OPPORTUNITIES AND CHALLENGES OF SMART GRID DEPLOYMENT

Badan Pengkajian dan Penerapan Teknologi

M.A.M. Oktaufik & A. Prastawa
Center for Energy Conversion & Conservation Technology
Agency for Assessment and Application of Technology (BPPT), Indonesia

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Outline

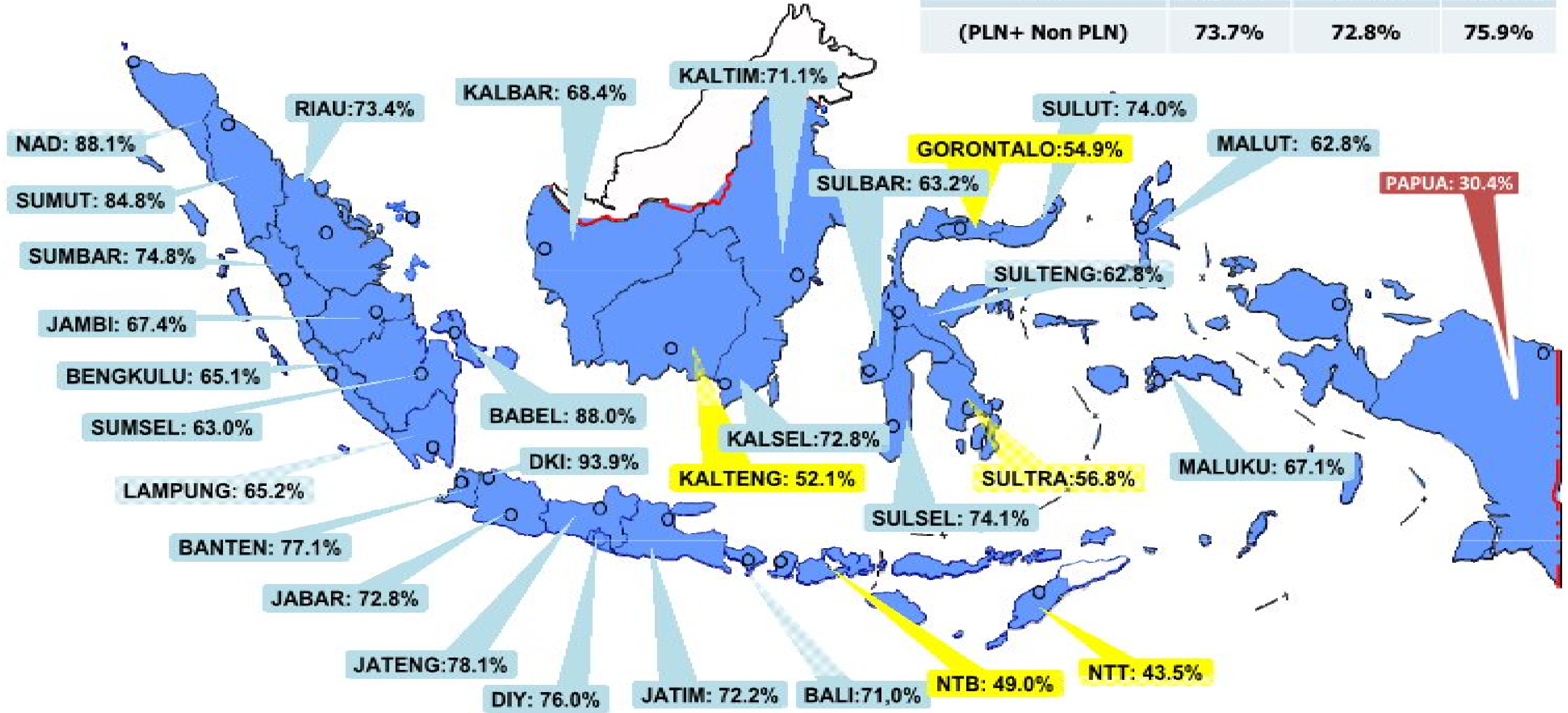
1. Background
2. Outlook of Indonesia Electricity
3. R&D and Potential Applications of Smart Grid Technology
4. Discussions & Recommendations: Opportunities & Challenges

