stabat | 01-040-01-01 | 01-040-00-01 | - | S. Wampu | N. Sumatera | Surrouding Stations | Available | PUSAIR |
| 3 | Lb. Sipelanduk | 01-055-03-02 | 01-056-00-01 | - | Bt. Pane | N. Sumatera | Surrouding Stations | Available | PUSAIR |
| 4 | Lb. Bendahara | 01-058-02-01 | 01-058-00-02 | - | S. Rokan | Riau | Surrouding Stations | Available | PUSAIR |
| 5 | Tj. Ampalu | 01-066-04-01 | 01-066-00-04 | - | Bt. Indragiri | W. Sumatera | Surrouding Stations | Available | PUSAIR |
| 6 | Sungai Dareh | 01-071-01-01 | 01-071-00-01 | - | Bt. Hari | W. Sumatera | Surrouding Stations | Available | PUSAIR |
| 7 | Muara Inum | 01-071-02-01 | 01-071-00-08 | - | Bt. Hari | Jambi | Surrouding Stations | Available | PUSAIR |
| 8 | Martapura | 01-074-01-01 | 01-074-00-44 | - | A. Musi | S. Sumatera | Project Report | Available | PUSAIR |
| 9 | Banjarmasin | 01-077-02-07 | 01-077-00-09 | - | W. TI. Bawang | Lampung | Surrouding Stations | Available | PUSAIR |
| 10 | Kunyir | 01-080-01-04 | 01-080-00-07 | - | W. Sekampung | Lampung | Surrouding Stations | Available | PUSAIR |
| 11 | Kp. Darang | 01-001-01-01 | 01-001-00-03 | - | Kr. Aceh | D.I. Aceh | Surrouding Stations | Available | PUSAIR |
| 12 | Tui Kareng | 01-205-01-01 | 01-205-00-01 | - | Kr. Teunom | D.I. Aceh | Surrouding Stations | Available | PUSAIR |
| 13 | Hp. Baru | 01-178-01-01 | 01-178-00-02 | - | Bt. Toru | N. Sumatera | Surrouding Stations | Available | PUSAIR |
| 14 | Air Batu | 01-141-01-01 | 01-141-00-01 | - | Bt. Indrapura | W. Sumatera | Surrouding Stations | Available | PUSAIR |
| 15 | Air Gadang | 01-165-01-01 | 01-165-00-02 | - | Bt. Pasaman | W. Sumatera | Surrouding Stations | Available | PUSAIR |
| 16 | Despetah | 01-074-01-02 | - | 01-074-17 | A. Musi | Bengkulu | Project Report | Available | PLN-LITBANG |
| B. Kalimantan | | | | | | | | | |
| 17 | Silat damsite | - | - | - | S. Kapuas | W. Kalimantan | Project Report | Not Available | - |
| 18 | Kelai-2 damsite | - | - | - | S. Berau | E. Kalimantan | Project Report | Not Available | - |
| 19 | Sei Langsat | 03-026-01-01 | 03-026-00-01 | - | S. Martapura | S. Kalimantan | Project Report | Available | PUSAIR |
| 20 | Panaan | 03-027-07-02 | 03-026-00-45 | - | S. Barito | C. Kalimantan | Project Report | Available | PUSAIR |
| C. Sulawesi | | | | | | | | | |
| 21 | Tulabolo | 04-003-01-01 | - | 04-003-01 | S. Bone | N. Sulawesi | Surrouding Stations | Not Available | - |
| 22 | Tincep | 04-127-01-01 | - | 04-127-01 | S. Munte | N. Sulawesi | Surrouding Stations | Not Available | - |
| 23 | Palili | 04-112-02-02 | 04-112-00-01 | 04-112-01 | S. Palu | C. Sulawesi | Project Report | Available | PLN-LITBANG |
| 24 | Gillirang | 04-072-01-01 | 04-072-00-01 | - | S. Gillirang | S. Sulawesi | Project Report | Available | PUSAIR |
| 25 | Bila | 04-073-03-01 | 04-073-00-04 | - | S. Cenranae | S. Sulawesi | Project Report | Available | PUSAIR |
| 26 | Likupande | 04-083-01-01 | 04-083-00-01 | - | Jene Klara | S. Sulawesi | Surrouding Stations | Available | PUSAIR |
| 27 | Bakaru | 04-093-03-01 | 04-093-00-14 | - | S. Sadang | S. Sulawesi | Surrouding Stations | Not Available | - |
| D. Jawa | | | | | | | | | |
| 28 | Kebon Randu | 02-107-06-01 | 02-107-02-05 | - | Cimandiri | W. Jawa | Surrouding Stations | Available | PUSAIR |
| 29 | Cibuni-3 damsite | - | - | - | Cibuni | W. Jawa | Project Report | Not Available | - |
| 30 | Rangkasbitong | 02-006-01-02 | 02-006-03-02 | - | Ciujung | W. Jawa | Project Report | Available | PUSAIR |
| 31 | Leuwi Goong | 02-026-01-06 | 02-026-02-01 | - | Cimanuk | W. Jawa | Surrouding Stations | Available | PUSAIR |
| 32 | Krangan-2 | 02-082-01-06 | 02-082-01-02 | - | K. Progo | C. Jawa | Surrouding Stations | Available | PUSAIR |
| 33 | Banyumas | 02-090-01-03 | 02-090-06-01 | - | K. Serayu | C. Jawa | Surrouding Stations | Available | PUSAIR |
| 34 | Kaulon | 02-057-01-08 | 02-057-03-05 | - | K. Brantas | E. Jawa | Surrouding Stations | Not Available | - |
| 35 | Wonorejo | 02-074-01-01 | 02-074-02-06 | - | K. Bondoyudo | E. Jawa | Surrouding Stations | Available | PUSAIR |
| E. Irian Jaya | | | | | | | | | |
| 36 | PLTM Werba | - | - | - | S. Werba | Irian Jaya | Project Report | Not Available | - |
| 37 | PLTA Warsamson | - | - | - | S. Warsamson | Irian Jaya | Project Report | Not Available | - |
| 38 | PLTA Genyem | - | - | - | S. Sermo | Irian Jaya | Project Report | Not Available | - |
| F. Bali | | | | | | | | | |
| 39 | Buangga | 07-022-01-01 | 07-021-00-03 | 07-016-01 | Tk. Ayung | Bali | Project Report | Not Available | - |
| G. Lombok | | | | | | | | | |
| 40 | Santong | 08-005-01-01 | 08-005-00-01 | - | K. Sidutan | W. Nusa Tenggara | Project Report | Available | PUSAIR |
| H. Halmahera | | | | | | | | | |
| 41 | PLTM Ira | - | - | - | A. Ira | Maluku | Project Report | Not Available | - |
| I. Seram | | | | | | | | | |
| 42 | PLTA Isal-2 | - | - | - | Wai Isal | Maluku | Project Report | Not Available | - |
| J. Timor | | | | | | | | | |
| 43 | PLTA Ira Lalaro | - | - | - | Ira Siquiro | E. Timor | Project Report | Not Available | - |

