THE POTENTIAL FOR ADVANCED BATTERY STORAGE MINI-GRIDS IN SOUTHEAST ASIA

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Hybrid innovative businesses and community projects from the global south

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Australia - Mekong Partnership
Environmental Resources & Energy Systems

SEA ELECTRICITY ACCESS: NOT ALWAYS AS IT SEEMS

Rapid national progress on electrification

Focused upon urban areas with **rural areas lagging behind**

- **Quality and consistency of supply remains a problem in many areas**
- National electrification figures often over-state actual access to electricity – **grid connection does not equal electricity access**
- Cost of grid based supply (borne by consumers and/or utilities) also remains an issue in many rural areas

Lack of effective electricity access (for household and productive uses) in many rural areas of SEA remains an important constraint to development and poverty reduction

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MINI-GRIDS HAVE AN IMPORTANT ROLE IN SEA

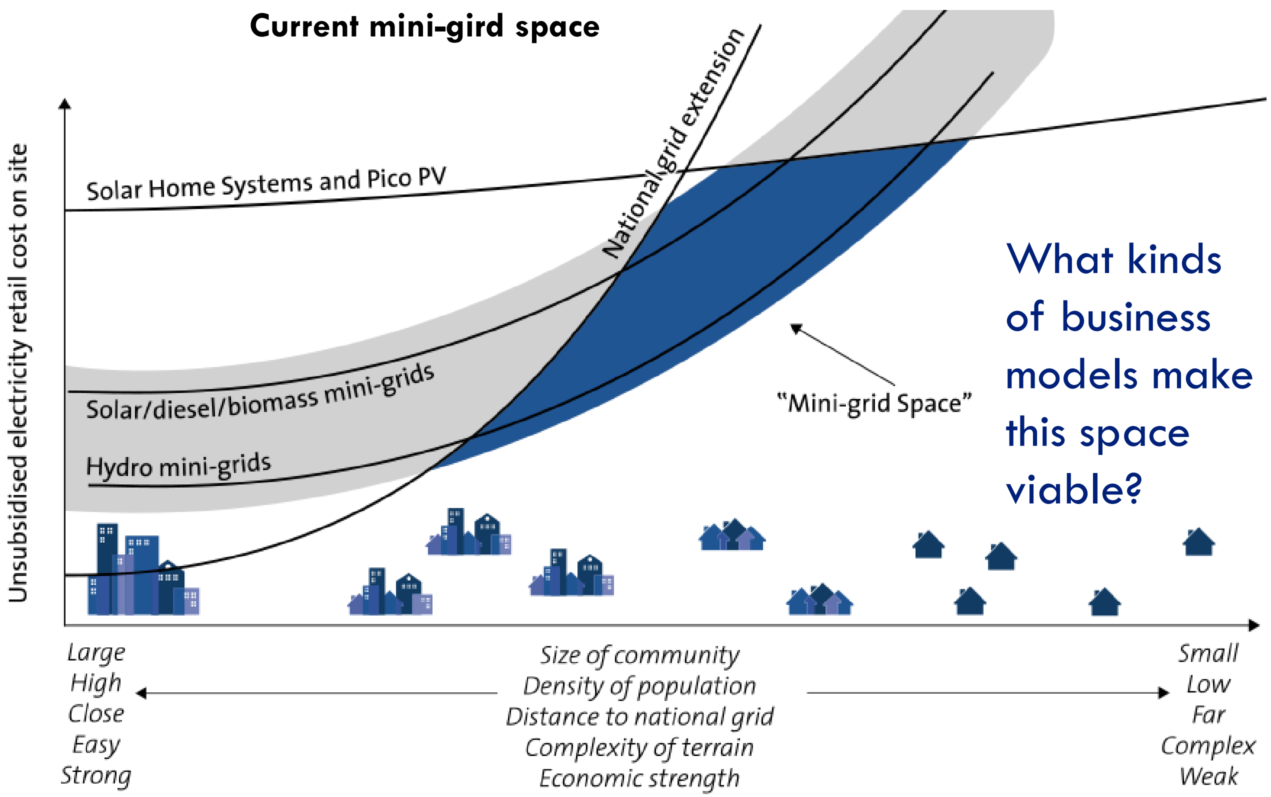
Two key **niches** for the development and deployment of mini-grid technologies:

- **Remote and difficult to reach communities** for example in mountainous areas (Vietnam, Laos) and on islands (Indonesia, Philippines)
- **Rural users in countries** such as Cambodia and Myanmar with **under-developed grids**

Development of mini-grids in SEA also has important ancillary benefits

- Local ownership and control of energy supply
- Integration of locally available RE
- Greater resilience to natural disasters

MINI-GRIDS ARE NOT ALWAYS THE OPTION OF LAST RESORT



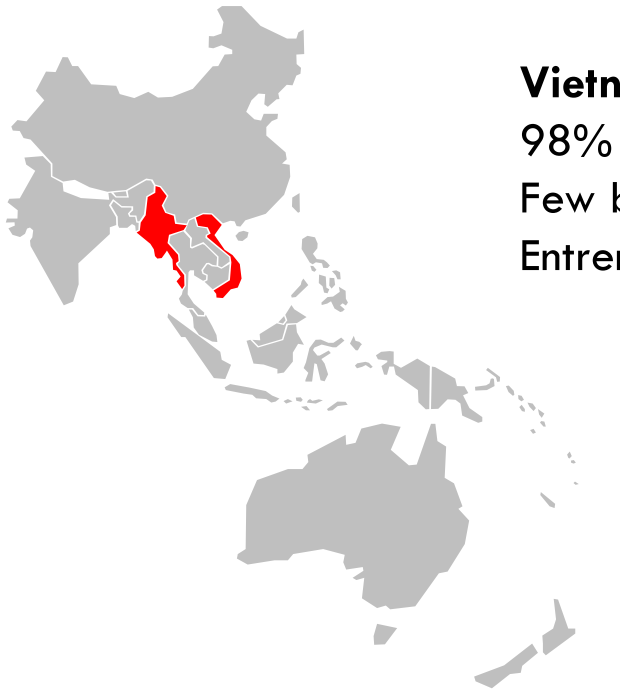
What kinds of business models make this space viable?

Mini-grids can function:

- More **cost effectively**
- With **greater reliability**
- With **greater resilience**
- With **lower environmental impact**

Source: Source: EU Energy Initiative Partnership Dialogue Facility (2014). Minigrid Policy Toolkit

TWO EXAMPLES FROM SEA



Vietnam
98% grid penetration
Few blackouts (normally from storms)
Entrenched off-grid 'islands'

Myanmar
30% grid penetration
Frequent blackouts
Wide-spread energy poverty in rural communities

HYDRO-MINI GRIDS IN VIETNAM

From 1960s

- Small hydro development in Vietnam started in the 1960s;
- Extensive construction of projects to serve small mini-grids in remote areas;
- Funding from the state budget for construction of civil works, with equipment imported from China and eastern Europe.

From 1980s

- Diversification of the forms of investment, many built by military units, cooperatives and local communities, most with provincial assistance.
- **Expansion of pico-hydro (<500W) – up to 150,000 units**
- Diesel and HFO generators also common
- SHP development slowed by early 1990s lack of investment capital
- Expansion of national grid into rural areas
- By 2000 many SHP abandoned e.g. 200 stations