1. BACKGROUND

- *Current-status of National electricity system:*
  - Total national power generation capacity (PLN IPP, PPU, and IO non oil fuel) in 2012: 44.8 GW (Consumption average Growth 6.2%/yr during 2000-2012).
    - Approximately 73% in Java and Bali, 18% in Sumatra, and the rest are in Kalimantan and Other Islands (Sulawesi, Maluku, NTB-NTT, Papua).
  - Manage by PT PLN (Persero) >73% (32.9 GW), Independent Power Producers (IPP) 17% (7.4 GW) , Private Power Utility (PPU) and Operation-Permits for non petroleum fuel, around 10% (4.5 GW).
  - Fuel Mix 2012: coal-fired plants and gas has the highest share:
    - 43% (19.1 GW) and 27% (12 GW), respectively, followed by oil-fired plants with a share of around 18% (8.1 GW).
    - The share of NRE power plants was increasing, such as geothermal with a share of close to 3% (1.3 GW), as well as hydro-based generation with a share of 9% (4.2 GW). In addition, solar/PV PP and Wind PP have also started operating with a total capacity of 6.9 MW.
  - Electrification Ratio 2012: 75.8%, 2013: 79.3%
    - Highest (DKI Jakarta, 99,99%); Lowest (Papua, 35,89%)
  - Electricity Subsidy: 2012 Rp. 94.5 T (targeted Rp 65 T), 2013 Rp. 100 T

Electrification Ratio (as of June 2012)

R/E	2012 Target	2012 Realisasi Sem I	2012 Pred
PLN	71.2%	70.5%	73.3%
(PLN+ Non PLN)	73.7%	72.8%	75.9%



1. BACKGROUND: Main Issues

- *Decrease/Fading out subsidy (mainly for Diesel Oil → more Renewable Energy),*
- *Increase Electrification Ratio (Accelerate New PP, more Local/Renewable Energy Sources)*
- *Government Commitment for Low Carbon technology development*

→required better Tariff and Technology

→Smartgrid concept/technology to accelerate and optimized renewable energy penetration

