Development of Sustainable Power and Water Supply utilizing Renewable Energy Resources for Remote and Rural Areas in Indonesia through Student Community Services Program

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RCE Award Project Presentations at the 9th Global RCE Conference
Youth Empowerment, Networking and Collaboration - 7 November 2014

Sustainable Development

In 1987, the United Nations released the Brundtland Report, which included what is now one of the most widely recognised definitions: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

http://sustainabledevelopment.un.org/

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Sustainable Energy for All

- Ensure **universal access** to modern energy services
- Double the global rate of improvement in **energy efficiency**
- Double the share of **renewable energy** in the global energy mix

2012

Sustainable energy - energy that is accessible, cleaner and more efficient - powers opportunity

http://www.sustainableenergyforall.org/

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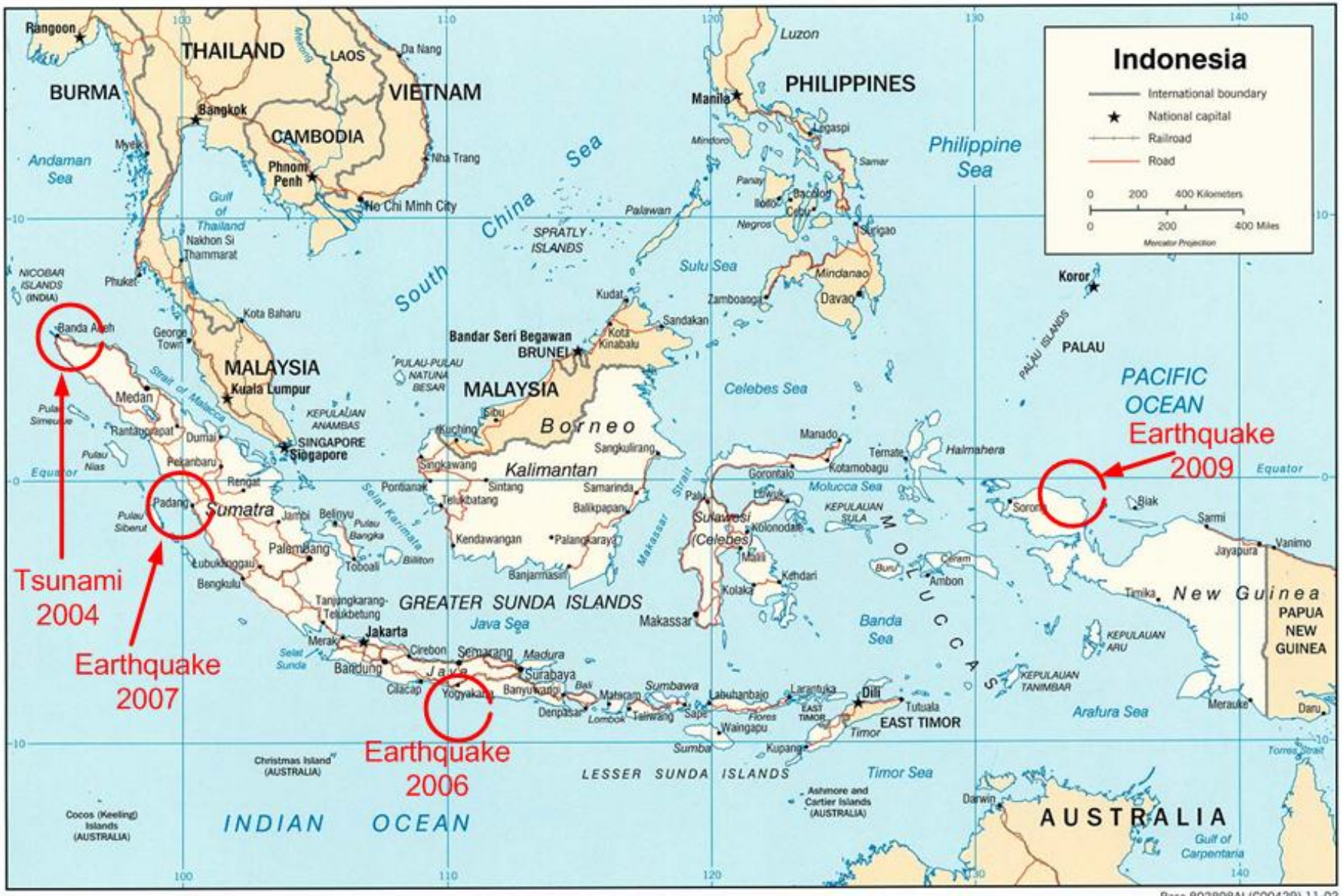
RE for Sustainable Development INDONESIA



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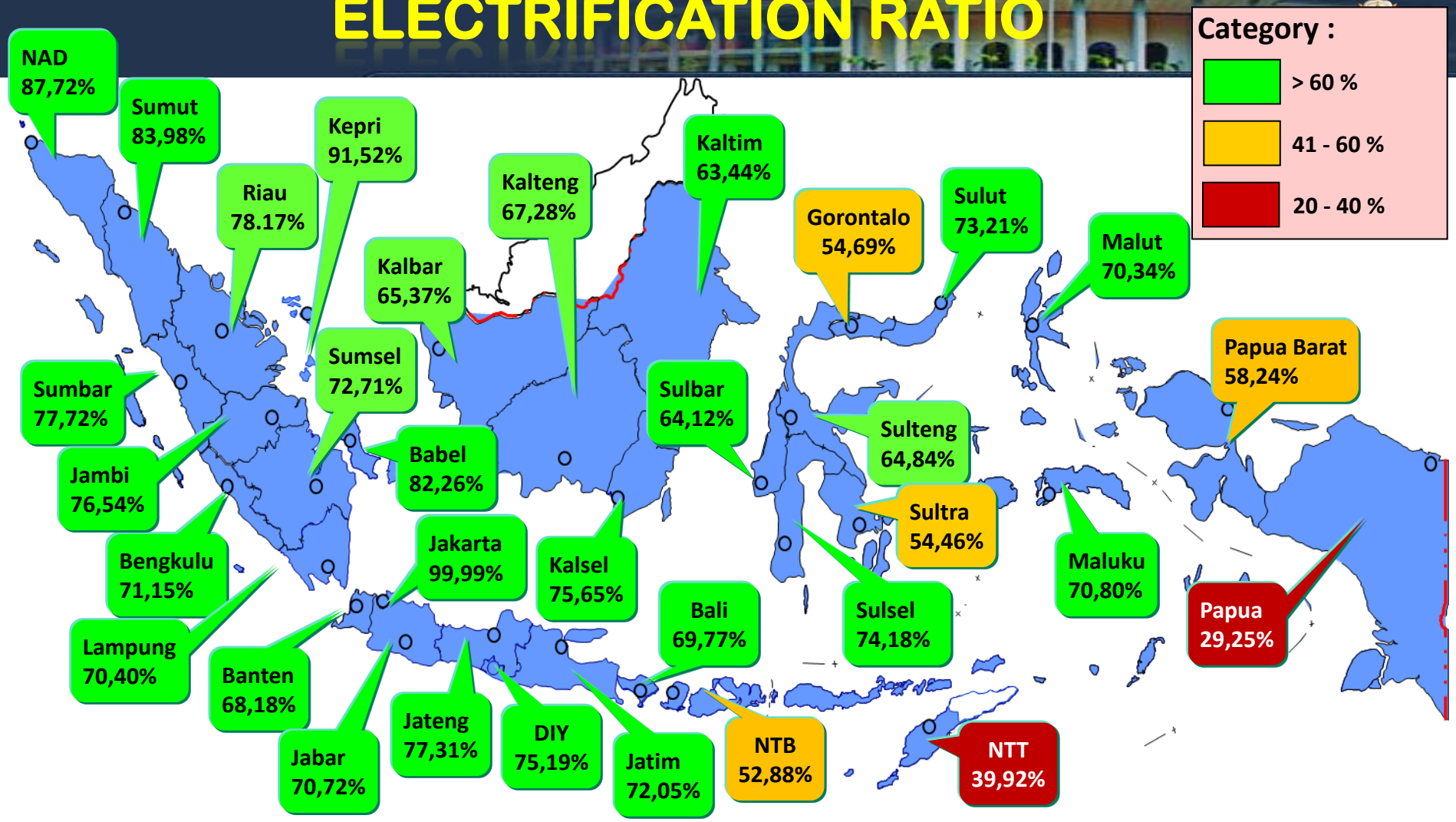
ELECTRIFICATION RATIO

