TERSE: Techno-Economic Framework for Resilient and Sustainable Electrification

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TERSE Project Funding Support & Partners

Funding Support

EPSRC
Engineering and Physical Sciences Research Council

GCRF
Global Challenges Research Fund

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Project Partners

MANCHESTER 1824
The University of Manchester

Newcastle University

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

厦門大學能源学院
College of Energy–Xiamen University

TERSE Supporting Partners

Malaysia:

China:

Chile (external research partner):

INTERNATIONAL
Microgrid
SYMPOSIUMS

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TERSE
Project Aim

Develop an innovative, ***integrated techno-economic framework*** for supporting ***decision-making*** and ***planning*** of sustainable, ***cost-effective and resilient*** energy infrastructure

Probabilistic, spatio-temporal impact assessment of severe weather and natural hazards

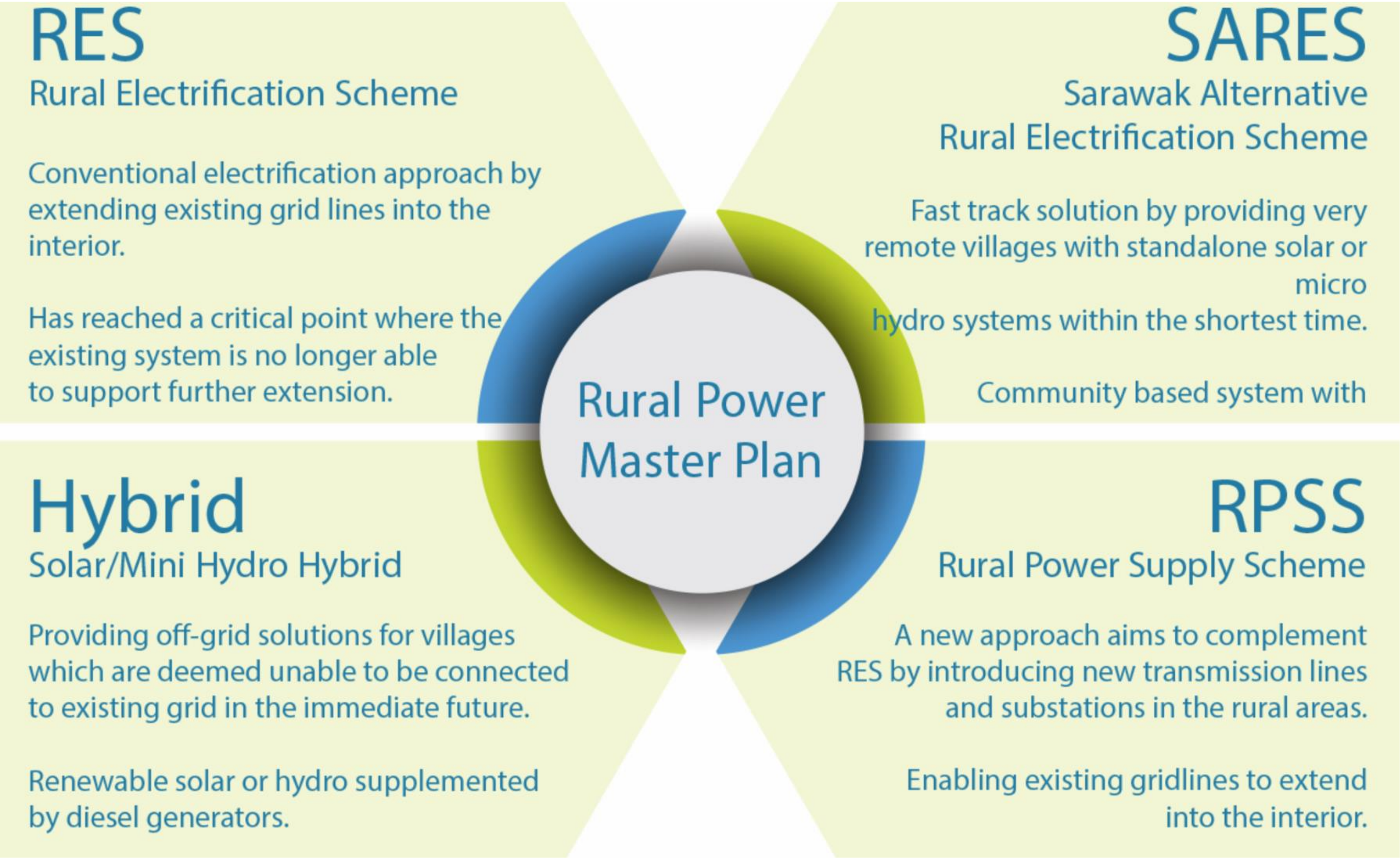
Multi-criteria evaluation of electrification portfolios (reliability, resilience and cost)

Decision-making on rural electrification planning for achieving effective trade-offs between multiple criteria

Presentation outline

1. Rural electrification transformation in Sarawak
2. SARES community-based solar project
3. Strategic sustainable rural electrification
4. TERSE video

Rural electrification transformation in Sarawak



Source: https://www.sarawakenergy.com/what-we-do/rural-electrification

RES MVCC Lines: Site photos

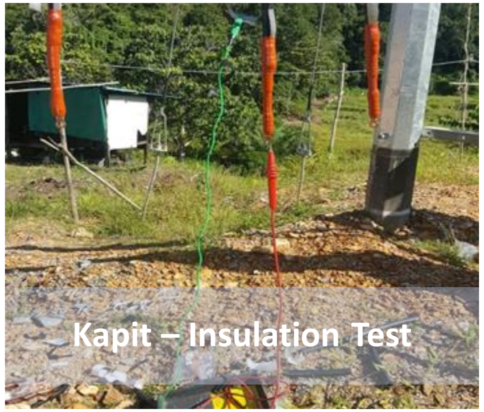
MVCC : Medium Voltage Covered Conductors

Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

RES Last Miles Phase 1 & 2 : Site Photos


Julau – Rh Pagai Transformer platform


Mukah – Transformer Installation


Kapit – Insulation Test


Similajau – LT Sagging & Killing


Sg Tinjar – Pole Erection


Sg Peking – Cable laying


Pakan – Pole Erection


Sekuau – Perasmian Pecah Tanah

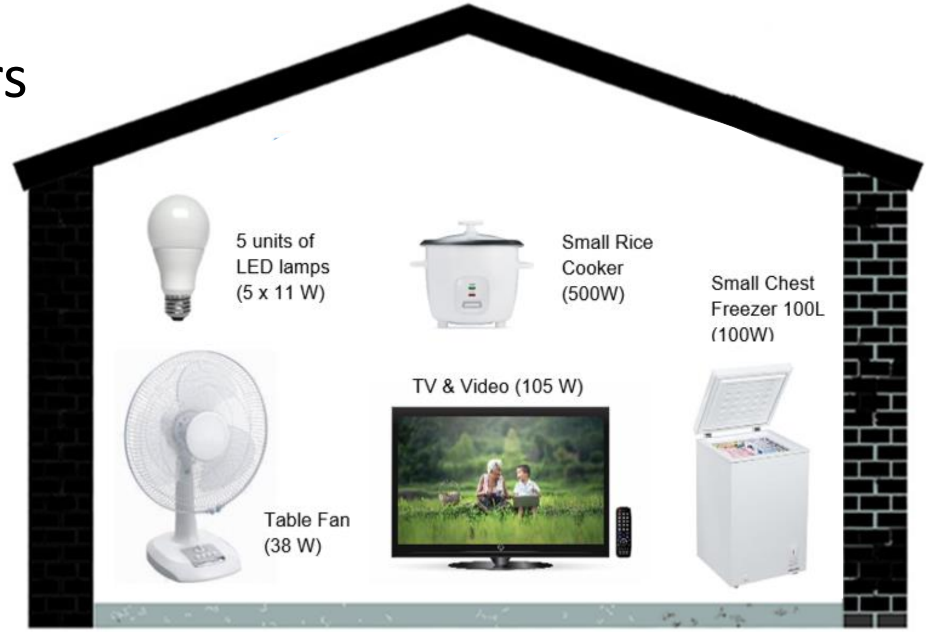

Selangau – Assembling Kicking Block


Tubau – Cable laying

Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

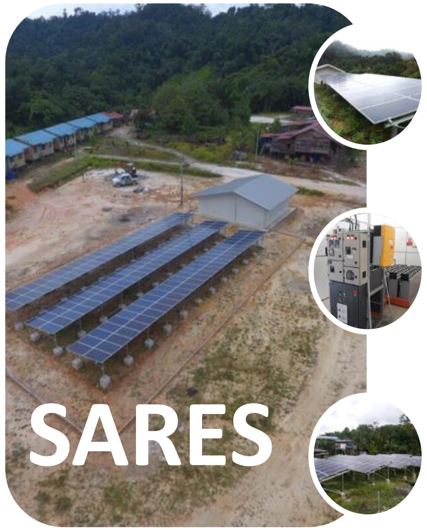
Sarawak Alternative Rural Electrification Scheme (SARES)

- SARES program was launched in March 2016
  - To electrify 300+ the remotest villages within 5 years from 2016 to 2020
  - RM 500 million funding
- To provide a basic level of service for every household
  - 1 kW power per household
  - Daily energy of 3 kWh per household
  - Capable to cover 2 continuous days of bad weather
- Sarawak Energy is appointed to implement the project
  - Completed systems are handed over to village communities to operate and maintain



Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

SARES Solar Implementation



Completed Phases 1, 2, 3, 4 & 5 (2016-2020)

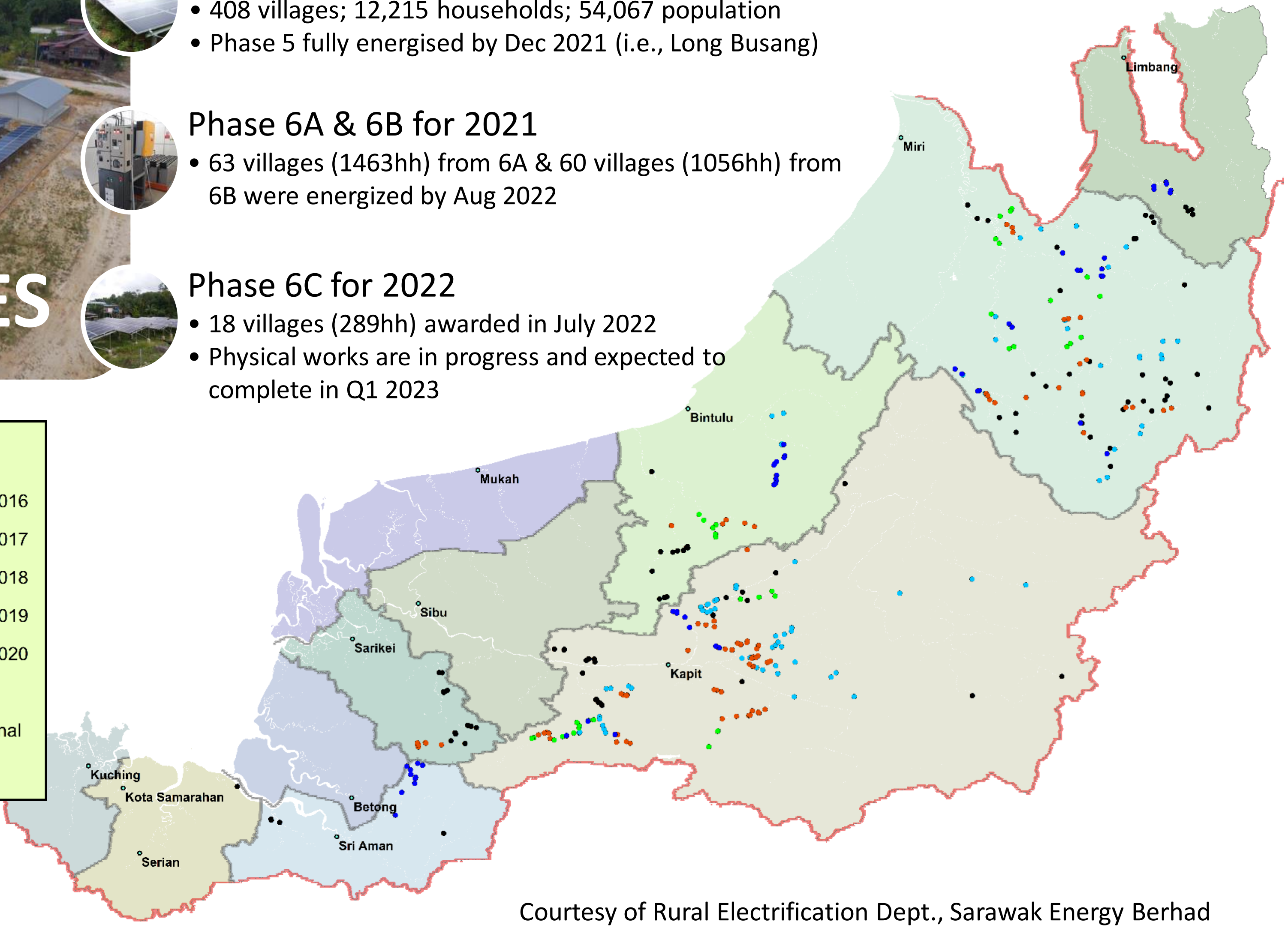
- 408 villages; 12,215 households; 54,067 population
- Phase 5 fully energised by Dec 2021 (i.e., Long Busang)