Source: RUPTL 2013-2022

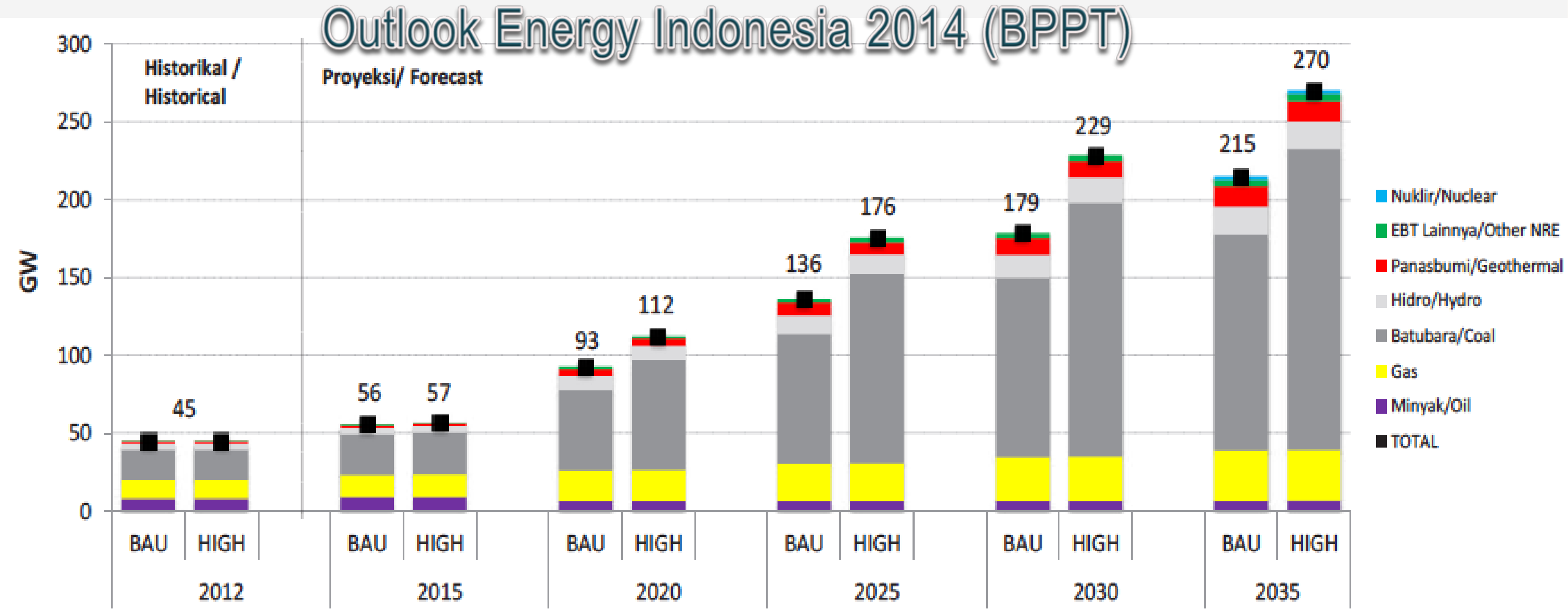
Geographics Electricity Systems

- Two of main islands have own interconnected systems
- The rests are: (about 500 clusters)
  - Clusters of service areas with main grids, including remote off-grid distributed systems (Kalimantan, Sulawesi, Papua)
  - Small islands: clusters of grids mainly of diesel systems, off-grid distributed systems

2. Outlook of Indonesia Electricity:

- Large increase in Electricity Demand: Outlook based on the Markal optimization method by BPPT show that:
  - During 2012-2035 period, national electricity generation capacity (PLN and non PLN) in BAU scenario will increase from 44.8 GW to 215 GW, or grew by 7.1% per year. In the high scenario by 2035, its capacity will be 26% higher than the BAU scenario of up to 270 GW or grows 8.1% / year. On these two scenarios, coal-fired power plant continues to dominate till 2035 with a share of 65% (139 GW) in the BAU scenario and up to 72% (194 GW) at high scenario.
- Long-term view supply-demand growth and optimal energy mix composition
- Projection of technology trend : distributed, indigenous, renewable resources
- Advanced electricity system of smart grid in city urban and rural area: converging high quality and reliability, efficiency, demand response, and renewable integration

Outlook: National Electricity Generation Capacity Projection and Type of Fuel



- 2035: Large-scale NRE power plants (e.g. geothermal and hydro power) are predicted will reach 12.8 GW (BAU) and 17.8 GW (High Scenario).
- For small-scale NRE power plants (e.g. PV, wind, landfill, biomass, ocean, and biofuels power plant), are projected to continue growing, its total capacity will reach 4.3 GW (BAU scenario) and 4.9 GW (high scenario), or has only 2% share in total national capacity

3. R&D and Potential Applications of Smart Grid Technology

What is a Smart Grid?

Distinguishing characteristics of the Smart Grid cited in US-EISA (US Energy Independence and Security Act, 2007) include:

- Increased use of **digital information and controls** technology to improve reliability, security, and efficiency of the electric grid;
- **Dynamic optimization** of grid operations and resources, with full cyber security;
- Deployment and integration of **distributed resources** and generation, including renewable resources;
- Development and incorporation of **demand response, demand-side resources, and energy-efficiency resources**;
- Deployment of **''smart'' technologies for metering**, communications concerning grid operations and status, and distribution automation;
- Integration of ''**smart'' appliances** and consumer devices;
- Deployment and integration of **advanced electricity storage** and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning;
- Provision to **consumers of timely information** and control options;

Source: US-NIST Framework and Roadmap for Smart Grid interoperability Standards, Release 2.0

