



 Centre for Energy and Environmental Markets 





## Enhancing the Sustainability of Off-grid Photovoltaic Energy Service Delivery in Indonesia

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### Solar PV energy systems (PVES): an example of technology ([www.iiasa.ac.at](http://www.iiasa.ac.at))

- Technology: *the art of knowing and doing*
- Dimensions of technology:
  - Hardware: *manufactured objects capable of producing a desired purpose*
  - Software: *the knowledge required to design, manufacture & use the hardware*
  - Orgware: *the societal & institutional context in which the hardware & software are organised & implemented*
- Rural PVES technology can use simple hardware & software but can't avoid complex orgware

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## PVES - Technology viability issues

Dimension	Weaknesses & Opportunities
Institutional (orgware)	<i>Areas of weakness:</i> Institutional infrastructure; performance monitoring; local capable agents <i>Opportunities:</i> Improved technology transfer; capacity building; best practice guidelines; capacity building, education & training
Financial (orgware)	<i>Areas of weakness:</i> hardware first cost barriers; financial sustainability; income-generating activities; maintenance costs; planning for refurbishment & replacement; decentralised & scattered market <i>Opportunities:</i> avoided expenditure on T&D & fuel; business skill development; micro-finance; smart subsidies
Hardware & software	<i>Areas of weakness:</i> hardware reliability, maintainability & operating life; software skills for end-users <i>Opportunities:</i> Modularity & rapid deployment; installation & maintenance services, system warranties; user education & networking
Social (orgware)	<i>Areas of weakness:</i> centralised, technocratic approach; equity & cultural issues <i>Opportunities:</i> job creation; education & health services; energy security; social inclusion & autonomy; income generation; provision of multiple services
Environmental (orgware)	<i>Areas of weakness:</i> waste management; life-cycle assessment <i>Opportunities:</i> reduction in direct & indirect environmental impacts

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## Key Issues for PVES Projects

- Project planning & implementation timeframe:
  - Compliance with technical standards
  - Careful allocation of roles & interfaces
  - Degree of autonomy of decision-makers
  - Rural communities have multiple objectives, eg:
    - Water for irrigation; biofuels may compete with food
- Following project completion:
  - Potential for project failure
  - Monitoring, evaluation & intervention if necessary

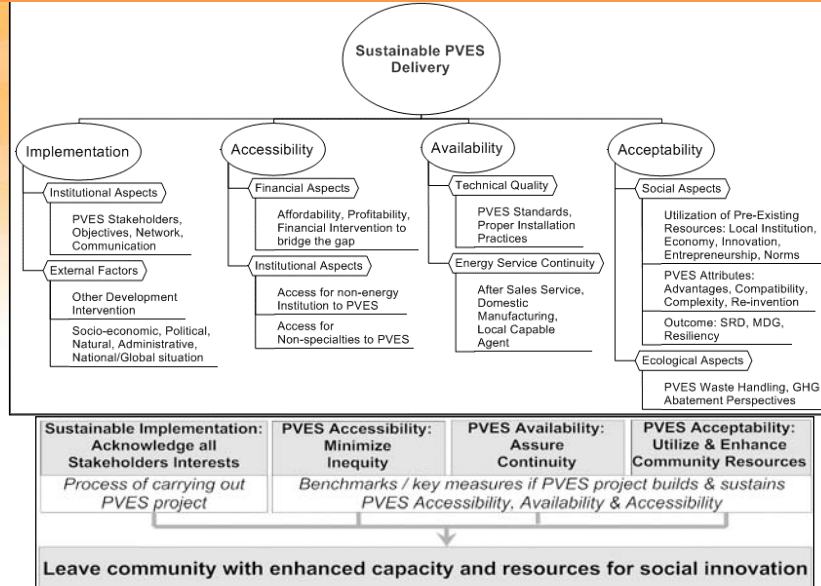
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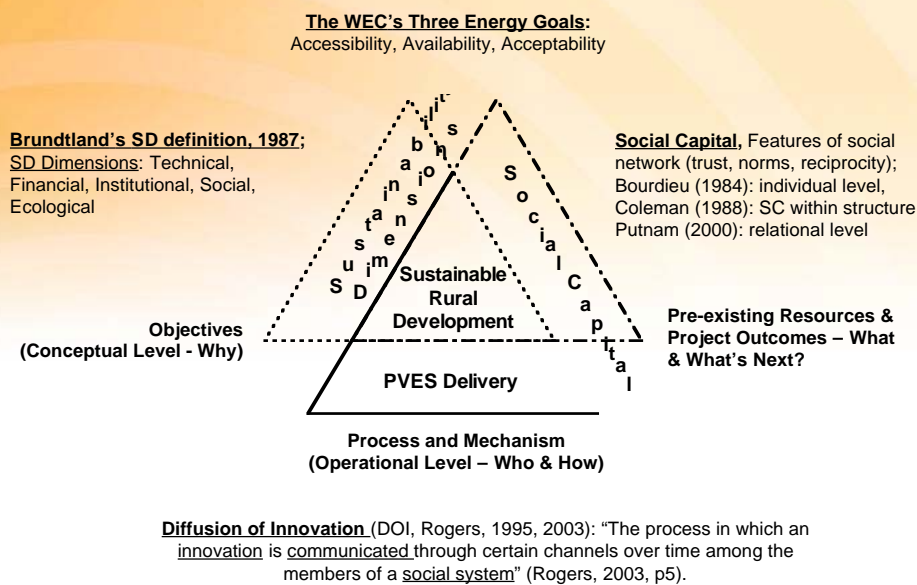
### The I3A Framework: A systematic approach to PVES project design, monitoring & evaluation



