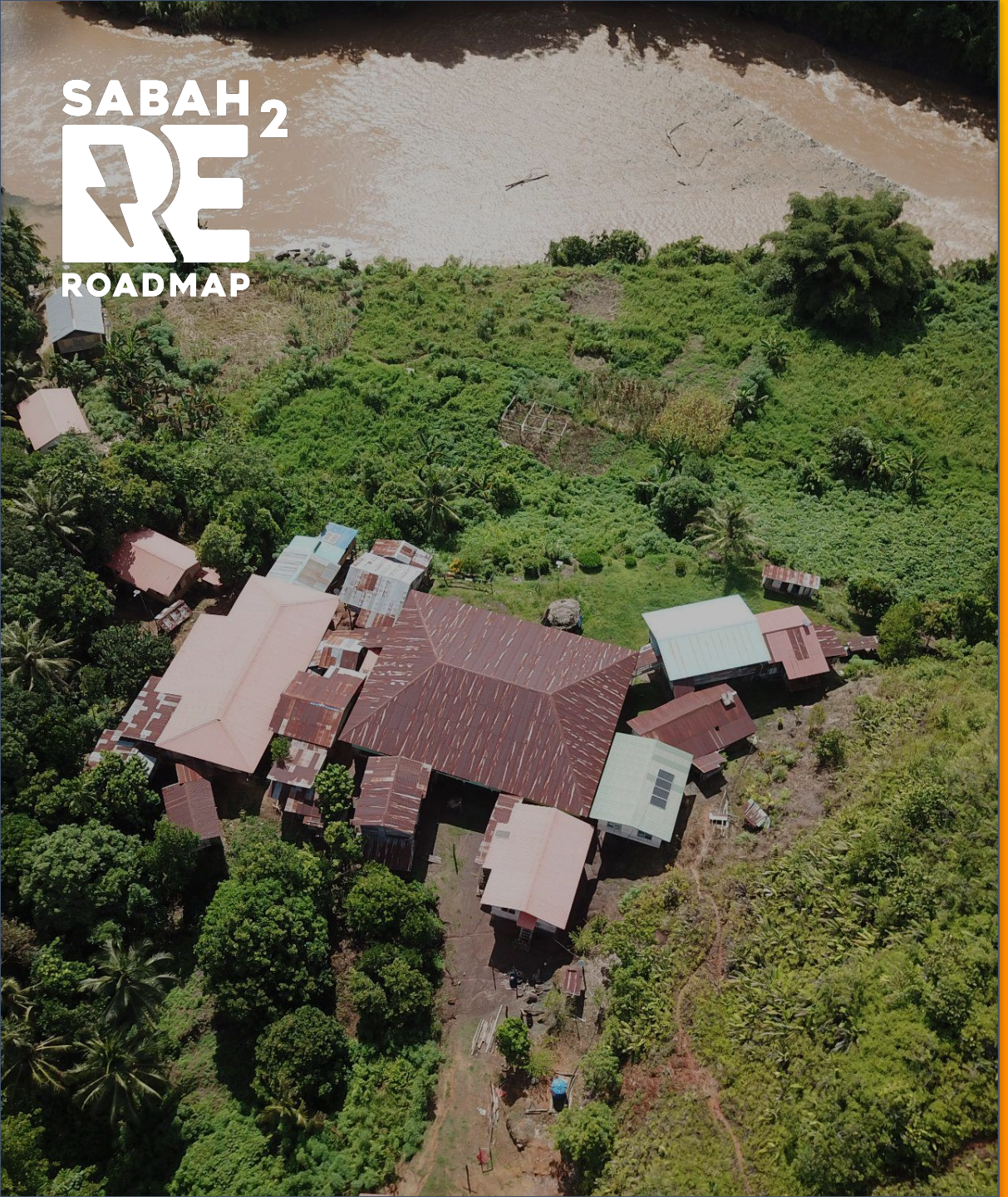
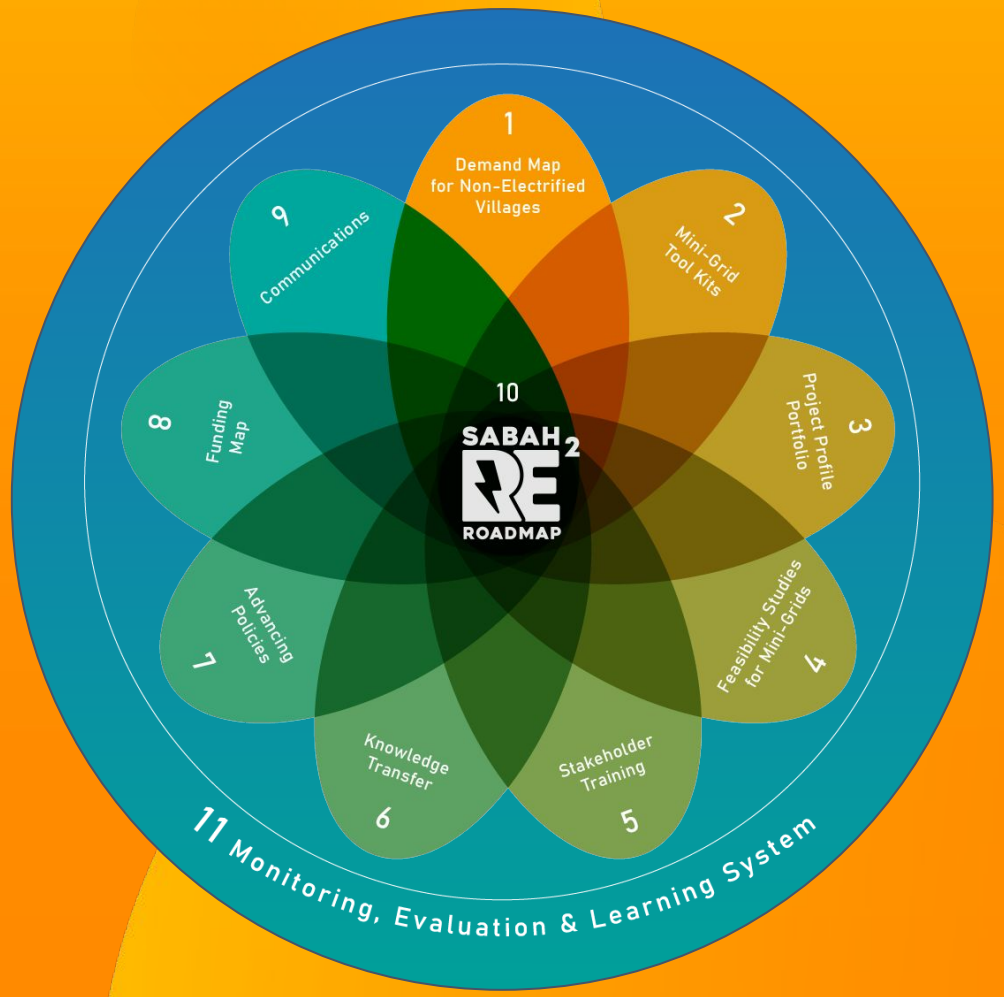


Sabah Renewable Energy

Rural Electrification Roadmap

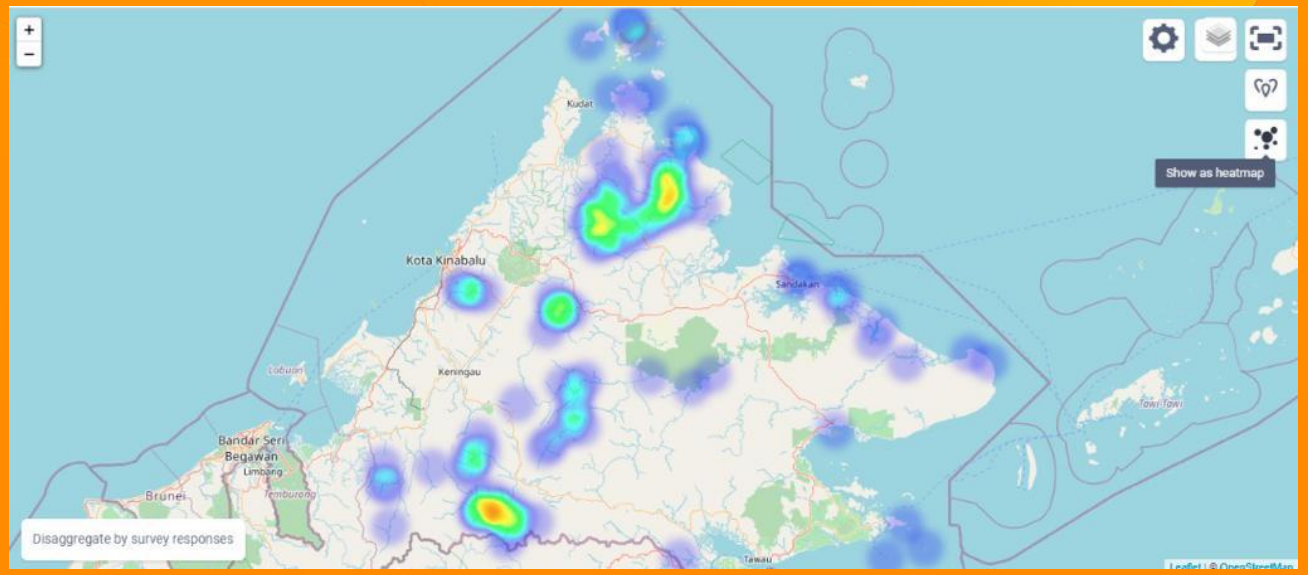
Mapping the Transition 2022-2030

www.sabahre2roadmap.org



Sabah Renewable Energy Rural Electrification Roadmap

is a multi-stakeholder initiative that charts a course for energy access for all in Sabah. The roadmap provides the tools, data and approaches required to optimize renewable energy deployment in rural Sabah, and connects climate change mitigation with energy justice, local economies and environmental stewardship.