Source: JICA Study Team based on HPPS2

## Table 5.3.2 List of Rainfall Stations in/around Key Stream Gauges (1/2)

| Rainfall Stations in/around Key Stream Gauges in HPPS2 (Monthly) | | | | | | | | | | Follow up in 2010 (monthly) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | Key Steam Gauge | | | | | | Rainfall Station | | | | |
| | No. | Station Name | Gauge ID by HPPS2 | River Basin | River | C.A. (km2) | No. | Station Name | Gauge ID by BMG | Availability | Source |
| A. Sumatera | 2 | Stabat | 01-040-01-01 | S. Langkat | S. Wampu | 3,870 | 1 | Selesai | | Available | BMKG |
| | | | | | | | 2 | Kabanjahe | | | |
| | | | | | | | 3 | Polonia | 127I | Available | BMKG |
| | | | | | | | 4 | Bukit Lawang | 133C | Available | BMKG |
| | | | | | | | 5 | Batan Serangan | | | |
| | | | | | | | 6 | Bungara | | | |
| | | | | | | | 7 | Marike | 132D | | |
| | | | | | | | 8 | Padang Brahrang | | | |
| | | | | | | | 9 | Turangi | | | |
| | | | | | | | 10 | Blang Kahan | 129D | Available | BMKG |
| | | | | | | | 11 | Rambutan | 140F | Available | BMKG |
| | | | | | | | 12 | Tanjung Kelling | 133B | | |
| | 6 | Sungai Dareh | 01-071-01-01 | Bt .Hari | Bt .Hari | 4,452 | 13 | Muarah Labuh | 29 | | |
| | | | | | | | 14 | Surian | 38B | Available | BMKG |
| | | | | | | | 15 | Sukarami | 27A | | |
| | | | | | | | 16 | Sitiung | 36B | Available | BMKG |
| | | | | | | | 17 | Pulau Punjung | 49G | | |
| | | | | | | | 18 | Lubuk Gadang | 30 | | |
| | | | | | | | 19 | Huberta | 28C | Available | BMKG |
| | 12 | Tui Kareng | 01-205-01-01 | Kr. Teunom | Kr. Teunom | 2,403 | 20 | Geumpang | 104b | Available | BMKG |
| | | | | | | | 21 | Tangse | 104a | Available | BMKG |
| | | | | | | | 22 | Blangpidie | 97c | Available | BMKG |
| | | | | | | | 23 | Meulaboh | 102 | | |
| | 13 | Hapesong Baru | 01-178-01-02 | Bt. Toru | Bt. Toru | 2,773 | 24 | Batang Toru | 80 | | |
| | | | | | | | 25 | Tarutung | 84 | | |
| | | | | | | | 26 | Hutaraya | 84C | Available | BMKG |
| | | | | | | | 27 | Sibolga | 02104 | | |
| | | | | | | | 28 | Baligi | 86B | Available | BMKG |
| | | | | | | | 29 | Simangunban | | | |
| B. Kalimantan | 19 | Sei Langsat | 03-026-01-01 | S. Martapura | S. Riam Kiw | 1,420 | 30 | Lumpangi Kiri | | | |
| | | (Riam Kiwa damsite) | | | | | 31 | Rantau | 306 | | |
| | | | | | | | 32 | Lampinit | | | |
| | | | | | | | 33 | Tatakan | | | |
| | | | | | | | 34 | Atayo | 308D | Available | BMKG |
| | | | | | | | 35 | Ulin | 308I | Available | BMKG, HIDB |
| | | | | | | | 36 | Lawa-Lawa | 308K | Available | BMKG, HIDB |
| | | | | | | | 37 | Binuang | 307B | Available | BMKG, HIDB |
| | | | | | | | 38 | Pengaron | 307 | Available | HIDB |
| | 20 | Panaan | 03-027-07-02 | S. Barito | S. Tabalong | 1,333 | 39 | Hayap | 299 | | |
| | | | | | | | 40 | Tanjung | 301 | | |
| | | | | | | | 41 | Batu Mandi | 303A | | |
| | | | | | | | 42 | Barabai | 305 | | |
| | | | | | | | 43 | Negara | 305B | Available | BMKG |
| | | | | | | | 44 | Rantau | 306 | | |
| C. Sulawesi | 22 | Tincep | 04-127-01-01 | S. Munte | S. Munte | 54 | 45 | Tondano | 336 | Available | HIDB |
| | | | | | | | 46 | Tomohon | 338 | | |
| | | | | | | | 47 | Noongan | 339A | Available | HIDB |
| | | | | | | | 48 | Tanawangko | 341 | Available | HIDB |
| | 23 | Palili | 04-112-02-02 | S. Palu | S. Lindu | 593 | 49 | Donggala | 363 | Available | HIDB |
| | | | | | | | 50 | Parigi | 365 | Available | HIDB |
| | | | | | | | 51 | Poso | 385 | Available | BMKG |
| | | | | | | | 52 | Lembasida | 363G | | |
| | | | | | | | 53 | Una-Una | 366 | | |
| | | | | | | | 54 | Bila | 399G | Available | BMKG |
| | 24 | Gillirang | 04-072-01-01 | S. Gillirang | S. Gillirang | 230 | 55 | Sakkoli | 403D | Available | BMKG |
| | | | | | | | 56 | Barukku | 399C | Available | BMKG |
| | | | | | | | 57 | Siwa | 400B | Available | BMKG |
| | | | | | | | 58 | Panekei | 400H | | |
| | | | | | | | 59 | Paria | 404B | Available | BMKG |
| | 25 | Bila | 04-073-03-01 | S. Cenranae | S. Bila-Hilir | 379 | 60 | Enrekang | 400 | | |
| | | | | | | | 61 | Baraka | 400F | Available | BMKG |
| | | | | | | | 62 | Barukku | 399C | Available | BMKG |
| | | | | | | | 63 | Bila | 399G | Available | BMKG |
| | | | | | | | 64 | Paria | 404B | Available | BMKG |
| | | | | | | | 65 | Paneki | 400H | Available | BMKG |
| | | | | | | | 66 | T. Tedong | 403D | | |

