Frameworks for Sustainable Energy Projects in Developing Countries – Lessons from Indonesian Case Studies

- Background about Indonesia & Renewable Energy in Indonesia
- Renewable Energy acculturation model: The acculturation of the PV-Wind-Diesel hybrid system in the village of Oeledo
- The I3A framework: A diagnostic tool to assess energy service / arrangement sustainability and a design tool to design a sustainable energy service arrangement

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Guest Lecture, Sustainable Energy in Developing Countries, UNSW Sydney 27 August 2012

Map of Indonesia (CIA 2012)

https://www.cia.gov/library/publications/the-world-factbook/maps/maptemplate_id.html

Dr. Maria Retnanestri

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In her PhD research, Dr Retnanestri developed the I3A (Implementation, Accessibility, Availability and Acceptability) Framework to investigate overall sustainability of renewable energy projects, considering their institutional, financial, technological, social and ecological sustainability dimensions. From 2008 to 2011, she then further developed and applied this research to identify ways to overcome barriers to renewable energy for sustainable development in Indonesia with financial support from an Australian Development Research Award. With that financial support, she conducted more than 20 workshops, seminars, public lectures, field visits and study tours in Indonesia involving various kinds of renewable energy stakeholders in knowledge sharing and capacity building activities.

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Selected indicators 2010 (WB 2012, IEA 2012, BP 2011)

Country	Pop (Millions)	GDP (US$, B)	GDP/capita (US$)	Elc Cons kWh/cap	Elc Ratio (%)	Pop w/o elc (Millions)	CO2 (MT)	CO2 T/capita
Australia	**22**	**1,235**	**50,748**	**11,113**	**100**	**-**	**399**	**18.57**
China	1,338	5,926	4,428	2,631	99.4	8	7,000	5.31
India	1,170	1,727	1,410	571	75	290	1,743	1.46
Indonesia	**237**	**706**	**2,945**	**630**	**64.5**	**82**	**406**	**1.73**

RE electricity generation, installed capacity 2010 (BP 2011)

Country	Geothermal	Solar PV	Wind
Australia	**1.1 MW**	**504 MW**	**2.1 GW**
China	24 MW	893 MW	44.8 GW
India		189 MW	13 GW
Indonesia	**1.2 GW**	**25 MW**	**3 MW**
Total Asia Pacific	**4.5 GW**	**7.4 GW**	**63 GW**
World	**11 GW**	**40 GW**	**200 GW**

Brief overview of the Indonesian electricity system – 2010

***Java-Bali system**: 60% population; 70% electricity demand; 73% electrification ratio; 815 kWh/capita; 10 million households un-served*

***Outside Java-Bali system**: 40% population; 30% electricity demand; 57% electrification ratio; 375 kWh/capita; 9.8 million households un-served*

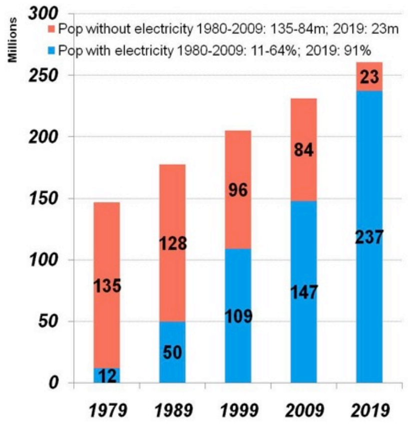
RE capacity installed 2009 & planned for 2025

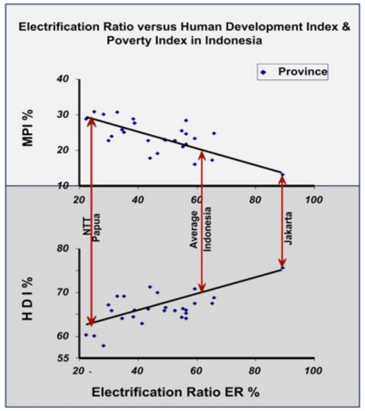
(ESDM 2006, 2009, 2010)

RE Potential	Technical Potential	Installed 2009	Planned 2025
Geothermal	28 GWe	1.2 GWe[1]	16 GWe[1]
Biomass	50 GWe	500 MWe[3]	870 MWe[4]
Biofuel	650 million ℓ	1 million ℓ	30 million ℓ
Biogas Digester	Data NA	2012: 8,000 units	
Large Hydro	76 GWe	5.7 GWe[2]	11 GWe[2]
Mini & Micro Hydro		218 MWe[4]	1.4 GWe[3]
PV	4.8 kWh/m²/d, 1.2 GWp	25 MWe[5]	580 MWe[5]
Wind	3-6 m/s, 9 GWe	3 MWe	240 MWe
Ocean	240 GWe		

RE techno park, Baron beach, Jogjakarta, 2010

Indonesian electrification ratio, HDI & MPI





***HDI:** Life expectancy, educational attainment, living standard*
***MPI:** Poor health, education & living standard*

Un-electrified in 2009: 84 millions. Lower electrification ratio correlates to high MPI & low HDI
Electricity development plan for up to 2019:

- State Utility PLN: Additional 55 GW by 2019 (Coal 65%, Geothermal 10%, Gas 8%, Cogeneration 6%, Hydro 6%, RE 5%, Diesel 1%). Small scale NRE: 3GW (Micro Hydro 51%, PV 20%, Biomass 13%, Gasified coal 8%, Wind 5%, Biofuel 3%, Ocean 1%)
- Off-grid RE: *Desa Mandiri Energi* (Energy Self-Sufficient Village) using MH, Biomass, Biogas, PV, Wind; 2014 Target – 2000 villages in 33 provinces

Renewable Energy system integration in Indonesia

- Grid-connected: Non-intermittent energy resources ie geothermal, hydro and biomass generation; PV with battery storage
- Isolated, off-grid & stand-alone applications: Intermittent energy resources requiring battery storage: Centralized PV, Hybrid PV-Wind, SHS, Wind power, Pico Hydro
- Transportation: Biofuel – *mostly exported to Europe, further uptake require more infrastructure*
- Cooking: Biogas & Biomass stoves – *acculturation effort required*

Geothermal PP, PLN 2011, RUPTL 2011-2020, page 49

6MW Biomass PP in Bekasi, West Java
http://santosorising.blogspot.com.au/2012/02/plt-biomass-bekasi-baru-sumbang-6-mw-ke.html

The 600 kWp PV Hybrid system installation (with battery storage) in Morotai Island, North Maluku, Indonesia as part of PLN's* 1000 Islands Electrification Program.