ASTAE, 2011

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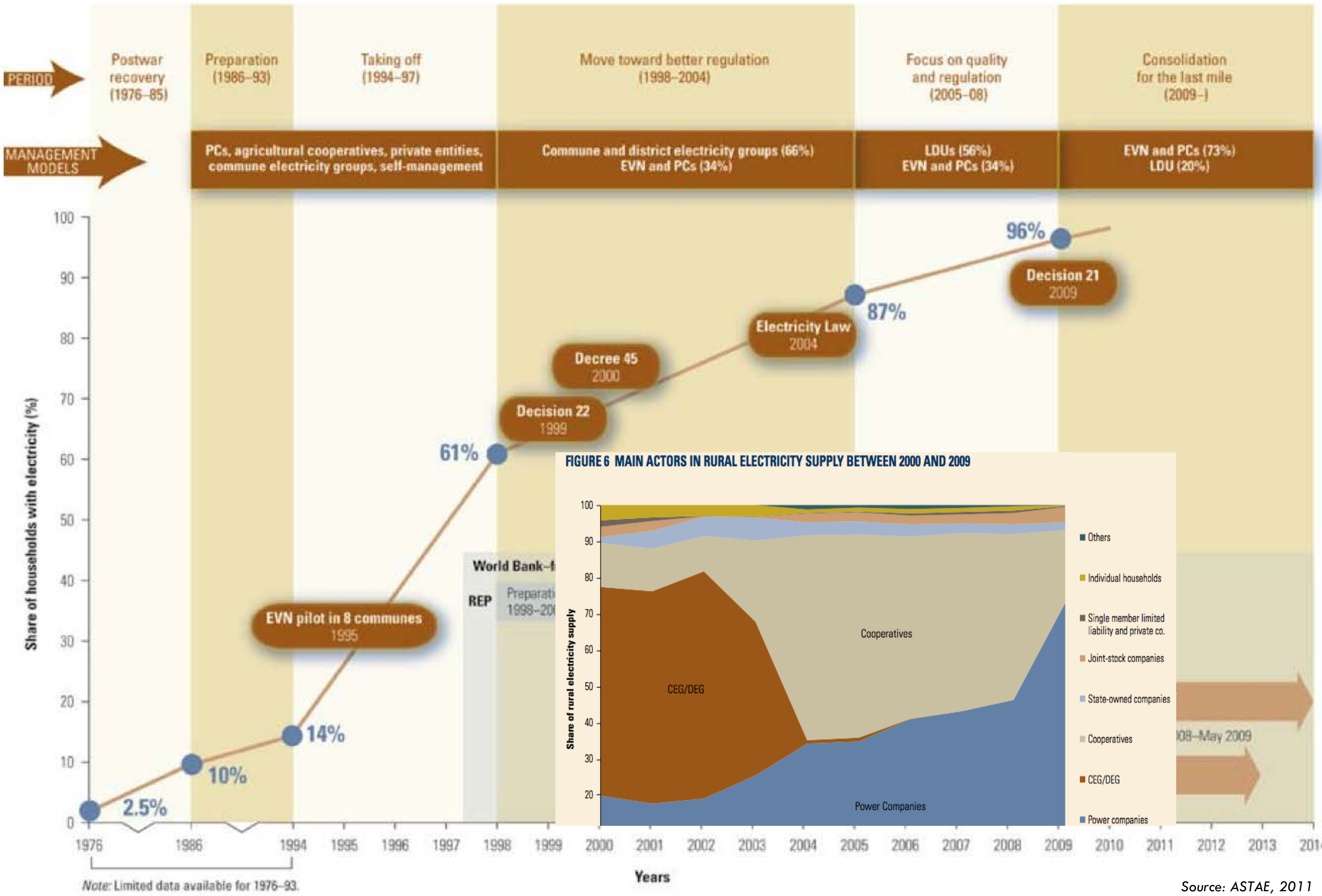

Source: ASTAE, 2011

KEY CHALLENGES FACING MINI-GRIDS IN VIETNAM

1. **National**: Entrenched powerful electricity utility with vested interests in incumbent technology & monopolized market
2. **Community level:** Capital investment