BPPT Tasks & Urgencies in Indonesian Smart Grid Development

BPPT assignments as the Executing Agency

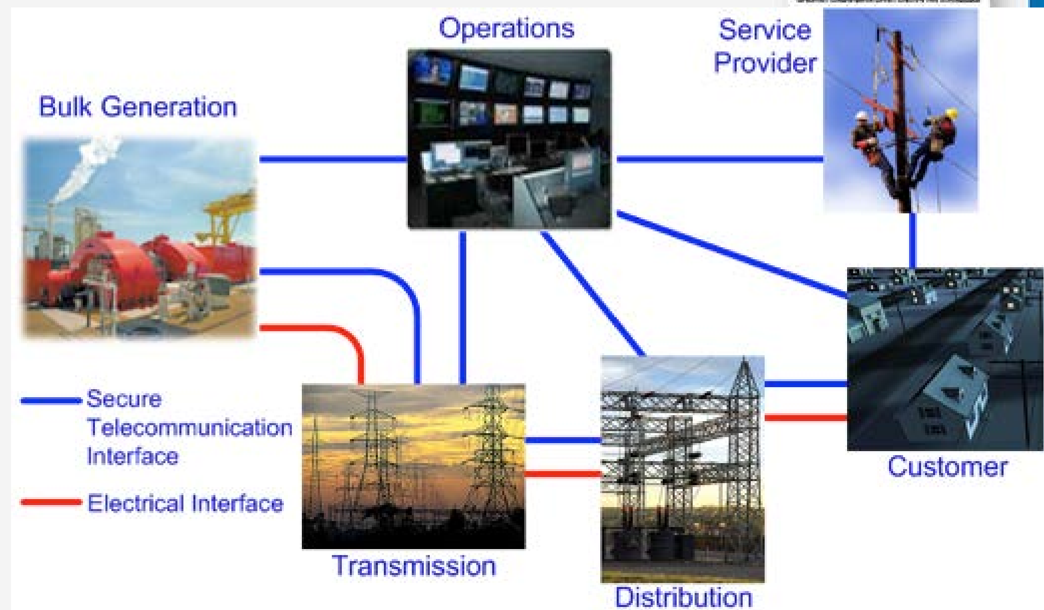
Prepares blueprint of Smart Grid implementation in Indonesian power system including large grid application and small isolated Smart Microgrid

Urgencies:

- Establishing more robust, efficient, fully automatic operation and control of interconnected power systems
- Achieving an international standards of 9 time maximum outages per consumer per year
- Boost ratio of electrifications up to 80% through development of transmission and distribution networks, as well as encouraging growth in generating capacity as much as 30,000 MW.
- Increase ratio of electrified villages to 98.9%
- Increase penetration of renewable energy
- Development of energy self-sustained villages

Smart Grid – Indonesian View

1. **Smart interconnection grids**
   - Improved reliability
   - Energy savings
   - Robustness of operation and control (Self-Heals)