*As an established utility, PLN is in a strong position to provide institutional certainty for long-term operation & facilitating RE acculturation

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The KPDAC Continuum – RE Acculturation Model

(Knowledge-Persuasion-Decision-Adoption-Confirmation)

The Acculturation of the PV-Wind-Diesel Hybrid System in the Village of Oeledo, NTT Province, Eastern Indonesia

For detailed discussion on conceptual background, see:

Retnanestri, M., 2007, The I3A Framework – Enhancing the Sustainability of Off-grid Photovoltaic Energy Service Delivery in Indonesia, PhD Thesis, Submitted to UNSW, http://primoa.library.unsw.edu.au/primo_library/libweb/tiles/lrs/unsworks/datastream.jsp?pid=UNSWorks1598

E7, 2001, Project E7-1: Indonesia Renewable Energy Supply Systems, Final Report, Lessons Learned

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Micro Hydro development in Indonesia

As per January 2012 (PLN 2012)

	PLN	IPP	kW
In operation	103	17	155,105
Under Construction	11	35	137,708
PPA, permit, proposal, FS	83	192	677,368
Total	**197**	**160**	**970,182**

A cross-flow MH turbine produced by Heksa Hydro in Bandung (2009

100 kW Micro Hydro installation of Gambung Tea Estate, Mekar Sari Village, Bandung, West Java, 2009

Oeledo Village, Rote Island, NTT Province – Overview 1

- Location: A remote coastal village located on Rote Island, at 11S and 123E, the southernmost Indonesian island bordering Australian waters
- Travel to Oeledo from Jakarta: By air to Kupang (NTT's capital city), Ferry from Kupang to Pantai Baru harbor on Rote, then 2 hour drive to Oeledo

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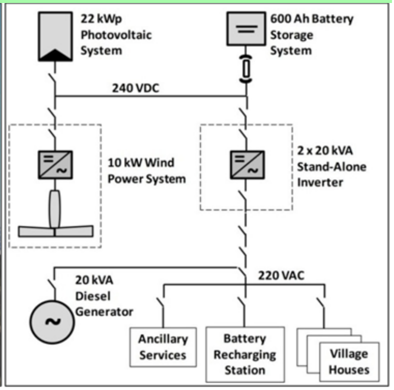
Oeledo Village, Rote Island, NTT Province – Overview 2

- Climate & environment: 8 months dry season, annual rainfall < 1000 mm per year; Wind speed 3-6 m/s; Solar irradiation 5-7 kWh/m2/d
  http://www.gaisma.com/en/location/kupang.html
- Economy: Fishing, agriculture relying on upland rice farming and *Lontar* (Palmyra) palm trees (all parts of Palmyra tree are used for drink, food, medicine, handicraft and building construction); Income per-capita at project start IDR 62K/month
- Social: Isolated community at project start, skeptical that sunlight and wind could be converted into electricity

The Oeledo PWD system deployment timeline & updates

- 1996-1997: Feasibility study, project approval, project familiarization
- 1998-1999: Project construction, establishment of PLD (*Pengelola Listrik Desa*, Village electricity utility), managerial and technical training for PLD officials, establishment of village cooperatives to improve local economy through fishing and handicraft improvement training and product marketing beyond Oeledo
- 2000: Commissioning, handing over & project conclusion
- 2001-2003: Project performance monitoring
  - Per capita income improvement: IDR62K (US$7) per month in 1999 to IDR 380K ($40) in 2003. Business development: 1999 – 1 kiosk, 1 fridge, 1 sewing machine; 2003: 10 kiosks, 6 fridges, 6 sewing machines, 1 telephone café, 2 carpenters, 80 fishermen, ice cubes, pumpkin sweets, electric generator rental (battery charging)
- 2004: ASEAN Energy Awards (Manila)
- 2005: Visitors from 30 countries learned about the PWD system deployment
- 2007: Income per capita improved further to IDR 620K ($65), further expansion hampered by high cost of connection and repair cost for imported equipment (electronic controller)
- 2008: Replacement of batteries
- 2010: PLD still functioning, PWD system integrated into Oeledo's community life, PLD viewed as a model by local authorities for rural/off-grid electrification, external funding required for capital investment and build local expertise for O&M

Oeledo PV-Wind-Diesel (PWD) Hybrid System Overview



- An AIJ project between G7 and GOI deployed as a model CDM project: Technology transfer, capacity building & sustainable development, facilitated by E7 & Womintra
- Project cost: US$ 1.8 million for capital investment; Users to pay for use & O&M fees
- Nominal capacity 50kW; Subscribers 127 households (600 people) with 0.5-2 Amp load limits; Electricity tariff IDR800 (US¢9) per kWh