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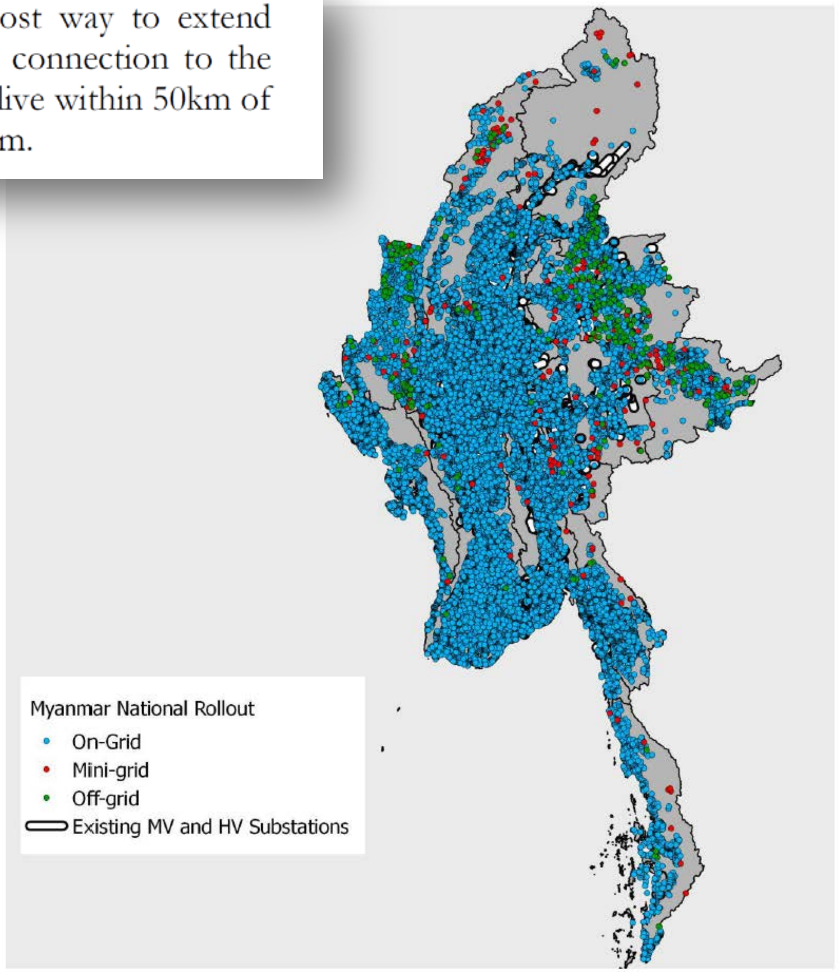
MYANMAR'S ELECTRIFICATION PLAN: 30 TO 100% IN 12 YRS

The key conclusion from this geospatial modelling is that the least-cost way to extend electrification to 98 per cent of the population in Myanmar is through connection to the national grid. Approximately 98 percent of the population of the country live within 50km of an existing or planned transmission line, with 92 percent living within 25km.

Figure 2.2: Recommended Electrification Solutions



Challenges with the existing plan:

1. **Ambition** – 100% universal electrification by 2030 by grid-only is… ambitious.

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MYANMAR’S ELECTRIFICATION PLAN