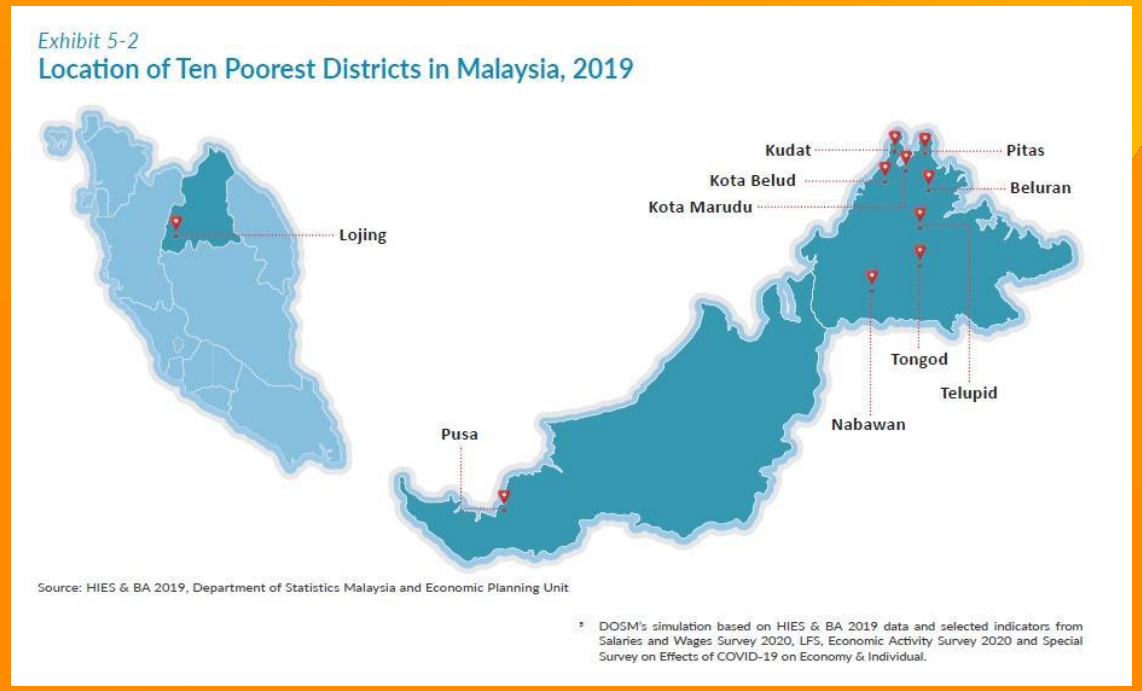


sabahre2roadmap.org

Led by four organizations converging their unique and diverse capacities towards a common goal.

green empowerment
Village Solutions for Global Change since 1997

Sabah is home to 72% of unelectrified rural Malaysians, and 8 of 10 poorest districts in Malaysia (12 Malaysia Plan). Our demand map (heat map in previous slide) has identified these communities, and the roadmap creates the pathway to energy access for them.



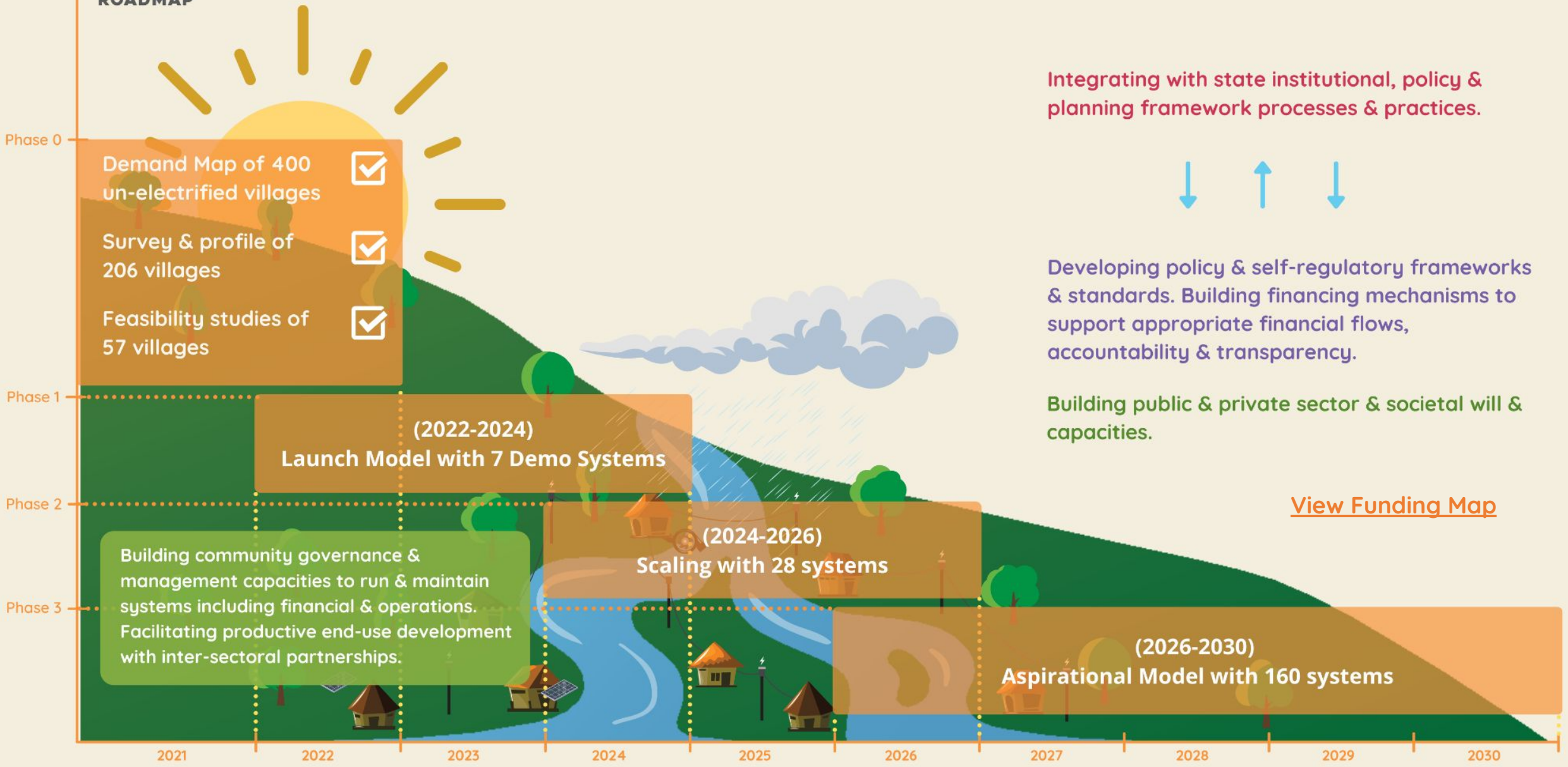
Principles & Scope:

A principles-based strategy that drives sustainable resource development and a transition towards distributed renewable energy systems; it focuses on equity, inclusion, prioritizes Sabah-based ownership, and sets a standard for quality of service while minimizing financial burden on communities.

Decolonizing rural electrification includes embracing the circular economy, investing in local practitioners, maximizing investment and earnings within the state, and promoting distributed power dynamics to build a strategy resilient to government turn over, external influence and corruption.

The map is a generative journey towards identifying existing and potential financial flows (federal and state, private and philanthropic, climate and development finance) into rural electrification with renewables in Sabah; proposing funding models appropriate to the circumstances and needs on the ground.

Flow Chart of Roadmap Rollout



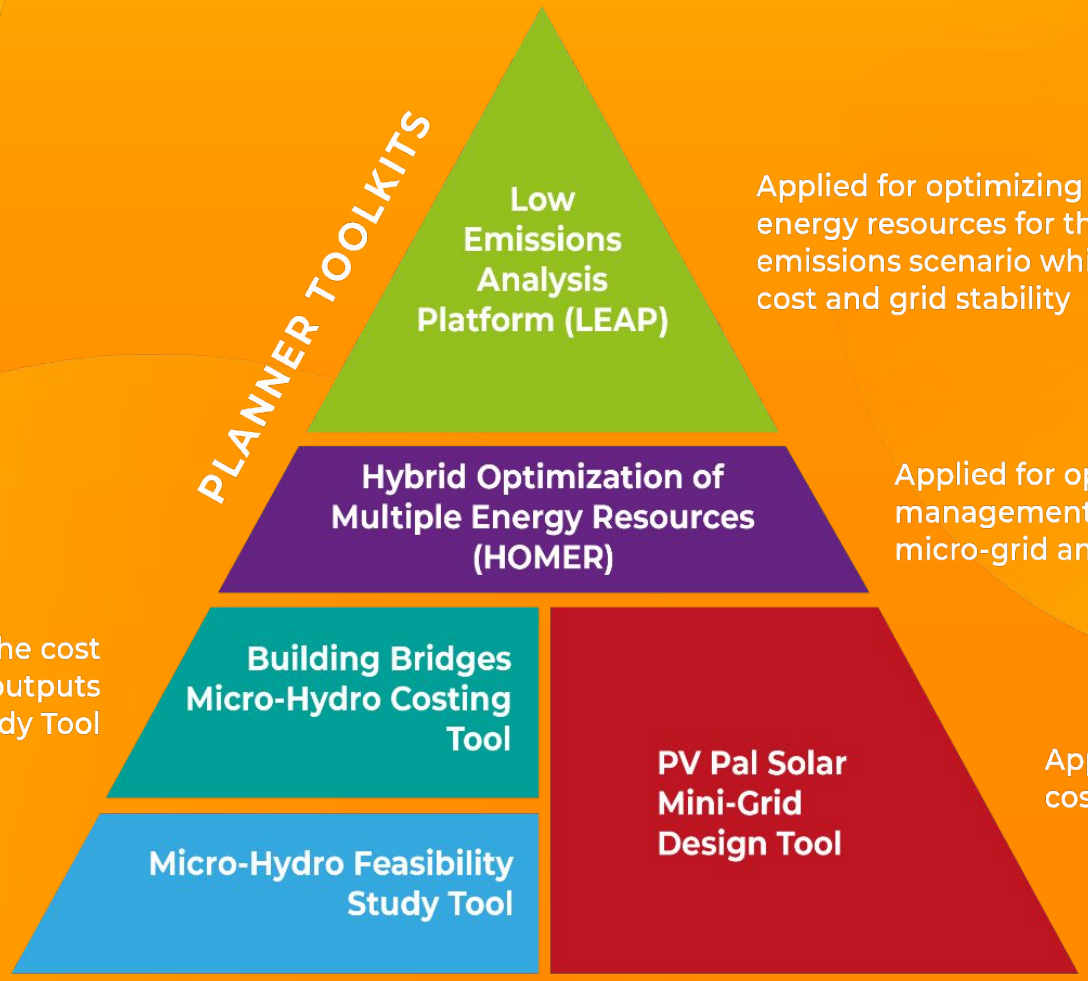
Integrating with state institutional, policy & planning framework processes & practices.

Developing policy & self-regulatory frameworks & standards. Building financing mechanisms to support appropriate financial flows, accountability & transparency.

Building public & private sector & societal will & capacities.