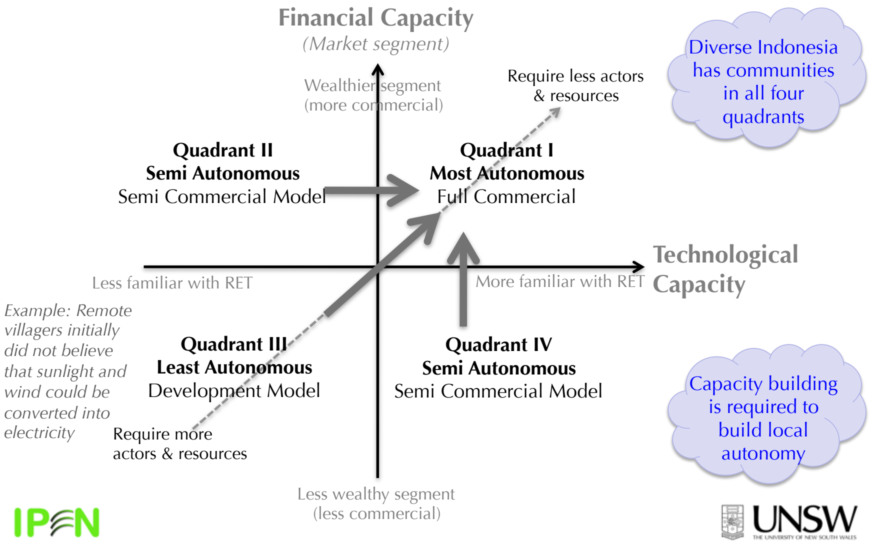
Building local economy within the Oeledo context: Building financial capacity from pre-existing economy & culture

Photos courtesy of Claus Dauselt 2009

- Women empowerment program: improving skills & quality control for handicrafts, the production, packaging & marketing of sweets made from pumpkins & other businesses
- Provision of fishing equipment (boat, nets, fish preservation & marketing)
- Establishment of village cooperatives (saving & loan services, product marketing)

Framework for Financial-Technological Capacity Building

Market mapping & strategies to build local capacities



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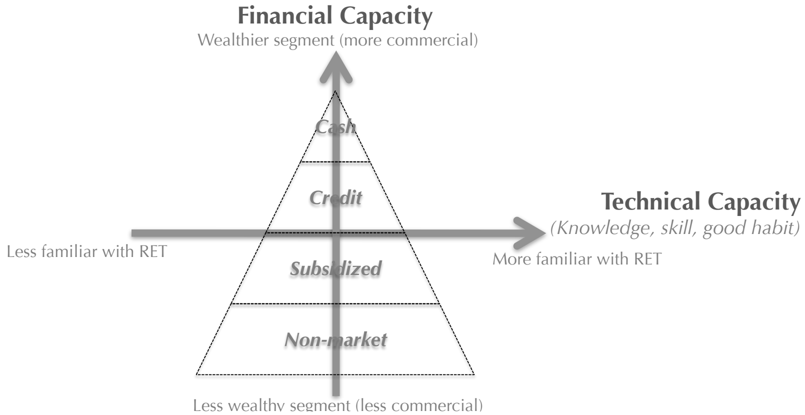
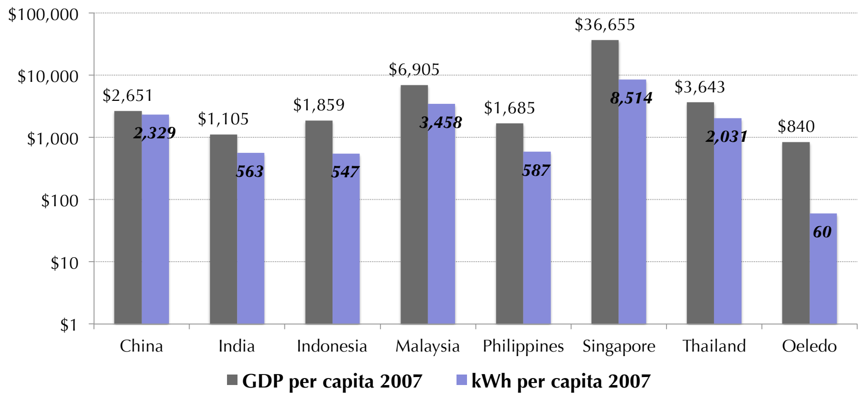
Framework for Financial-Technological Capacity Building – Cont'd



- **Building financial capacity (y-axis):** Assist local communities to move from subsistence level (development based) to the more commercial (market based) level in the market pyramid; Use RET as a tool for rural socioeconomic development (use energy for productive and social activities)
- **Building technical capacity (x-axis):** Use the KPDAC continuum model to integrate RET into pre-existing local culture (Knowledge, Persuasion, Decision, Adoption, Confirmation)

Per capita GDP & electricity consumption 2007

Selected Asian countries (WB 2011) & Oeledo (Dauselt 2009)



GDP & kWh per capita of Oeledo remain low compared to the Indonesian average, however Oeledo's per capita income increased tenfold from the installation of the PWD system in 1999 to 2007.
(Australia 2010, GDP per capita $50,748; kWh/per capita 11,113)

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Renewable Energy Technology (RET) transfer:

Holistic view of technology, RET as cultural capital & KPDAC continuum

- **Holistic view of technology**
  Interpretation of technology as a compound of **hardware** (equipment), **software** (skill, knowledge) and **orgware** (institution, rules), based on Dobrov (1979, "The Strategy of Organized Technology in the Light of Hard-, Soft, and Org-ware Interaction", *Long Range Planning*, Vol 12 August 1979 pp 79-90)
- **RET as cultural capital**
  Parallel interpretation of technology as **objectified, embodied & institutionalized** cultural capital, necessary to understand requirements for technology transfer for RET to be integrated into a pre-existing local culture. Cultural capital concept was introduced by Bourdieu (1986 "The Forms of Capital", in Richardson J, *Handbook of Theory and Research for Sociology Education,* Westpoint CT: Greenwood pp 241-258)
- **RET acculturation process** expressed using the **KPDAC continuum**
  To explain the acculturation stages and the process of deploying the RET hardware, software and orgware into the community, highlighting the roles of all stakeholders involved in the process (noting that RET stakeholders act as agents of RET acculturation). The KPDAC continuum was constructed from the work of Rogers (2003, *Diffusion of Innovations*, Fifth edition, Free Press, New York, ISBN 0-7432-2209-1)