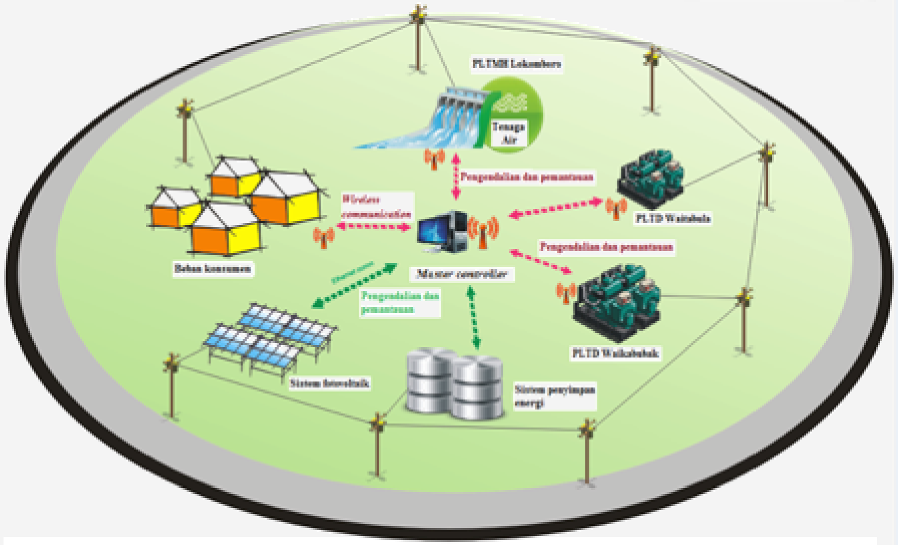


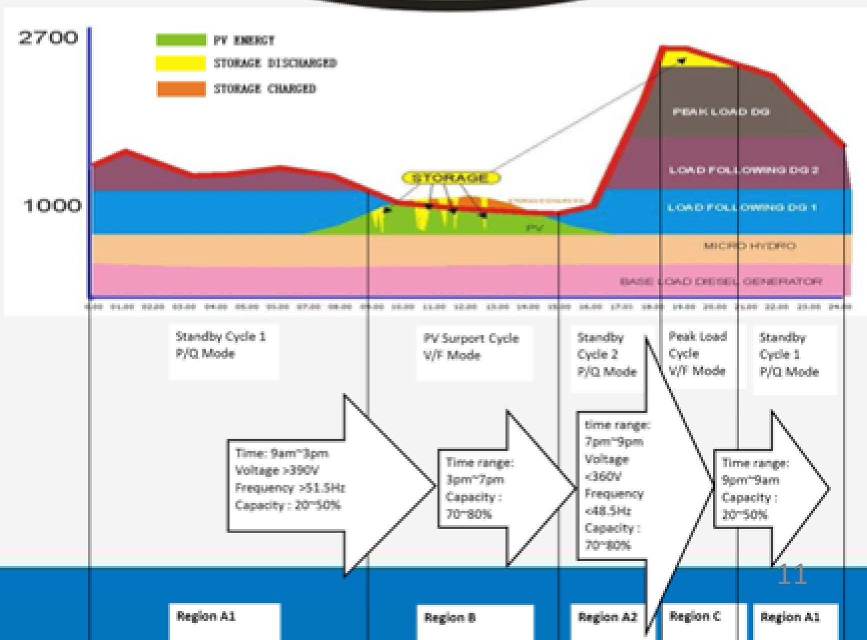
2. **Smart micro-grids for high penetration distributed energy resources (DER)**
   - Improve operational control capabilities.
   - Smoothing high renewable DER integration

Sumba Pilot Plant

Development of smart grid technology has been initiated by BPPT in 2011