Phase 6A & 6B for 2021

- 63 villages (1463hh) from 6A & 60 villages (1056hh) from 6B were energized by Aug 2022

Phase 6C for 2022

- 18 villages (289hh) awarded in July 2022
- Physical works are in progress and expected to complete in Q1 2023



Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

- Initial **RM500 million** funding for 323 villages & 8,700 households
- Additional **RM110 million** in Projek Rakyat funding
- KPLB Fasa 1B of **RM35 million**, completed in 2018
- KPLB Fasa 2 of **RM200** million funding for 2021/22 projects

Year	Villages	Households
2016	58	1,388
2017	59	1,604
2018	75	1,968
2019	85	3,028
2020	131	4,227
Subtotal	**408**	**12,215**
2021/22	141	2,863
Total	**549**	**15,078**

SARES Community Based Solar Schemes

- Villages at the remotest regions
- Without proper land access
- Limited disposable household income

- Simple design and ease of O&M
- Villagers trained to undertake basic O&M
- No charge/bill for electricity used

Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

SARES – Implementation Process

sarawak energy

Community engagement

Transportation of materials

Civil & structural construction

Electrical installations

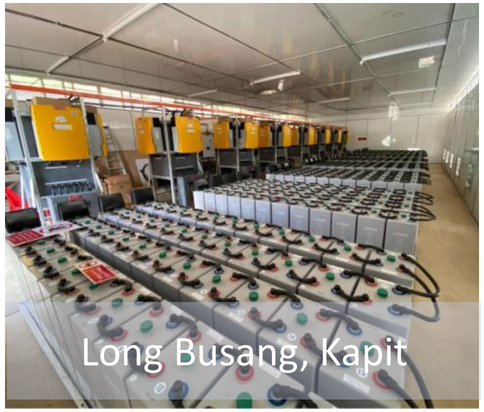
Solar installations

Commissioning & training

Handing over to community

Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

SARES Phase 5 – Project photos



Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

SARES Community engagement

Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

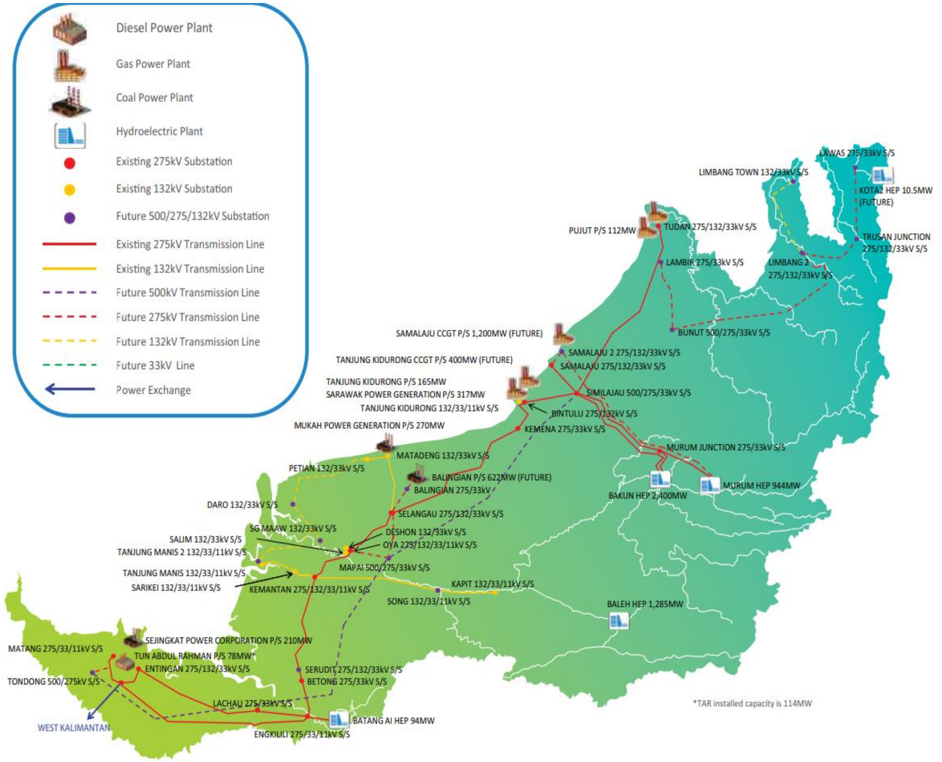
Sustainability of SARES scheme






Courtesy of Rural Electrification Dept., Sarawak Energy Berhad

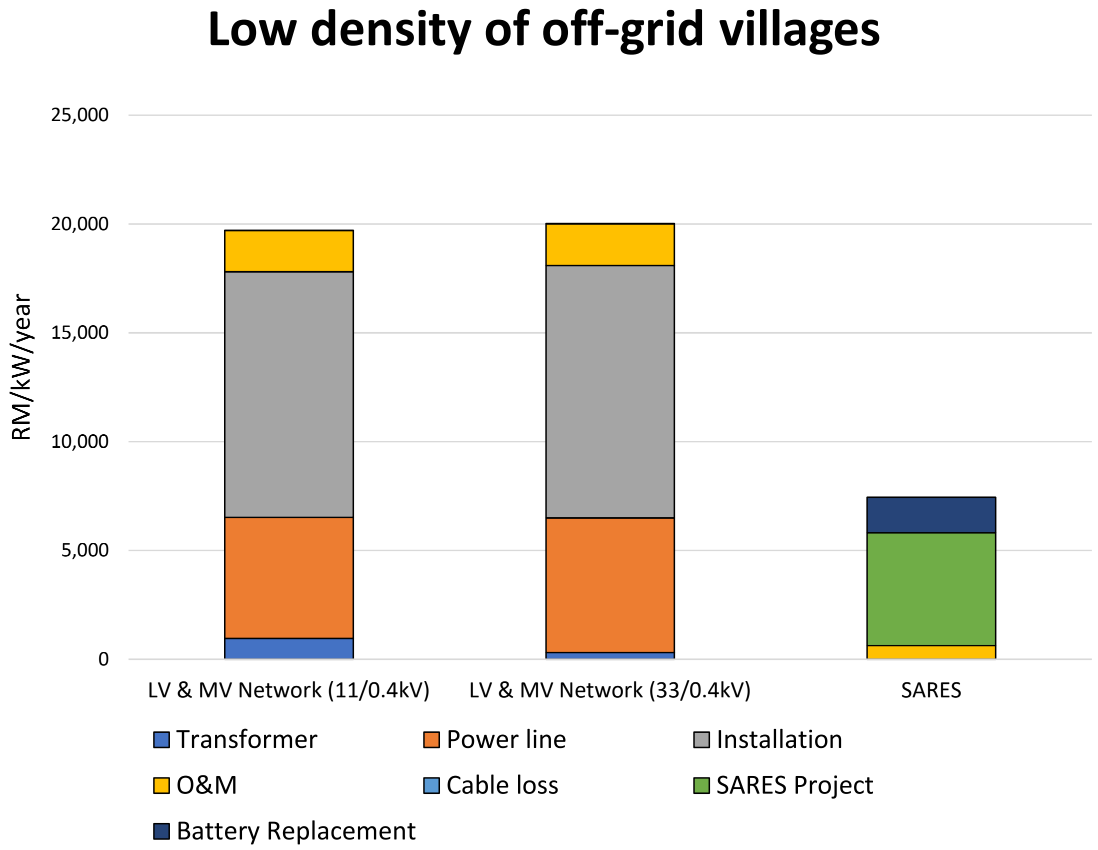
Strategic sustainable rural electrification

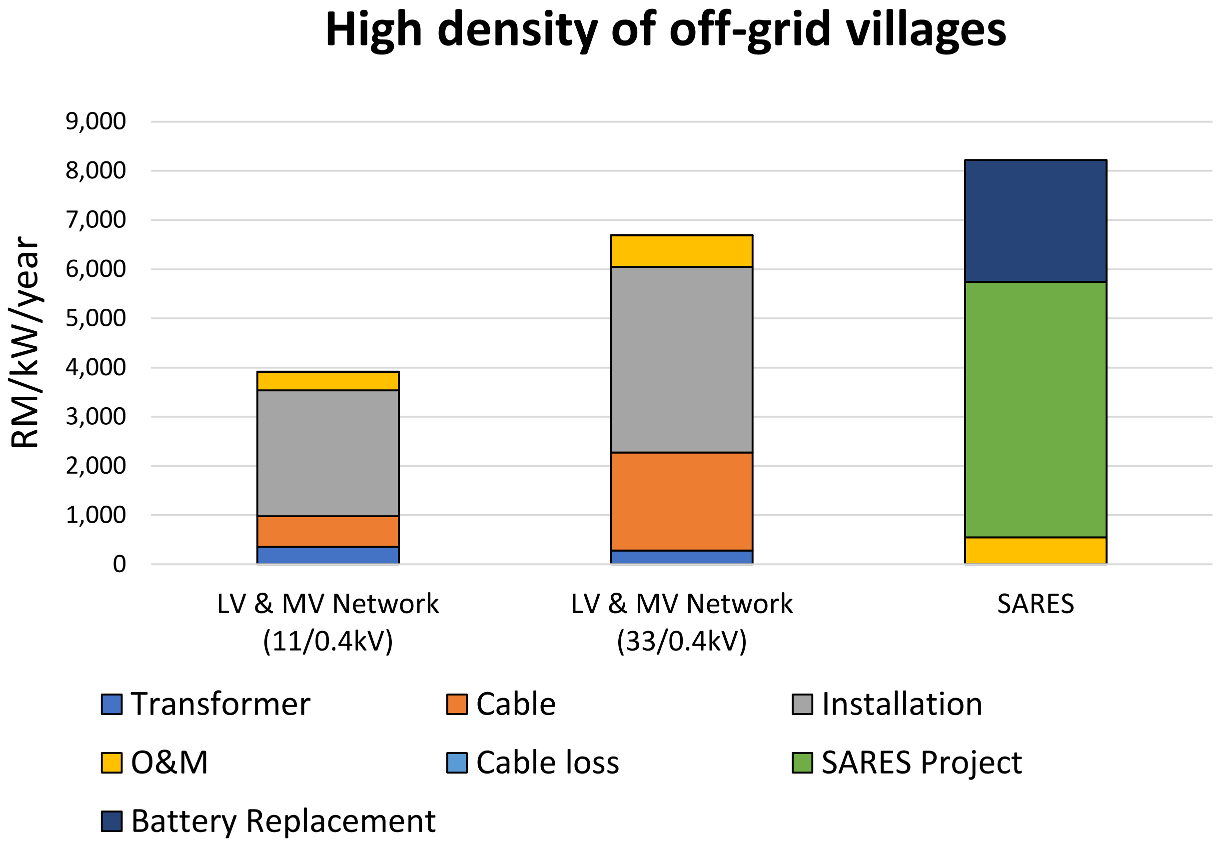


Integration of economics, reliability and resilience considering

- **Grid expansion** vs off-grid applications
- Hybrid **micro-grids** based on renewable energy sources
- Considering **geographical** conditions and road access
- Analysis of **social impacts** from energy access, e.g. health, education, employment and economic benefits
- Single and multi-**hazard** risk analysis

