



PV-WIND-DIESEL HYBRID SYSTEM Stand-Alone Electricity Supply in NTT

in cooperation with the
Indonesian Government

Presented by

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Overview

- **Background**
- **Video**
- **Implementation / Operation**
- **Socio-Economic Integration**
- **Lessons Learnt**





Objectives



- In remote areas, examine the feasibility of small-scale rural electrification using renewable energies focusing on
 - * Reliable / Appropriate Technologies
 - * Financial Viability
 - * Cooperation with Indonesian Partners
 - * Common View of Environmental, Socio-economic, Management Concerns
- Perform a project under the Activity Implemented Jointly (AIJ) - Pilot Phase and national Acknowledgement



Framework



Project Partners

- Indonesian State Ministry of Environment (endorsed *LoI*)
- Directorate General of Electricity and Energy Utilization (signed *MoU*)
- The E7 Initiative (ratified *PA*)

Project Tasks (e7 member companies)

Project Management Unit (PMU)	RWE
Socioeconomic Integration (SEI)	EDF / HQ
Solar Home Systems(200 SHS)	KANSAI
Micro Hydropower (4 MHP)	TEPCO
Hybrid Wind/PV (1 HS)	ENEL
Financial Sustainability Analysis (FSA)	EI (AEP)
Activities Implemented Jointly (AIJ)	OPG
Monitoring and Evaluation (LLR)	RWE



Project Chronology



- During 1996** Feasibility Study
Project Design and Concept
Project Approval (LOI, MOU, PA)
- During 1997** Establish Project Office in NTT (EPO)
Statistical Household Income Survey
Reconstruction of SHS in NTT
Assessment Candidate Sites
- During 1998** Final Site Selection
Environmental Assessments
Socioeconomic Assessments
Manifold Technical Studies
Tendering of Procurement
- During 1999** Construction of Facilities
7 PLDs Established
Financing Schemes Established
- During 2000** Commissioning and Handing Over
Follow-up Commercial Operation
Conclusion of E7-1 Project (Lessons Learnt)
- 2001-2003** Active Monitoring of Project Performance