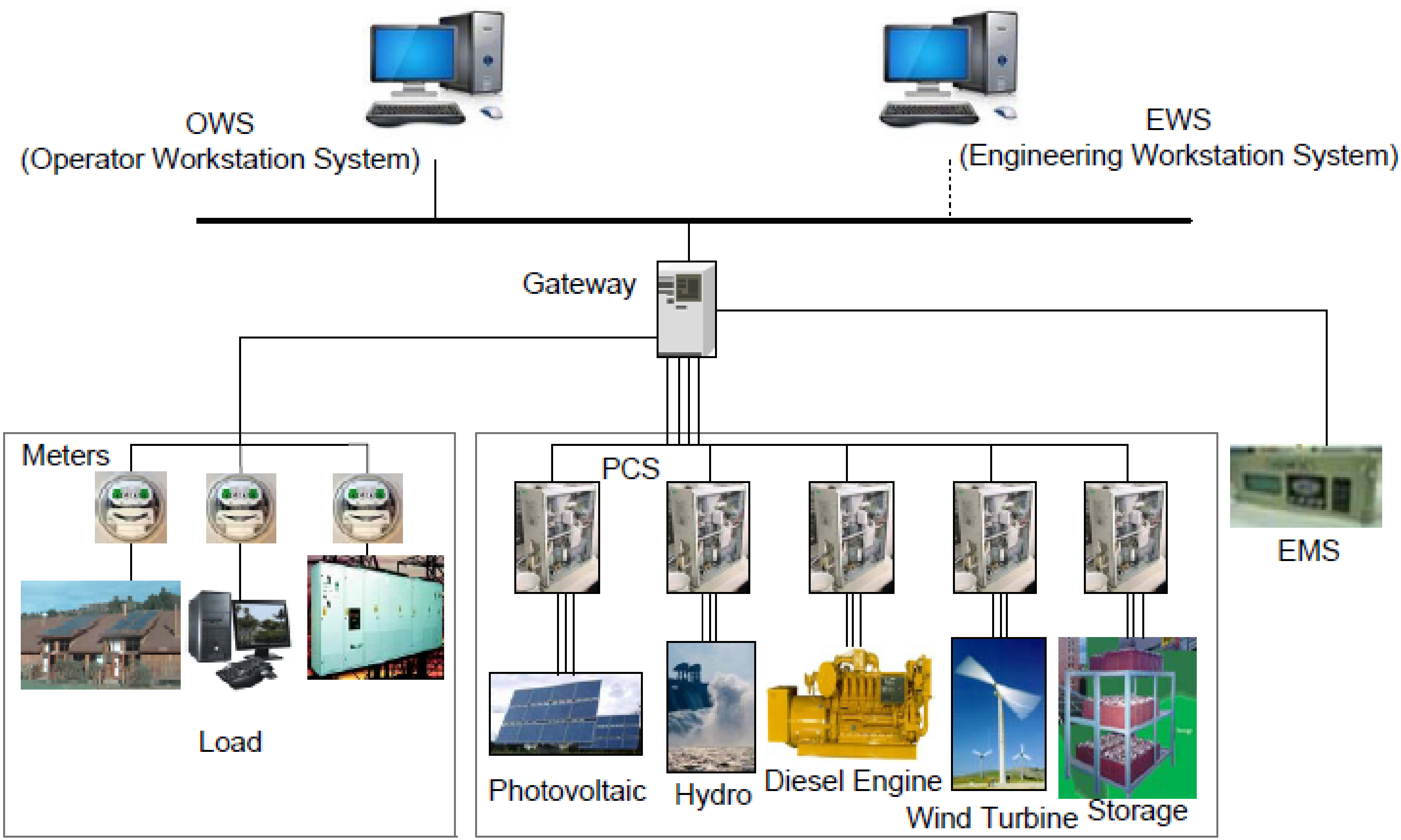
- Utilization of renewable energy of large-scale solar photovoltaic technology 500 kWp
- 3 unit micro hydro with total capacity of 1.800 MW
- Energy storage equipment with capacity 0f 500 kWh/day
- 13 unit diesel power plant with total capacity of 4.946 MW