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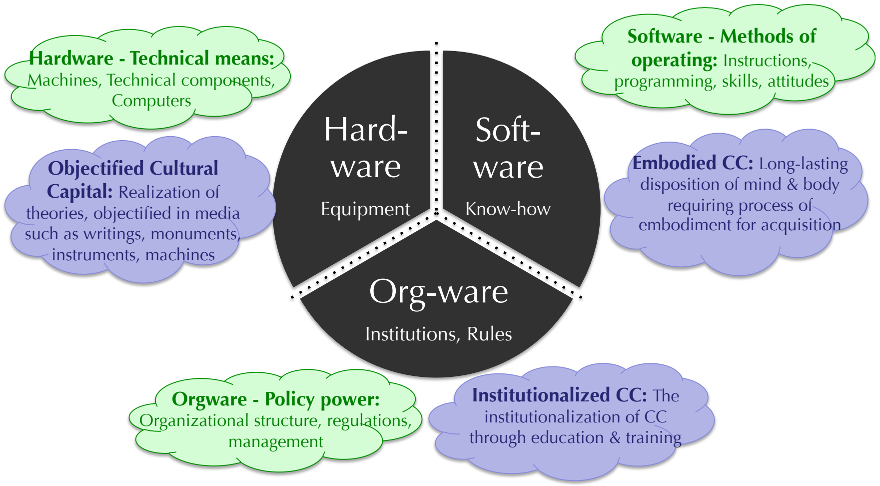
Holistic View of Technology: **Hardware, Software & Orgware**



Technology as Cultural Capital: **Objectified, Embodied & Institutionalized**

The KPDAC Continuum & Acculturation process for RET

RET Acculturation: The extent to which RET diffuses into and is assimilated by a community

RET innovation-decision process: Potential adopters progress from gaining *knowledge* of RET, to *forming an attitude* toward RET, to a *decision* to adopt or reject RET and, if to adopt, to confirm or repudiate the *adoption* decision (adapted from Rogers 2003)

Prior Condition	1 Knowledge	2 Persuasion	3 Decision	4 Adoption	5 Confirmation
Unaware of RET existence	Aware of RET existence	Form un/favourable attitudes to RET	Decision to adopt or reject RET	Adopt RET; Re-invention may occur	Confirmation of RET adoption
Q0. *Is the current practice the best option?*	***Q1.*** *What is RET? How does it work? Why does it work?*	***Q2.*** *What are the dis/advantages in my situation?*	***Q3.*** *What are the consequences of my decision?*	***Q4.*** *Where can I obtain RET? How can RET best fit my situation?*	***Q5.*** *Dis/Continue RET adoption.*
Roles of Facilitators in each stage of the RET Acculturation process					
Diagnose problems, shed light on alternative ways to address problems	*Establish information-exchange relationship; Knowledge awareness; Promotion; Education: Provide sufficient and accessible information*			*Implementation, Financial & technical assistance, User education*	*Stabilize adoption, discourage discontinuation.*
	RET Acculturation Process →				***RET is acculturated if users continue to confirm its benefits***

Hardware, software & orgware must continue to function for RET to become community cultural capital

RET as Cultural Capital & Technology Transfer – Oeledo Context

HSO-wares	Cultural Capital	Oeledo *RET CC context*	Tech Transfer *Transmission of CC*
Hardware *Equipment*	**Objectified CC** *Cultural goods/objects such as books, paintings, instruments, machines*	The PWD system, distribution network, electrical appliances	Hardware is transferred in its materiality (eg through sale or gift)
Software *Know-how*	**Embodied CC** *Long-lasting dispositions of mind and body, possessed by individual or agent*	Information, skill, knowledge to operate & maintain the hybrid system; Technical & managerial skill to run PLD	Software is transferred through a process of embodiment (requires time & effort)
Orgware *Institution, Rules, Network*	**Institutionalized CC** *Educational qualifications; Institutionalization of embodied cultural capital*	Transmission orgware: Project organization structure, PLD, rules defined & agreed by stakeholders	Orgware facilitates transfer of hardware and software (embodiment process through education & training)

E7 Initial holder of the PWD system CC ↔ **Womintra** Facilitator of the PWD system CC transfer ↔ **Oeledo** Appropriator of the PWD system CC

The Oeledo cultural capital transmission orgware

The KPDAC context of Oeledo

Prior Condition	1 Knowledge	2 Persuasion	3 Decision	4 Adoption	5 Confirmation
Diagnose problems, shed light on alternatives	*Establish information-exchange relationship; Knowledge awareness; Promotion; Education: Provide sufficient and accessible information*				*Stabilize adoption, discourage discontinuation.*
1996-97: Survey, FS	1999-2000: Project familiarization, construction, commissioning, hand over				*2000- full PLD operation* *2001-2003: Monitoring*
Isolated community, unaware of RET existence, skeptical of RET feasibility, suspicious of foreign people & ideas, rely on conventional energy	**The heart of RET acculturation process in which RET hard-soft-orgware are rolled in into the community as cultural capital** •Field officers stayed for 2 years for the HSO-wares deployment (with high emphasis on orgware) to provide SHS demonstration, form PLD utility, provide technical & managerial training, form cooperatives to enhance local economy, assist in opening up bank account, provide handicraft & fishing improvement training •127 out of 354 families decided to subscribe, paid Down Payment & monthly fees •Communities involved in the decision-making process, implementation, Operation & Maintenance				*2000, 2002, 2004: Energy awards.* *2005: Visitors from 30 countries to learn lessons* *2010:* PLD functioning, economy improved, further expansion hampered by high capital & repair cost for imported equipment, PLD viewed as a model but external funding required