Source: JICA Study Team based on HPPS2

# Table 5.3.3 List of Rainfall Stations in/around Key Stream Gauges (2/2)

| Rainfall Stations in/around Key Stream Gauges in HPPS2 (Monthly) | | | | | | | | | | Follow up in 2010 (monthly) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | Key Steam Gauge | | | | | | Rainfall Station | | | | |
| | No. | Station Name | Gauge ID by HPPS2 | River Basin | River | C.A. (km2) | No. | Station Name | Gauge ID by BMG | Availability | Source |
| D. Jawa | 28 | Kebon Randu | 02-107-06-01 | Cimandiri | Cicatih | 486 | 67 | Sukabumi | 57 | | |
| | | | | | | | 68 | Cikidang | 10 | | |
| | | | | | | | 69 | Tjipetir | | | |
| | | | | | | | 70 | Sukamaju | 12 | | |
| | | | | | | | 71 | Cikembang | 45 | | |
| | | | | | | | 72 | Cibunar | 36 | Available | BMKG |
| | | | | | | | 73 | Ubrug | 45A | Available | BMKG |
| | | | | | | | 74 | Ciburayut | 61 | | |
| | 29 | Cibuni-3 damsite | - | Cibuni | Cibuni | 1,124 | 75 | Cimenteng | 54C | | |
| | | | | | | | 76 | Sukanegara | 98 | | |
| | | | | | | | 77 | Pagelaran | 109A | Available | BMKG |
| | | | | | | | 78 | Citambur | 129 | | |
| | | | | | | | 79 | Cibuni | 133 | Available | HIDB |
| | | | | | | | 80 | Dinewati | 65 | | |
| | | | | | | | 81 | Agrabintana | 114A | Available | BMKG, HIDB |
| | 30 | Rangkasbitung | 02-006-01-02 | Ciujung | Ciujung | 1,383 | 82 | Cilaki | 43B | Available | BMKG |
| | | | | | | | 83 | B. Irigasi | 44A | Available | BMKG |
| | | | | | | | 84 | Rangkasbitung | 37 | | |
| | | | | | | | 85 | Cikadu | 37B | Available | BMKG |
| | | | | | | | 86 | Cimarga | 37E | Available | BMKG |
| | | | | | | | 87 | Cisalak | 37F | | |
| | | | | | | | 88 | Peudeuy | 38A | | |
| | | | | | | | 89 | W. Guning | 26C | | |
| | | | | | | | 90 | Padeglang | 26 | | |
| | 31 | Leuwi Goong | 02-026-01-06 | Cimanuk | Cimanuk | 760 | 91 | Pamegatan | 213A | Available | BMKG |
| | | | | | | | 92 | K. Pawitan | 205C | Available | BMKG |
| | | | | | | | 93 | Toragong | 205B | Available | BMKG |
| | | | | | | | 94 | Sumedang | 194 | Available | BMKG |
| | | | | | | | 95 | Ujungjaya | 193 | | |
| | | | | | | | 96 | Panjalu | 223 | | |
| | 32 | Krangan -2 | 02-082-01-06 | K. Progo | K. Progo | 423 | 97 | Badran | 87 | | |
| | | | | | | | 98 | Plered | 88 | | |
| | | | | | | | 99 | Temanngung | 86 | Available | BMKG |
| | | | | | | | 100 | Seneng | 80 | | |
| | | | | | | | 101 | Pakis | 98A | Available | BMKG |
| | | | | | | | 102 | Kebraman | 79 | | |
| | | | | | | | 103 | K. Angkrik | 75 | | |
| | 33 | Banyumas | 02-090-01-03 | K. Serayu | K. Serayu | 2,632 | 104 | B. Raden | 25 | | |
| | | | | | | | 105 | B. Sari | 26 | | |
| | | | | | | | 106 | T. Gering | 26A | Available | BMKG |
| | | | | | | | 107 | Klampok | 36B | Available | BMKG |
| | | | | | | | 108 | Adipala | 44 | | |
| | | | | | | | 109 | Rumput | 46C | | |
| | | | | | | | 110 | K. Gesing | 60 | | |
| | 34 | Kaulon | 02-057-01-08 | K. Brantas | K. Brantas | 2,620 | 111 | Semen | 153 | Available | HIDB |
| | | | | | | | 112 | Wlingi | 164 | Available | HIDB |
| | | | | | | | 113 | Batu | 7 | Available | BMKG, HIDB |
| | | | | | | | 114 | Singosari | 51 | Available | HIDB |
| | | | | | | | 115 | Doko | 165 | Available | HIDB |
| | | | | | | | 116 | Dampit | 28 | Available | BMKG |
| | | | | | | | 117 | Kepanjen | 39 | Available | HIDB |
| | 35 | Wonorejo | 02-074-01-01 | K. Bondoyudo | K. Bondoyu | 314 | 118 | Ranukiakah | 180 | | |
| | | | | | | | 119 | Widodoren | 24 | | |
| | | | | | | | 120 | Candipura | 188 | | |
| | | | | | | | 121 | G. Sawur | 188B | Available | BMKG |
| | | | | | | | 122 | S. Jambe | 209E | | |
| | | | | | | | 123 | Watu Urip | 20 | | |
| I. Seram | 42 | PLTA Isal-2 dam | - | Wai Isal | Wai Isal | 242 | 124 | Manusela | 485A | Available | HIDB |
| | | | | | | | 125 | Wahai | 486 | Available | HIDB |
| | | | | | | | 126 | Riring | 487C | Available | BMKG |
| J. Timor | 43 | PLTA Ira Lalaro d | - | Ira Siquiro | Ira Siquiro | 406 | 127 | Tutuala | 690C | Available | HIDB |
| | | | | | | | 128 | Los Palos | 690B | Available | HIDB |

Legend: BMKG (Badan Meteorologi Klimatologi dan Geofisika), HIDB (Hidro-Inventory Database in HPPS2)