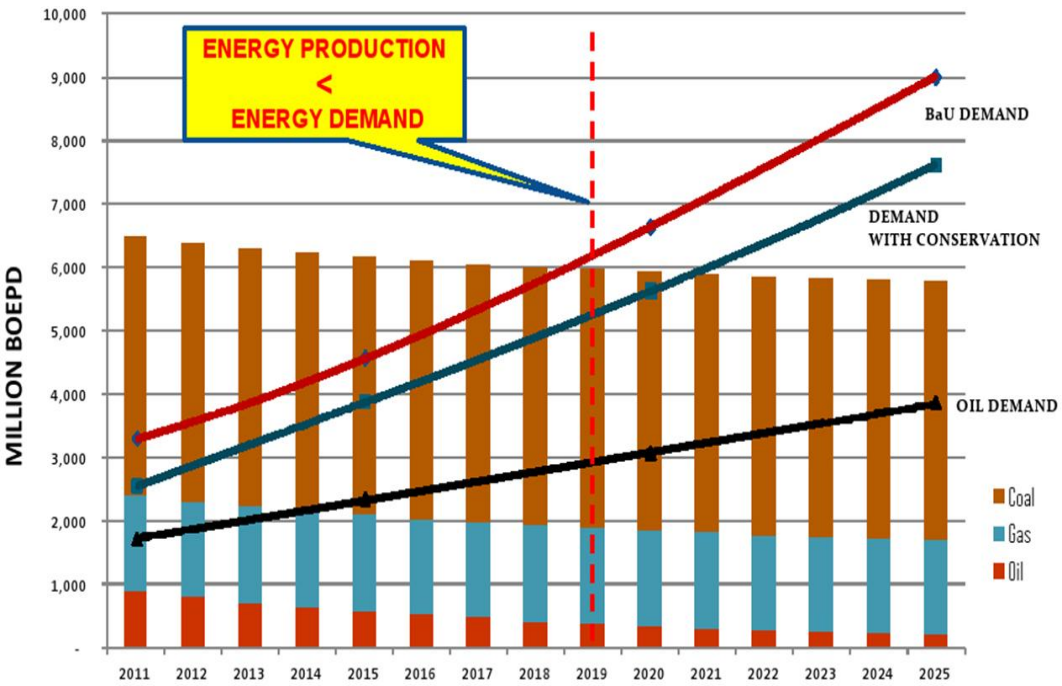


	Year											
	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Electrification Ratio	8%	16%	28%	43%	53%	62%	63%	64.34%	65.10%	65.79%	67.15%	72.95%

Source: Dr.-Ing Hasrul Laksmana Azahari M.Met.E, Director New and Renewable Energy, ESDM @INDOEBTKE CONEX 2012

ENERGY SUPPLY – DEMAND 2011 -2025

- In the year of 2011, energy production (fossil) reach 6,5 Million BOE per day, while on the other side energy needs (fossil) 3,3 Million BOE per day
- On the year of 2019, if energy managed by business as usual without apllying energy conservation, Indonesia is predicted to be a net-energy importir



Indonesia might be an net-energy importing country in year 2019

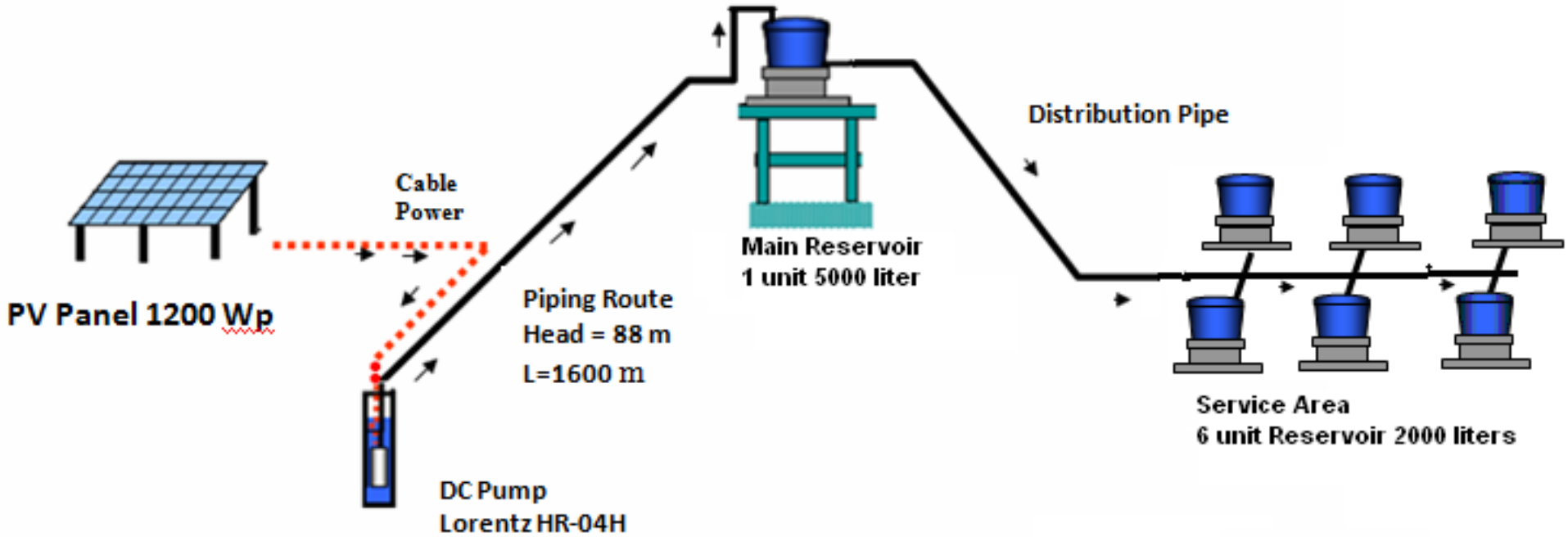
BOEPD: Barrels of Oil Equivalent Per Day

Water Resources

Mondialogo Engineering Award 2007

1. Solar Water Pumping System

https://sites.google.com/site/aasetiawansite/research-project---videos



UNESCO

Curtin University of Technology

DPU

UGM

DAIMLER

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Social Preparation Activities

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System Installation Activities

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DESAIN PENGANGKATAN AIR TENAGA SURYA DI DUSUN SURENG, KECAMATAN TEPUS, KABUPATEN GUNUNG KIDUL

RISTEK

FAKULTAS TEKNIK
UNIVERSITAS GADJAH MADA

BACKGROUND

Desa Purwodadi di Kecamatan Tepus merupakan daerah dengan tanah karst yang tidak bisa menyimpan air. Saat musim penghujan, air hujan ditampung untuk memenuhi kebutuhan air sehari-hari. Saat kemarau dan persediaan air pada penampungan air hujantelah habis air harus dibeli dari truk tangki seharga Rp 100.000,00 per tangki dengan volume 4.000 liter.

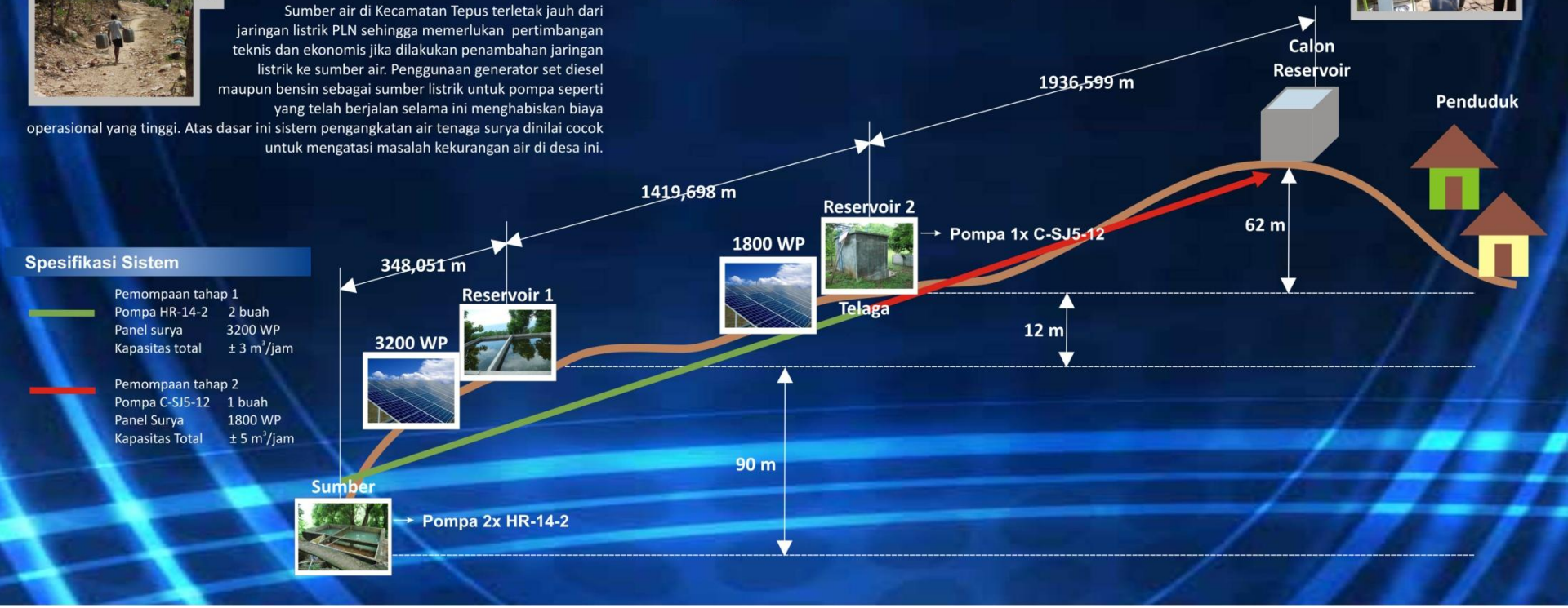
Bagi yang tidak mampu mereka harus mengambil air dari sumber air Sureng yang terletak 2 km dari pemukiman penduduk.