KPDAC & facilitator's tasks: Assist Oeledo villagers to progress from gaining *knowledge* of the PWD system, to *forming an attitude* toward PWD system (*is it better then previous energy practices?*), to a *decision* to adopt RET and, if to adopt, to confirm the *adoption* decision

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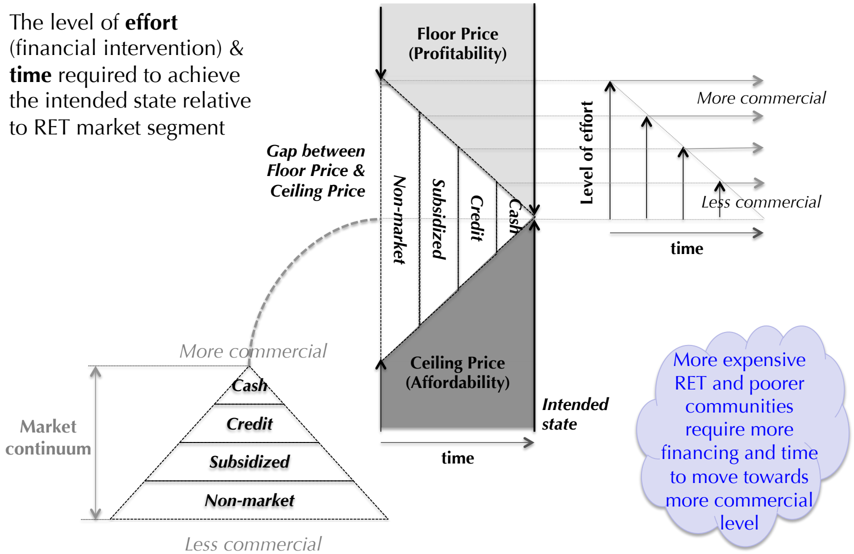
The Cultural Capital context of Oeledo

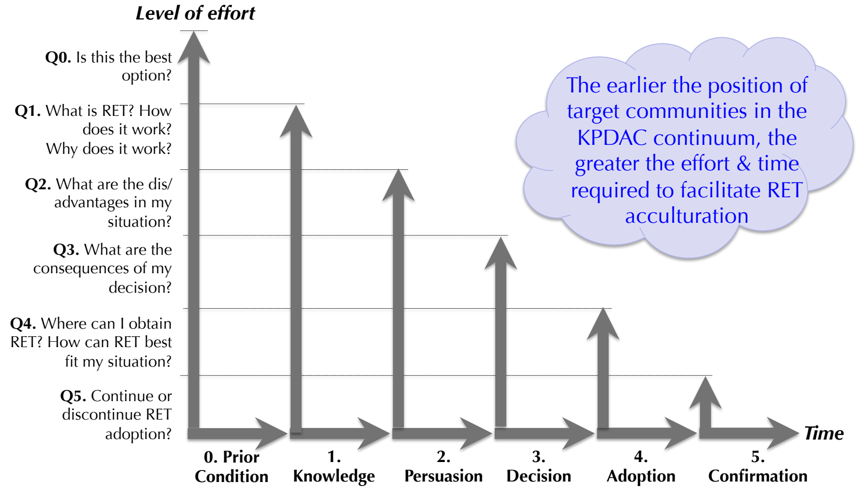
- E7: Initial holder of the PWD system CC; Oeledo villagers: Appropriator of the PWD CC
- PWD system hardware (objectified CC) can be transferred in its materiality
- PWD system software (embodied CC – information, knowledge & skill to operate & maintain the PWD system hardware as well as the managerial skill to run PLD utility) must be transferred through an embodiment process, requiring time & effort (labour of assimilation) in which the appropriator must invest personally/first hand; Taking local capability into account helped assimilate the new knowledge into local culture more easily "management tools were adapted to the micro project environment with local capability in mind" (E7 2001)
- PWD system orgware institutionalized the PWD system CC by replication – transferring PWD system software by education & training → Providers & Facilitators need to have sufficient resources & capacity for proper technology transfer

Generalization 1 – Building Financial Capacity

The level of **effort** (financial intervention) & **time** required to achieve the intended state relative to RET market segment

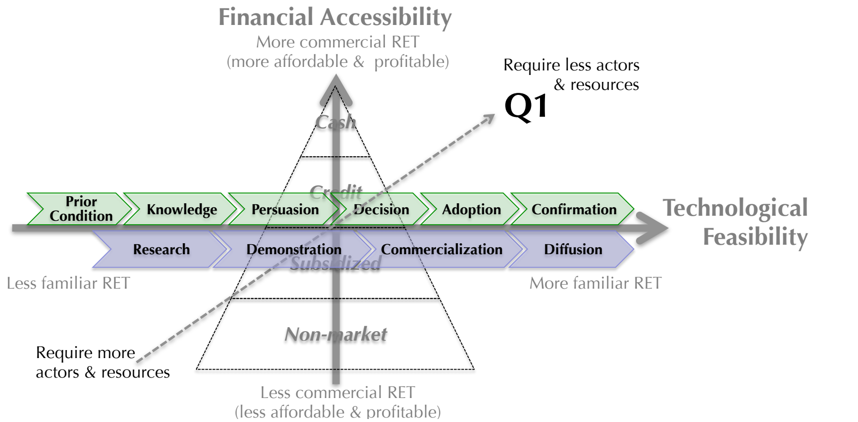


Generalization 2 – Building Technological Capacity



The level of **effort** & **time** (length of intervention) required to facilitate RET acculturation within the KPDAC continuum context

Generalization 3 – Building RET Financial & Technological Capacities



- **Financial accessibility (y-axis):** RET to be affordable & profitable (RET still faces challenges to bringing down cost)
- **Technological feasibility (x-axis):** RET to acculturate in community's life (RET still faces challenges for wider community acceptance & acculturation)
- The aim is to achieve Q1 situation: RET to be financially & technologically accessible, and
- To assess what stakeholders need to do to bring RET from Research stage to Market stage