Source: JICA Study Team based on HPPS2

**Table 5.3.4 Weighted Annual Mean Runoff and Rate of Change**

| | | | Supplemented Annual Mean Runoff in HPPS2 | | Collected Annual Mean Runoff | | Weighted Annual Mean Runoff | |
|---|---|---|---|---|---|---|---|---|
| Region | No. | Station Name | Runoff (m3/s) | Number of Years | Runoff (m3/s) | Number of Years | Runoff (m3/s) | Rate of Change (%) |
| Sumatra | 1 | Lhok Nibong | 175.7 | 21 | 241.2 | 3 | 183.9 | 4.7% |
| | 2 | Stabat | 201.7 | 22 | 184.2 | 5 | 198.5 | -1.6% |
| | 3 | Lb. Sipelanduk | 28.4 | 20 | - | 0 | 28.4 | 0.0% |
| | 4 | Lb. Bendahara | 141.5 | 19 | 120.0 | 5 | 137.0 | -3.2% |
| | 5 | Tj. Ampalu | 77.6 | 18 | 57.5 | 5 | 73.2 | -5.6% |
| | 6 | Sungai Dareh | 310.2 | 18 | 247.4 | 6 | 294.5 | -5.1% |
| | 7 | Muara Inum | 107.6 | 17 | - | 0 | 107.6 | 0.0% |
| | 8 | Martapura | 225.0 | 25 | 183.3 | 2 | 221.9 | -1.4% |
| | 9 | Banjarmasin | 36.8 | 22 | 40.1 | 6 | 37.5 | 1.9% |
| | 10 | Kunyir | 23.1 | 26 | 17.4 | 4 | 22.3 | -3.3% |
| | 11 | Kp. Darang | 33.1 | 16 | 31.1 | 3 | 32.8 | -0.9% |
| | 12 | Tui Kareng | 183.9 | 11 | 212.7 | 3 | 190.1 | 3.4% |
| | 13 | Hp. Baru | 128.9 | 21 | 80.9 | 4 | 121.3 | -6.0% |
| | 14 | Air Batu | 31.3 | 20 | 41.7 | 6 | 33.7 | 7.7% |
| | 15 | Air Gadang | 121.3 | 20 | 100.1 | 5 | 117.1 | -3.5% |
| | 16 | Despetah | 45.2 | 18 | - | 0 | 45.2 | 0.0% |
| Kalimantan | 17 | Silat damsite | 73.7 | 15 | - | 0 | 73.7 | 0.0% |
| | 18 | Kelai-2 damsite | 293.6 | 16 | - | 0 | 293.6 | 0.0% |
| | 19 | Sei Langsat | 60.3 | 20 | - | 0 | 60.3 | 0.0% |
| | 20 | Panaan | 45.6 | 27 | 26.3 | 5 | 42.6 | -6.6% |
| Sulawesi | 21 | Tulabolo | 60.6 | 9 | - | 0 | 60.6 | 0.0% |
| | 22 | Tincep | 3.2 | 18 | - | 0 | 3.2 | 0.0% |
| | 23 | Palili | 21.2 | 15 | - | 0 | 21.2 | 0.0% |
| | 24 | Gillirang | 8.2 | 15 | 12.5 | 3 | 8.9 | 8.7% |
| | 25 | Bila | 15.7 | 15 | 18.8 | 4 | 16.4 | 4.1% |
| | 26 | Likupande | 15.5 | 12 | 11.3 | 8 | 13.9 | -10.8% |
| | 27 | Bakaru | 69.1 | 19 | - | 0 | 69.1 | 0.0% |
| Jawa | 28 | Kebon Randu | 29.6 | 27 | - | 0 | 29.6 | 0.0% |
| | 29 | Cibuni-3 damsite | 78.0 | 30 | - | 0 | 78.0 | 0.0% |
| | 30 | Rangkasbitung | 94.3 | 24 | 63.6 | 6 | 88.1 | -6.5% |
| | 31 | Leuwi Goong | 30.0 | 30 | 30.5 | 4 | 30.0 | 0.2% |
| | 32 | Krangan-2 | 17.0 | 24 | 11.5 | 9 | 15.5 | -8.8% |
| | 33 | Banyumas | 241.3 | 20 | 170.0 | 8 | 220.9 | -8.4% |
| | 34 | Kaulon | 102.5 | 21 | - | 0 | 102.5 | 0.0% |
| | 35 | Wonorejo | 16.9 | 15 | 17.8 | 9 | 17.2 | 1.8% |
| Irian Jaya | 36 | PLTM Werba | 4.4 | 11 | - | 0 | 4.4 | 0.0% |
| | 37 | PLTA Warsamson | 63.6 | 30 | - | 0 | 63.6 | 0.0% |
| | 38 | PLTA Genyem | 16.4 | 17 | - | 0 | 16.4 | 0.0% |
| Bali | 39 | Buangga | 9.8 | 14 | - | 0 | 9.8 | 0.0% |
| Lombok | 40 | Santong | 1.5 | 15 | 1.7 | 6 | 1.6 | 3.8% |
| Halmahera | 41 | PLTM Ira | 4.1 | 10 | - | 0 | 4.1 | 0.0% |
| Seram | 42 | PLTA Isal-2 | 16.6 | 10 | - | 0 | 16.6 | 0.0% |
| Timor | 43 | PLTA Ira Lalaro | 9.5 | 21 | - | 0 | 9.5 | 0.0% |