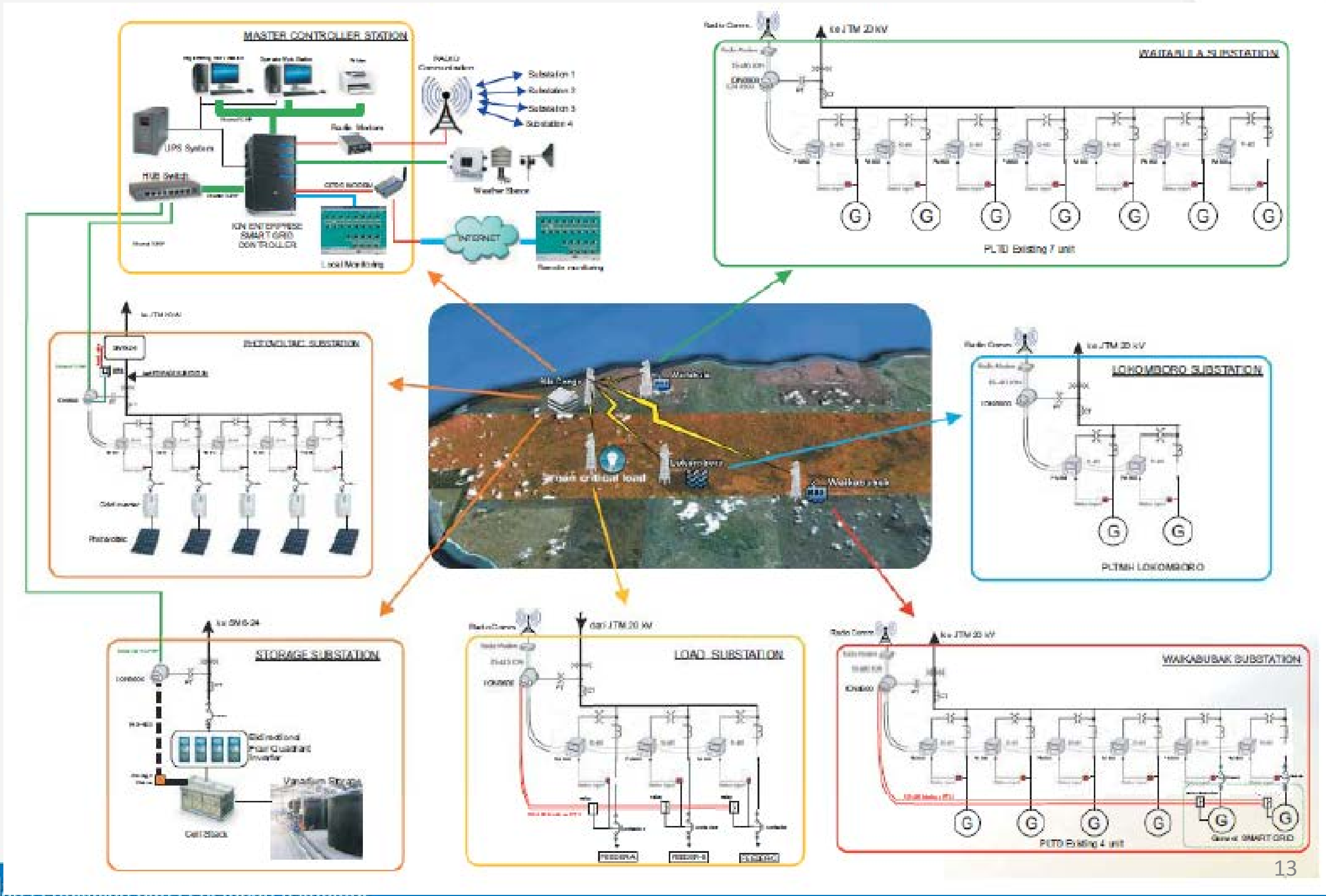


Objective: provide best practice of high renewable energy penetration by the ability of integrated control for firming generation fluctuation

Pilot Plant – Sumba Smart Microgrid Configuration



Smart Micro-Grid Architecture at West Sumba



Sumba Case : Lesson Learned

- *Proofing of concept* of integrated control for high Solar PV penetration ability in small grid (up to 40% of daytime system load)
- *Appropriate technology* for tapping high solar resources in area with long dry seasons
- *Improving ease of system operation* through integrated control
- Control *data communication and energy storage* technology play important role
- VRB energy storage technology is found *appropriate for high fluctuated system*, but suffer an ineffective operation due to its high internal load and *vulnerability to frequent system black-out*