View Funding Map

Mini-Grid Systems: Planner & Implementer Toolkits (Methodology)



Applied for optimizing configuration of energy resources for the lowest emissions scenario while considering cost and grid stability

Applied for optimizing cost, load management and reliability of hybrid micro-grid and grid-connected systems

Applied to analyze and determine the cost of micro-hydro systems based on outputs from the Micro-Hydro Feasibility Study Tool

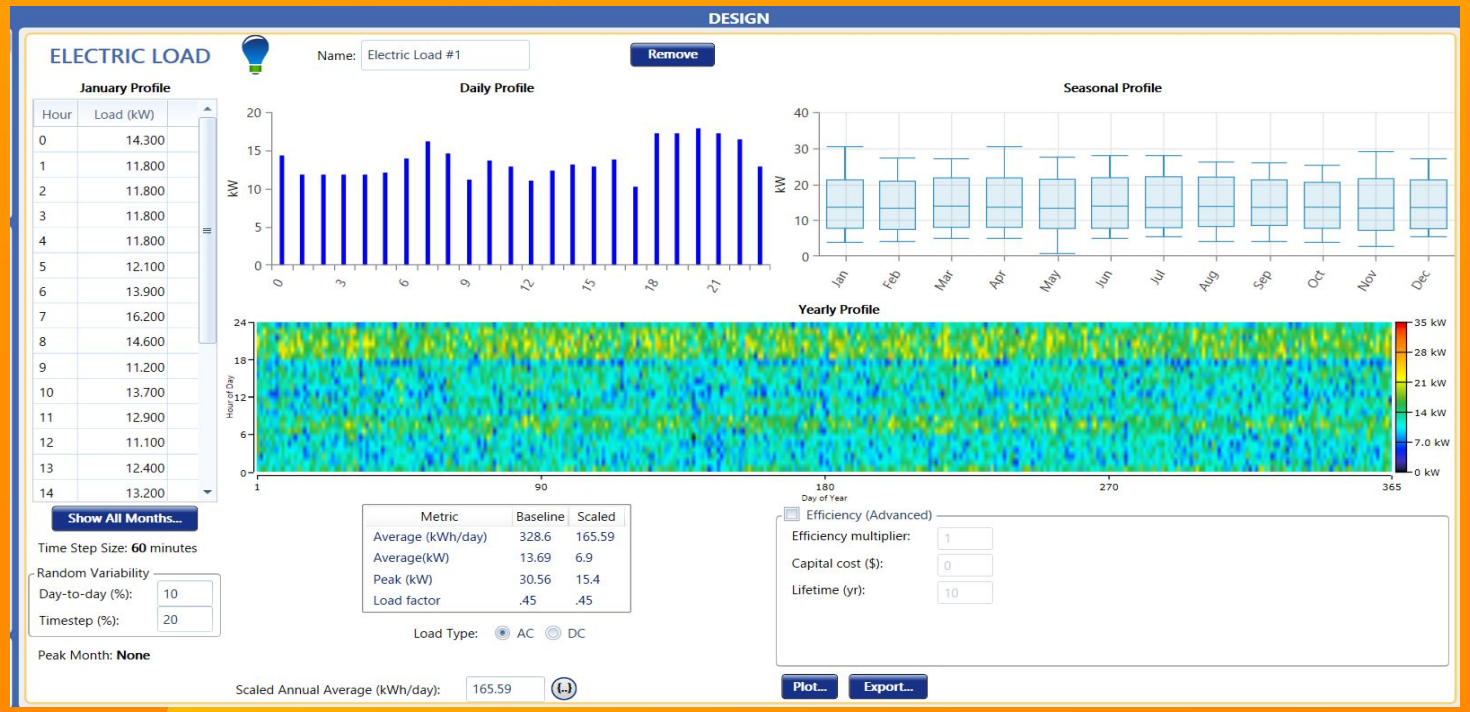
Applied to analyze micro-hydro data from the field and determine potential energy capacity in kilowatts

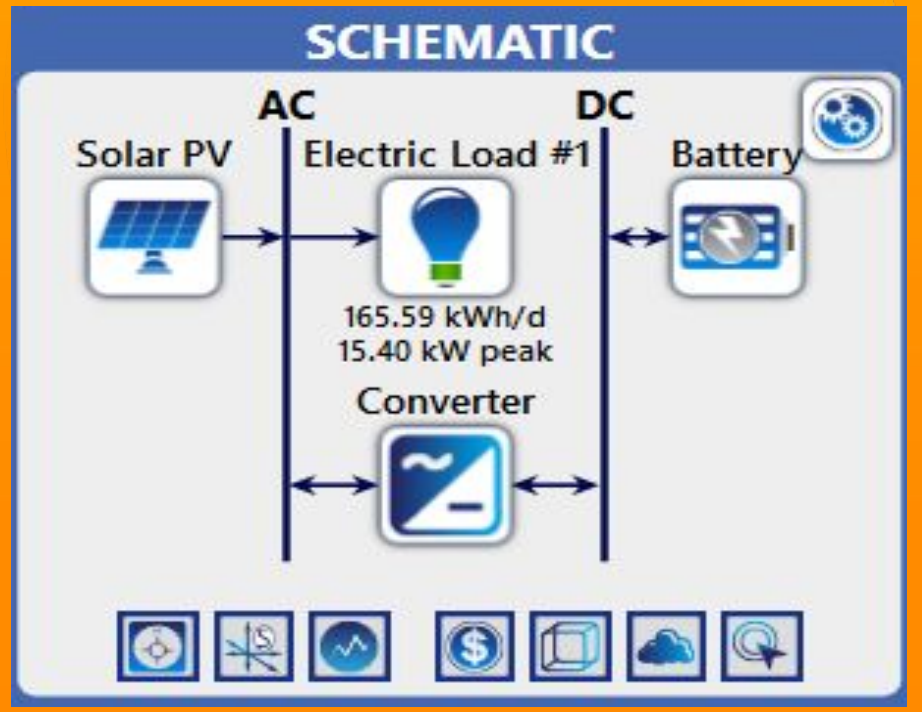
Applied to analyze and determine both cost and size of solar PV mini-grids

View Planner & Implementer Toolkits

Mini-Grid Systems : Planner & Implementer Toolkits (Methodology)

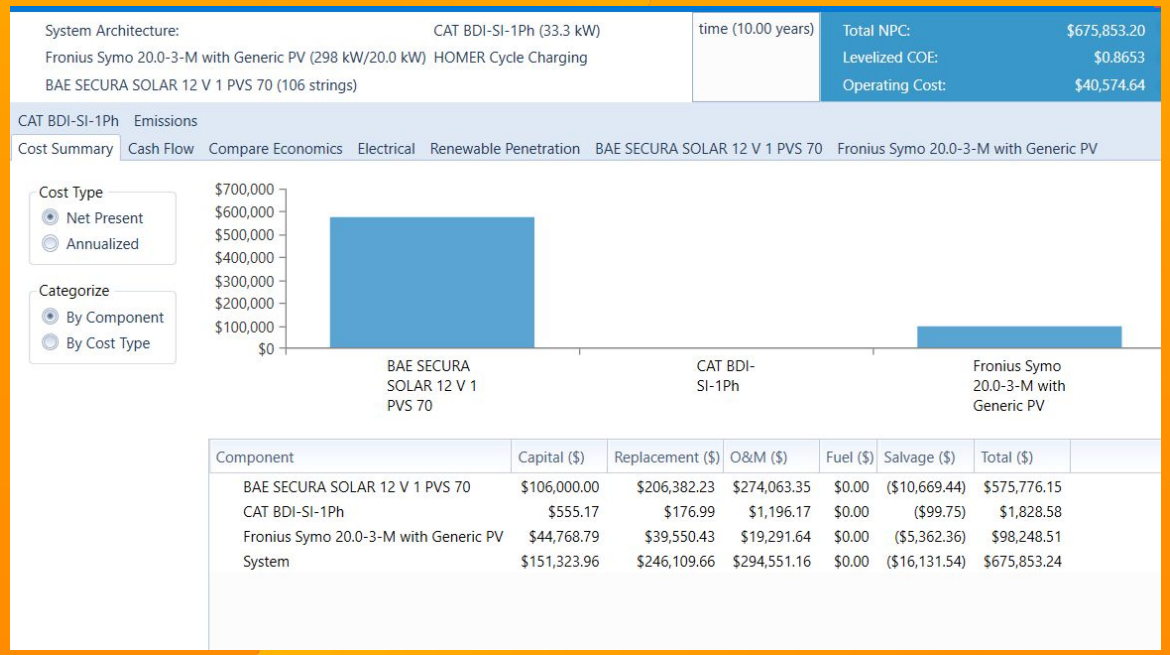
The outputs of HOMER based on dataset collected from 53 households in Kg Atog, Paitan sub-district



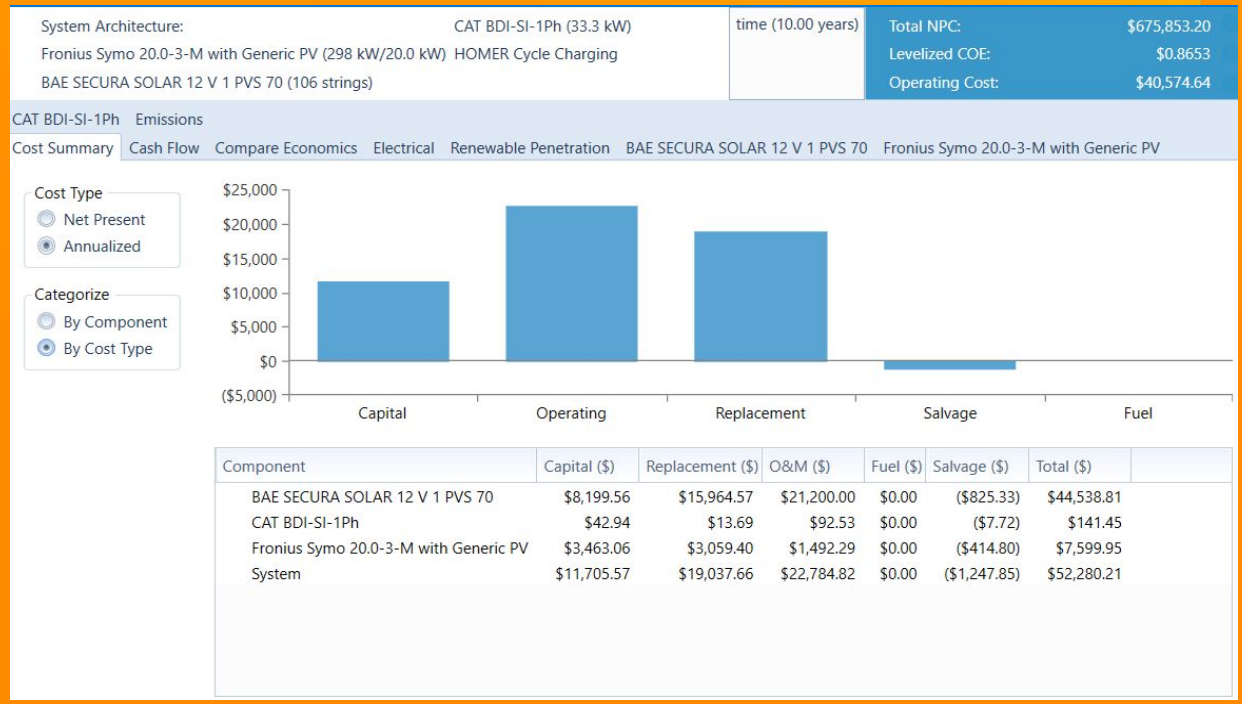


The tool optimizes the design of a mini-grid system based on lifetime costs, and anticipated loads throughout the day and annually, over its lifespan.

Mini-Grid Systems: Planner & Implementer Toolkits (Methodology)



HOMER was applied to estimate the cost of renewable energy deployment for 53 households of Kg Atog, Paitan sub-district.



The tool is also capable of optimizing the cost of a hybrid power system (i.e. combination of multiple systems or components), from utility-scale and distributed generation to standalone microgrids.