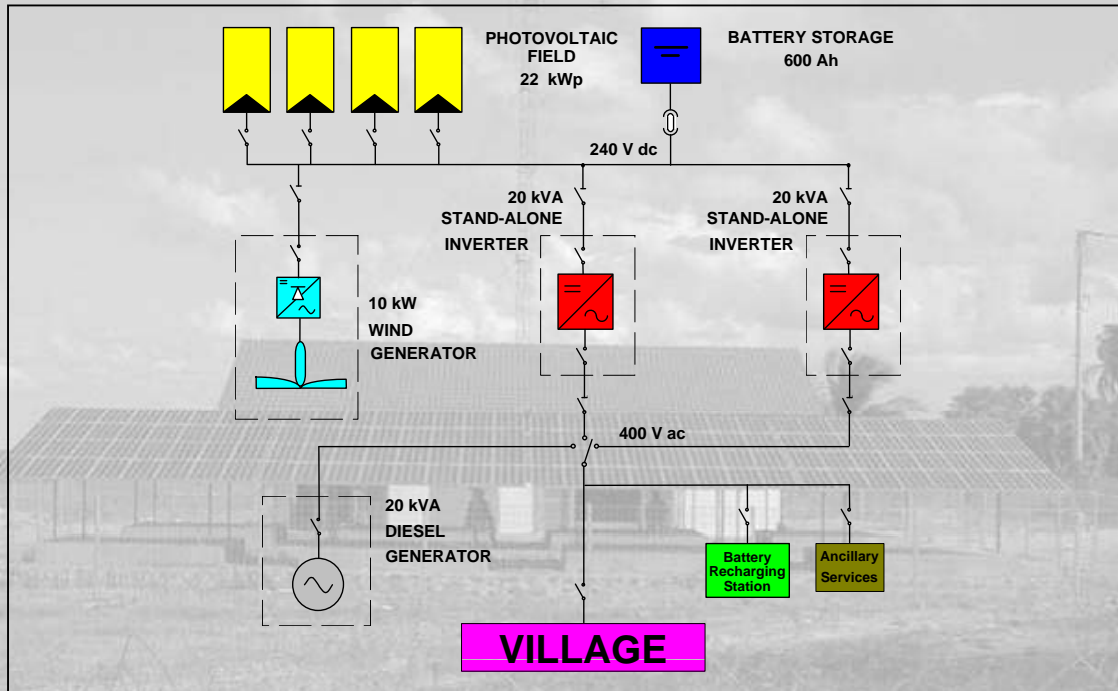


Video





Single Line Diagram



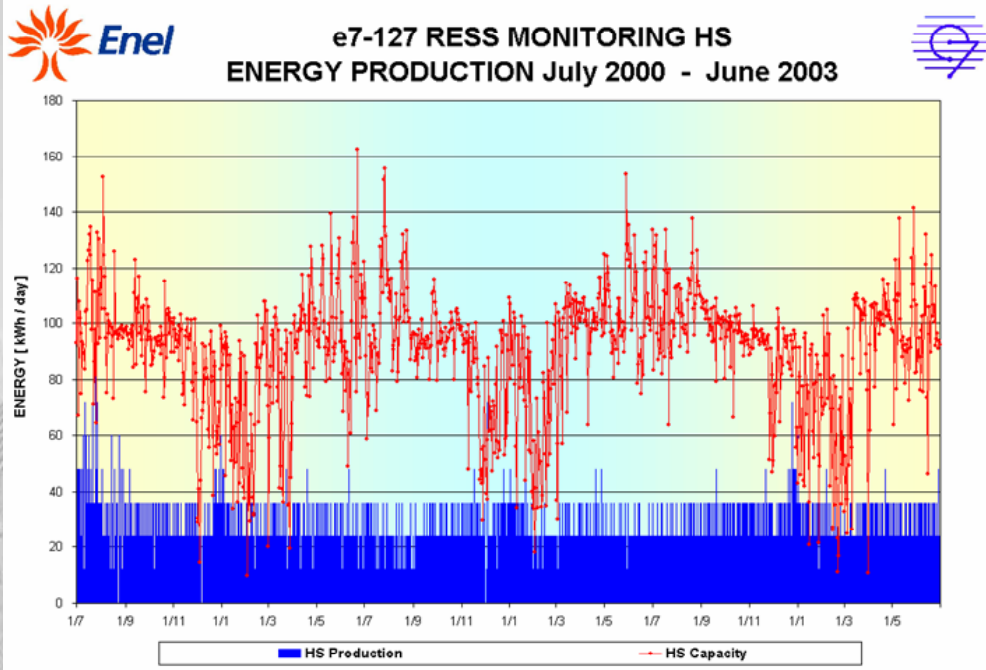
Technical System Data



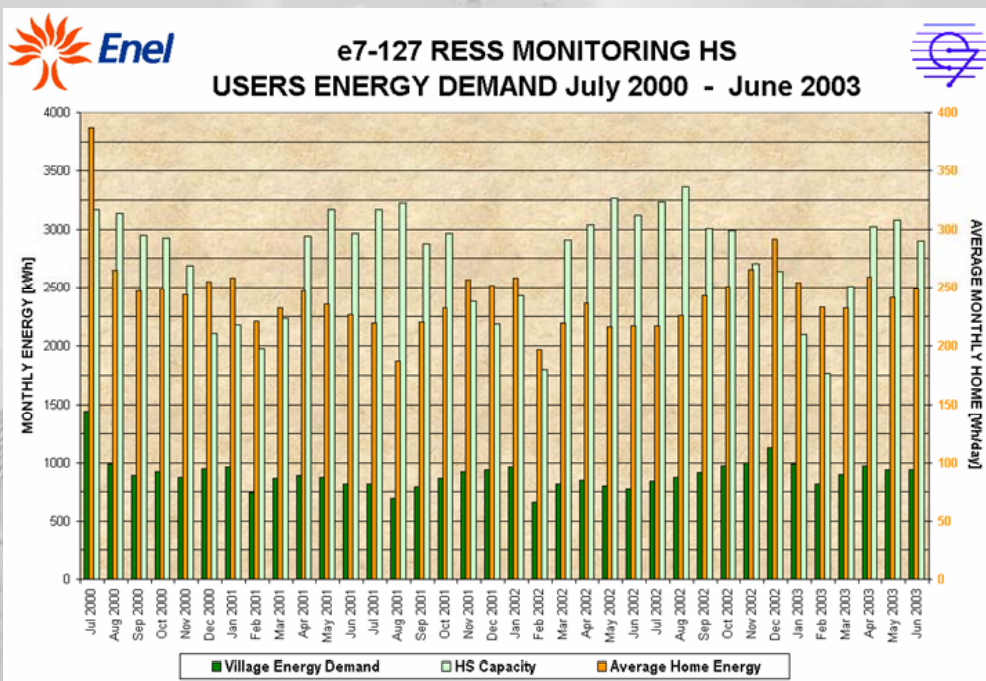
Photovoltaic generator	Nominal power of modules	86 Wp
	Total nominal power	22 kWp
Wind generator	Nominal power AC side	10 kW @ 12 m/s / 18m high
	Nominal voltage AC / DC side	220/380 Vac – 50 Hz 3-phase / 240 Vdc
Diesel generator	Nominal AC power	22 kVA @ $\cos\phi = 0.8$
	Nominal AC voltage	220/380 V - 50 Hz 3-phase
	Engine	4-stroke, natural induction, 2732 cm ³
Battery storage	Elements / Voltage	120 elements / 240 Vdc
	Nominal capacity (each element)	600 Ah – 2 Vdc
Inverter	Nominal AC power	20 kVA (70 kVA for 5 sec.)
	Nominal AC voltage	220/380 V – 50 Hz 3-phase
	Electronics	Static converter by IGBTs
Battery Charging Station	Nominal input AC voltage / units	220 V – 50 Hz / 3 units
	Nominal DC output (each unit)	12 V – 5 A
LV Distribution Network	Length of main distribution	3975 m – No. 82 poles
	Number of households	127
	Length of house connections	3917 m



System Operation



System Operation





System Operation Overview



	Energy from Photovoltaic [kWh]	Energy from Wind [kWh]	Energy for HS Services [kWh]	Energy delivered to the Village [kWh]	Energy losses [kWh]		Utilisation Ratio [%]
1st Year	15587	5185	462	11208	9102	43.8%	34.6%
2nd Year	14576	4818	438	9900	9056	46.7%	29.7%
3rd Year	15988	4328	252	11268	8796	43.3%	33.8%
Total	46151	14332	1152	32376	26955	44.6%	32.7%

Note - Energy losses: ~25% inverter (low load), ~13% battery (gas and efficiency), ~3% grid, ~2-5% stolen
 Utilisation Ratio: ratio between HS delivery and theoretical capacity



Scheme Management



PLD Management (Village Electrification Unit)

- * Indigenous Management Unit (PLD)
- * Local Cash Management
- * Documented Scheme Performance
- * Service / Lease Contracts