Grid expansion vs off-grid applications

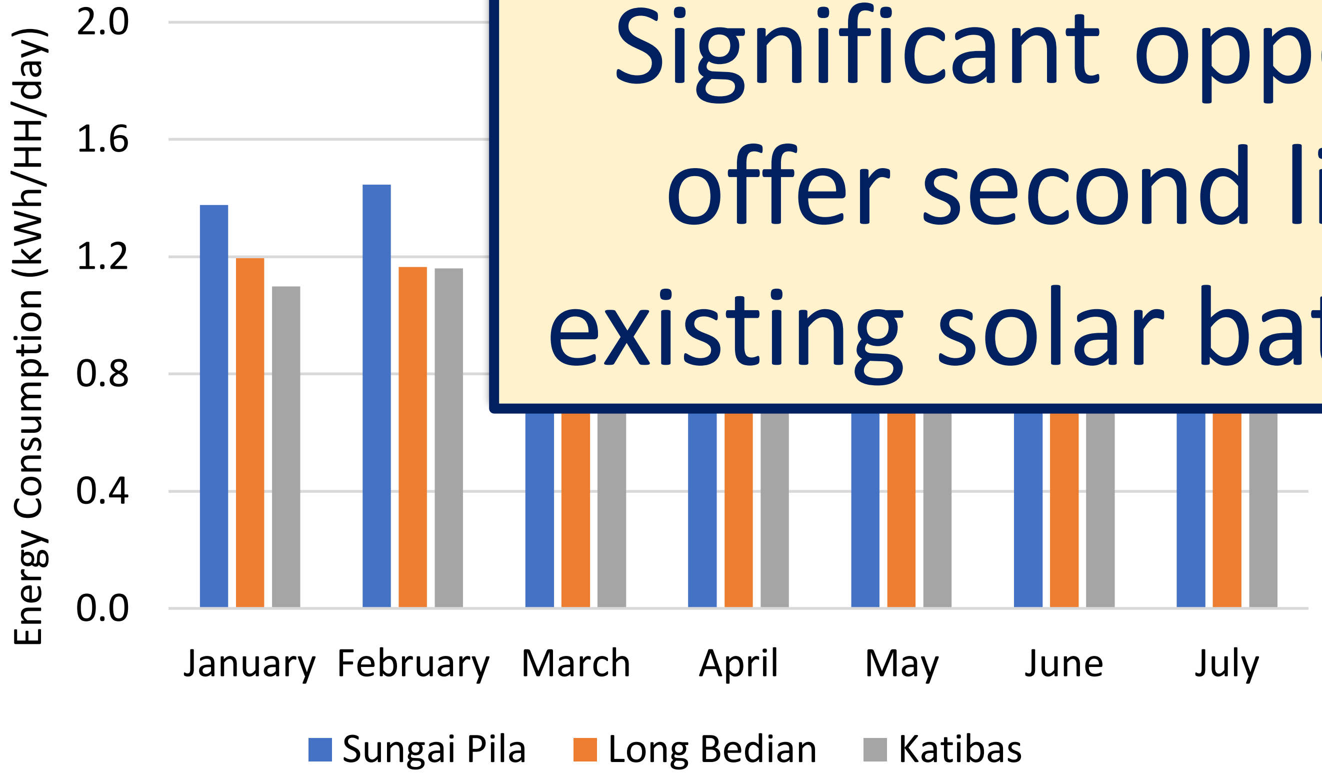




As the number of villages increases, it may be more cost-effective to electrify the villages through on-grid options

What's next **AFTER** the on-grid transition

Average actual consumption =
1.3 kWh/HH



Average Solar Energy from SARES system =
3.76 kWH/HH

	Solar Energy (kWh/HH/day)
	3.67
	3.60
	4.01

Significant opportunity to offer second life for the existing solar battery system