FEASIBILITY STUDIES

View Feasibility Studies

KAMPUNG SIZE

- 4-23 Households
- 24-47 Households
- 48-95 Households
- 96-326 Households

- 4-23 Households
- 24-47 Households
- 48-95 Households
- 96-326 Households

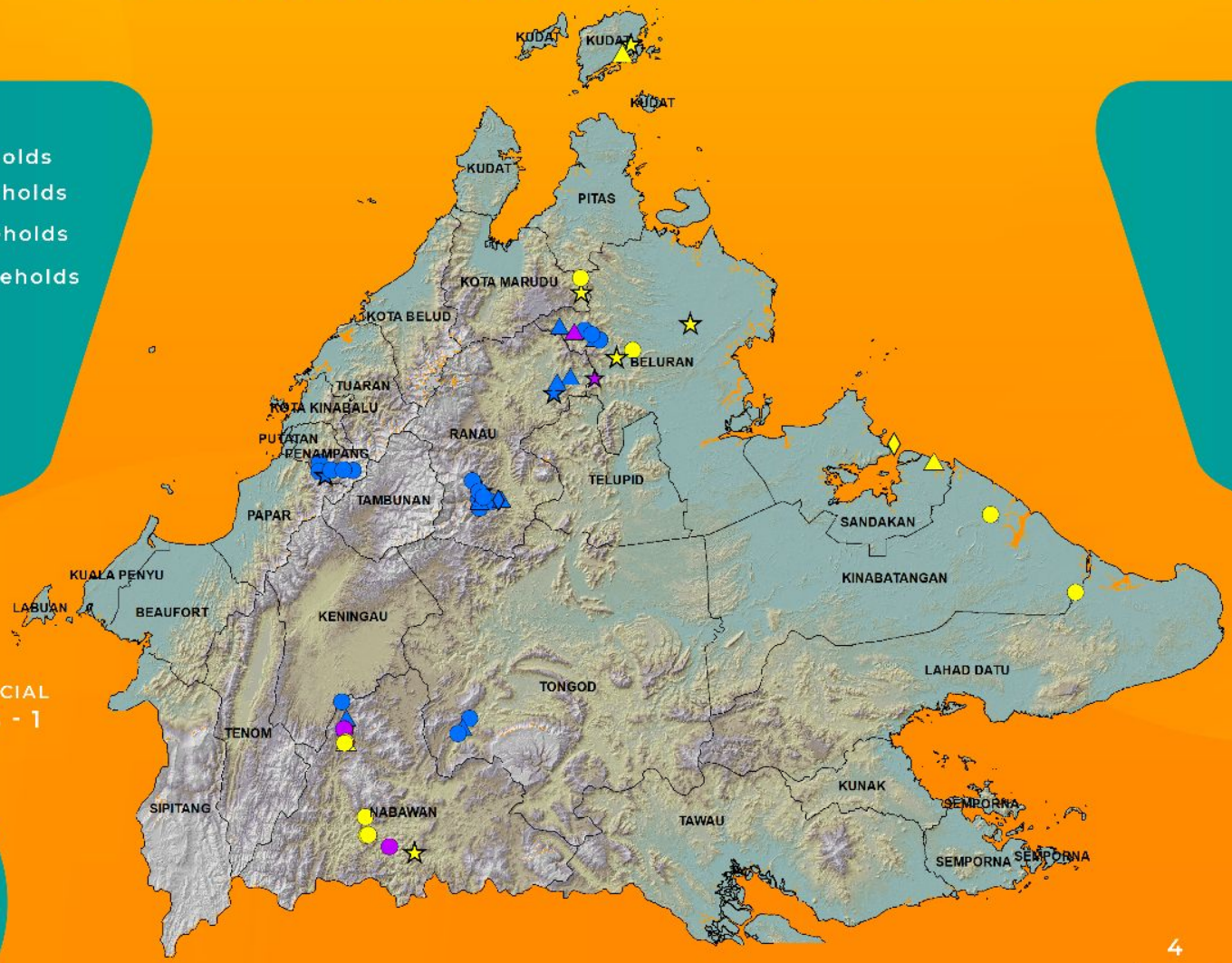
- 4-23 Households
- 24-47 Households
- 48-95 Households

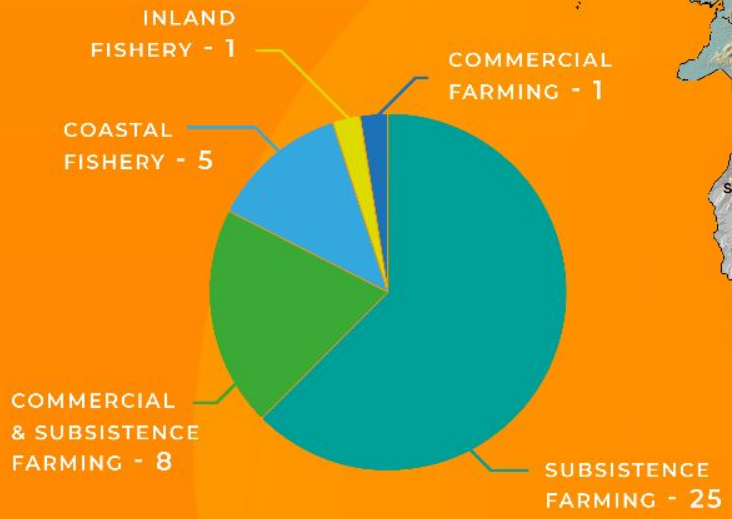
LEGEND

- Solar
- Solar
- Solar
- Solar

- Micro-hydro
- Micro-hydro
- Micro-hydro
- Micro-hydro

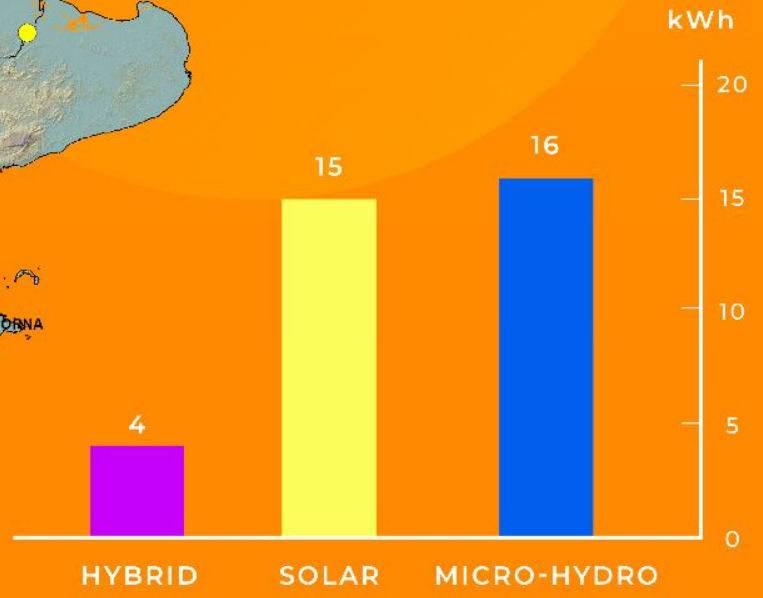
- Solar-hydro hybrid
- Solar-hydro hybrid
- Solar-hydro hybrid