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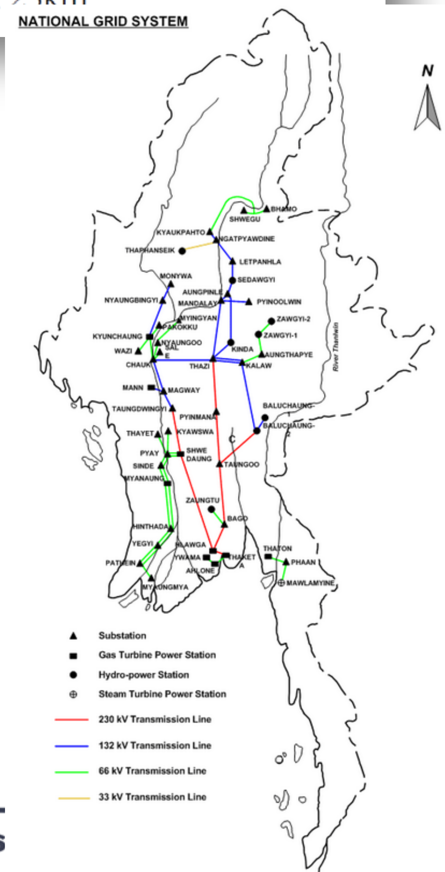
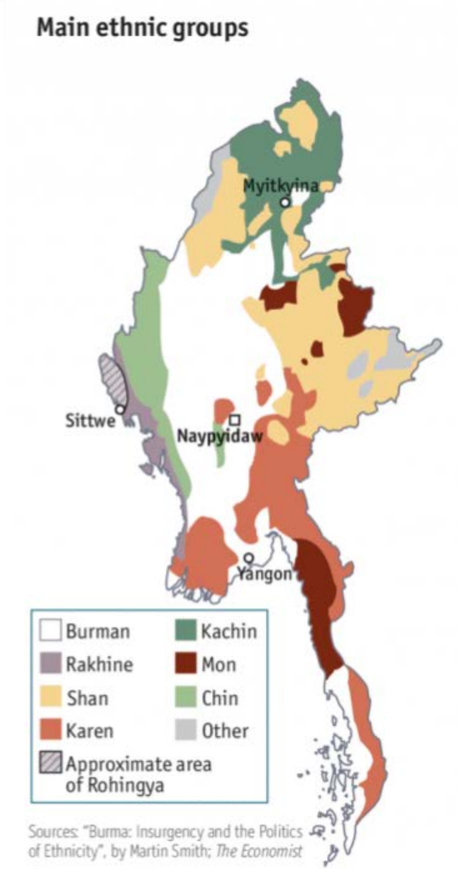
Challenges with the existing plan:

1. **Ambition** – 100% universal electrification by 2030 by grid is ambitious.
2. **Equity** – rate of access to electricity will be uneven for peoples of Myanmar.





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MYANMAR'S ELECTRIFICATION PLAN

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Challenges with the existing plan:

1. **Ambition** – 100% universal electrification by 2030 by grid is ambitious.
2. **Equity** – rate of access to electricity will be uneven for peoples of Myanmar.
3. **Practicality** – the plan ignores the 1000s of existing mini-grids that exist already as part of a thriving commercial-community ecosystem (economy).

Generation type (DRD data)	Number of villages	Main source of lighting (2014 Census data)	Number of households		
Category		Category	Rural	Urban	Total
Generator	13,088	Generator (private)	835,840	177,309	1,013,149
Mini-or micro-hydropower	2426	Water mill (private)	151,721	25,786	177,507
Biomass/gas	1232		N/A	N/A	N/A
Solar system	2693	Solar system/energy	902,431	42,811	945,242
Total	19,439		1,889,992	245,906	2,135,898
Total (not including solar)	16,746		987,561	203,095	1,190,656