Scheme Tariffs

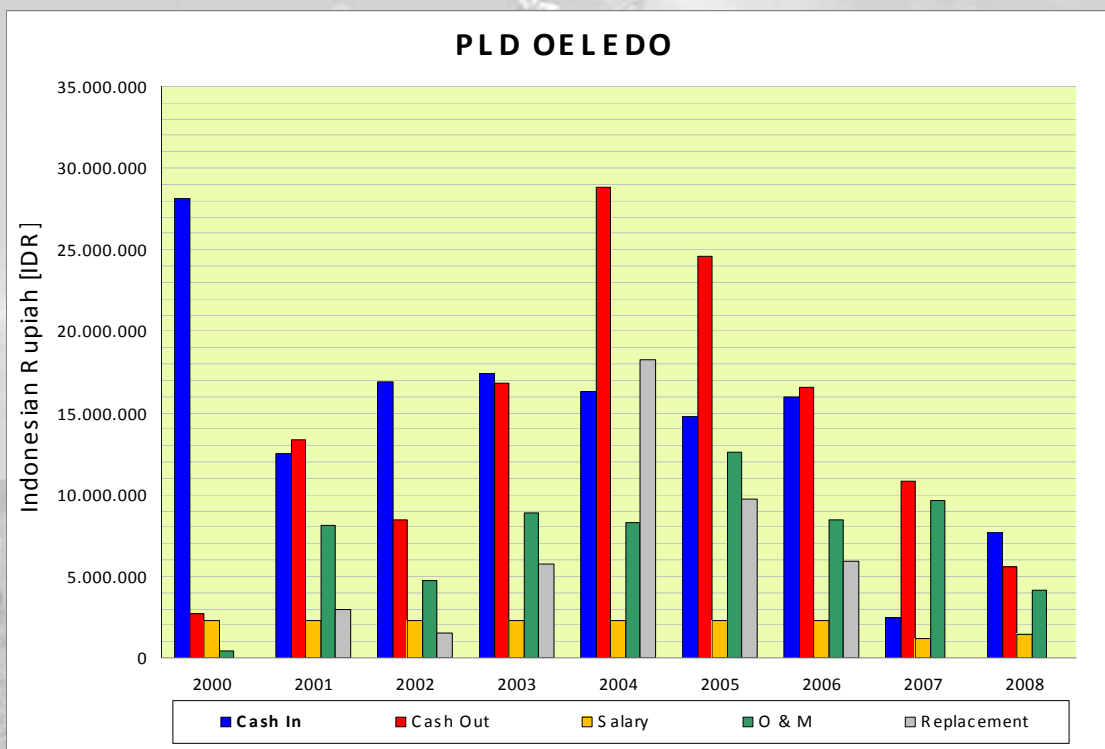


	Down Payment (Irp.)	Fees (Irp.) Capacity (A) / Energy (kWh)	Perform *1
SHS	175,000;	36,000/month	80-86%
HS	175,000; (3,000,000) *3	5 - 15,000 / 800 (10 - 20,000 / 1,500) *3	83%
MHP 1	175,000;	5 - 15,000 / 800	73%
MHP 2	175,000;	5 - 15,000 / 600	23%
MHP 3	175,000;	5 - 15,000 / 400	36%
MHP 4	400.-/kWh		- - *2

1US\$=9,000 Irp.; *1: 120 hh-400 Wh/day/hh; *2: reconnected 07-03; *3: New Tariffs for 2009 (53 new costumers)