57 VILLAGES & 35 SYSTEMS

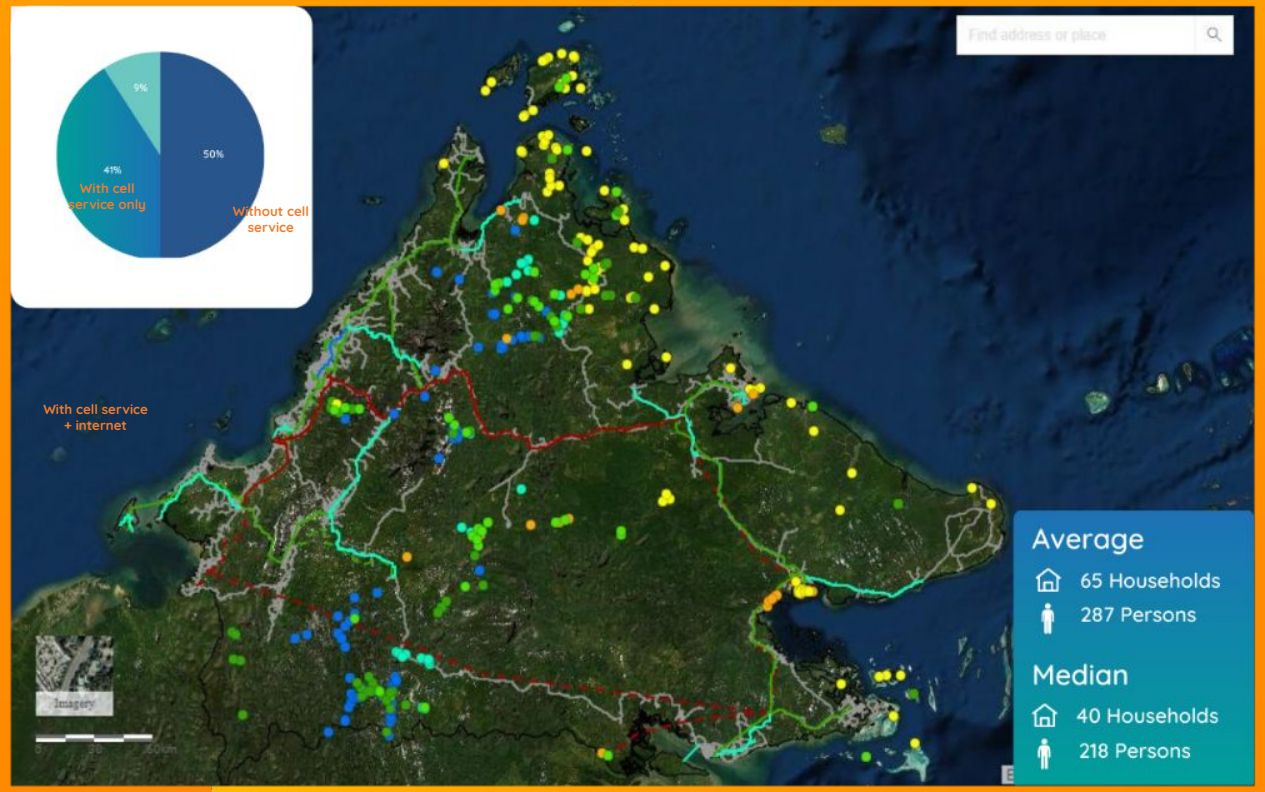
APPROXIMATE POPULATION OF 13,049

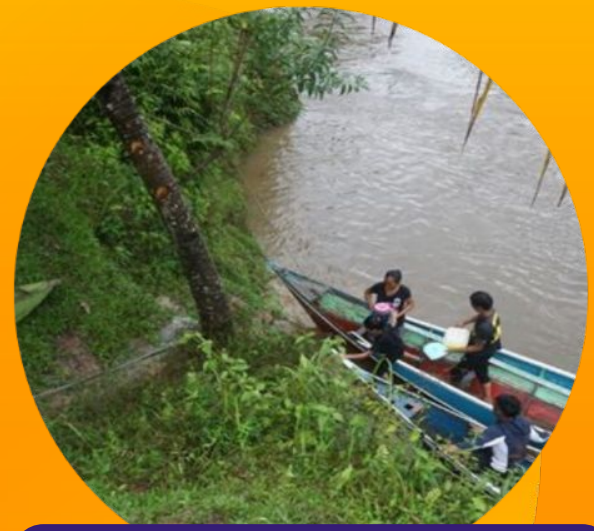


Feasibility Studies

Village Name	District	Population	Livelihood	System	Size/Capacity (Potential)	Estimated cost (USD)
Terian	Penampang	370	Subsistence farming	Micro-hydro	25	$ 527,205.00
Tiku	Penampang	218	Subsistence farming	Micro-hydro	36	$ 426,832.00
Pongobonon	Penampang	200	Subsistence farming	Micro-hydro	11	$ 241,766.00
Longkogungan	Penampang	174	Subsistence farming	Micro-hydro	12	$ 241,766.00
Buayan	Penampang	323	Subsistence farming	Micro-hydro	N/A	
Kalanggaan	Penampang	65	Subsistence farming	Micro-hydro	27	$ 378,930.00
Susui	Tongod	57	Subsistence farming	Micro-hydro	35	$ 426,832.00
Kawayoi (Sub-village:Kuom)	Tongod	190	Subsistence farming	Micro-hydro	N/A	
Tambunan 2	Tongod	36	Subsistence farming	Micro-hydro	25	$ 378,930.00
Abuan 1 & 2	Beluran (Paitan)	850	Subsistence farming	Micro-hydro	1	$ 75,786.00
Waigon 1 & 2	Beluran (Paitan)	757	Subsistence farming	Micro-hydro	5	$ 120,883.00
Mangkasulap	Beluran (Paitan)	300	Subsistence farming	Micro-hydro	5	$ 120,883.00
Walou/Pinulango	Ranau	140	Commercial farming	Micro-hydro	89	$ 609,760.00
Wakaku	Ranau	135	Subsistence farming	Micro-hydro	18	$ 421,764.00
Paus/Pakolo	Ranau	50	Subsistence farming	Micro-hydro	20	$ 303,144.00
Tinanom + Botun	Ranau	256	Subsistence farming	Micro-hydro	16	$ 316,323.00
Kigiwit + Barambang + Kodop Baru + Mindahu	Ranau	596	Subsistence farming	Micro-hydro	N/A	
Patau/Tokokodo	Ranau	360	Commercial & subsistence farming	Micro-hydro	10	$ 241,766.00
Tundingon	Ranau	355	Subsistence farming	Micro-hydro	3	$ 120,883.00
Pamaitan	Ranau	230	Subsistence farming	Micro-hydro	3.5	$ 120,883.00
Katalirus (sub-village: Matur)	Nabawan(Pagalungan)	264	Subsistence farming	Micro-hydro	13	$ 362,649.00
Tagapalang	Beluran (Paitan)	460	Commercial & subsistence farming	Hybrid	10	$ 103,380.00
Monopod	Beluran (Paitan)	150	Subsistence farming	Hybrid	20	$ 206,760.00
Buntung	Nabawan(Pagalungan)	130	Inland fishery	Hybrid	10	$ 103,380.00
Ponontomon (sub-villages: Kalabi (S.Kalabi), Penarakan dan Katapu	Nabawan (Pagalungan)	308	Subsistence farming	Hybrid	20	$ 206,760.00
Sasandukon	Nabawan(Pagalungan)	280	Commercial & subsistence farming	Solar	25	$ 562,500.00
Siwalor/Sumab	Nabawan(Pagalungan)	162	Commercial & subsistence farming	Solar	10	$ 225,000.00
Lampas Sabinait	Nabawan(Pensiangan)	80	Commercial & subsistence farming	Solar	10	$ 225,000.00
Layon A, B, C	Nabawan (Pagalungan)	395	Subsistence farming	Solar	20	$ 450,000.00
Linayukan	Beluran (Paitan)	208	Commercial & subsistence farming	Solar	25	$ 562,500.00
Dampiron 2	Beluran (Paitan)	68	Commercial & subsistence farming	Solar	25	$ 562,500.00
Atog	Beluran (Paitan)	218	Commercial & subsistence farming	Solar	20	$ 675,000.00
Salangan	Kudat (Banggi)	120	Costal fishery	Solar	20	$ 450,000.00
Tambising	Kudat (Banggi)	105	Subsistence farming	Solar	10	$ 225,000.00
Pulau Berhala	Sandakan	2123	Costal fishery	Solar	10	$ 225,000.00
Bongon	Sandakan	270	Costal fishery	Solar	50	
Pitas Laut	Kinabatangan	117	Costal fishery	Solar	10	$ 225,000.00
Dagat	Kinabatangan	243	Costal fishery	Solar	10	$ 225,000.00
Sonsogon Magandai	Kota Marudu	644	Subsistence farming	Solar	20	$ 450,000.00
Sonsogon Suyad	Kota Marudu	300	Subsistence farming	Solar	20	$ 450,000.00

Understanding Sabah's Un-Electrified Villages





TERRITORIES & ECOLOGY

Most are in isolated forested regions where villagers combine multiple livelihoods often living along rivers. A second cluster are within mangroves, on islands and in other isolated coastal regions where fisheries dominate. Traditional lands and ways of life are threatened, and communities divided about sustainability & long-term strategies

CULTURAL VALUES

Collective identity remains strong: "We practice communal labour in most of our activities such as farming, building repairs and celebrations." – Kg. Terian, Penampang

INTERSECTING ISSUES

Un-electrified villages also typically face water problems, and for cooking half access gas cylinders and half use firewood: opportunities for integrated solutions

FINANCIALLY POOR

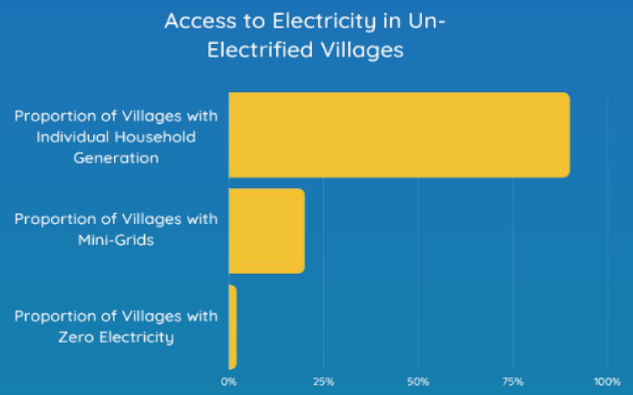
8 of the 10 poorest districts in Malaysia are in Sabah: 71% of the project portfolio's villages are in these very districts.

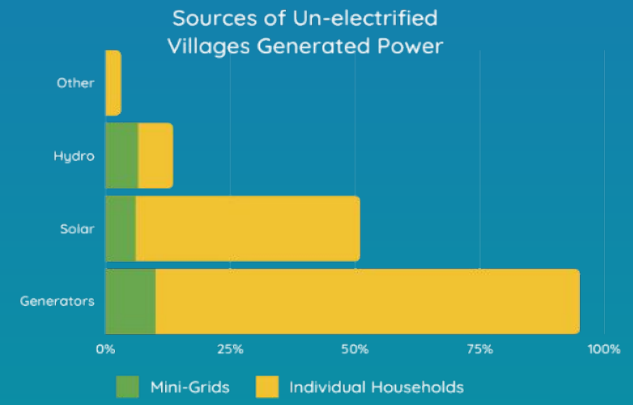
PHYSICALLY ISOLATED

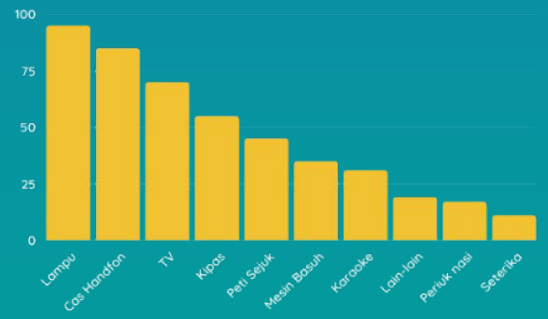
Far from sealed roads, commercial centres & nearly half reliant on boats for access.

PARTIALLY ABANDONED

Poor services mean 60% of villages experience seasonal abandonment (average of 8.6 households absent 6 months/year) and some whole villages are 'fallow'.







Current Electrical Access and Use in Sabah's Un-Electrified Villages

Most "Un-Electrified" villages have some access, however, it is mostly non-renewable, very expensive, and available only a few hours a day.

ACCESS TO ELECTRICITY

- 98% of villages have some Electricity – made up of basic mini-grids & in individual household systems.
- The most commonly used are diesel generators, of which there were an average of 15.7/village & 89% of villagers with at least one personal generator.
- However, these systems do not reach all villagers & have numerous operational problems.

HIGH COST

Due to the high cost transporting diesel over long distances using bad roads or boats, average lighting & electricity generation costs RM200-RM300 per month.

RELIABILITY

The situation varies widely across both villages and individual villagers, along a continuum between zero supply and continuous electricity of insufficient quality & expensive. Assessed against the ESMAP (World Bank) Multi Tier Framework they are at Tiers 0 to 3, whereas need and aspiration seek tiers 4 to 5.

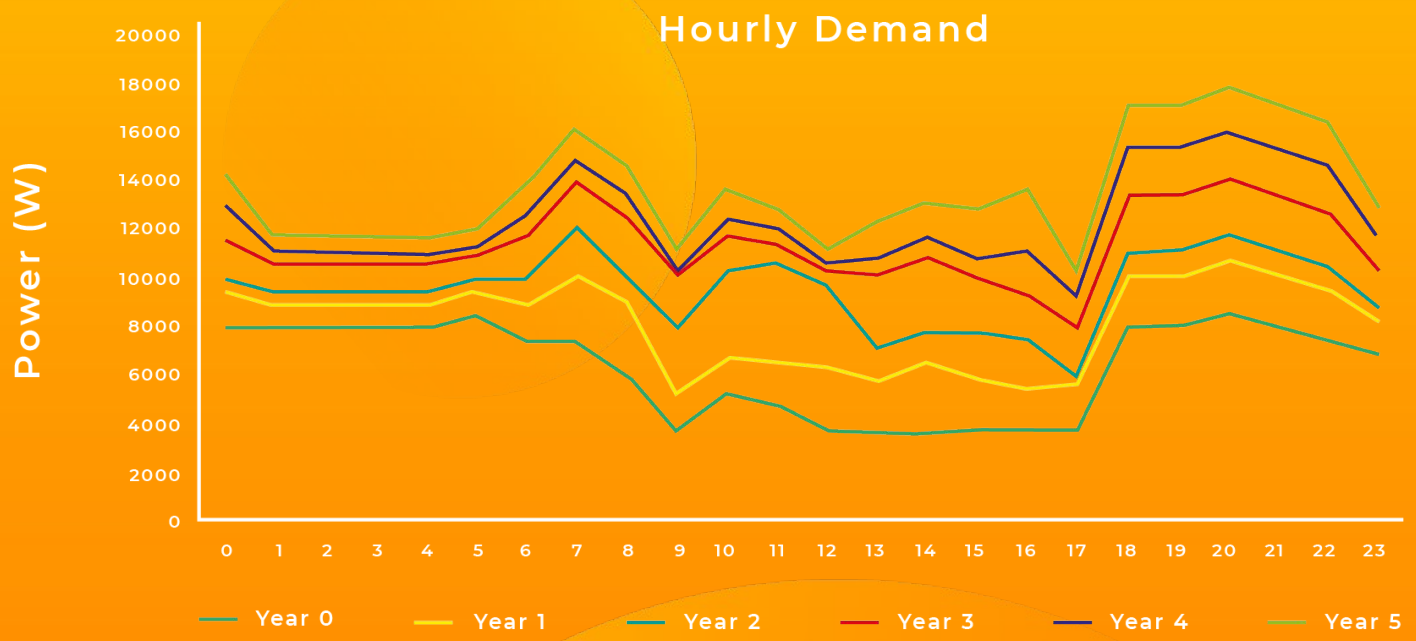
INSTITUTIONS

- 80% have churches or mosques, only half with electricity.
- 30% have schools and 9% have clinics – nearly all depending on diesel or diesel-solar hybrids.
- 43% have sundry shops, most un-electrified.
- 14% have agri-processing facilities, mostly un-electrified.