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### The I3A Framework: Conceptual background



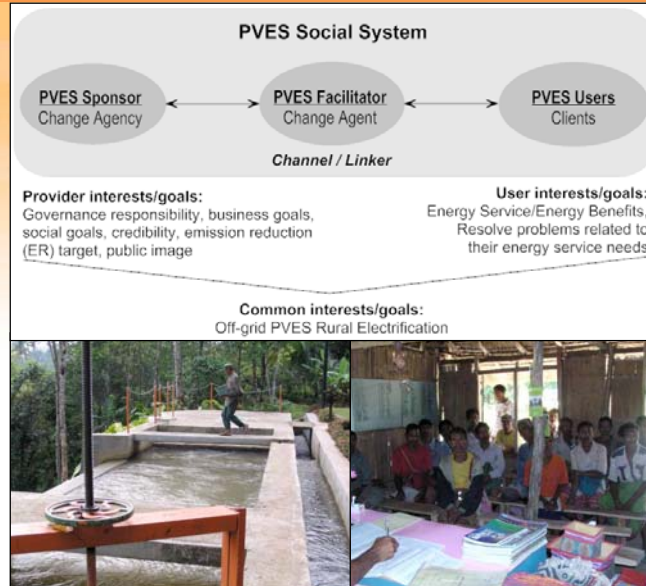
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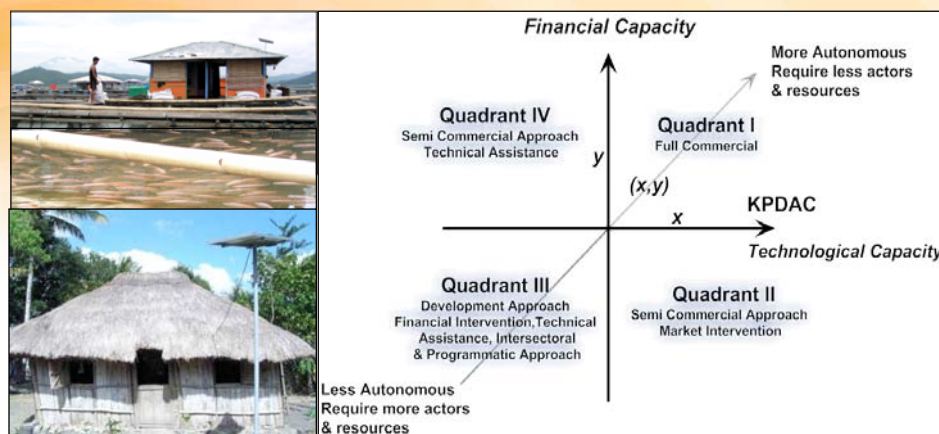


### Implementation: Acknowledge all Stakeholders Interest



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### Degree of Autonomy of Target Communities