Graecen, 2014, Mini-grids in Myanmar: SWOT analysis & a roadmap for scale-up

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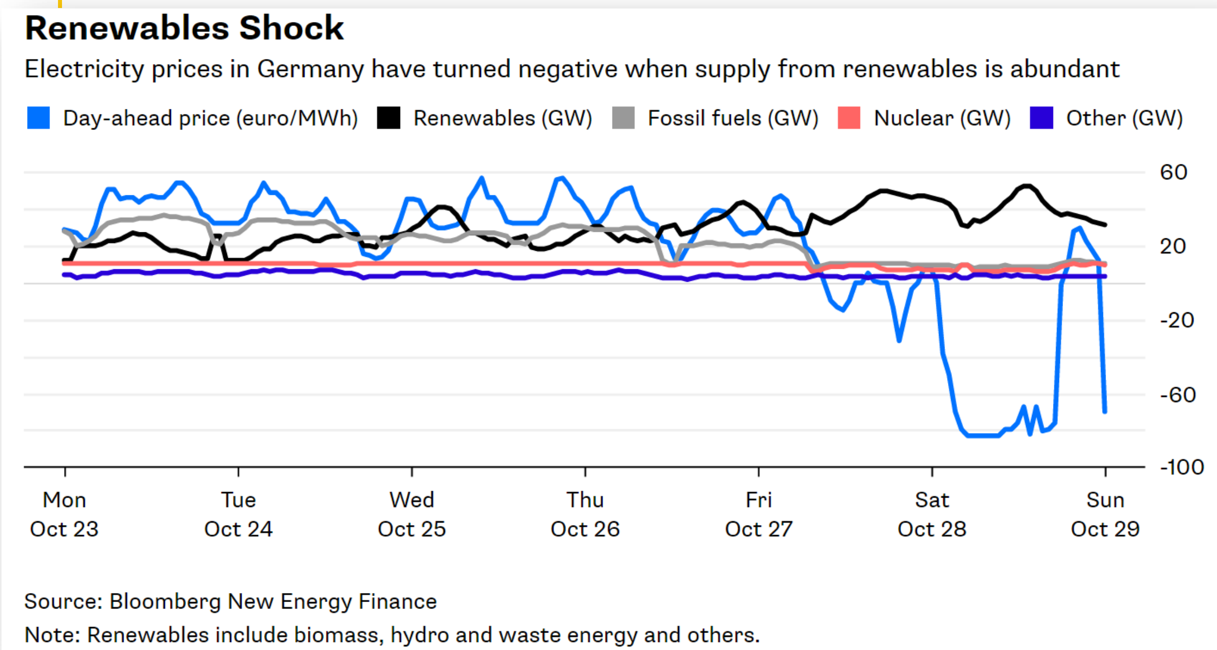
Sai Hla Htun Brothers Co.

80kW pelton turbine

KEY CHALLENGES FACING MYANMAR'S EXISTING HYDRO MINI-GRIDS

1. Access to financing
2. Ill-suited banking sector
3. Inconsistent and unsupportive regulatory climate & arrival of the grid
4. Poor visibility of the sector
5. No platform for industry advocacy
6. Profitability in the dry season (i.e. resource variability)
7. Limited scope for specialization
8. Investment in research
9. Instruments to stimulate productive uses

HOW COULD ADVANCED BATTERY ENERGY STORAGE (BESS) HELP?



RENEWABLES GRIDS/MINI-GRIDS NEED:

1. **Reliability** – ensure dependable supply
2. **Flexibility** – buffer variability between supply and demand

LEARNING FROM BESS OFF-GRID APPLICATIONS IN AUSTRALIA

UNLIMITED ENERGY AUSTRALIA

TESVOLT
THE ENERGY STORAGE EXPERTS

OFF-GRID AVOCADO FARM, PEMBERTON WA

- 53kW solar PV
- 160kWh Aquion (salt water)
- 48kWh TESVOLT (li-ion)

- Ground mounted pv system is capable to run the Farm 100% on renewable sources.
- Combination of different battery technologies together with SMA multicluster solution.
- First time salt water batteries have never been used in a deployment of this scale and configuration.
- In order to meet high surge demand 48kWh TESVOLT TS was used as a 3rd cluster to provide fast discharge option.

37-45 AU cents/kWh
Peak tariff

63A
80A

System
upgrade
Single phase limit

Unpredictable
Energy prices

Alternative safe
Energy supply

Modular System
420-900A

60-100%
Independence

53 kW SOLAR PV + 160 kWh AQUION CLEAN & SAFE ENERGY STORAGE + 48kWh TESVOLT TS 50 / OFF-GRID

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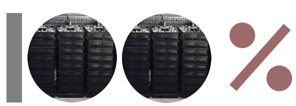
TESVOLT
THE ENERGY STORAGE EXPERTS

TWO BATTERY TECHNOLOGIES

AQUION (Aqueous ion)

TESVOLT (Li-ion)

- 4.8kWh Module Increments
- In-house battery management system (BMS) to optimize SOC