Source: JICA Study Team

**Table 5.3.5 Calculated Annual Mean Runoff at Key Stream Gauges**

| | | | Supplemented Annual Mean Runoff in HPPS2 | Result of Analysis | | Weighted Annual Mean Runoff |
|---|---|---|---|---|---|---|
| | | | | Runoff | Rainfall | |
| Region | No. | Station Name | Runoff (m3/s) | Rate of Change (%) | Rate of Change (%) | Runoff (m3/s) |
| Sumatra | 1 | Lhok Nibong | 175.7 | 4.7% | – | 183.9 |
| | 2 | Stabat | 201.7 | -1.6% | – | 198.5 |
| | 3 | Lb. Sipelanduk | 28.4 | – | – | 28.4 |
| | 4 | Lb. Bendahara | 141.5 | -3.2% | – | 137.0 |
| | 5 | Tj. Ampalu | 77.6 | -5.6% | – | 73.2 |
| | 6 | Sungai Dareh | 310.2 | -5.1% | – | 294.5 |
| | 7 | Muara Inum | 107.6 | – | – | 107.6 |
| | 8 | Martapura | 225.0 | -1.4% | – | 221.9 |
| | 9 | Banjarmasin | 36.8 | 1.9% | – | 37.5 |
| | 10 | Kunyir | 23.1 | -3.3% | – | 22.3 |
| | 11 | Kp. Darang | 33.1 | -0.9% | – | 32.8 |
| | 12 | Tui Kareng | 183.9 | 3.4% | – | 190.1 |
| | 13 | Hp. Baru | 128.9 | -6.0% | – | 121.3 |
| | 14 | Air Batu | 31.3 | 7.7% | – | 33.7 |
| | 15 | Air Gadang | 121.3 | -3.5% | – | 117.1 |
| | 16 | Despetah | 45.2 | – | – | 45.2 |
| Kalimantan | 17 | Silat damsite | 73.7 | – | – | 73.7 |
| | 18 | Kelai-2 damsite | 293.6 | – | – | 293.6 |
| | 19 | Sei Langsat | 60.3 | – | 2.6% | 61.8 |
| | 20 | Panaan | 45.6 | -6.6% | – | 42.6 |
| Sulawesi | 21 | Tulabolo | 60.6 | – | – | 60.6 |
| | 22 | Tincep | 3.2 | – | -3.5% | 3.1 |
| | 23 | Palili | 21.2 | – | 2.2% | 21.6 |
| | 24 | Gillirang | 8.2 | 8.7% | – | 8.9 |
| | 25 | Bila | 15.7 | 4.1% | – | 16.4 |
| | 26 | Likupande | 15.5 | -10.8% | – | 13.9 |
| | 27 | Bakaru | 69.1 | – | – | 69.1 |
| Jawa | 28 | Kebon Randu | 29.6 | – | – | 29.6 |
| | 29 | Cibuni-3 damsite | 78.0 | – | 0.6% | 78.5 |
| | 30 | Rangkasbitung | 94.3 | -6.5% | – | 88.1 |
| | 31 | Leuwi Goong | 30.0 | 0.2% | – | 30.0 |
| | 32 | Krangan-2 | 17.0 | -8.8% | – | 15.5 |
| | 33 | Banyumas | 241.3 | -8.4% | – | 220.9 |
| | 34 | Kaulon | 102.5 | – | 2.0% | 104.6 |
| | 35 | Wonorejo | 16.9 | 1.8% | – | 17.2 |
| Irian Jaya | 36 | PLTM Werba | 4.4 | – | – | 4.4 |
| | 37 | PLTA Warsamson | 63.6 | – | – | 63.6 |
| | 38 | PLTA Genyem | 16.4 | – | – | 16.4 |
| Bali | 39 | Buangga | 9.8 | – | – | 9.8 |
| Lombok | 40 | Santong | 1.5 | 3.8% | – | 1.6 |
| Halmahera | 41 | PLTM Ira | 4.1 | – | – | 4.1 |
| Seram | 42 | PLTA Isal-2 | 16.6 | – | -5.1% | 15.8 |
| Timor | 43 | PLTA Ira Lalaro | 9.5 | – | -1.3% | 9.3 |

Source: JICA Study Team

## 5.4 PROJECT COST AND BENEFIT

The price escalation from year 1996, when the previous estimation was made in HPPS2, until year 2011 was computed with two price indices expressed in US Dollars. One is the WBG indices called MUV[1] (Manufactures Unit Value Index) for the foreign currency portion. According to the MUV index, the foreign price of year 2011 in US Dollar was raised 1.0224 times of that of year 1996. The other is the consumer's price indices in Indonesia derived from the OECD database[2]. According to the OECD price index, the local price of year 2011 in US Dollar was raised 1.3015 times of that of year 1996.

Assuming that the price proportion is 50:50 for the foreign and local currency portions, the 2011 price is evaluated to be 1.16 times greater than the 1996 price, as computed below.

**Table 5.4.1 Price Indices for Updating the Project Cost**

| | FC | LC | Total |
|---|---|---|---|
| 1996 Price | 50.000 | 50.000 | 100.00 |
| Price escalation | 1.0224 | 1.3015 | 1.1620 |
| 2011 Price | 51.12 | 65.08 | 116.20 |

| | FC | LC | | |
|---|---|---|---|---|
| Year | Price Index*1 | Rupiah Index*2 | Exchange Rate*3 | Foreign Index |
| 1996 | 100.00 | 125.77 | 2,329.35 | 100.00 |
| 1997 | 93.02 | 133.61 | 2,872.66 | 86.14 |
| 1998 | 89.50 | 211.70 | 10,094.11 | 38.84 |
| 1999 | 89.20 | 255.05 | 7,809.23 | 60.49 |
| 2000 | 87.31 | 264.46 | 8,374.51 | 58.49 |
| 2001 | 84.74 | 294.87 | 10,189.44 | 53.60 |
| 2002 | 83.68 | 329.97 | 9,321.52 | 65.56 |
| 2003 | 89.96 | 352.26 | 8,573.68 | 76.09 |
| 2004 | 96.16 | 373.63 | 8,934.84 | 77.45 |
| 2005 | 96.16 | 412.68 | 9,714.67 | 78.67 |
| 2006 | 97.70 | 466.77 | 9,165.12 | 94.32 |
| 2007 | 102.29 | 496.68 | 9,141.98 | 100.62 |
| 2008 | 109.15 | 547.47 | 9,663.93 | 104.92 |
| 2009 | 104.56 | 571.49 | 10,380.69 | 101.96 |
| 2010 | 105.29 | 600.83 | 9,081.83 | 122.53 |
| 2011 | **102.24** | 633.88 | 9,020.00 | **130.15** |

Source: JICA Study Team

Project economy is evaluated by simplified cost-benefit analysis. Project benefit is taken as the same as set out in Chapter 14 and 20.

1 MUV is an index that is generally accepted as a proxy for the price of developing country imports of manufactures in U.S. dollar terms. http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:20587651~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html

2 OECD.StatExtracts http://stats.oecd.org/Index.aspx

# CHAPTER 6 ISSUES IN HYDROPOWER DEVELOPMENT

## 6.1 INTRODUCTION

Hydropower is known to public as one of the most matured renewable energies. As Indonesia has abundant hydropower potential, its widespread development must bring huge benefit to the country. However, there must exit some barriers to do so. They are:

a) Hydropower generally requires high initial investment. — Therefore, investors, whoever from the Public or Private Sector, may be discouraged at the beginning of a project promotion.

b) Hydropower potential is intermittent and highly geography dependent. — Therefore, it becomes more difficult to acquire the land required for a project than any other power development that has in general alternative lands.

c) Hydropower heavily relies on hydrology, which cannot be figured out precisely without deep and long lasting investigations and studies. — Most of the cases, the hydropower potential site does not go with the developer's preference. It could be located where access is difficult, cost is high, or even somewhere with a 'keep out' sign, like the forest reserves.

d) Long term soft loan can hardly be expected from local financial institutions/banks. — Therefore, developers can hardly formulate their financing scheme.

e) There is the Government policy to fossil fuel subsidies. — Therefore, the hydropower generation can hardly be competitive compared to any other electricity generation.