4. Discussions & Recommendations

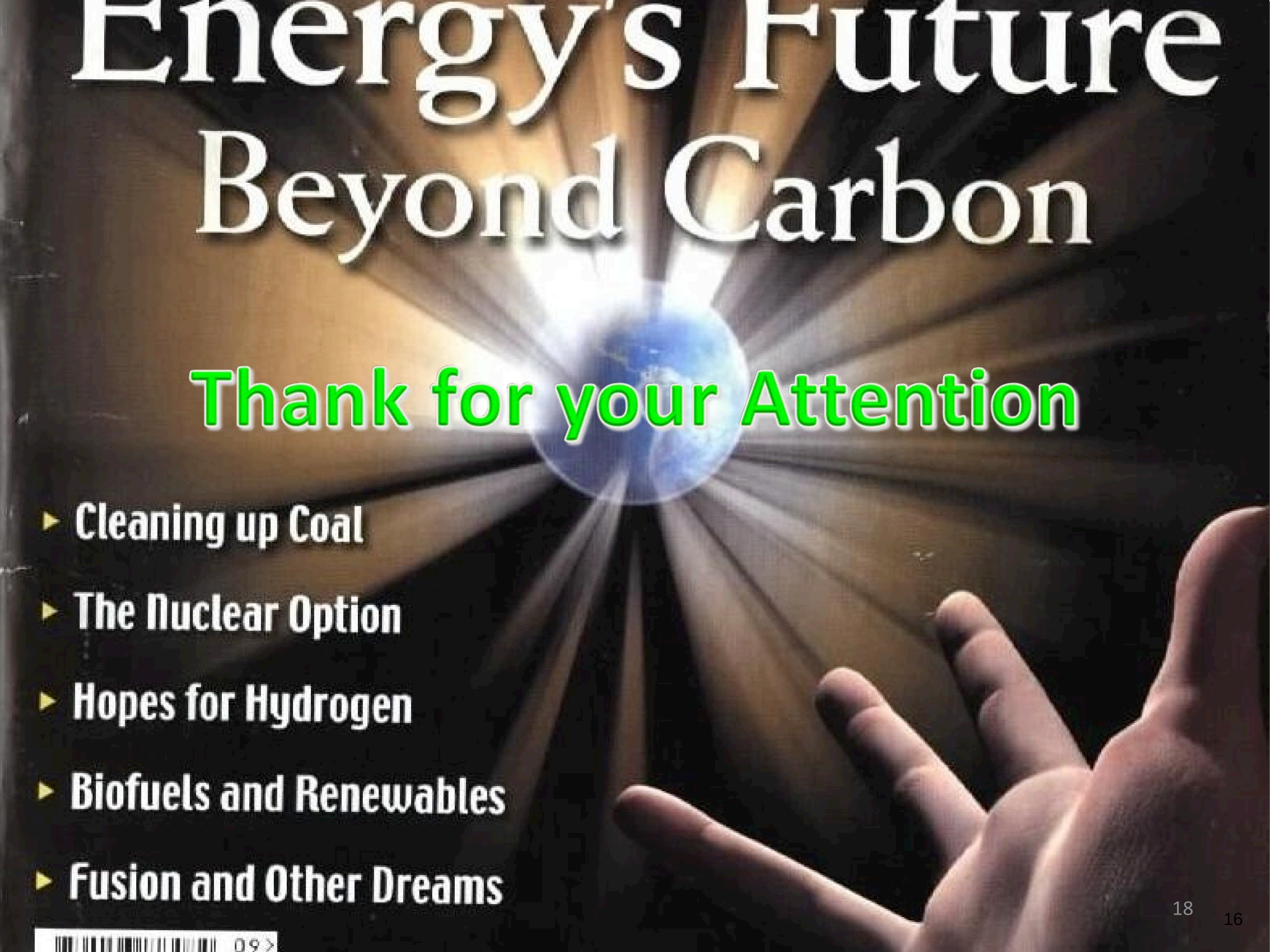
- Long-term Indonesia's energy posture by 2030 is ***still dominated by fossil fuel***(83%), as to compare with renewable energy (17%).
- ***RE utilization is still slow*** and most likely would not achieve the long-term national energy policy target.
- ***Gap of electrification ratio still remain***, unless there is any progressive initiatives.
- This provide ***wide opportunity*** for RE technologies & resources development.
- Fluctuated nature of RE source: placing Micro and Smart Grid technology at ***important role*** for seamless RE electricity integration, hence accelerate the level of utilization.
- High IKE (building energy consumption intensity) more than 240 kWh/m2/year; efficient level is less than 144 kWh/m2/year: ***smart building would be an appropriate technology*** for promoting high energy efficiency building.
- Advanced Metering Infrastructure (AMI) may provide a tools to ***improve consumer effectiveness in energy use***; including repressing electricity theft

Smart Grid Technology Development Initiatives for Clean Electricity in Rural and Urban City

- Objectives:
  - Community Energy Management for effective integration of renewable energy source plants, high efficiency devices utilization, efficient use of electricity, etc.
  - Residential Building Energy Management for smart integration of renewable energy, smart building controller, and demand response facility for consumer’s participation, etc.
  - Commercial Building Energy Management, for application of smart building automation, consumer’s electricity control, optimization of own plant operation, ambient smart control for HVAC and lighting, etc.
- Current Activities:
  - Evaluation of a Smart Grid demonstration plant that integrates renewable energy sources with the local electricity system in Sumba.
  - Reviewing the feasibility application of this technology in electrical system of large cities in Indonesia to support demand response, conservation, and renewable energy integration.

Challenge to Smart Grid Development in Indonesia

- Communication Infrastructures
  - Big Cities: Available but Expensive
  - Small Towns: poor infrastructure
  - Rural: inexistence
- Information Technology
  - Limited SCADA capabilities
  - Smart meters only for large consumers
- Regulatory aspects:
  - Non-competitive Electricity Market,
  - Regulated Government Pricing
- Unsteady supply from Renewable Energies: need advance, cost-effective storage technology
- High capital investments
- Low consumers interest to participate
- Very limited number of Smart Building applications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Beyond Carbon
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▸ The Nuclear Option
▸ Hopes for Hydrogen
▸ Biofuels and Renewables
▸ Fusion and Other Dreams