Sumber air di Kecamatan Tepus terletak jauh dari jaringan listrik PLN sehingga memerlukan pertimbangan teknis dan ekonomis jika dilakukan penambahan jaringan listrik ke sumber air. Penggunaan generator set diesel maupun bensin sebagai sumber listrik untuk pompa seperti yang telah berjalan selama ini menghabiskan biaya operasional yang tinggi. Atas dasar ini sistem pengangkatan air tenaga surya dinilai cocok untuk mengatasi masalah kekurangan air di desa ini.

SOSIALISASI dan PENYERAHAN SPAM

Pembangunan pemasangan pompa surya ini ditandai secara simbolis dengan penyerahan pompa oleh Asisten Deputi Iptek Masyarakat, Kemenristek, Drs. Momon Sadiyatmo, MT kepada wakil Bupati Gunung Kidul, Imawan Wahyudi, dalama cara sosialisasi program pemasangan pompa surya di Balai Desa Purwodadi, Tepus, GunungKidul, Selasa (17/7). Penyerahan pompa surya tersebut disaksikan Wadek Bidang Kemahasiswaan, Penelitiandan Kerjasama Fakultas Teknik UGM, Prof. Ir. Jamasri, Ph.D, Kepala Satker PAM PU DIY, Ir. Hardjono Sudjanadi, MM serta Kepala Desa Purwodadi, Suprihatin.

Dalam pemasangan pompa surya ini, peneliti energi terbarukan, Dr. Ahmad Agus Setiawan, mengatakan pihaknya menggandeng mahasiswa KKN PPM. Selanjutnya selama 2 bulan, mahasiswa bersama masyarakat akan memasang dua pompa dan 32 panel surya agar bisa mengangkat sumber air yang berada di sekitar 3 kilometer dari rumah penduduk.



Spesifikasi Sistem

Pemompaan tahap 1

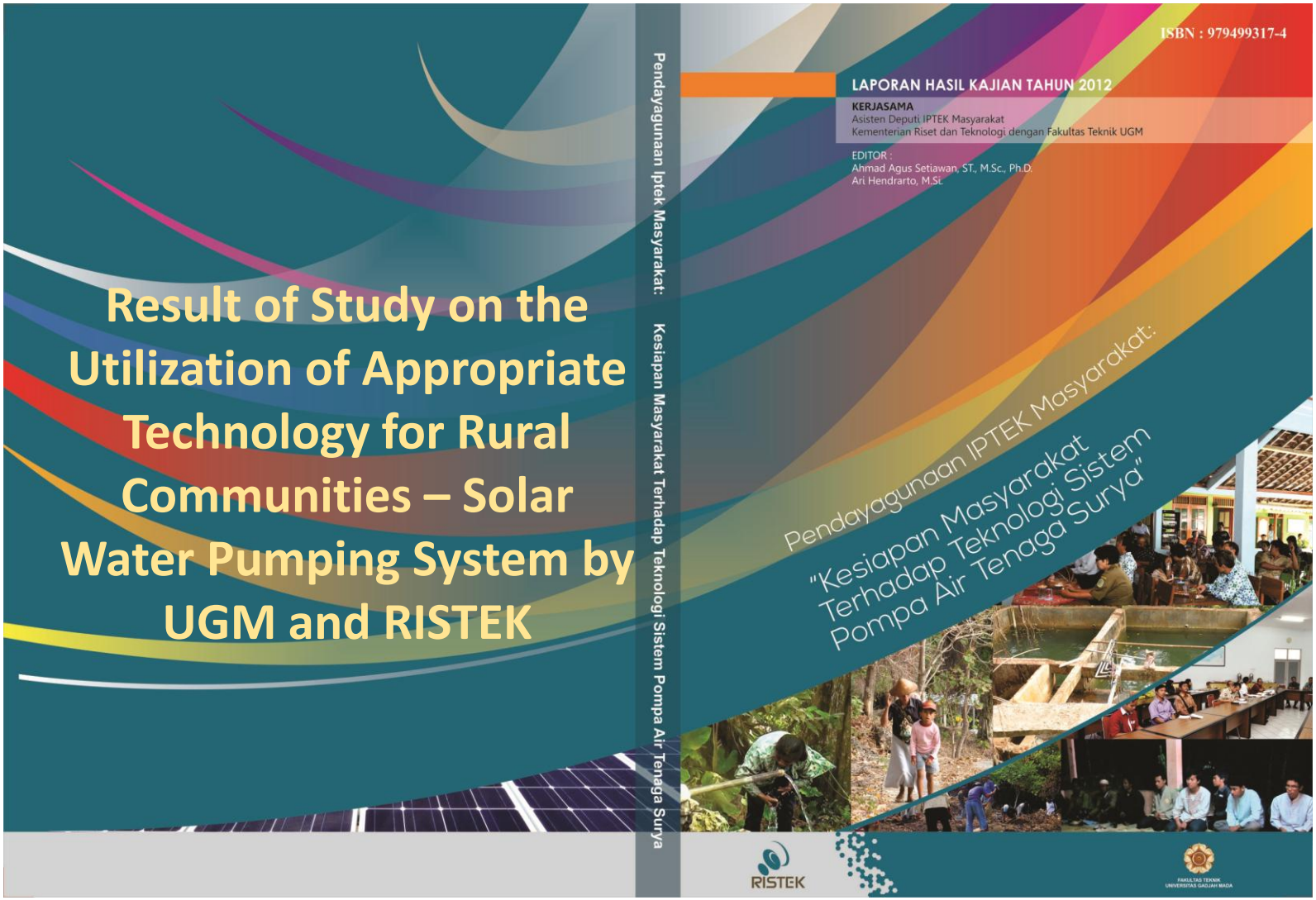
Pompa HR-14-2	2 buah
Panel surya	3200 WP
Kapasitas total	± 3 m^3/jam

Pemompaan tahap 2

Pompa C-SJ5-12	1 buah
Panel Surya	1800 WP
Kapasitas Total	± 5 m^3/jam

Video Coverage on Student Community Services

Adopting Renewable Energy Technology



Crucial Issues

- Local community involvement
- Community empowerment
- Support for technical – economy and social issues
- Capacity building - Organization
- Network Support Model from R&D institution, universities, local and national government for sustainabilty

Initiative MODEL for SWPS in Rural Areas

Survey

Design & Planning

Socialization – Technical & Organization

System Installation

Sustainability Issues

Through Continuous Student Community Services Program in 3 – 4 years

2. Solar Power System for Disaster Response and Reconstruction

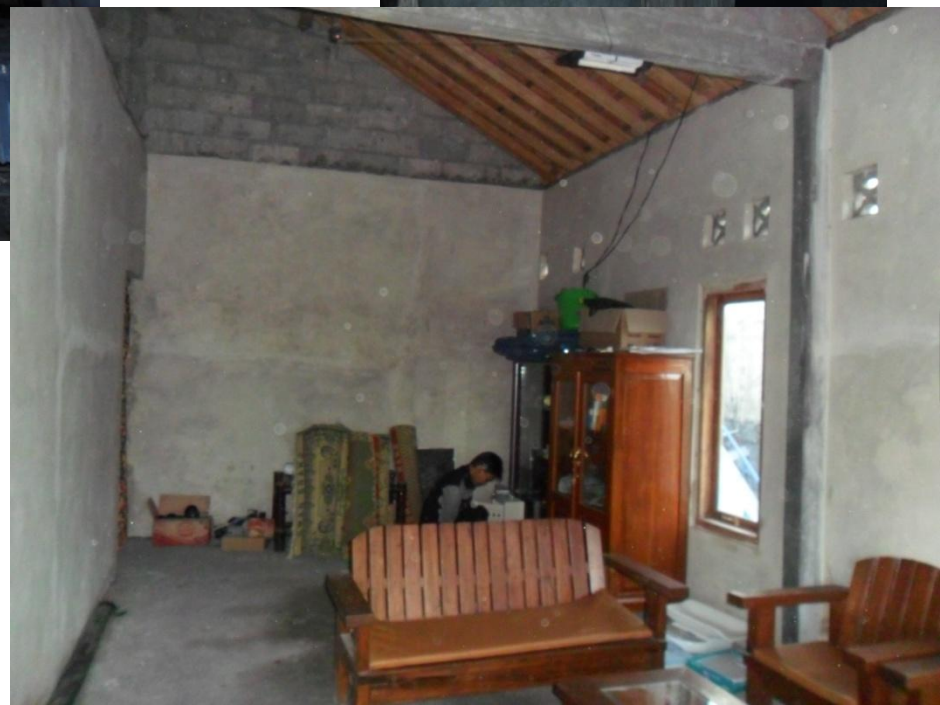
Deployment of Solar-PV Power System for Disaster Response & Reconstruction in Padang, West Sumatera

Faculty of Engineering Universitas Gadjah Mada in cooperation with the Institute of Research and Community Services (LPPM-UGM) has been deploying Solar Power System for Disaster Response and Reconstruction for the Padang Earthquake Aftermath, on 6 - 8 January 2010. Department of Engineering Physics has been assigned for the design and building the prototypes and on behalf of the Faculty of Engineering Universitas Gadjah Mada, It organizes the packaging and deployment to the location that was embedded into the Student Community Services program.