Role of stakeholders in facilitating RET transfer

Prior Condition	1 Knowledge	2 Persuasion	3 Decision	4 Adoption	5 Confirmation
Unaware of RET existence	Aware of RET existence	Form un/ favourable	Decision to adopt or reject RET	Adopt RET; Re-invention may occur	Confirmation of RET adoption
RET stakeholders & roles					
Target Communities	***Research bodies, universities***	***Government, Donors, NGO***	***Industry, Utility, Cooperatives***	***New adopters/ Users – Individual, group***	***Confirming Users – Individual, group***
Energy Needs/ Problems	RET Research (Basic & Applied)	RET Demonstration	RET Commercializatio	RET Adoption & Diffusion	RET Outcomes
Prior experience, expectations for energy services	*Research, education, hardware, software, orgware expertise*	*Policy, funding, program, manage-ment expertise*	*Business, hardware, software expertise*	*Initial outcomes from RET adoption: actual experience*	*Long-term outcomes from RET adoption: actual experience*

Sharing of experience & knowledge among stakeholders to build capacity and design facilitating policy/strategy to achieve successful RET acculturation

The I3A framework:

A *diagnostic tool* to assess energy service / arrangement sustainability and a *design tool* to design a sustainable energy service arrangement

For detailed discussion on conceptual background, see:

Retnanestri, M., 2007, The I3A Framework – Enhancing the Sustainability of Off-grid Photovoltaic Energy Service Delivery in Indonesia, PhD Thesis, Submitted to UNSW,
http://primoa.library.unsw.edu.au/primo_library/libweb/tiles/lrs/unsworks/datastream.jsp?pid=UNSWorks1598

The KPDAC continuum, RE study tour & capacity building activities

- Australian Development Research Award (ADRA) research activities (2008-2011): Seminars, workshops, study tours & field visits
- RE study tour provided hands-on **knowledge** of RE practices ➔ Knowledge is the entry point of KPDAC acculturation ➔ Model for RE capacity building through educational institutions

What is I3A?

An **Implementation** that maintains RE service **Accessibility** (financing, skill, network, resources), **Availability** (reliability & security of supply) & **Acceptability** (social & ecological) considering the hardware, software & orgware aspects of RE service delivery during & beyond initial project life

A framework that is used as a **diagnostic tool** to assess energy service/arrangement sustainability or a **design tool** to design a sustainable energy service arrangement (scope: can be for country level or technology specific level)

What are the I3A objectives?

Sustainable Implementation: Acknowledge all Stakeholders Interests	RE Accessibility: Minimize Inequity	RE Availability: Assure Continuity	RE Acceptability Utilize & Enhance Community Resources
Process of implementing a RE project	*Benchmarks / key measures to assess whether a RE project builds & sustains RE Accessibility, Availability & Accessibility*		

Leave community with enhanced capacity and resources for social innovation

The 21 steps of the I3A model to assess energy arrangement sustainability

I3A Energy Sustainability

Implementation that maintains energy Accessibility, Availability & Acceptability in short & long runs

Implementation Orgware & Enabling Factors	Accessibility Access to Financing & Resources	Availability Service Reliability & Resource Security	Acceptability Social & Ecological Improvement
1. Orgware: Stakeholders, objectives, interrelationships 2. Enabling factors: Policy, strategy, administration, coordination, governance 3. External factors: Other programs, socioeconomic, political, global situations	4. Affordability-Profitability (A-P) levels 5. Financial intervention to bridge the A-P gap 6. Access to energy financing, market, network 7. Access to energy education 8. Access to energy resources	9. Primary resource availability 10. Technical quality: Standards, safety, warranty 11. Energy system integration 12. Domestic manufacturing 13. After-sales infrastructure 14. Local capable agent 15. User education	16. Utilization of local resources (institutions, economy, norms) 17. Attributes vs User needs 18. Socioeconomic outcomes 19. Suitability to environment 20. Energy waste handling 21. Contribution to climate change mitigation effort

➔ I3A covers the Institutional, Financial, Technological, Social and Ecological aspects of RE service delivery

Implementation: Process of implementing a RE project

Orgware & Enabling Factors	1. Orgware: RE stakeholders, objectives, roles, interrelationships 2. Enabling factors: Policy, regulations, administration, governance 3. External factors: Other programs, socio-economic/political situations

The Oeledo Orgware:

E7 RE Sponsor ⟷ *Top-down* ⟷ **Womintra** RE Facilitator ⟷ *Bottom-up* ⟷ **Oeledo** RE Users

Provider interests/goals:
Governance responsibility, business goals, social goals, credibility, emission reduction (ER) target, public image

User interests/goals:
Energy service/energy benefits, resolve problems related to their energy needs

Common interests/goals:
RE rural electrification

Enhancing the sustainability of RE service delivery in 21 steps using I3A

Implementation *Orgware & Enabling Factors*	1. Orgware: RE stakeholders, objectives, roles, interrelationships 2. Enabling factors: Policy, regulations, administration, governance 3. External factors: Other programs, socio-economic/political situations
Accessibility *Access to Financing & Resources*	4. Affordability – Profitability (A-P) levels 5. Financial intervention to bridge the Affordability – Profitability gap 6. Access to RE financing, market, network 7. Access to RE education and training for non RE specialist 8. Access to RE resources
Availability *Service Reliability & Resource Security*	9. RE primary resources availability 10. RE technical quality: Standards, Safety & Warranties for components, system, installation, appliances 11. RE system integration 12. Domestic manufacturing 13. After-sales service infrastructure 14. Local capable agent 15. User education
Acceptability *Social & Ecological Sustainability*	16. Utilization of local resources: Norms, institution, economy, local innovation 17. RE attributes & Users requirements: Advantage, complexity, compatibility, reinvention, etc 18. Socioeconomic outcomes: Millennium Development Goals (MDG), socioeconomic improvement 19. RE suitability to local physical environment 20. RE waste handling 21. RE contribution to climate change mitigation effort