Upon these difficulties, the Indonesian Legislation is well backing up the hydropower development, especially through the Government Regulation No. 26/2006 (Regulation on Electricity Supply and Utilization), the Ministerial Decree: No. 1122 K/30/MEM/2002 (Small Scale Power Generation Scheme for Renewable Energy), Ministerial Regulation No. 002/2006 (Medium Scale Power Generation Scheme for Renewable Energy), etc. These regulations ease the hydropower difficulties. However, there still exist some issues related to the hydropower development, as discussed in the following sub-section.

## 6.2 HYDROPOWER PROJECTS UNREALIZED / DELAYED

(1) Outlook of Hydropower Development in Indonesia

In order to make the problems clearer, if any, this sub-section attempts to compare two sets of the hydropower development plans of the country, as tabulated in Table 6.2.1. All of the hydropower projects are derivations from the respective development list given in the National Electricity Supply Plans 2006-2015 or 2009-2018.

**Table 6.2.1 Promotion Status of Hydropower Projects**

| No. | Area | Project | As of 2006 | | | | | As of 2009 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Type | Cap (MW) | Stage | Year | Owner | Type | Cap (MW) | Stage | Year | Owner |
| 1. | Aceh | Peusangan 1&2 | ROR | 82 | DD | 2012 | PLN | ROR | 86 | Constr | 2012 | PLN |
| 2. | North Sumatra | Asahan 1 | ROR | 180 | DD | 2010 | IPP | ROR | 180 | Constr | 2010 | IPP |
| 3. | North Sumatra | Asahan 3 | ROR | 154 | DD | 2011 | PLN | ROR | 174 | DD | 2012 | PLN |
| 4. | Jambi | Merangin 2 | ROR | 350 | DD | 2013 | IPP | ROR | 350 | DD | 2016 | IPP |
| 5. | North Sulawesi | Bone 1&2 | ROR | 17 | PreFS | 2013 | PLN | ROR | 17 | DD | 2014 | PLN |
| 6. | North Sulawesi | Poigar 2 | ROR | 30 | Constr | 2008 | PLN | ROR | 30 | Suspended | N/A | PLN |
| 7. | Central Sulawesi | Solewana I | ROR | — | — | — | IPP | ROR | 10 | Pre PPA | 2010 | IPP |
| 8. | Central Sulawesi | Solewana II | ROR | — | — | — | IPP | ROR | 10 | Pre PPA | 2011 | IPP |
| 9. | Central Sulawesi | Solewana II | ROR | — | — | — | IPP | ROR | 10 | Pre PPA | 2012 | IPP |
| 10. | Central Sulawesi | Palu | ROR | — | — | — | PLN | ROR | 30 | Financing | 2016 | PLN |
| 11. | Central Sulawesi | Poso | RES | — | — | — | IPP | RES | 145 | Pre PPA | 2011 | IPP |
| 12. | South Sulawesi | Poko | RES | 234 | FS | 2014 | PLN | RES | 234 | FS | 1017 | PLN |
| 13. | South Sulawesi | Bili-Bili | RES | 20 | Constr | 2005 | PLN | RES | 20 | Completed | 2005 | PLN |
| 14. | South Sulawesi | Malea | ROR | 182 | FS | 2012 | IPP | ROR | 90 | Constr | 2016 | IPP |
| 15. | South Sulawesi | Bonto Batu | RES | 100 | PreFS | 2015 | PLN | RES | 100 | FS | 2016 | PLN |
| 16. | South Sulawesi | Bakaru 2 | ROR | 126 | FS | 2015 | PLN | ROR | 126 | Financing | 2016 | PLN |
| 17. | East Kalimantan | Kusan 3 | RES | 130 | FS | 2011 | PLN | RES | 65 | Suspended | 2015 | PLN |
| 18. | Irian Jaya | Genyem | ROR | 19 | FS | 1010 | PLN | ROR | 20 | FS | 2012 | PLN |
| 19. | Irian Jaya | Warsamson | RES | 30 | FS | 1014 | PLN | RES | 30 | Suspended | N/A | PLN |
| 20. | Maluku | Isal II | ROR | — | — | — | PLN | ROR | 20 | Financing | 2015 | PLN |
| 21. | West Java | Upper Cisokan | PSP | 1,000 | DD | — | PLN | PSP | 1,000 | DD | 2014 | PLN |
| 22. | West Java | Rajamandala | RES | — | — | 2013 | IPP | RES | 30 | PPA | 2016 | IPP |
| 23. | West Java | Jatigede | RES | — | — | — | IPP | RES | 110 | Tender | 2017 | IPP |
| | | Total | | | | | | | 2,887 | | | |

Note: Cap = Installed Capacity, Year = Scheduled commissioning date, ROR = Ron-of-River type, RES = Reservoir type,

PSP = Pumped Storage Hydropower, DD = Detailed Design, FS = Feasibility study.

Source: Electricity Supply Plans 2006 and 2009, PLN.

There are 15 candidate projects listed in the development plan as of 2006. Out of these 15, only 2 candidates are successful in keeping their scheduled commissioning dates (COD) as of 2009. The average of the COD postponement is computed to be more than two years for the same 15. As the two sets development plans differ only three years, the 2 years of postponement should be regarded enormous. Further, one of the two successful projects is the Asahan No. 1 Hydropower IPP, of which original PPA was signed before the Asian Currency Crisis in 1997. One should realize therefore that the Indonesian hydropower development has not been under control by the authority, and cannot be developed as scheduled.

These delayed projects can be classified into three categories; i) Not Qualified in Environments, ii) Simply delayed in the promotion procedures but on the right track, and iii) Under Extended Suspension. Details follow.

(2) Hydropower Projects Not Qualified in Social and/or Natural Environments

- Kusan 3 Hydropower Project

  The feasibility study of the Kusan 3 Hydropower, South Kalimantan, was made in 1988 to 1990 by using WBG finance. Assuming PLN ownership, its detailed design targeted to the contractor procurement was conducted with ADB finance in 1997 to 2000. According to the design, the installed capacity was originally 130 MW supported by the 100 m high dam and the 40 km2 widespread reservoir. Inhabitants required to be resettled counted over 670 people because of the large submerged area by the reservoir. Notwithstanding immediate development planned by PLN, the project was not able to advance forward its construction, mainly due to lack of the PLN's financial capacity just after the Asian Currency Crisis.