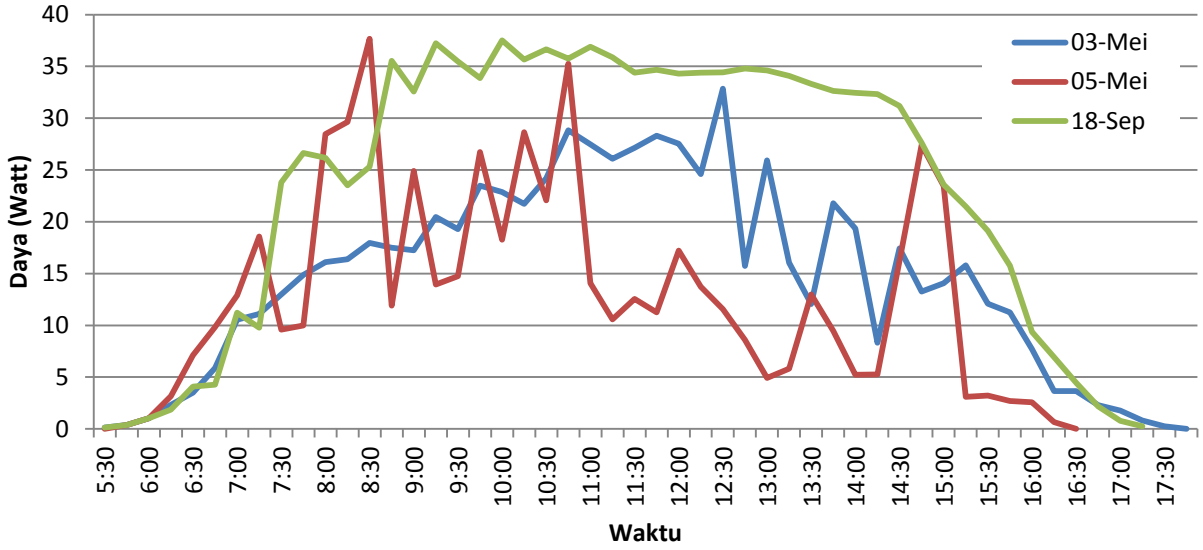
After the Padang Earthquake in 2009

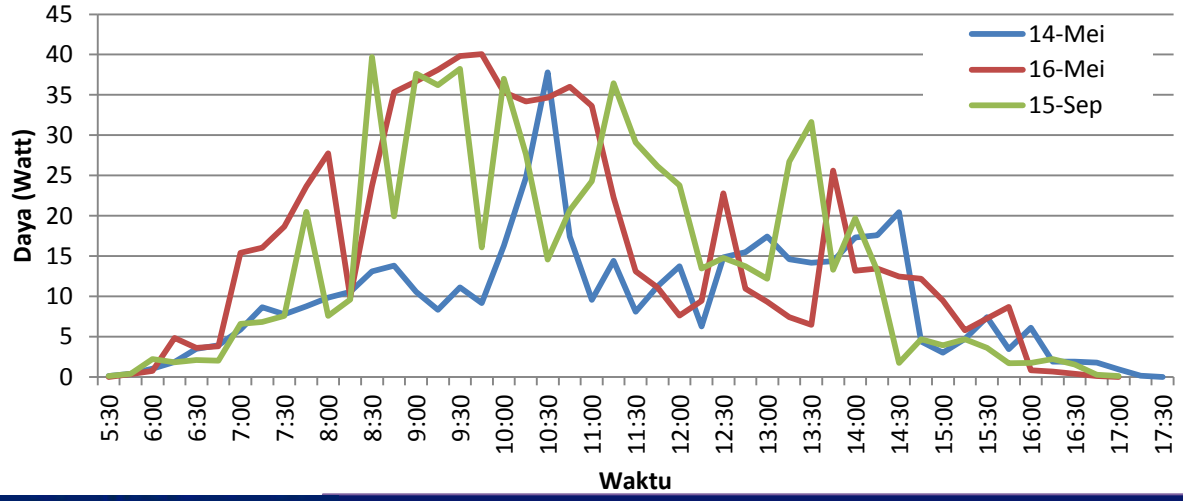
Field Test Experiment

Post Merapi Volcano Eruption – Reconstruction 2012



Power produced for emergency condition





3. Solar Powered Aeration Technology Transfer for Fish Farmer : A Student Perspective

Agus Setiawan and Ahmad Agus Setiawan
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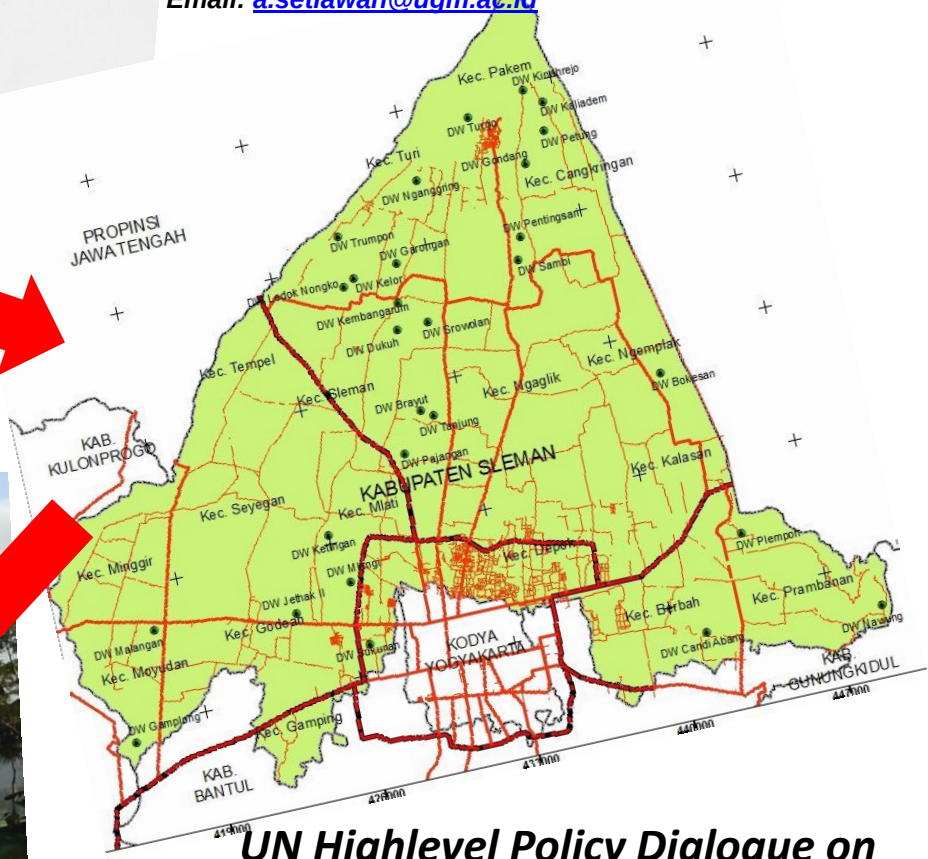
Fisheries Producer



UN Highlevel Policy Dialogue on Technology Transfer for Smallholder Farmer, CAPSA 13 Feb 2013