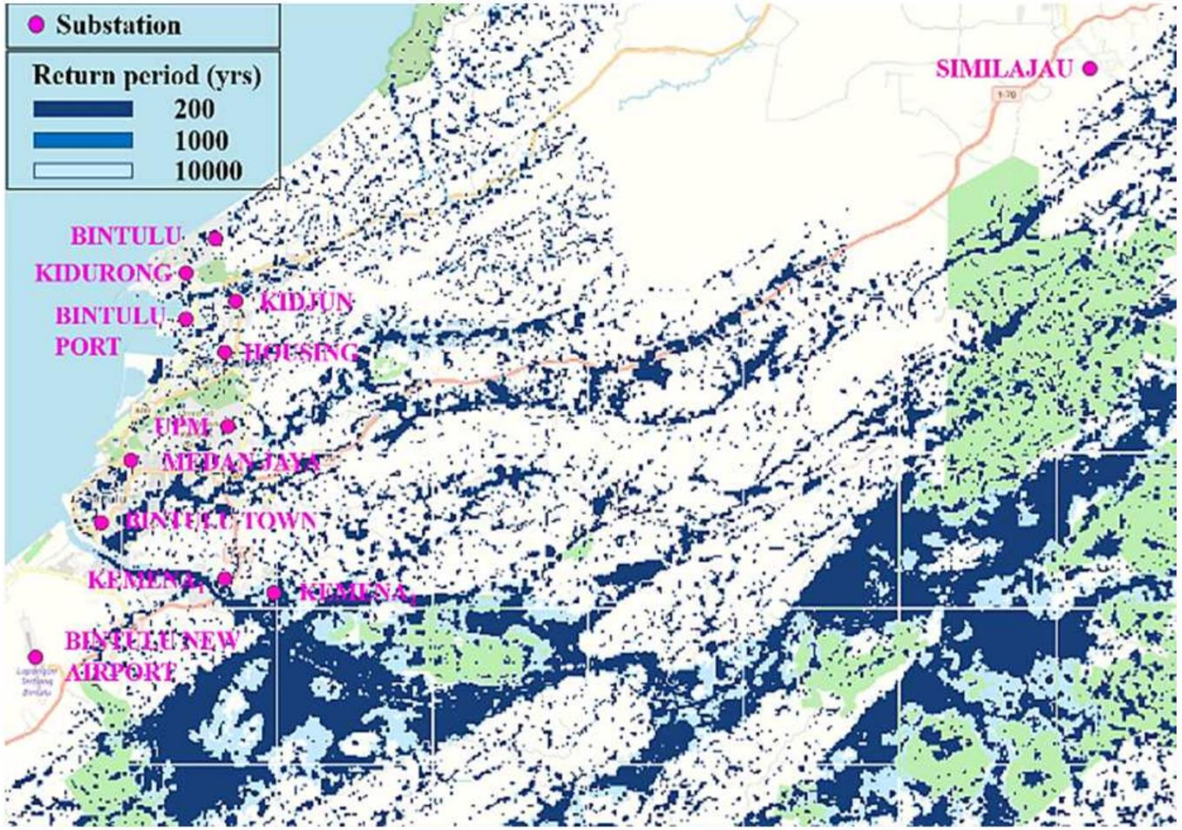
Average solar energy utilisation = 35%

HH = Household

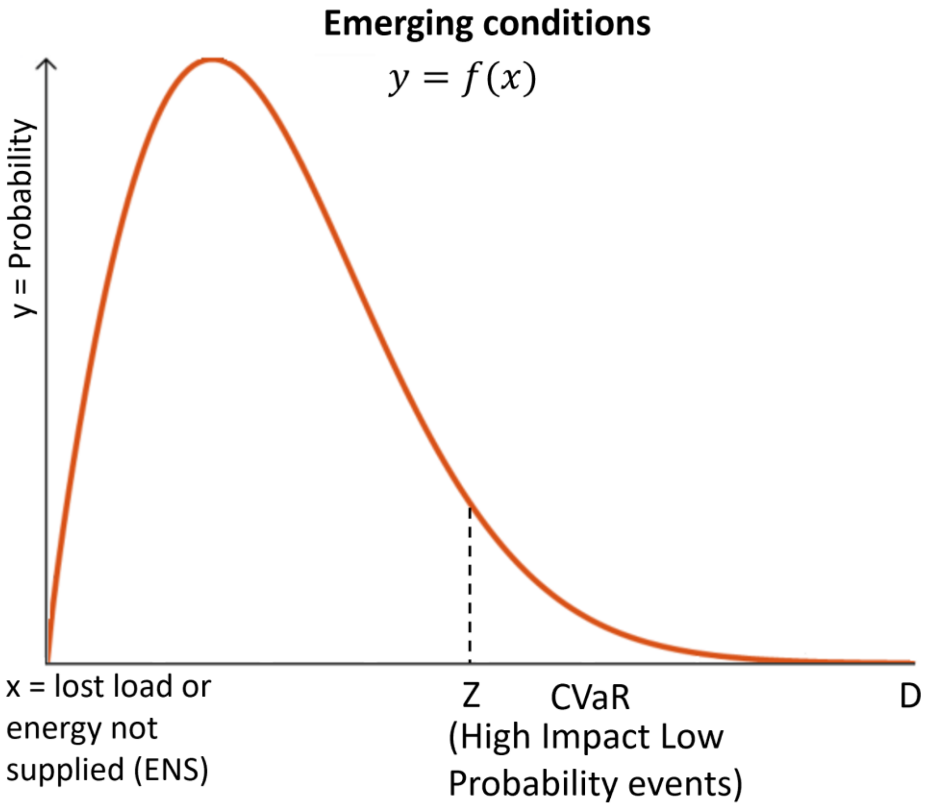
Source: https://globalsolaratlas.info/map

Assessing power system resilience to floods

Inundation risk map for substations in Bintulu



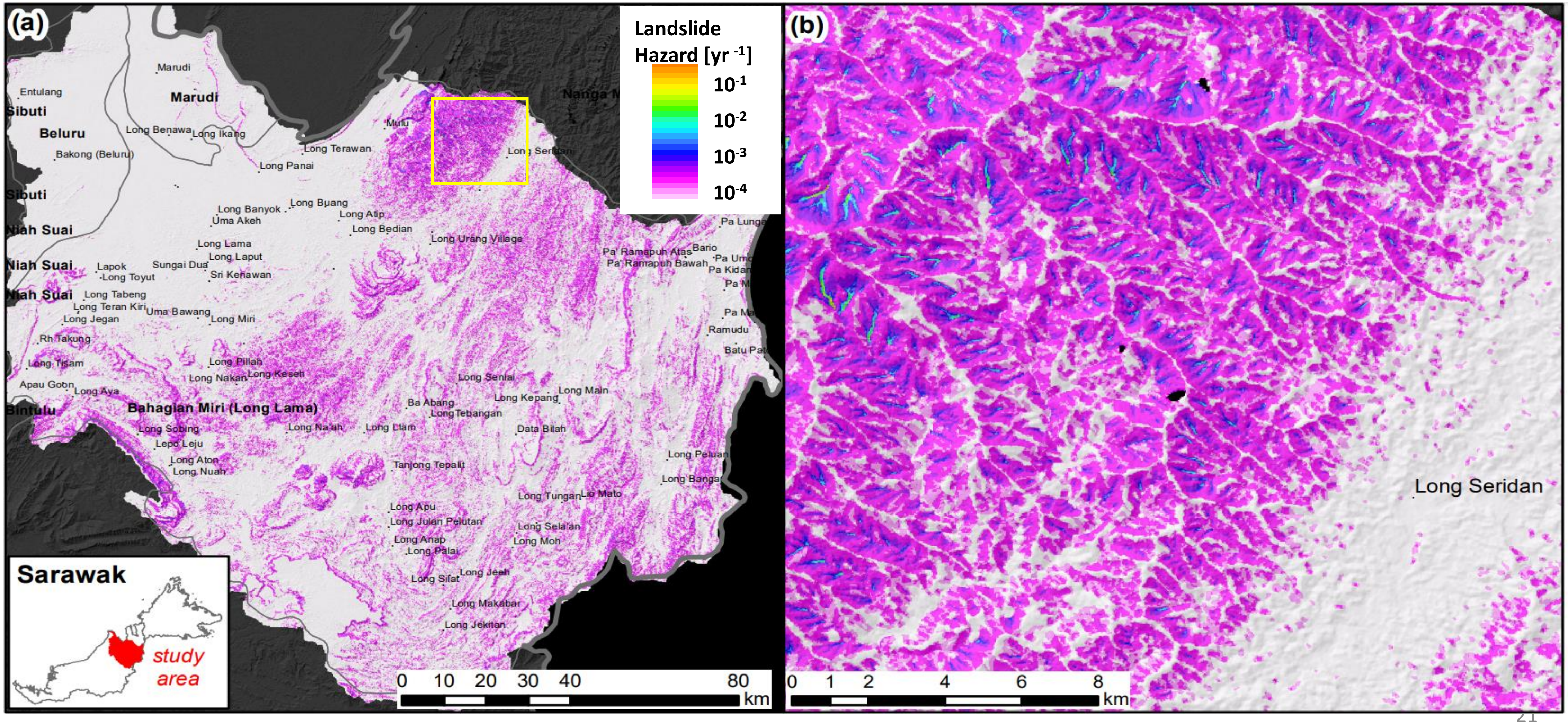
Focus on extremes:
Conditional Value at Risk (CVaR) of ENS



Wenzhu Li, et al., "Assessing Power System Resilience to floods: A Geo-Referenced Statistical Model for Substation Inundation Failures", 2022 IEEE ISGT-Europe, Serbia, October 2022.