  In 2008, JICA reviewed the project and re-planned as a much smaller scale scheme. The revised features are then turned to be 65 MW of the capacity with the 69 m high dam and 8 km2 of the reservoir. Number of persons who need to be resettled got dramatically reduced to zero. The greatest attentions to the social and natural environments were paid during the project preparation stage. Nevertheless, the project was not able to take off toward realization, because the long nosed monkey (*proboscis monkey)* which is registered as endangered species by IUCN was identified within the project area and mitigation measures for coexistence with the project could not be framed. Today, the project is suspended.

- Poigar 2 Hydropower Project

  The 30 MW Poigar 2 Hydro, North Sulawesi, was once promoted as a run-of-river type hydro by ADB, as one of many mini hydropower developments in the outer islands. Although a Design-Build based contractor procurement was completed in 2006 by PLN, its construction could not be started as a part of the project was located within the Conservation Forest area defined by the Government.

(3) Hydropower Projects Delayed but on the Right Track

- Upper Cisokan Pumped Storage Hydro

  It will become the first pumped storage hydropower in Indonesia. 1,000 MW of the capacity in West Java. Despite slower promotion speed than expected, the project seems on the right track toward its realization. The reason why the promotion speed is slow is reportedly due to number of resettlements count over 1,000 persons and it cannot be concluded quickly, e.g., review of EIA, preparation of Land Acquisition and Resettlement Plan (LARAP), etc.

  Indonesia already applied for a loan from IBRD-WBG in the amount of about US$600 million equivalent toward the cost of the project development. The development will consist of i) a lower reservoir with around 10 million m3 of volume and impounded by a RCC dam with a maximum height of 90 m, ii) an upper reservoir with around 10 million m3 of volume and impounded by a RCC dam with a maximum height of 100 m, iii) two inclined shaft tunnels connecting the lower and upper reservoirs, iv) an underground powerhouse with an installed capacity of 4 x 260 MW, and v) associated 500 kV transmission lines to connect the power station to the Java-Bali power system.

Notwithstanding the scheduled COD in 2014, the Upper Cisokan Pumped Storage seems difficult in its in-time commissioning.

- Poko Hydropower

30 MW in South Sulawesi. JICA carried out the feasibility study review in 1995 to 1996. According to the review, the project is financially viable and technically feasible. However, the project demands resettlements over 1,000 people, and accordingly careful attention needs to be paid. The project is located at the Sadang River, where Bakaru 1 Hydro operated at as well. The development of Poko is needed to be examined with the operation and extension plan of Bakaru, since the Sadang holds sedimentation which needs to be cope with.

- Rajamandala Hydropower IPP

A private investor first proposed the IPP development nearly 7 years ago for the 30 MW of hydro in the Citarum river, West Java. After long negotiation with PLN, the private investor won the exclusive right of the development studies in 2007. As of May 2010, the project is speeding its development by the same private firm to keep the scheduled COD in 2016.

(4) Hydropower IPP Projects Under Extended Suspension

- Merangin 2 Hydropower

A 350 MW run-of-river hydro in Jambi, Sumatra. Sometimes called Kerinci by private investors. The detailed design was executed during 1995 – 1997, and its development by PLN was once ready expecting finance from ADB. However, mainly due to the economic recession in 1997, PLN was not successful enough to obtain finance for the construction. The project development was then suspended. Many private investors came to the project afterwards. Today, a local investor company holds the development permit and no lively activity is observed in the field. Not withstanding the investor’s interest, PLN is still keen for the project and attempting to put the project’s name on the national project list, so-called the Blue Book, assuming the financing from a bilateral financing institution.

- Malea 1 Hydropower

A 182 MW run-of-river hydro in Tana Toraja, South Sulawesi. The hydropower was first identified during the Hydropower Potential Study financed by IBRD in early 1980s. The feasibility study was made by PLN in 1983 to 1984 again by IBRD finance. In 1997, ADB once decided financing for development. However, it was finally cancelled due to the Asian Currency Crisis and the development was suspended. In 2000s, a private investor obtained the exclusive development right. After several changes of the investor consortium, today the project is reportedly reduced half in its installed capacity without clear reasons disclosed. A delay extending over a long period of time is observed, as the original project development once began in 1997.

## 6.3 INSTITUTIONAL AND LEGAL ISSUES IN HYDROPOWER DEVELOPMENT

(1) Issues Related to Social and Natural Environments

Many hydropower projects are forced slow down the development speed by administration processes for the social and natural impact mitigation. However, these impact mitigation processes are mandate to conserve the global environments and it seems there is no almighty solution. Those who work for the hydropower development should make sure that no hydropower projects can be built instantly.

(2) Issues Related to Micro Hydropower Development

Because of incentives given by Ministerial decrees, there are a number of private plans of micro hydropower projects. These micro hydropower plans are being proposed by private investors as small scale hydropower IPPs, firstly to the regional governments concerned. These private activities should be highly appreciated in view of the renewable energy development policy of the country and exactly comply with the present legal system. The Indonesian electricity sector should welcome these private proposals of the micro hydropower developments, which can potentially reduce the financial burden of the Public Sector. However, because private developers and even the regional governments do not have any reference that could guide them toward the optimal development, many micro hydropower proposals are not optimal in terms of the total hydropower potential of the river concerned. Further many of them are exclusive projects that do not allow any better plans. This is called “mutually exclusive projects” and could happen to the hydropower, because one river allows multiple hydropower projects only when they are built in cascade. The “mutually exclusive projects” issue is powerful enough to cancel the very best development plan, like the country’s hydropower development policy. For example, a perfect 100 MW hydropower project may possibly be denied by a 5 MW micro hydropower proposed by a private investor.

Notwithstanding the “mutually exclusive projects”, the Ministry concerned is able to avoid the issue effectively even under the present legislation, because the electricity business license is only granted from the Minister without any exceptions. The Minister has a legal right not to grant an electricity business license to an investor who plans an IPP that denies the National plan. However, such Ministerial power should be exercised only after comprehensions by the stakeholders, especially the regional governments concerned.