Solar Powered Aeration System

RISTEK

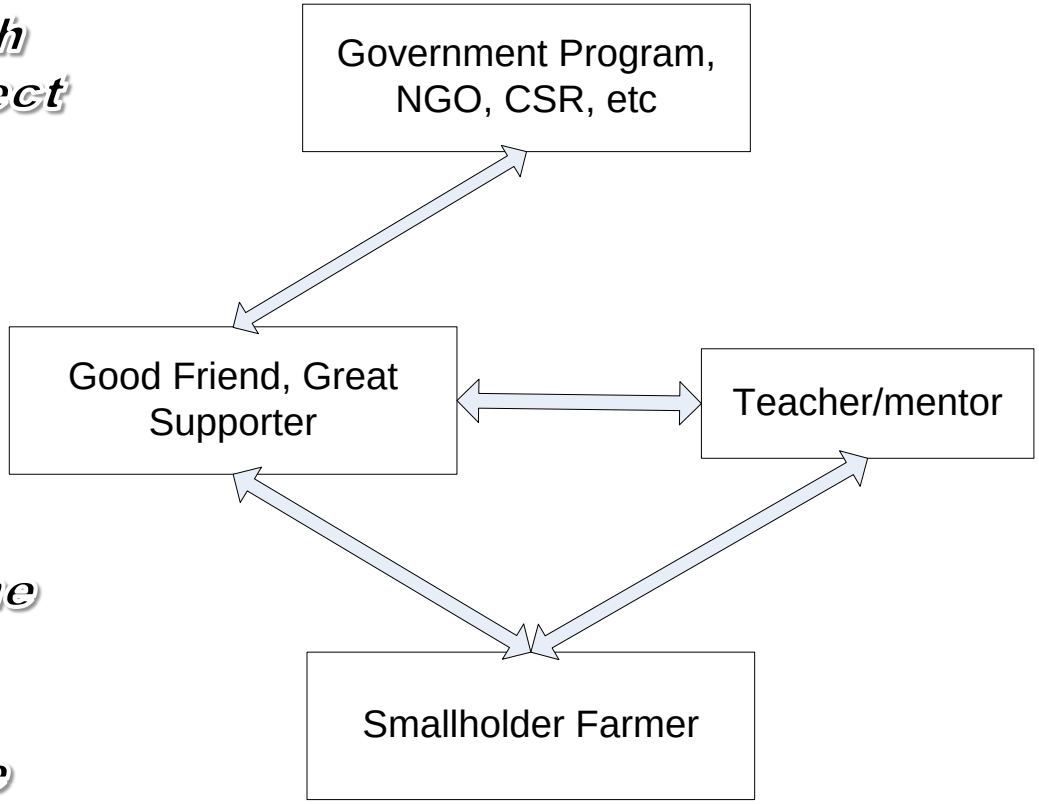
Technology Transfer Communication for smallholder farmers

Assist the community through local student where the project implemented

Needs educated person who understand local community & culture

Any business will not be successful unless we become friend with people

Motivate and accompany the farmer while they learn from role model in their business/expert practitioner



Project Experience

Solar powered aeration technology to support fish farming in SPEKLOK program by Ministry of Research and Technology Indonesia

Solar powered aeration promoted as a renewable energy research

Develop the community to adopt supporting technology for improving fisheries production

Technology adoption process involving student for assisting local community

Adaptation of technology should include social and institutional practices that increase the resilience of the smallholder farmer*

•) Thanakvaro De Lopez, Tin Ponlok and Va Dany. "Community Adaptation to Climate Change in Cambodia: Technology and Development Aspects for Agriculture". *Technology for Adaptation : Perspective and Practical Experiences,* UNEP Riso Centre, Roskilde, Denmark, 2011.

Knowledge sharing by students supervised by lecturer

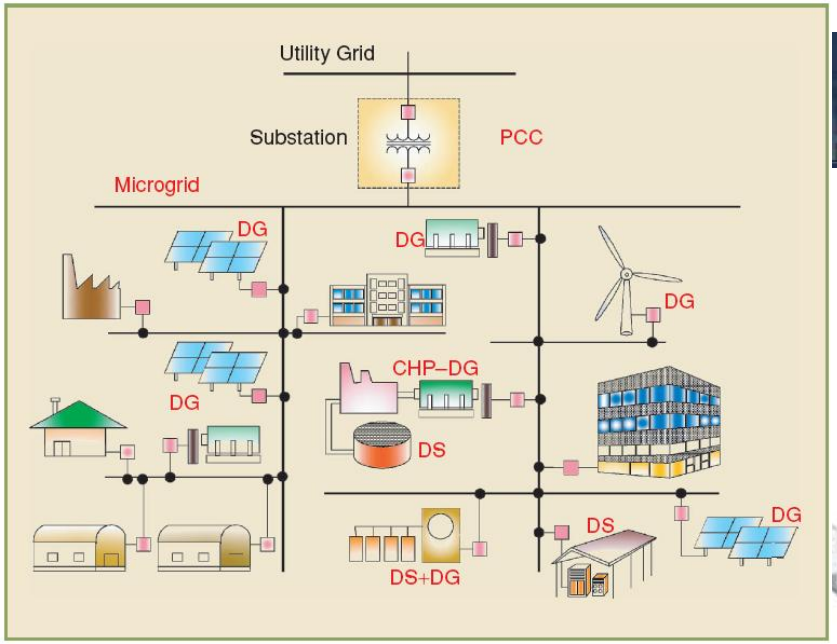
All technologies or practices to be transferred are not necessary high technology, adaptable techniques that are useful at the current of targetted smallholder farmer are sufficient enough*

*) Gyoung-Rae Cho. "South Korean Strategy for Agricultural Technology Transfer to Developing Countries". *US-Korea Dialogue on Strategies for Effective Development Cooperation,* Asia Foundation Korea Center for US-Korea Policy, 2011.

Fish farmer learn from the expert practitioner

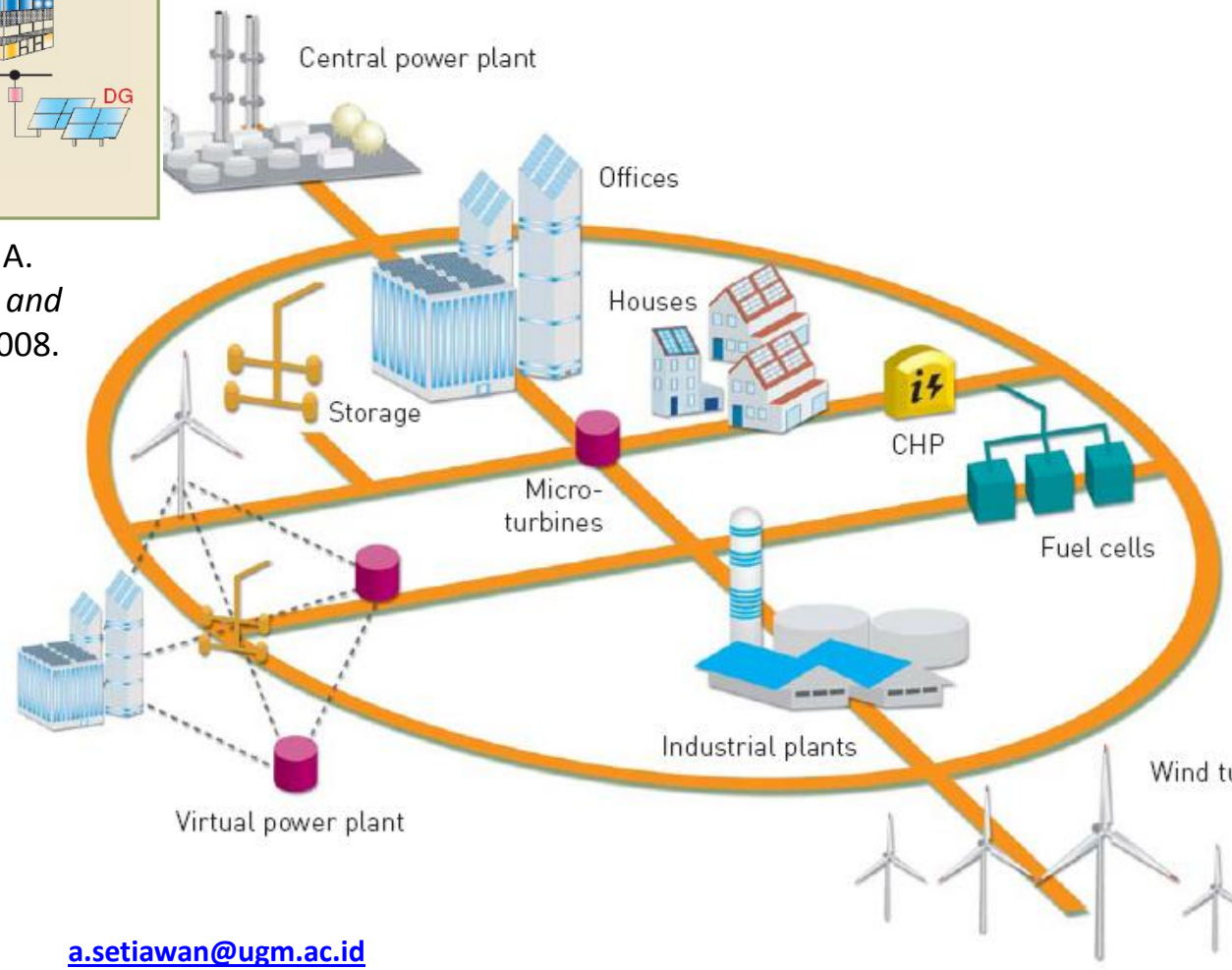
Community participation is needed for capacity building, students involvement as a catalyst in the technology transfer and improve the communication process among the stakeholder

SMART GRIDS IN EUROPE



F. Katiraei, R. Iravani, N. Hatziargyriou, and A. Dimeas, "Microgrids management," *Power and Energy Magazine, IEEE,* vol. 6, pp. 54-65, 2008.