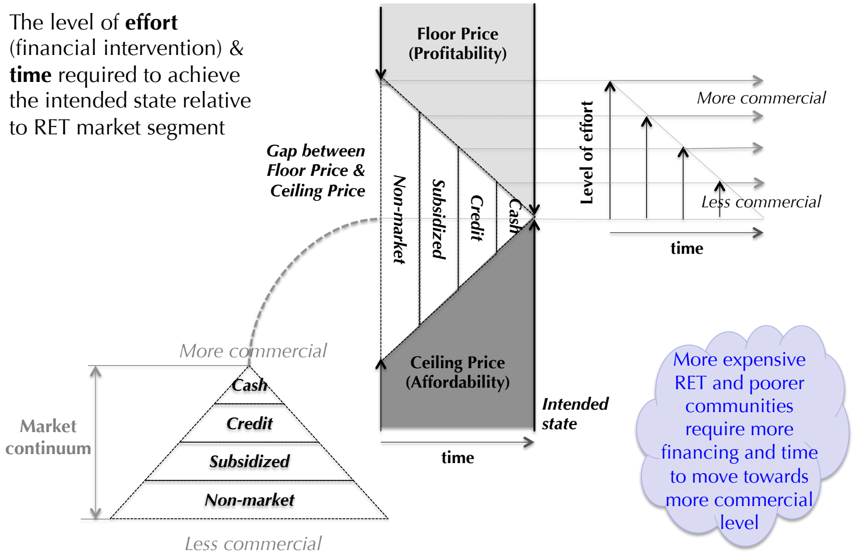
Accessibility: Minimize inequity

Access to Financing & Resources	4. Affordability – Profitability (A-P) levels 5. Financial intervention to bridge the Affordability – Profitability gap 6. Access to RE financing, market, network 7. Access to RE education and training for non RE specialist 8. Access to RE resources

Combined program of RE delivery & empowerment of pre-existing rural economy in NTT improved Users economic standing & helped Users to pay PV service & installments regularly

Generalization 1 – Building Financial Capacity

The level of **effort** (financial intervention) & **time** required to achieve the intended state relative to RET market segment

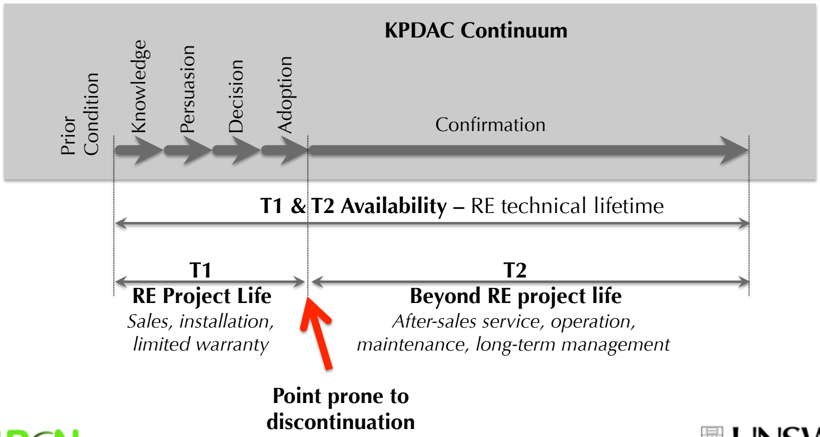


Availability: Assure continuity – Issues

Malfunctioned PV system in Eastern Indonesia and Thailand

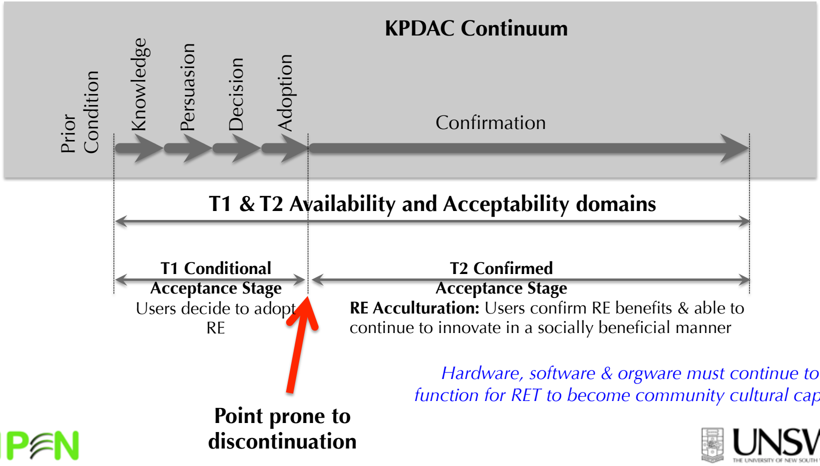
Availability: Assure continuity

Service Reliability & Resource Security	9. RE primary resources availability; 10. RE technical quality: Standards, safety, warranties for components, system, installation, appliances; 11. RE system integration; 12. Domestic manufacturing; 13. After-sales service infrastructure; 14. Local capable agent; 15. User education



Acceptability: Utilize & enhance community resources

Social & Ecological Sustainability	16. Utilization of local resources: Norms, institution, economy, local innovation; 17. RE attributes & Users requirements: Advantage, complexity, compatibility, reinvention; 18. Socioeconomic outcomes: Millennium Development Goals (MDG), socioeconomic improvement; 19. RE suitability to local physical environment; 20. RE waste handling; 21. RE contribution to climate change mitigation effort



Hardware, software & orgware must continue to function for RET to become community cultural capital

IPEN UNSW

Acceptability: Acculturated RE

A traditional 5 kW Micro Hydro installation in the Tundagan village, Central Java, built by a local farmer (Bachri 2000).
http://www.suaramerdeka.com/harian/0207/15/dar12.htm