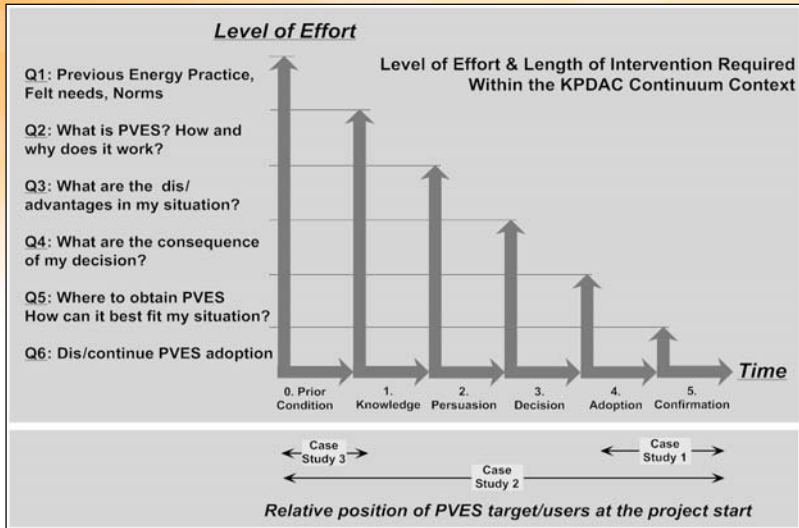


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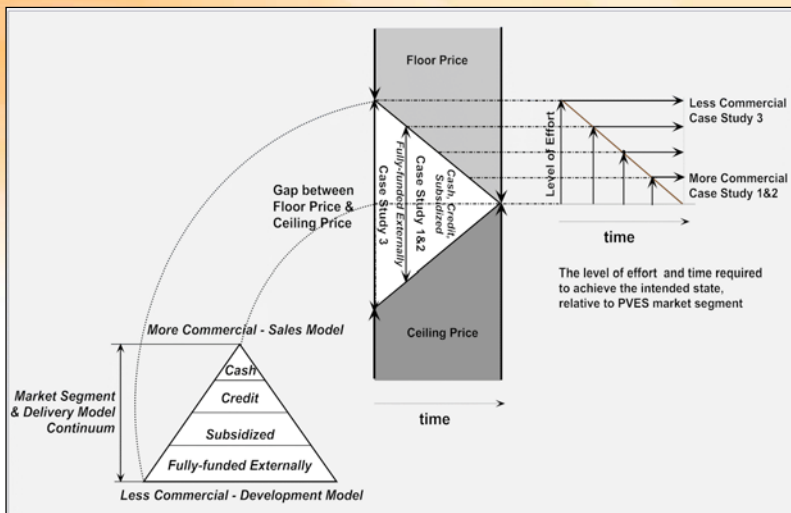


### Technological Capability of Target Communities & Level of Effort Required



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### Accessibility: Minimize Inequity



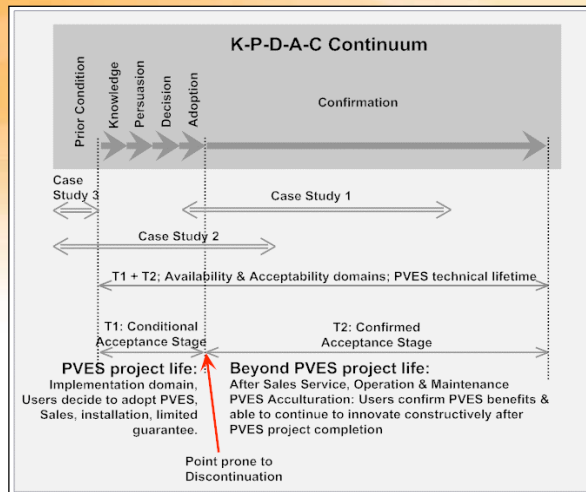
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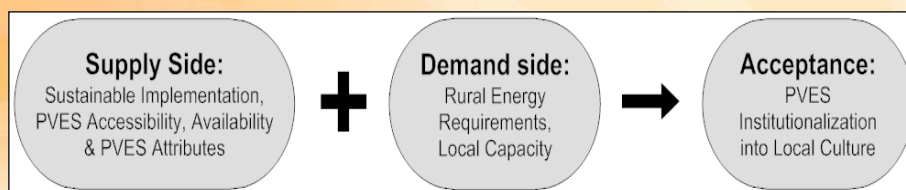


### Availability: Assure Continuity



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### Acceptability: Utilize & Enhance Community Resources



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## Conclusions

- PVES can contribute to sustainable rural development:
  - Fossil fuel displacement, Improve HDI, reduce HPI
- However, a sustainable delivery of PVES is required: hardware, software & orgware
- The I3A Framework:
  - A systematic approach to PVES project design, monitoring & evaluation
  - Could be applied to other RE technologies & to efficient energy use