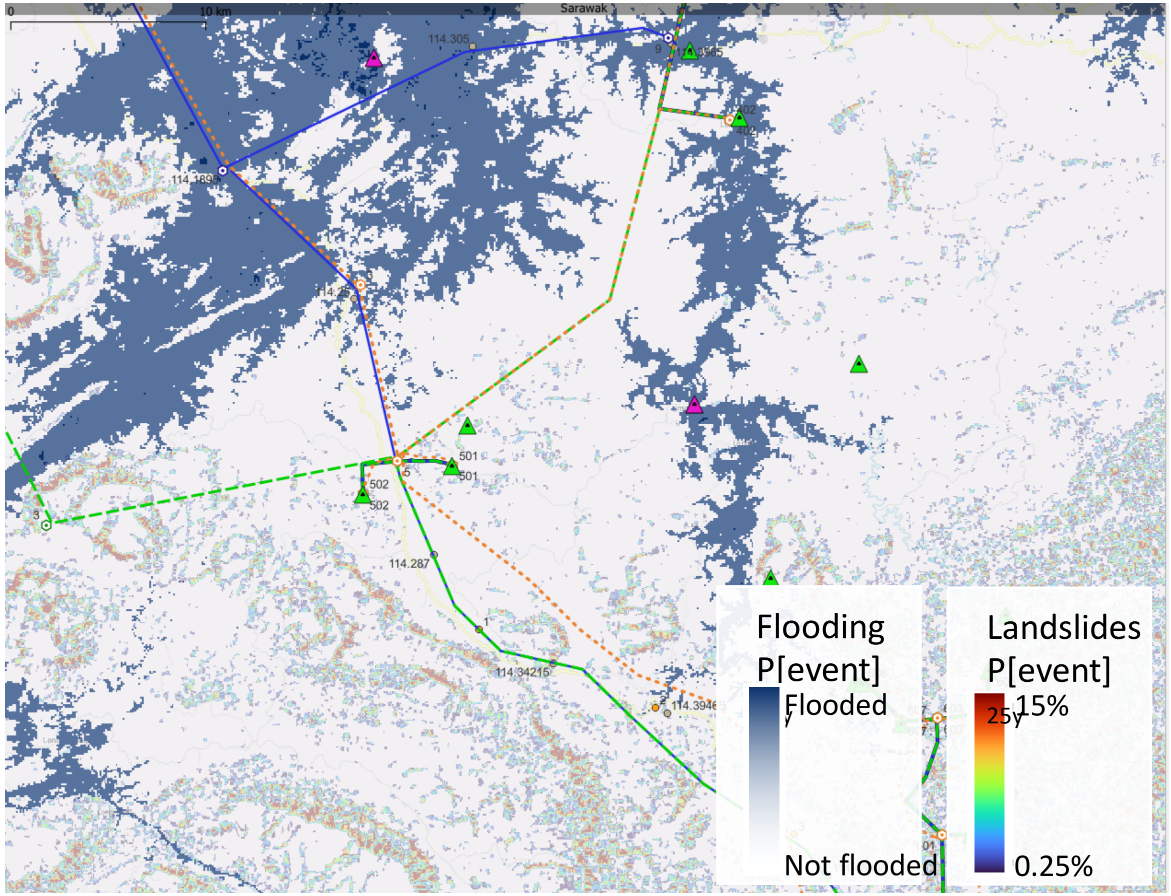
Landslide hazard

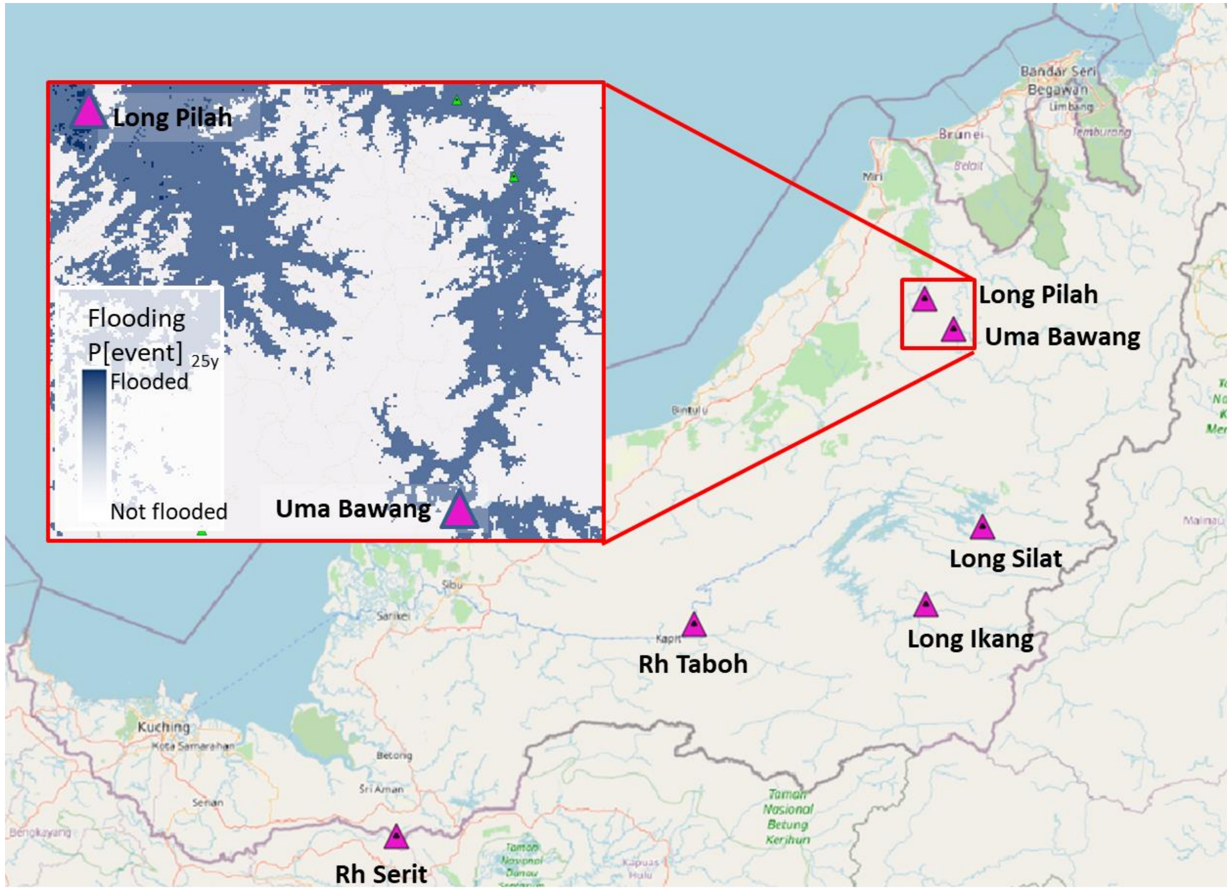
To generate spatial prediction of the probability of an area (e.g. a grid cell) being hit by a landslide per unit time.