European Smart Grids Technology Platform, Directorate General for Research Sustainable Energy Systems, 2006



How about INDONESIA ???

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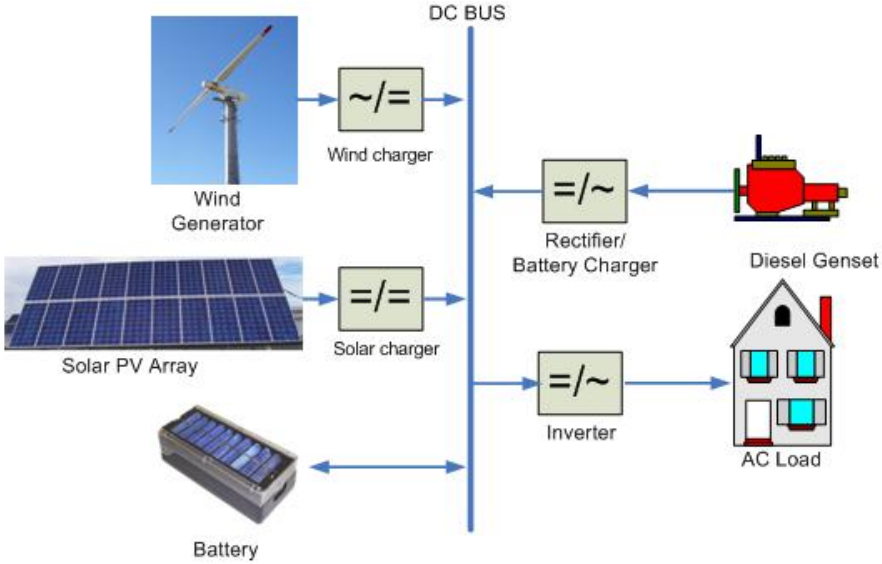
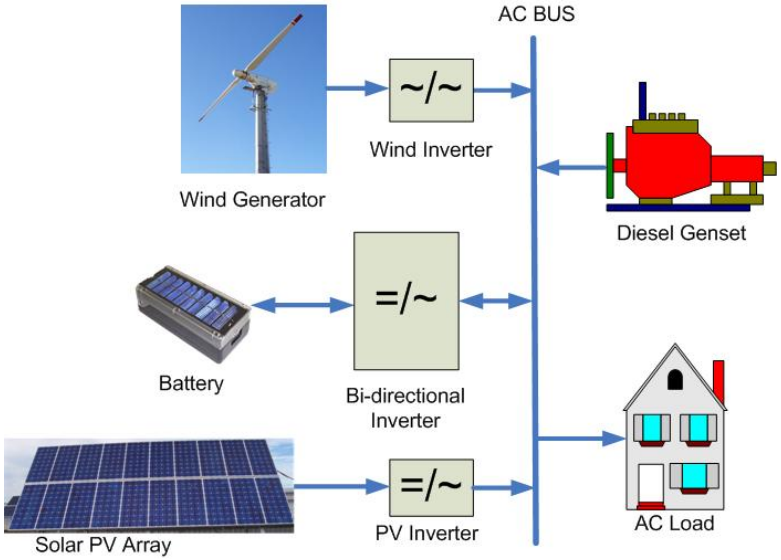
4. Hybrid Power System

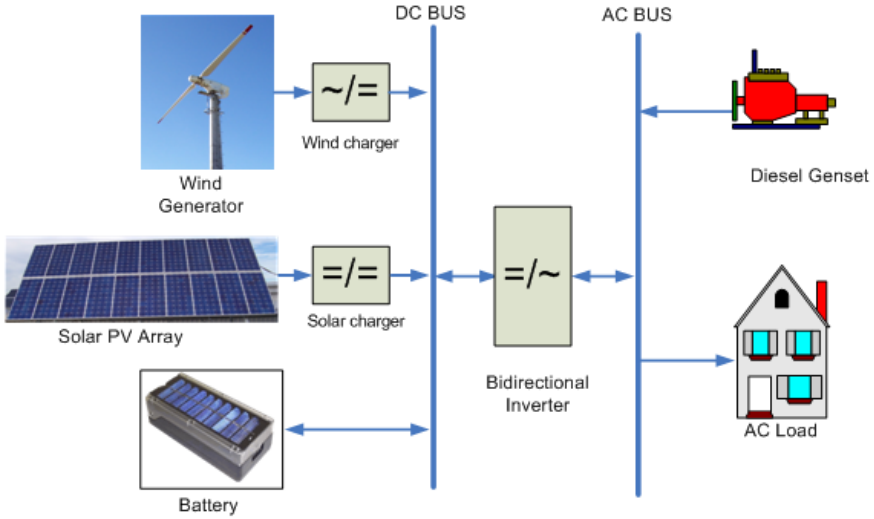
Series hybrid power system configuration



Parallel hybrid power system configuration



AC coupling hybrid power system configuration



A. A. Setiawan, "Development of a Modular AC Coupling Minigrid Hybrid System for Sustainable Power Supply in Remote Areas and Disaster Response and Reconstruction," in *Department of Electrical and Computer Engineering,* PhD Dissertation, Perth: Curtin University, 2009

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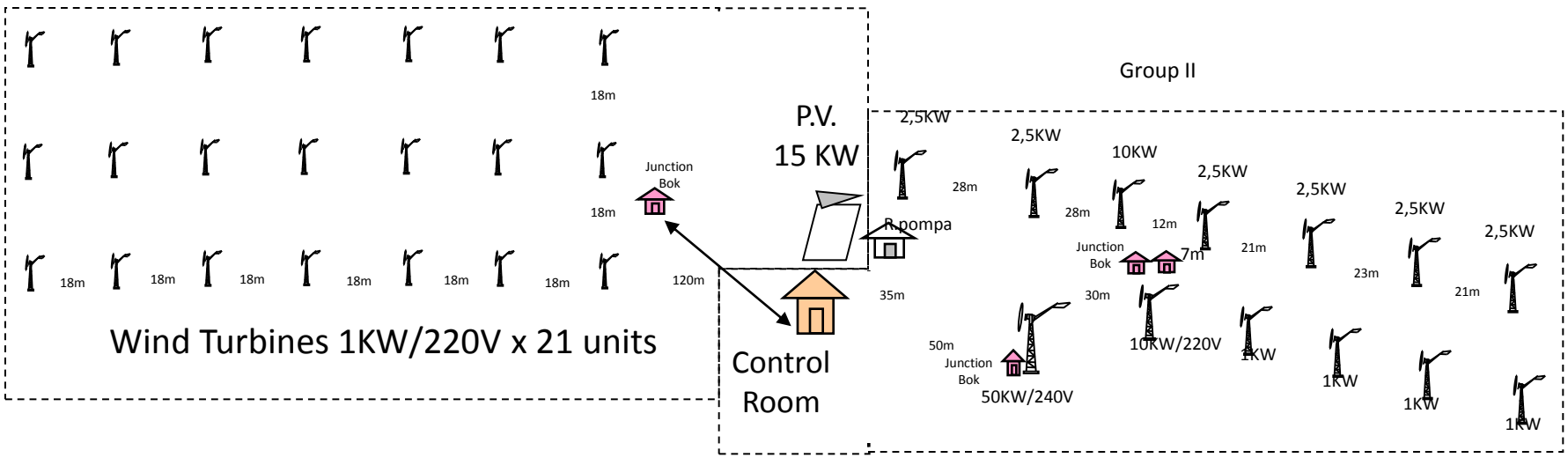
Hybrid Power System in Bantul



Hybrid Power System consisting of Wind Turbines and PV Generator Group – I and Group – II