LOW AVAILABILITY FOR MOST

- On a given day 23-53% of villages report they have 4 hours of power or less and 60-86% have six hours of power or less; only 2% reported routinely 24 hour access.
- This is due to high diesel expense & the use of lower tier renewable energy systems.
- Most villages reported interruptions in supply daily, weekly or monthly.
- Many current systems also cannot support high energy appliances e.g. refrigeration.

A Future with Mini-Grids



FORECASTING NEEDS & GROWTH:

Calculations of daily demand level and flux suggests only mini-grids can meet current needs, let alone anticipate future demand for most villages: indeed we estimate demand will double over 8 years.

DEVELOPING & MANAGING MINI-GRIDS:

- Communities identified a variety of existing village level community organisations with the capacity to implement and manage mini-grids alongside local government agencies.
- 40% of communities pointed to village religious institutions, 10% pointed to women's groups and 10% to youth groups.
- Few villages believed they lacked institutions that could do this.

LOCAL BUSINESS OPPORTUNITIES:

- 56% of villages described ongoing business activities that would immediately benefit from electrification.
- Fridges & freezers were identified as key for both sundry shop development but also for cold storage for local products (including fish).
- Opportunities with electrification are homestays (ecotourism), restaurants, agri-processing, print shops, etc.
- Hands-on support for developing village enterprise could go hand-in-hand with technical support for electrical supply systems.

ANCHOR CLIENTS:

- One third of the villages have government facilities (schools & clinics) currently paying heavily for diesel generation with unreliable supply.
- 10% have agri-processing facilities that could be anchor clients.
- Telecommunications towers exist – or should exist – in most locations.
- Most villages have places of worship relying on expensive diesel gensets.

CAN PAY, WILL PAY:

- Willingness to pay for electricity, on a scale of 1-10, where 5 is the SESB rate; the most common response was 9 and the mean 8.29.
- Levelized Cost of Energy calculations suggest micro-hydro at RM0.90 & solar at RM2.78 per kWh, well below SESB grid connection rates.
- With 50% installation support we can be commercially viable at less cost than villagers currently pay for intermittent mostly non-renewable supplies (SESB tariffs is perhaps 80% subsidized).

DOMESTIC EXPRESSED NEEDS:

- Need for electricity for lights & phones is universal.
- 36% named need for fridges & mini-grids must support this for food handling & comfort.
- TVs and fans are sought by most, and a third want karaoke machines.
- Remote villages appear to afford these appliance purchases.

Legal forms of community ownership:

Community Ownership Model

Co-operatives

Co-operatives are jointly owned by their members to achieve common economic, social or cultural goals based on the democratic principle of "one member, one vote". Co-operatives rely largely on volunteers but can have paid staff.

Partnerships

In partnerships, individual partners own shares in the community-ownership model. The key objective of a partnership is to generate profits for the shareholders, in addition to any other benefits of the project. Unlike co-operatives, partnerships may not operate on the basis of "one member, one vote". Nor do partnership firms rely largely on volunteers, as co-operatives do. They may employ full-time staff to provide expertise needed for specific projects.

Non-profit Organisations

A non-profit organisation is formed by investments from its members, who are responsible for financing the organisation but do not take back any profits. Profits are reinvested in projects focused on community development.

Community Trust

Trusts use the returns from investment in community projects for specific local purposes. These benefits are also shared with people who are not able to invest directly in projects.

Housing Associations

A form of non-profit, such association offer housing to low-income families and individuals.

Mini-Grid Operational Models:

1 Utility

Pros:

- Experienced, with more capacity
- Usually more established

Cons:

- Governed by political agenda
- Market-driven (low rural electrification priority)

2 Private

Pros:

- May have better operational/ management capacity
- Incentivised to promote financial viability

Cons:

- Lack of financial support

3 Community

- Co-operatives
- Community-owned management committee
- Housing associations

Pros:

- Buy-in/Sense of ownership
- Reduces bureaucracy

Cons:

- Lack of technical skills
- Governance and social conflicts

4 Hybrid

Pros:

- Opportunity to combine different strengths and advantages

Cons:

- Inclusion of multiple entities could increase (transaction) costs
- Need to balance different interests

Existing rural electrification efforts in Malaysia:

Rural Electrification	Estimated Costs	Challenges/Shortcomings	Notes
Grid extension through BELB (Government rural electrification programme)	< RM100,000/household connection (budgeted limit)	Relies heavily on government energy policy, particularly in the south, where generation capacity is low Relies on road access Not cost-effective for remote areas	First-choice (but not always least coast) strategy. Other options are only considered if costs exceed RM100,000/household (for Sabah. RM80,000/household for Peninsular Malaysia).
Off-grid mini-grids through BELB (Government rural electrification programme)	RM15,000 - 50,000/household for 20 - 100 households. Not included: Additional costs for transportation other than water and land.	Lack of operations and maintenance know-how locally Focus is solely on delivering electricity connections	Costs are for solar hybrid systems. Systems deployed are a mix of technologies (e.g. diesel, solar, micro-hydro, solar hybrid).
Solar home systems through BELB (Government rural electrification programme)	*N/A. The World Bank estimates that good quality solar home systems cost between USD 200-400.*	Limiting in its ability to support productive end-uses of electricity Also relies on technical support network for maintenance which currently does not exist	Only for extremely remote communities.
Sarawak's SARES program (State rural electrification programme)	RM55,000 - 65,000/household connection	So far dedicated to residential energy use only	For a daily 1kW, 3kWh per household systems. Mostly solar mini-grids, with some micro-hydro. Solar home systems for extremely remote and small communities.
Community-based/involved Mini-grids (Private/civil society initiatives)	RM30,000 - 65,000/household (based on technology, location)	May operate outside of safety and reliability standards or regulations	For systems between 5-30kW systems. Mostly micro-hydro, with some solar.

How can we accelerate rural electrification to these communities?

Note: Presentation transitions from individual "projects" to the "program"

Now that we understand the need and the potential solutions, **how do we support the local energy access sector** and **how to we ensure that these projects meet the immediate and long-term needs of rural Sabahans?**

We need a strategic intervention in Sabah's renewable energy sector to **accelerate the funding, prioritization and deployment** of off-grid renewable energy installations.

We need to enable an **ecosystem where the public sector, financiers, civil society, community stakeholders, and community-based partner organizations** work together in harmony.

Communities need to be **engaged to ensure ownership, participation, and accountability** of the projects.

Must be cost effective - less than BELB programs and designed to sustained sufficient quantity (kwH/HH) and maintenance of system over time.

The proposed "program" efficiently and transparently **manages available funds and channels them to the people who need them** – the rural communities and those that can best help communities meet those needs.

Launch Model

Goal: demonstrate that this is a cost-effective, socially responsible, sustainable model to fund, execute rural electrification at an accelerated pace.

Aspirational Model

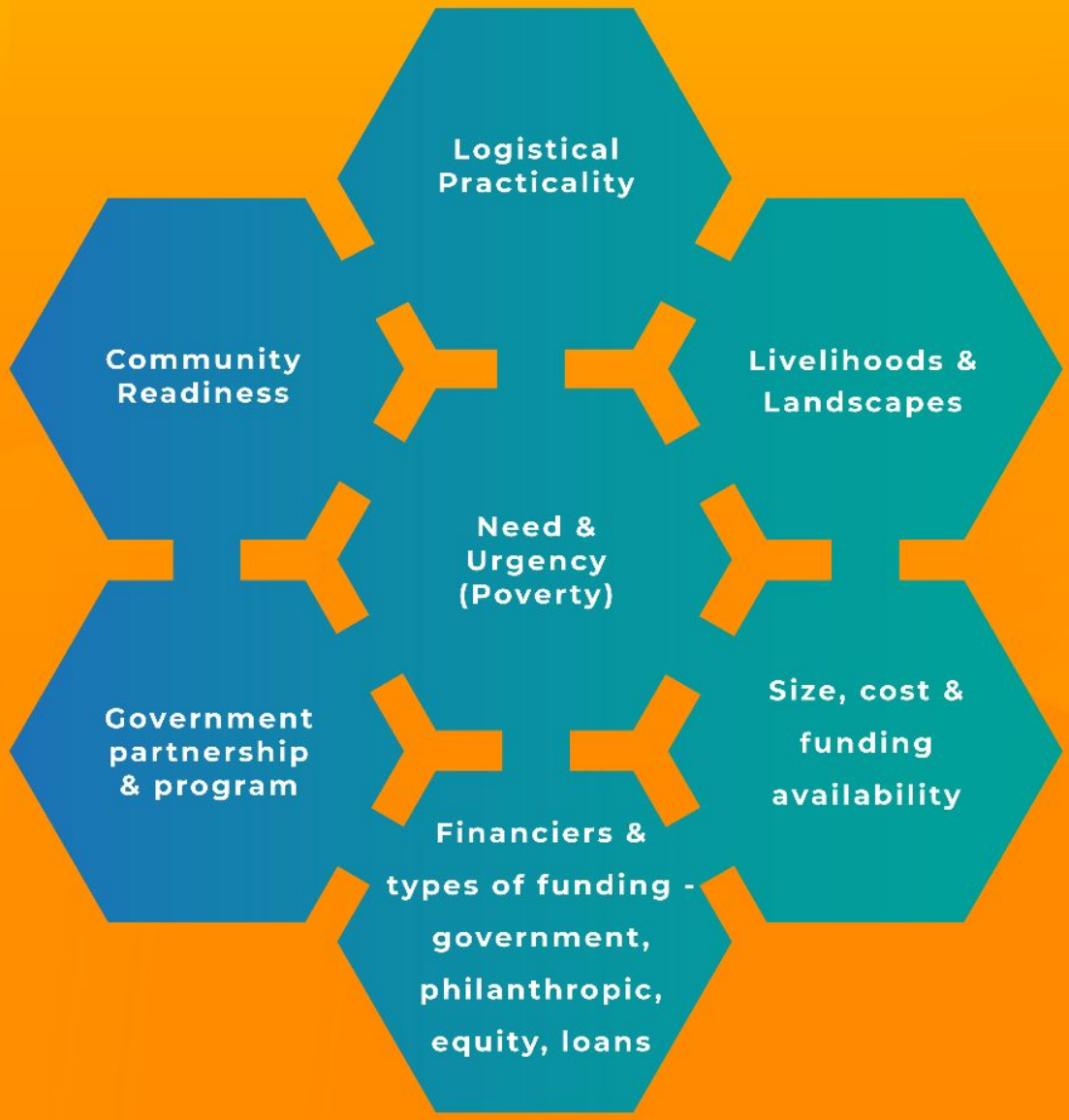
Goal: Based on a proven track record with technically successful and financially viable mini-grids in earlier phases, the program becomes an independently-operating initiative with an electrification fund and a self-sustaining business model that can achieve 100% electrification for Sabah's rural communities.