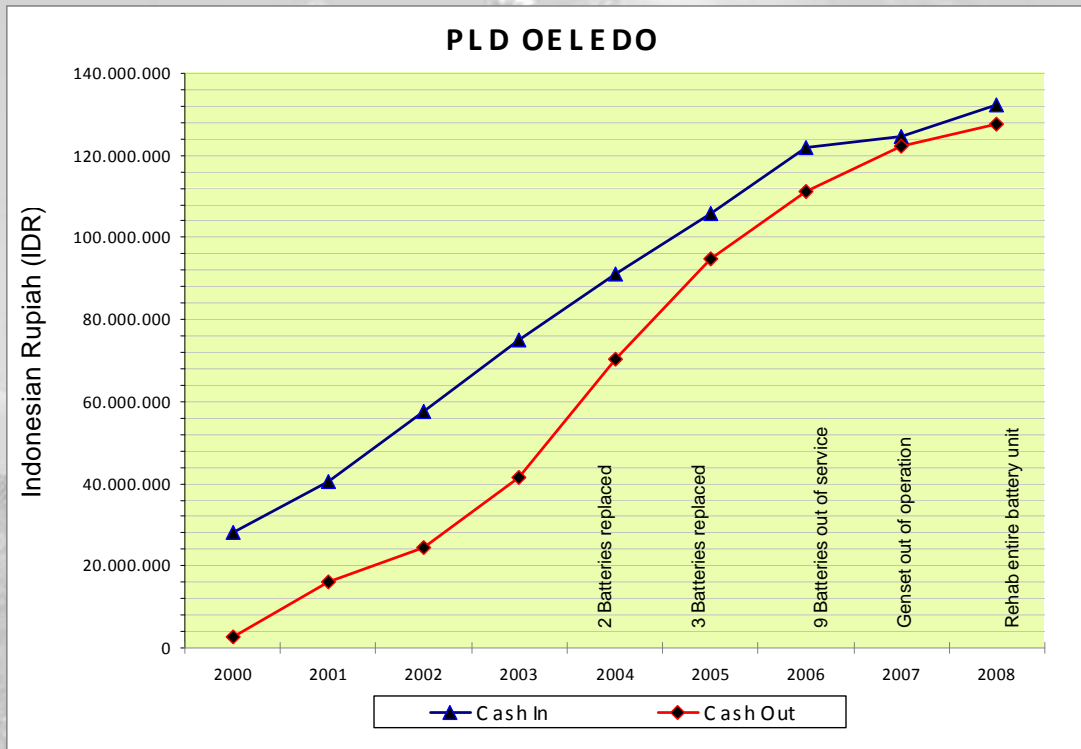


Cash Flow Details





Cash Flow Accumulated



Increase in Productivity



JICA sponsored
**Women
Empowerment
Program**
2002-2003





Income Development



Income Situation before Electrification

- Small Business: * 1 kiosk, 1 fridge, 1 sewing machine
 * small cattle breeding, liquid sugar production (1 L-2,000 Irp.)

Income per Capita 1999: 62,000 IDR/month

Income Situation after Electrification

- Small Business: * 10 kiosks, 6 fridges, 6 sewing machines, 1 Wartel, 2 carpenters
 * s.c.b.: hard sugar production (1kg-3L-20,000 Irp.)
 80 fishermen, sticky pumpkin rice (dodol), ice cubes,
 flavored ice, coconut oil, power rental

Income per Capita 2003: 380,000 IDR/month

Income per Capita 2007: 620,000 IDR/month



Scheme Status



Technical

- + System in operation since 8 years
- + Routine replacements
- + Good/competent M&O&M
- Particular replacements

Financial

- + Good transparency in cash management
- + High/competent fee collection enforcement
- Cash flow problems in year 7

Management

- + Competent PLD (org.+ planning)
- + 100% PLD-User Service contracts signed
- Low supervision by local Government
- 3rd PLD generation in 2008

Socioeconomic

- + High user participation (PLD meetings)
- + Increase in productivity (Small business)
- + High user awareness for PLD scheme benefits





Scheme Experience



KEY ASPECTS for SUCCESS

- Strong involvement of villagers since the beginning
- Clear understanding of project aim and scheme
- Simple design, clear specifications, strict control of construction and severe commissioning
- PLD management by local people
- Training, scheduled maintenance, availability of spare parts and secured revenues for M&O&M
- Local, proactive levels of control on PLD actions
- Economic Potential prior to Electricity Services



Emission Reduction HS



	Unit	E7 Project AIJ URF	E7 Project Experience	CDM simple mod. (2003)	Comments
Baseline	kg CO2/y / hh	522	522	522	
Crediting period	Years	20	14 (10)	2 x 7	Lifetime system
Households	No.	100	127	127	Expanding
ER / Lt	t/CO2	993	338	585	Actual capacity 60%
Revenues for ER / y	US\$/y	209	90	167	Basis : 4 US\$/tCO2 (PCF)



Emission Reduction Project



Project Scenario	Emissions Avoided (in t CO2)	Comments
AIJ concept Original	33,000	Life : 30y MHP, 20 y HS, 15 y SHS
AIJ concept 14y	15,000	Life reduction to 14 y for all
Experience presently	3,321	Due to: low consumption, feed-in + techn. Problems
CDM modalities Draft	4,735	Low values of CDM modalities
Medium term estimate	10,000	Feed-in+techn.problems solved



Recommendation CDM



Small-scale projects (type I, renewables) with emission reductions below 60,000 t CO2 during a crediting period of 10-14 years are not attractive to be developed as CDM projects



Sustainability



Criteria	Indicators	Bokin	Palesan	Taba	Waikelo	Oeledo	Lengko.	Oelnain.
		(MHP)	(MHP)	(MHP)	(MHP)	(HS)	(SHS)	(SHS)
Technical Reliability	System Availability	low	medium	high	low	high	medium	medium
Economic Justification	Cash Flow Scheme	low probability	low probability	high probability	low probability	low probability	low probability	low probability
Manageability	PLD Performance	low	medium	High	low	high	medium	high
Replication	Acceptance - Stakeholder Performance	low	medium	high	Low	high	high	high
Outlook	Continuity	high risk	high risk	viable	high risk	viable	viable	viable

- 1) Power Purchase Conditions (interface to PLN) – financially not feasible
- 2) All inclusive RE Energy Price not competitive with subsidized Conv. Energy Price
- 3) Sustainability possible only if these 4 Criteria can be achieved



Acknowledgement



Thank You

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