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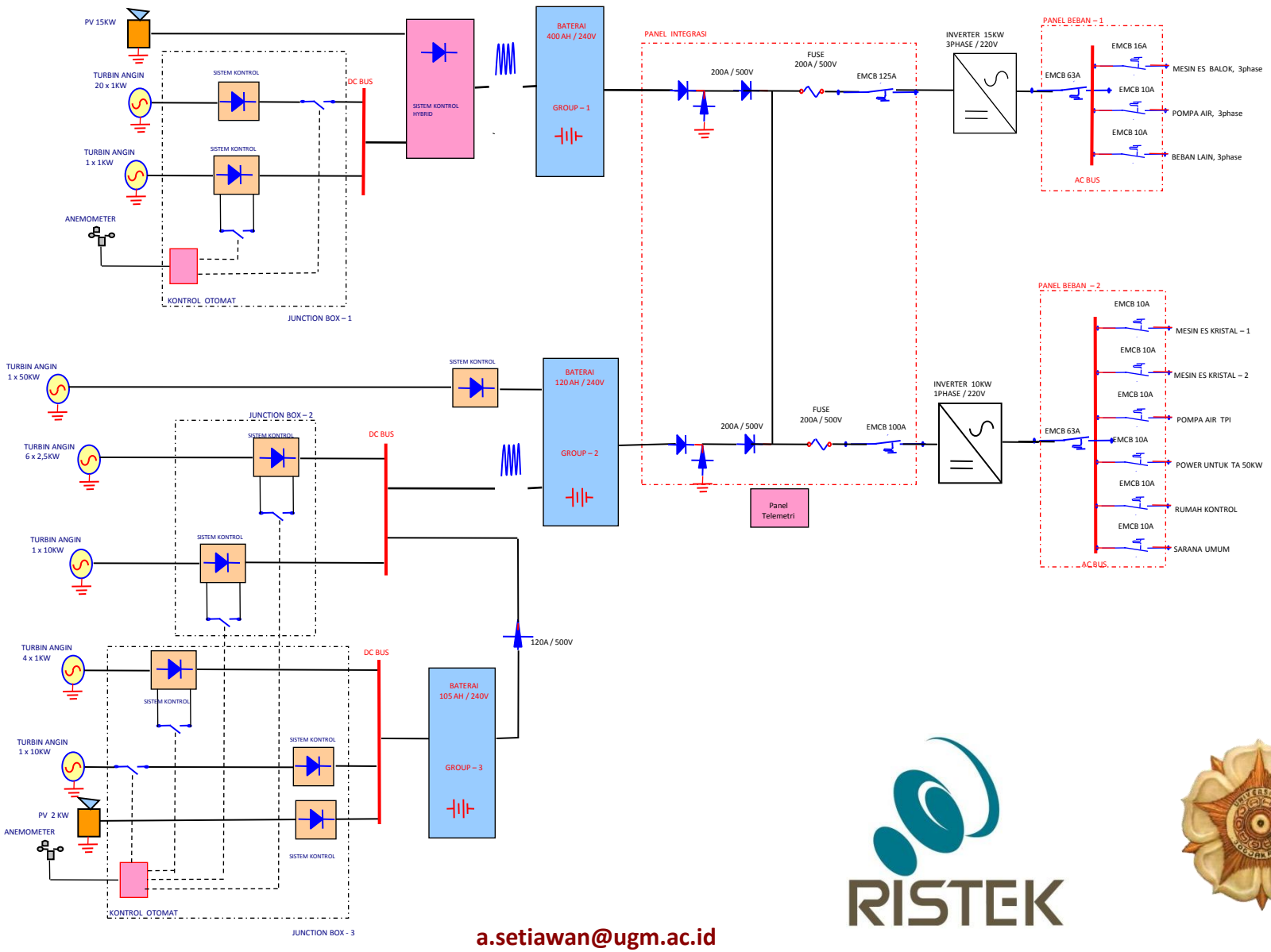
Single Line Diagram Hybrid Power System Bantul



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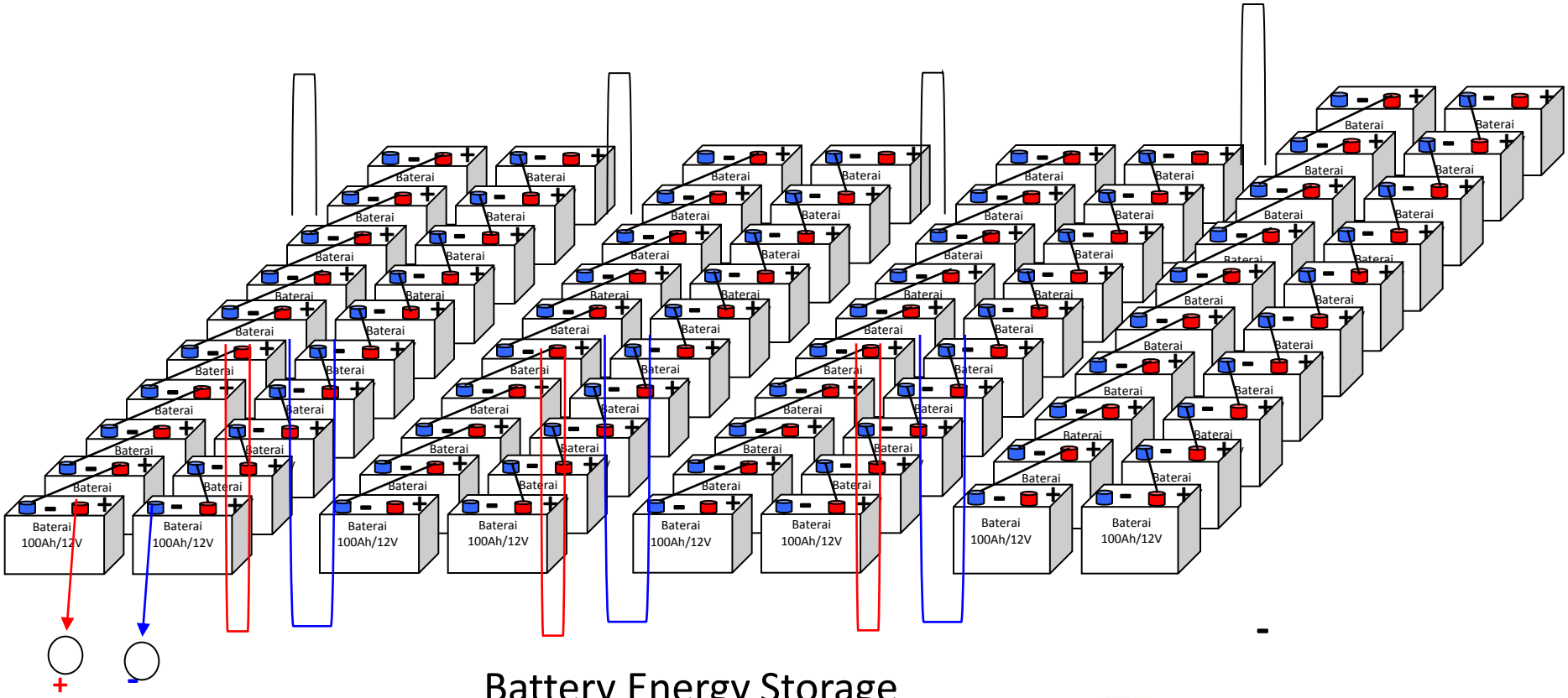
Hybrid Power System in Bantul



Battery Energy Storage
Total Capacity of 400Ah / 240 VDC

RISTEK

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5. MARAMPIT

CITRA SATELIT PULAU MARAMPIT KABUPATEN TALAUD

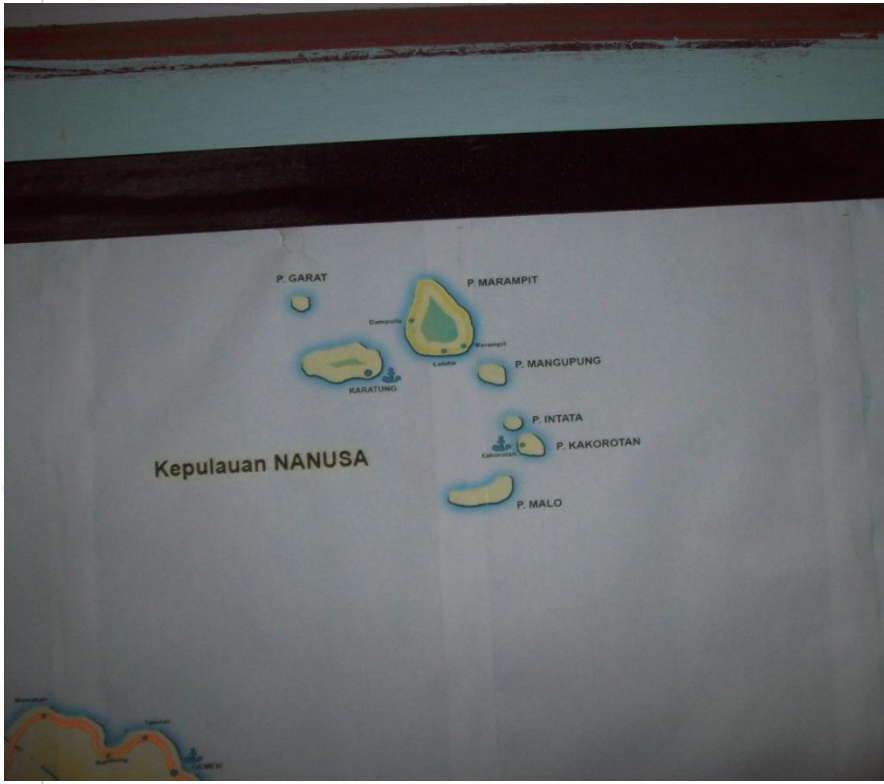
Keterangan :