Flow of money

Flow of goods & services

Flow of reporting & mandate

Selection Criteria



DELIVERY ECOSYSTEM

Funders
UPEN
KPLB
IDS
NRO
Others

Government Engagement
Advisory Board

Sector Accompaniment
Support

Funding ◀ Support

Installations
Tech support

Sector
Accompaniment

Community
Engagement

Universities
Social Enterprises
Private Developers
Vocational Centres
SESB
"Sol Energy"
Others

Installations
- Community Systems
- Developer Systems (TSD)

◀ Support

CBOS
DEV groups
Enterprise Dev. groups
KPLB Programs
Others

Phased Rollout & Funding

PHASE 1

(2022-2024):

Launch Model with 7 Demo Systems

USD2,500,000

Philanthropic grants
Government programs
Private Funding (e.g. CSR)

PHASE 2

(2024-2026):

Scaling with 28 Systems

USD9,140,000

Philanthropic grants
Government programs (incl. loan guarantees)
Private funding (e.g. equity)
Impact Investment
Loans - direct, subsidized interest, etc.
Climate/ESG funding

PHASE 3

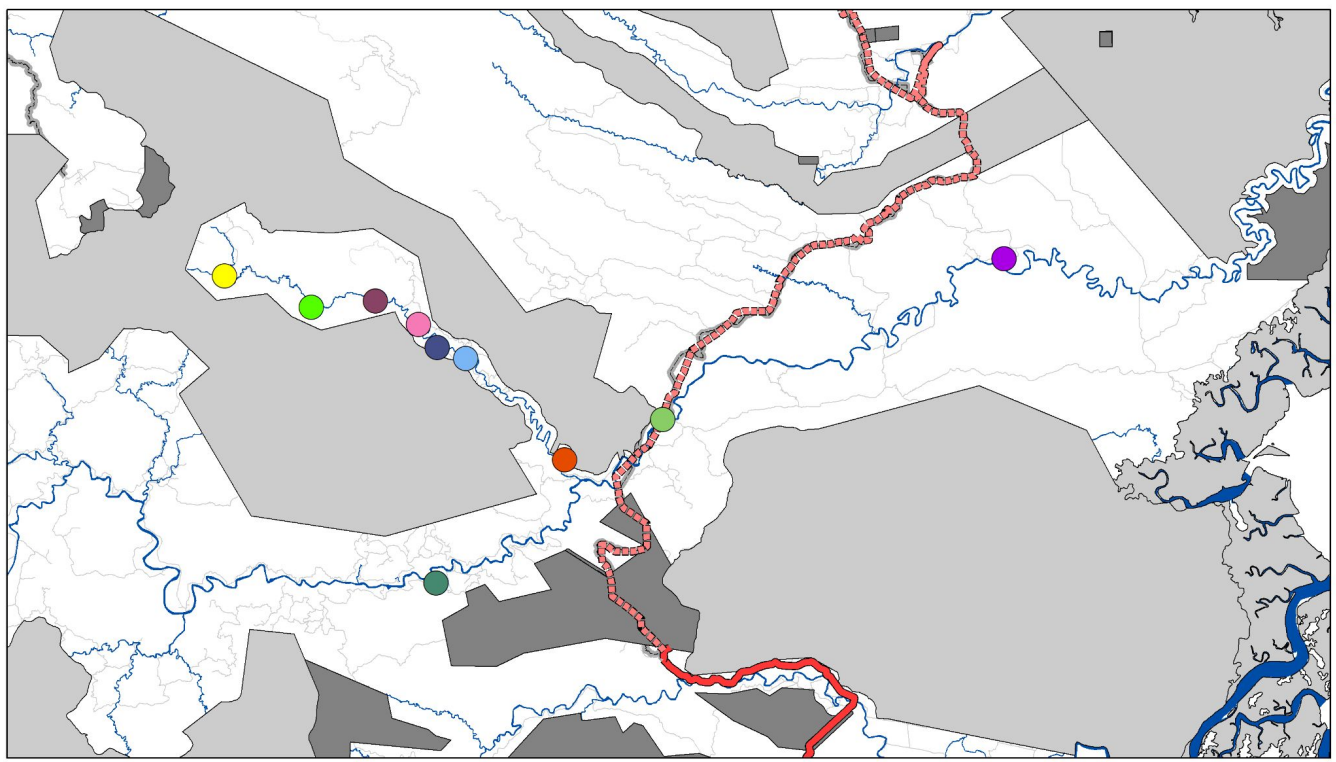
(2026-2030):

Aspirational Model with 160 Systems

USD50,000,000

Philanthropic grants
Government programs (incl. loan guarantees)
Private funding (e.g. equity)
Impact Investment
Loans - direct, subsidized interest, etc.
Climate/ESG funding

Phase 1 - 2022 to 2024



Key Aims

- 7 mini-grids completed
- 5 new contracting companies trained to work on mini-grids
- 5 productive end-use business plans developed
- Pilot regulatory & quality assurance framework and roll-out
- 160 mini-grid feasibility studies completed

RE Output Targeted

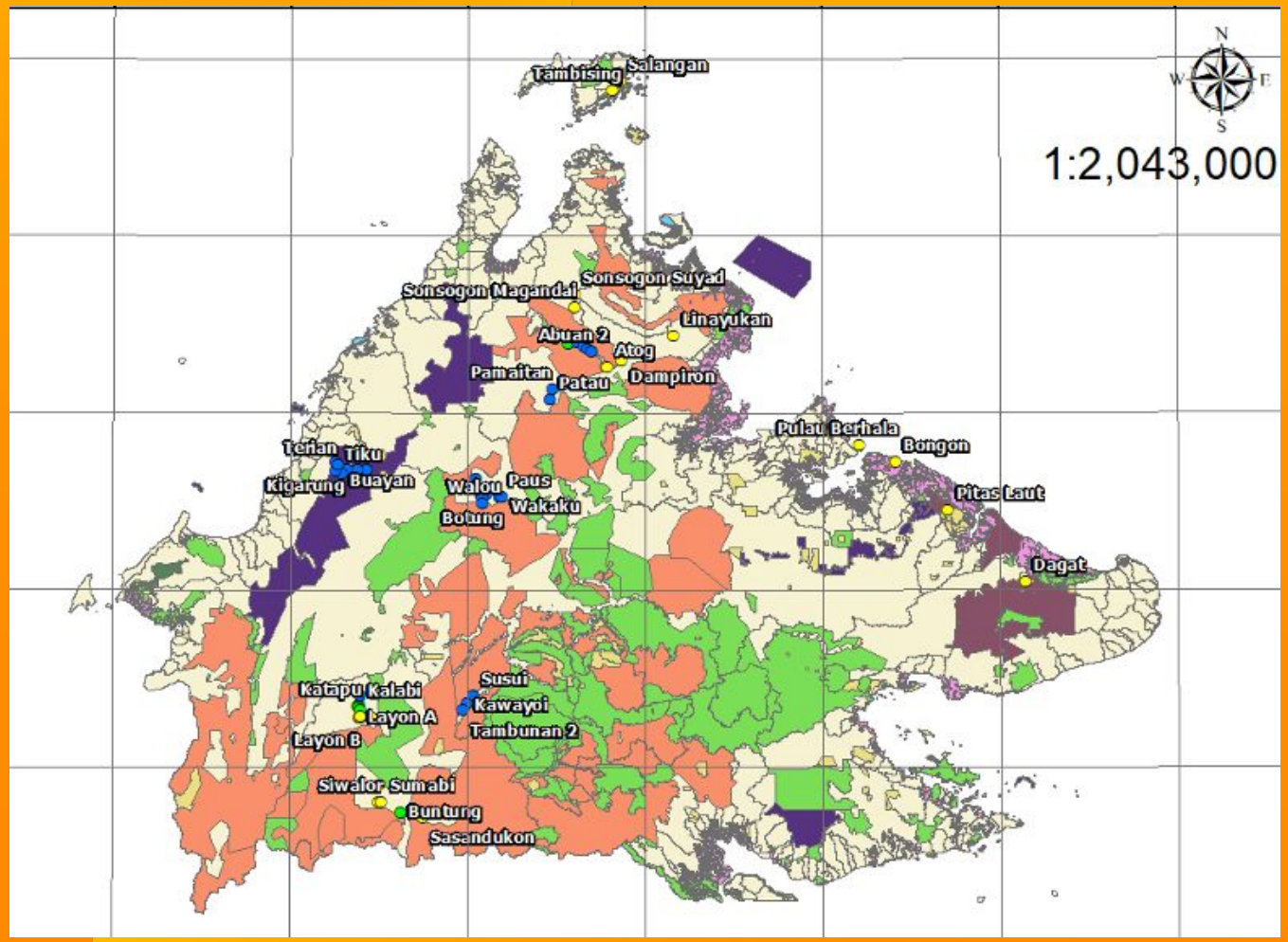
- 120 kW

Estimated Cost

- $2,500,000

The 10 kampungs in Paitan, a sub-district of Beluran, were selected for discussion as an important accessible cluster, along a single river system to simplify logistics and collaborative training in one of the poorest districts of Sabah. 7 are in RMK12; due to high potential for Micro-Hydro Power, we studied and present a comparison.