**Table 6.3.1 Status of Micro Hydro IPPs (North Sumatra)**

| | Project | River | Capacity | Status | Remarks (conflicts with National Master Plan) |
|---|---|---|---|---|---|
| 1. | Parlusan | Aek Kualu | 4 MW | PPA | |
| 2. | Huta Raja | Anek Silang | 5 MW | PPA | |
| 3. | Pakkat | Anek Silahar | 10 MW | PPA negotiation | Conflict with Sirahar, 35 MW |

| | Project | River | Capacity | Status | Remarks (conflicts with National Master Plan) |
|---|---|---|---|---|---|
| 4. | Parlilitan | Anek Simonggo | 8 MW | Operation | |
| 5. | Silau-2 | Anek Silau | 8 MW | PPA | |
| 6. | Lae Gunung | Anek Gunung | 10 MW | PPA negotiation | Conflict with Gunung 2, 23 MW |
| 7. | Lae Ordi | Lae Ordi | 10 MW | PPA negotiation | |
| 8. | Lae Kombih | Lae Kombih | 8 MW | MOU | |
| 9. | Batan Toru | Batan Toru | 8 MW | PPA negotiation | Conflict with Toru 1, 38 MW |
| 10. | Raisan Hutadolok | Anek Raisan | 7 MW | MOU | |
| 11. | Raisan Naga Timbul | Anek Raisan | 7 MW | MOU | |
| 12. | Karai 1 | Karai | 10 MW | PPA negotiation | |
| 13. | Karai 7 | Karai | 7 MW | PPA negotiation | |
| 14. | Karai 12 | Karai | 7 MW | PPA negotiation | |
| 15. | Karai 13 | Karai | 8 MW | PPA negotiation | |
| 16. | Lae Ordi 2 | Lae Ordi | 10 MW | PPA negotiation | |
| 17. | Tara Bontang | Aek Riman | 10 MW | PPA negotiation | |
| 18. | Simonggo | Simonggo | 9 MW | MOU | Conflict with Simanggo 1 & 2, 103 MW |
| 19. | Sei Wampu I | Sei Wampu | 9 MW | MOU | |
| 20. | Sei Wampu II | Sei Wampu | 5 MW | Presentation | |
| 21. | Rahu 01 | Rahu | 8 MW | MOU | |
| 22. | Rahu 02 | Rahu | 5 MW | MOU | |
| 23. | Sidikalang 02 | Renun | 7 MW | Presentation | |
| 24. | Sidikalang 01 | Renun | 9 MW | Presentation | |
| 25. | Hasang I | Aek Kualau | 10 MW | Request | |

Source: Study Team based on information obtained from PLN Medan, as of end 2009.

## 6.4 INSTITUTIONAL AND LEGAL FRAMEWORK TO BE REINFORCED

(1) Optimal and efficient development shall be taken into account at the beginning stage of the hydropower project promotion, especially when it is promoted as an IPP project. It is strongly desired that the optimal hydropower development on every major river can be institutionalized by DGEEU at the early stage of each development. PLN, who administers hydropower potentials of the country, is in a position to vigorously assist DGEEU.

(2) No hydropower project should be developed, if it excludes/wastes great part of the hydropower resources of the river concerned. (If a hydropower project is planed enormously less than the expected electricity generation compared with the total hydropower potential of the river, then the project design should be so rectified.)

(3) All of hydropower projects should be designed, so that PLN can effectively supply customers with electricity in the power system concerned. (If a developer proposes a hydropower project that is extremely ineffective in terms of the electricity supply, the project design should be so rectified.)

(4) A set of the Indonesian legislations renders meritorious service in the small scale hydropower development by using private money, if it is less than or equal to 10 MW. One should anticipate a number of realizations of micro hydropower in the near future. However, one does not exactly know yet the real performances of the proposed micro hydropower projects. The Indonesian electricity sector should be prepared for the potential event such that many of them cannot

achieve the scheduled power generation owing to technical, financial, and/or administrative shortage.

(5) Notwithstanding the active private proposals for the small scale hydropower projects less than 10 MW, private investors are not well incentivized yet for the mid to large scale hydropower, over 10 MW. The Indonesian electricity sector should seek out a new financial scheme for developing such mid to large scale hydropower. Possible schemes are, for example,

i) A private finance based hydropower development, which releases PLN from the financial burden for construction and incentivizes potential investor even for the high risk mid to large scale hydropowers. The most probable scheme is either so-called BLT (build-lease-transfer) or DBFO (design-build-finance-operate). The concept of BLT is straightforward. PLN prepares a hydropower project as a conventional PLN project done before, from the initial investigations to the tender documentation. Here the project is assumed PLN’s ownership. Then, PLN puts the project out to tender. Unlike the conventional tender, however, the BLT tender should qualify all capabilities of the contractors/investors in finance, design and construction. At the end of the day, PLN operates the completed asset and compensates the investment and initial costs incurred by the contractor/investor. The PLN compensation is expected to be pre-agreed with the contractor/investor, and can be treated either as a differed payment or leasing charge. Specifications and any other requirements for the project can be at PLN’s discretion. The concept of DBFO is similar to the conventional IPP in view of financing and operation. However, PLN remains having the ownership and commercial risk.

**Table 6.4.1 Business Models Applicable to Hydropower**

| Business Schemes | Financing | Ownership | Commercial Risk | Operation | Design & Construction |
|---|---|---|---|---|---|
| 1. Pure Public (PLN) | PLN | PLN | PLN | PLN | PLN |
| 2. Design-Build (DB) | PLN | PLN | PLN | PLN | PRIVATE |
| 3. Design-Build-Operate (DBO) | PLN | PLN | PLN | PRIVATE | PRIVATE |
| 4. Design-Build-Lease (DBL) | PLN | PLN | PRIVATE | PRIVATE | PRIVATE |
| 5. Design-Build-Finance-Operate (DBFO) | PRIVATE | PLN | PLN | PRIVATE | PRIVATE |
| 6. Build-Lease-Transfer (BLT) | PRIVATE | PRIVATE | PLN | PLN | PRIVATE |
| 7. Build-Own-Operate (BOO) | PRIVATE | PRIVATE | PRIVATE | PRIVATE | PRIVATE |

Note: This table compares conceptual demarcations in major business models.

Source: Study Team

ii) A package development by using a soft loan. PLN has a number of experiences in the hydropower development by using a soft loan mainly from the bi- or multilateral financial institutions. But its development was basically for a single project. Because future hydropower potential left undeveloped for the country is relatively small in terms of its capacity, one should seek a packaging, so that the amount of a single soft loan can be maintained as large as before.

(6) Hydropower development is forced to influence the social and natural environment to a greater or lesser degree. A set of national guidelines is expected to standardize the decision criterion how hydropower should be developed at the sacrifice of environment.