Sistem Proyeksi	: U T M
Sistem Grid	: Geografi dan UTM
Datum	: WGS 84
Zona UTM	: Utara 52
Tanggal Perekaman	: 28 Februari 2011
Jenis Data	: WORLDVIEW-2

INSET LOKASI

PUSAT PEMANFAATAN TEKNOLOGI DIRGANTARA
LEMBAGA PENERBANGAN DAN ANTARIKSA NASIONAL

BADAN PERENCANAAN PEMBANGUNAN DAERAH
KABUPATEN TALAUD



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LOCATION 1

LOCATION 2

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LOCATION 3

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Hybrid power system marampit

ENERGY and CLEAN WATER SUPPLY ISSUES

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journal homepage: www.elsevier.com/locate/renene

Design, economic analysis and environmental considerations of mini-grid hybrid power system with reverse osmosis desalination plant for remote areas

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Reverse osmosis
Economic analysis
Emissions
CO_2
NO_x
Remote areas
HOMER
Emergency relief

ABSTRACT

This paper discusses the design process of a mini-grid hybrid power system with reverse osmosis desalination plant for remote areas, together with an economic analysis and environmental considerations for the project life cycle. It presents a design scenario for supplying electricity and fulfilling demand for clean water in remote areas by utilising renewable energy sources and a diesel generator with a reverse osmosis desalination plant as a deferrable load. The economic issues analysed are the initial capital cost needed, the fuel consumption and annual cost, the total net present cost (NPC), the cost of electricity (COE) generated by the system per kWh and the simple payback time (SPBT) for the project. The environmental considerations discussed are the amount of gas emissions, such as CO_2 and NO_x, as well as particulate matter released into the atmosphere. Simulations based on an actual set of conditions in a remote area in the Maldives were performed using HOMER for two conditions: before and after the Tsunami of 26th December 2004. Experimental results on the prototype 5 kVA mini-grid inverter and reverse osmosis desalination plant, rated at 5.5 kWh/day, are also presented here to verify the idea of providing power and water supplies to remote areas.

1. Introduction

Providing energy for a community, in a sustainable manner, nowadays has become a more and more important issue as we face global warming and climate change realities. Power generation engineers and designers have a responsibility to improve techniques of energy conversion in order to reduce emissions of CO_2 and NO_x, which are believed to be a source of environmental degradation. Harnessing renewable energy sources which are abundantly available in nature provides an opportunity to produce energy in an environmentally friendly way.

There are many locations, especially in remote areas of developing countries, which have no access to a reliable power supply. This situation mainly is due to the geographical conditions of the areas, which make it uneconomic to build any connection to the existing power grid lines. Most of these areas rely on diesel generators for their power supply. However, this conventional generation depends on the availability of fossil fuel that usually is quite expensive. Beside that, the engines usually operate at low efficiency due to the typical loads in remote areas that vary considerably during the day and night. Therefore, with an appropriate design, combining a reliable diesel generator with a renewable energy generator can solve these economic and environmental problems to supply the energy demands for those particular areas in a sustainable way.

In addition, there are plenty of opportunities for renewable energy applications in emergency relief conditions, for example, after the tsunami disaster that happened recently, as well as any other natural disaster (such as earthquake, volcanic eruption, etc.), which usually results in isolating affected areas, especially if it happens in a remote location. Most of these areas usually suffer from the destruction of their infrastructure such as power and water supplies.

This paper presents a design process, economic analysis and environmental considerations of a mini-grid hybrid power system with reverse osmosis desalination plant for providing electricity and clean water supplies for remote areas. The design steps are presented for supplying electricity and clean water in remote areas by utilising renewable energy sources (wind and photovoltaic) and a diesel generator with a reverse osmosis desalination plant as a deferrable load. The economic analysis considers the initial capital cost needed, the fuel consumption and annual cost, the total net present cost and the cost of electricity generated by the system per kWh. Furthermore, the simple payback time (SPBT) calculation is also presented in order to show the project feasibility from an economic point of view. The environmental aspects analysed are the amount of gas emissions such as CO_2 and NO_x as well as particulate matter released into the atmosphere.

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Providing a reliable and sustainable power supply with appropriate environmental considerations to remote areas, especially in developing countries, is the main aim of this research. There have been many natural disasters in Indonesia, primarily the Aceh Tsunami on Boxing Day 2004, and followed by many others, such as the earthquake in Yogyakarta in 2006, the Padang earthquake in 2007, and earthquake in Manokwari, Papua, in early 2009. Some other disasters in other regions include: the Maldives, a country formed by a group of natural atolls located to the southwest of India, which was affected by the Asia Tsunami 2004, the China earthquake in 2008 and the cyclone in Burma in the same year. Such catastrophes usually result in the affected areas being isolated, particularly if the events happen in remote locations. Most of these areas usually suffer from destruction of their vital infrastructure, such as power and water supplies. These occurrences demonstrate the need for an appropriate and environmentally-friendly solution to the lack of power and water supplies in remote areas as part of disaster response and reconstruction.

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Ahmad Agus Setiawan was born in Indonesia on August 1975. He obtained a BSc in Electrical Engineering from Gadjah Mada University in 1999, an MSc in Sustainable Energy Engineering from The Royal Institute of Technology (KTH), Sweden, in 2002, and continued to pursue his doctoral study at Curtin University of Technology, Australia in 2009.

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Ahmad Agus Setiawan

RE Applications for SD

Ahmad Agus Setiawan

Renewable Energy Applications for Sustainable Development

Development of a Modular AC Coupling Minigrid Hybrid System for Sustainable Power Supply in Remote Areas and Disaster Response and Reconstruction

VDM Verlag Dr. Müller

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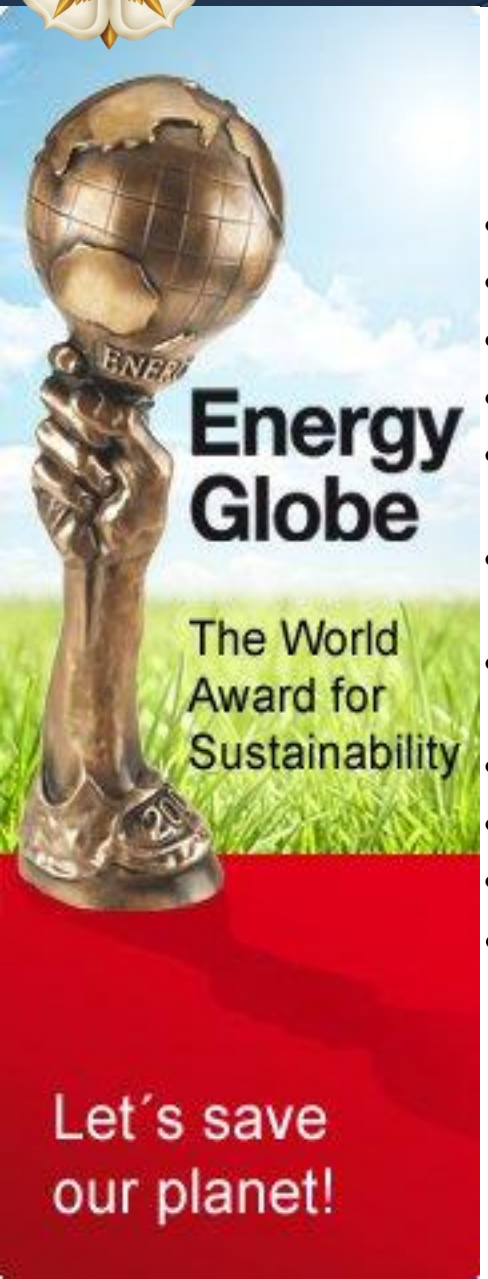

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- Habibie Award 2014 in Engineering
- Energy Globe Ambassador 2013
- UGM Award 2013 for Supervisor of Student Community Services
- Finalist World Energy Globe Award 2012
- Australian Alumni Awards 2011 for Sustainable Economic & Social Development
- PII ENGINEERING AWARD 2010 - ADHICIPTA PRATAMA, The Institution of Engineers Indonesia
- UGM Award 2009 and 2010 for Research-based Community Services
- UGM Education for Sustainable Development 2010, 2011, 2012
- Mondialogo Engineering Award, Daimler and UNESCO, 2007
- Member of Indonesian Renewable Energy Society (IRES)
- **Education**
  - PhD in Renewable Energy Systems, Dept. of Electrical Engineering, Curtin University, Australia, 2009
  - MSc in Sustainable Energy Engineering, Dept. of Energy Technology, KTH, Sweden, 2002
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Discussion ???

Thank You

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