Phase 2: 2024-2026



Key Aims

- 28 mini-grids completed
- 5 new contracting companies trained to work on mini-grids
- “Mock” debt financing covers minimum of 30% of the costs of all mini-grids
- Village productive end-use activities supported in (at minimum) 9 of the villages
- Payment for ecosystem service (PES) models piloted in 9 villages
- Clear standards established for mini-grid development and contracting procedures

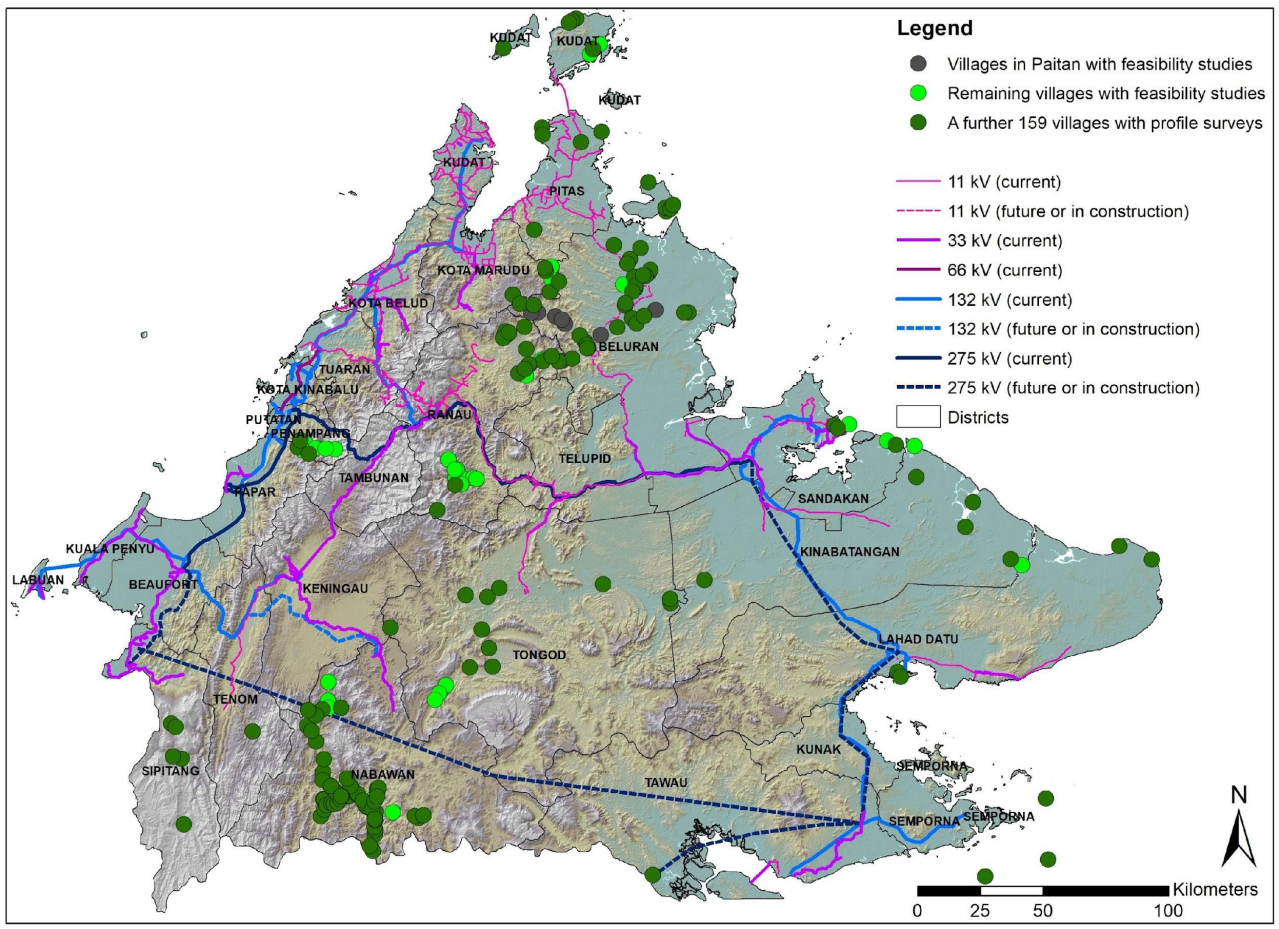
RE Output Targeted

- 580 kW

Estimated Cost

- $9,140,000

Phase 3 - 2026 to 2030



Key Aims

- 160 mini-grids completed
- Aspirational Model roll out
- Policy Framework established

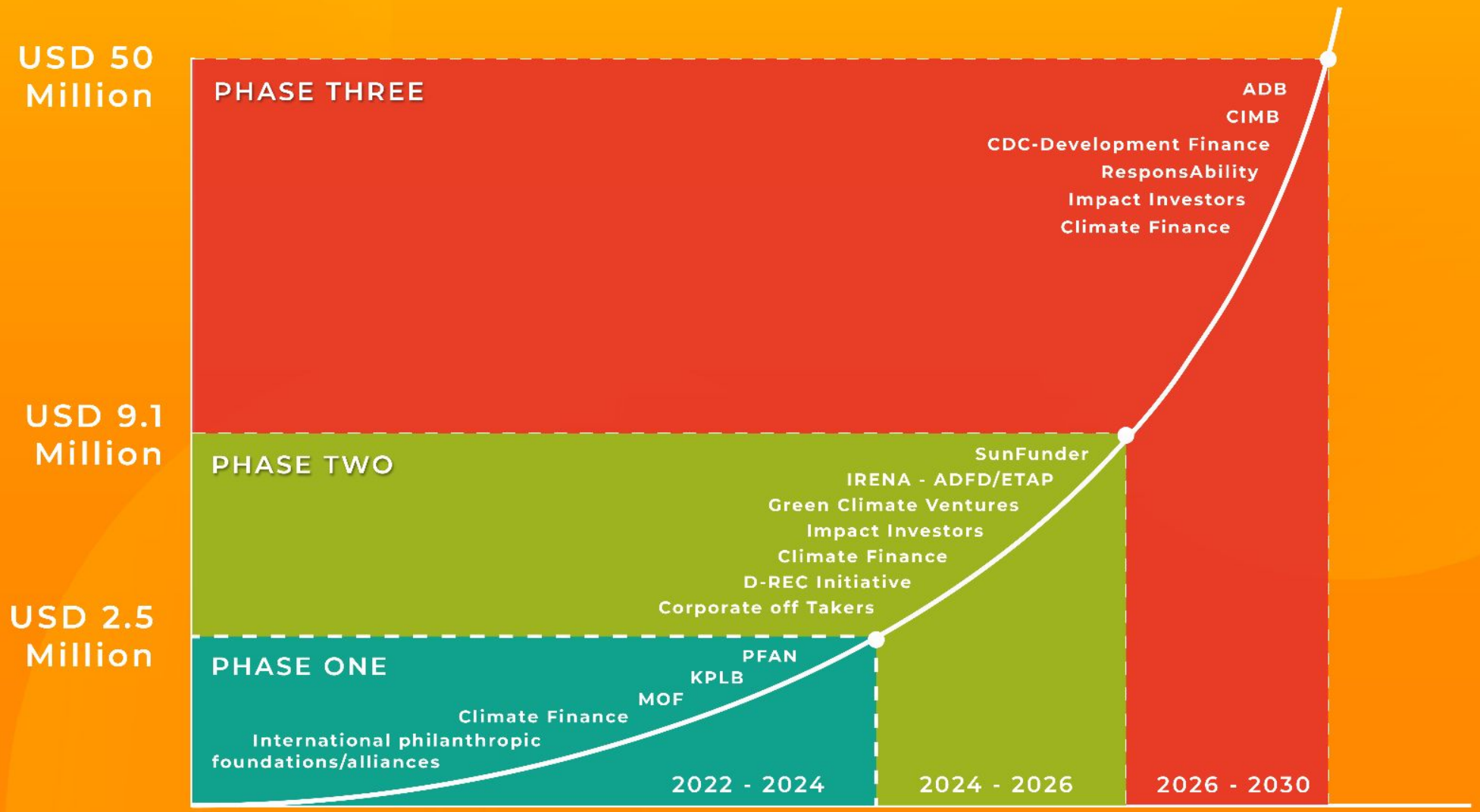
RE Output Targeted

- 3,000 kW

Estimated Cost

- $50,000,000

Potential Funding Partners



Immediate Next Steps

Jan to June 2022

Socialization amongst finance advisory group for feedback and fine-tuning

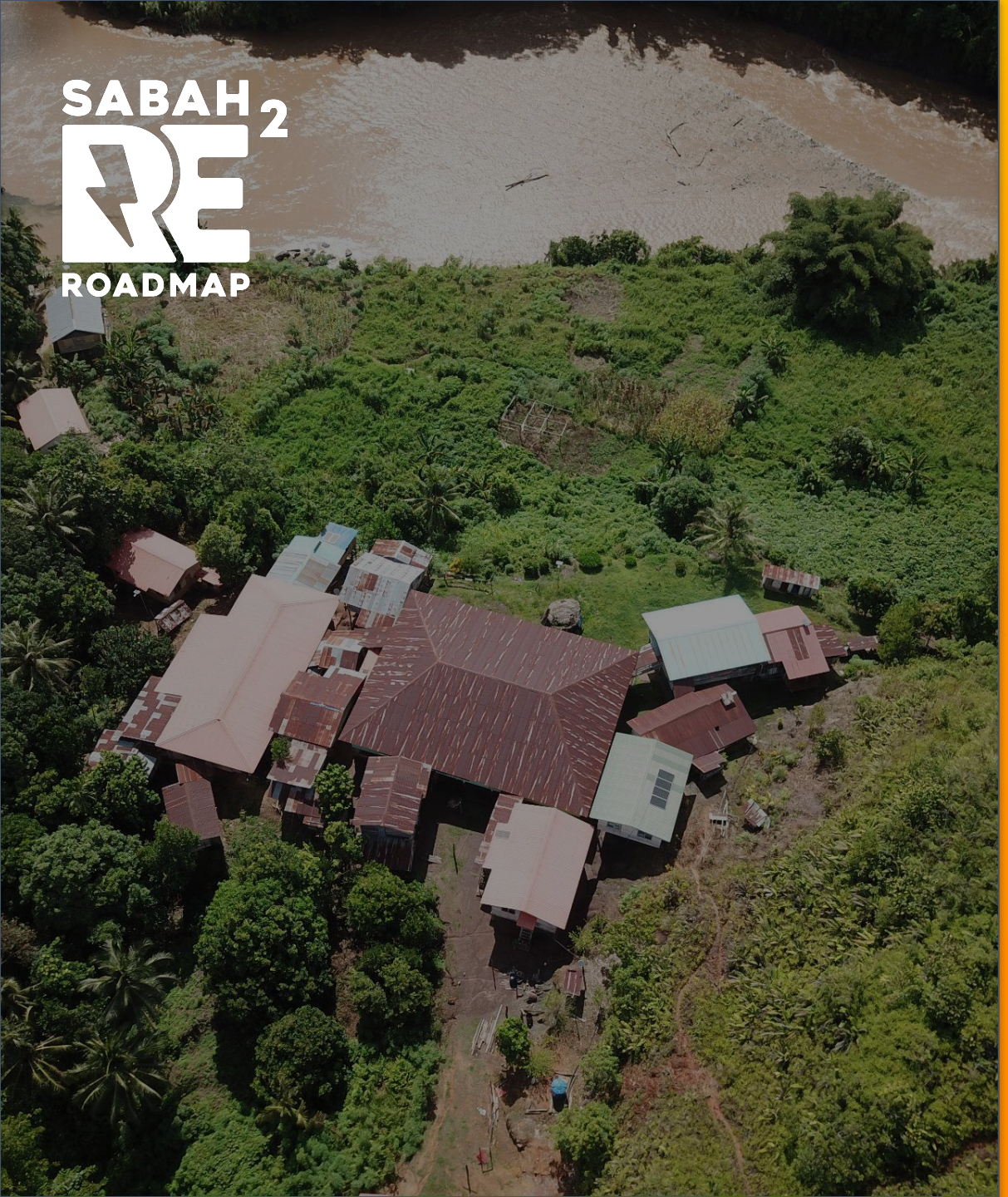
Socialization amongst Government partners - along with other components of the Roadmap - for input

Key discussion and decision with Government Partners around Launch and Aspirational Models, Selection Criteria and Phased Approach

Deeper discussions and decisions with Government Partners on Phase 1 - locations, district/s, partnerships, timeline

Specialized expertise to collaborate on Fundable Proposals for Phase 1

Continued engagement with potential funding partners



For More Info

Sabah Renewable Energy Rural Electrification Roadmap

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