IPEN UNSW

Acceptability: Utilize & enhance community resources - Issues

Malfunctioned micro-hydro and wind-power systems in Eastern Indonesia

IPEN UNSW

Experience with the I3A:
The I3A workshop in Kupang, NTT Province, Eastern Indonesia, 8/6/2010

- Assessment of RE progress and challenges in NTT Province
- Group of mix of different stakeholders discuss, analyze & report the discussion outcomes
- ABCG stakeholders: Academics, Business, Community and Government
- Demonstrated the use of I3A as a systematic diagnostic tool to identify RE potential and barriers
- Actively engaging diverse stakeholders, I3A can facilitate formation of consensus in identifying issues & formulating recommendations
- I3A qualitative outcomes can be complemented with quantitative enquiries

Group discussion followed up with report of discussion outcomes

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Outcomes of the NTT's I3A Workshop

Implementation: Orgware & enabling factors

1. RE stakeholders: *Form **Forum Energi Daerah** & define roles, coordination & interrelationships among RE stakeholders (ABCG Academics, Business, Community and, Government in NTT)*
2. Enabling factors: *Relevant policy & strategies for mainstreaming RE in NTT, **accessible information** for all*
3. External factors: Complimentary factors: *Existing programs and strong commitments from outside NTT to assist RE development in NTT;* Competing factors*: People in remote NTT are **not open to external ideas** for change*

Accessibility: Access to Financing & Resources

4. Affordability – Profitability level: *Poverty level in NTT is high (24% in 2010), the A-P gap is significantly high*
5. Financial intervention: *Financing from state or regional budget, community fund, incentives for RE developers*
6. Access to RE financing, market, network: *Collaborate with NGO, donor institutions*
7. Access to RE education: ***Community training centre**, provision of RE training equipments, **field laboratory**, technology transfer*
8. Access to energy resource: *Land dispute may impede RE development*

Availability: Service Reliability & Resource Security

9. Primary resource availability: *Solar resource available across NTT, wind and hydro in certain areas; resource mapping required*
10. RE Standards, Safety, Warranties: *Use of appliances complying to accepted standards; Training on Standardisation & Certification*
11. RE system integration: *Experts & training are needed*
12. Domestic manufacturing: *Maximize local content, transfer of manufacturing capacities to NTT, use of local wisdom/innovation*
13. After-sales service infrastructure: ***Empower community & cooperatives** to sell spare parts & provide after sales service*
14. Local capable agent: *Design curriculum for **RE education** from **primary school** to **university** level**, workshop** at **kabupaten** level*
15. User education*: Trained community group (through TOT) to train RE users; **life skill training** eg. RE for agriculture*

Acceptability: Social & Ecological Sustainability

16. Utilization of local resources: *Need understanding on the natural and institutional resources capacities for appropriate project design*
17. RE attributes & Users requirements*: RE equipments made more affordable, **RE beyond lighting**, more user friendly*
18. Socioeconomic outcomes: *RE to create jobs & welfare in NTT, **RE** for **agricultural development** important for NTT*
19. RE suitability to local physical environment: *Need understanding on the impacts of the environmental conditions to RE equipment*
20. RE waste handling: *Need understanding on the impacts of RE waste to the environment, AMDAL assessment needed*
21. RE & GHG mitigation effort: ()

I3A exercise:
The Tundagan & the Cinta Mekar micro-hydro case studies

Acculturated RE: A traditional 5 kW Micro Hydro installation in the Tundagan village, Central Java, built by a local farmer (Bachri 2000).

The 120 kW Cinta Mekar Village MH, West Java: **Accommodation of local requirements:** A written agreement was made to allocate at least 300 l/s to irrigate 50 hectares of fields prior to water being used for electricity generation.

Discuss/analyze the I3A aspects of the two case studies:

1) Have the projects been implemented in a way that maintains energy service accessibility, availability and acceptability considering the hardware, software & orgware aspects of RE service delivery during & beyond initial project life?
2) Have the projects left community with enhanced capacity and resources for social innovation?

Concluding Remarks

RE development in Indonesia

- RE share is set to increase in the Indonesian energy mix, however issues related to technological, institutional and socio-cultural integration need to be addressed by a holistic-interdisciplinary approach to maintain RE sustainability

The KPDAC Continuum, RE Acculturation, Lessons from Oeledo

- The KPDAC continuum can be used to explain the RE acculturation process and the role of RE stakeholders in that process, in which each stakeholder acts an RE acculturation agent
- The deployment of the PV-Wind-Diesel hybrid system provided an example of the diffusion & acculturation of investment & expertise into a remote community culture
- RE stakeholders (as acculturation agents) need sufficient resources & capacities to facilitate RE technology acculturation (integration of RE technology into communities' institution and culture) that can be generalized into RE integration at wider level
- RE study tour provided college staff students with access to hands-on knowledge of RE practices, instrumental for creating capable agent for RE acculturation. This can be viewed as a model for RE capacity building through educational institutions

Concluding Remarks – Continued

- **The I3A framework & NTT Workshop**
- The I3A Framework can be used both as an assessment tool & design tool to design a sustainable energy service arrangement. The scope can be for country level or technology specific level
- The I3A workshop undertaken in NTT was part of ADRA's capacity building activities to transfer practical know-how to wider audience. It is used as a systematic diagnostic tool to **identify** RE potential & barriers and **facilitate consensus** building among diverse stakeholders in formulating recommendation for further action
- It can be used for assessing/designing a sustainable renewable RE service by applying the following criteria:
  - Sustainable Implementation: Create facilitating environment
  - Accessibility: Facilitate access to financing, skills, network
  - Availability: Ensure availability both during & beyond project life
  - Acceptability: Facilitate RE acculturation into local life by utilization & enhancement of pre-existing resources
- The I3A process provided qualitative outcomes that can be broken down further or complemented with quantitative enquiries