Courtesy of David Milledge, Newcastle University

Landslides and flooding





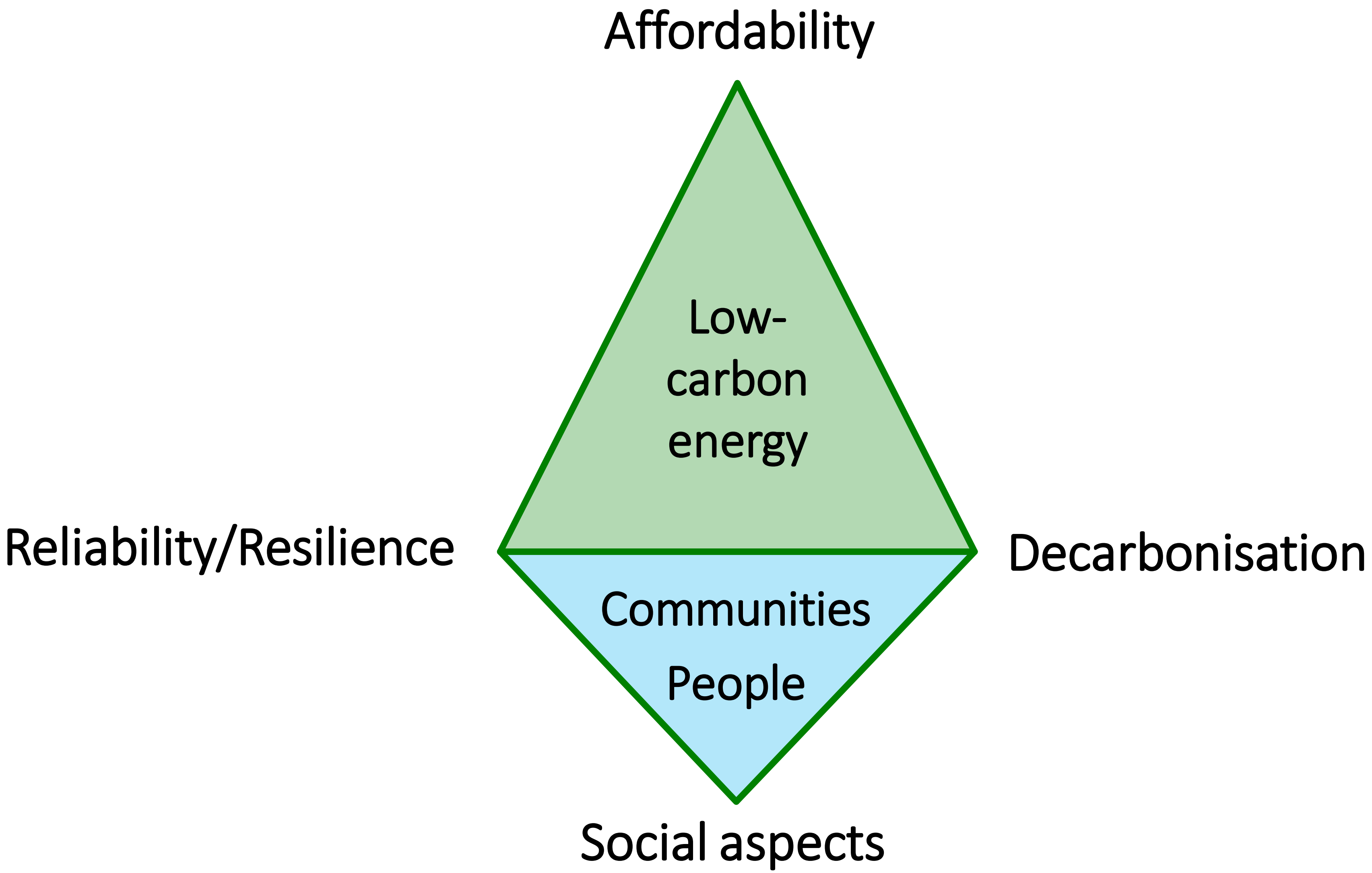
Scenarios:

1. Access – following existing roads
2. Avoiding areas with moderate/high risk of landslides
3. Avoiding areas with moderate/high risk of flooding

There can be trade-off between the exposure to different hazards, e.g., areas with lower flooding risks may experience higher landslide risks

Courtesy of Ruben Bravo Vargas, University of Manchester

The energy quadrilemma



Courtesy of Pierluigi Mancarella, University of Manchester / University of Melbourne

INTERNATIONAL Microgrid SYMPOSIUMS

Social aspects - site visit to SARES villages

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Visited 7 long house villages to understand how the SARES scheme had impacted communities' lives

TERSE Project Video

Courtesy of Amy Chin Swin Yee, Sarawak Energy Berhad   Available: https://www.youtube.com/watch?v=QQDmuit-r5M

Acknowledgements

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  - Prof. Richard Dawson, Dr Fergus McClean, Dr David Milledge
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  - Rural Electrification Department
  - Research and Development Department
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Thank you

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