CLEAN and SAFE

SALT-WATER BATTERIES

UNLIMITED ENERGY AUSTRALIA

COMBINED

with

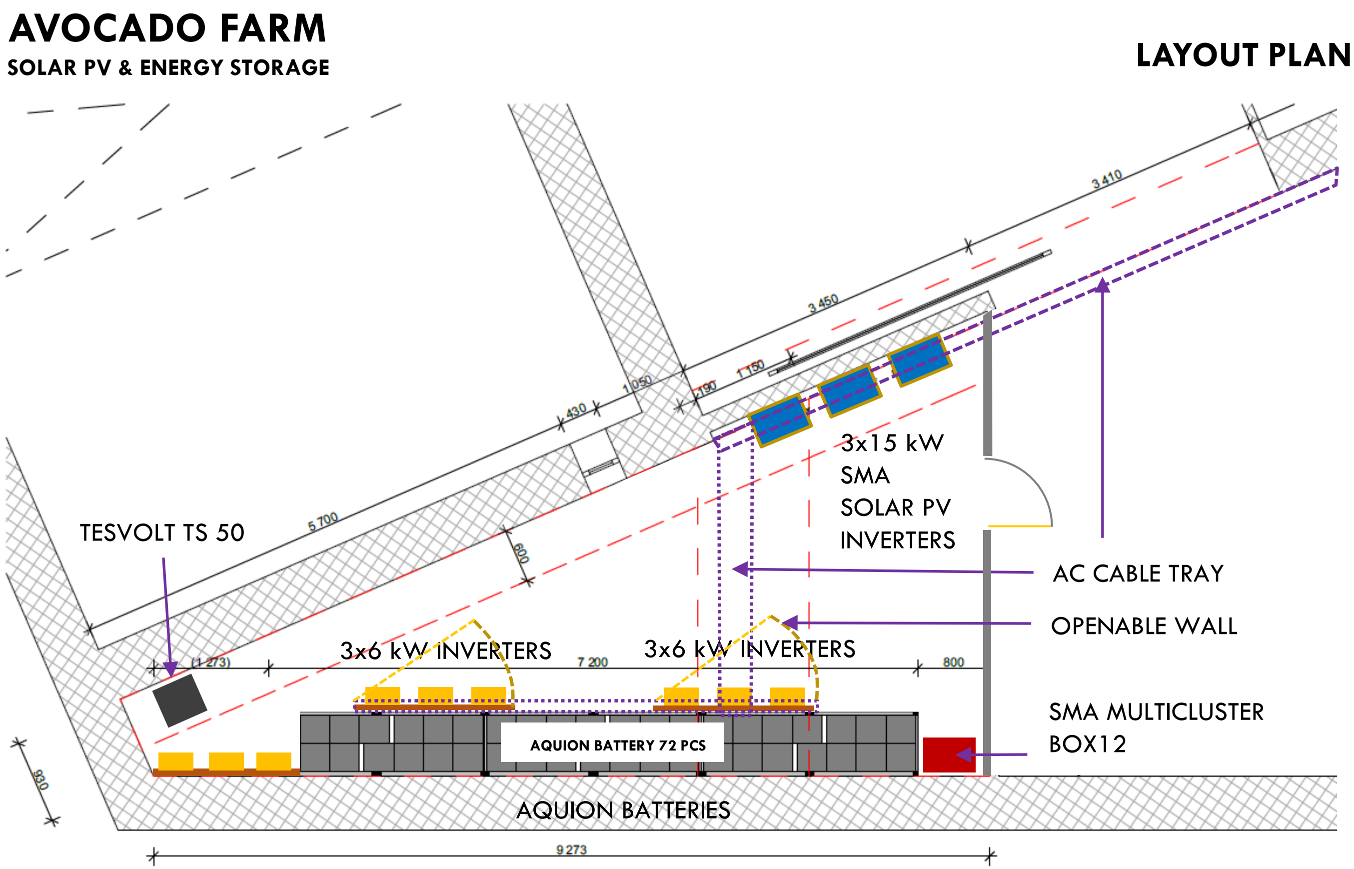
HIGHLY EFFICIENT

TESVOLT SYSTEM

TESVOLT

THE ENERGY STORAGE EXPERTS

BESS LAYOUT



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TESVOLT THE ENERGY STORAGE EXPERTS

Phase I.
160 kWh Aquion
Batteries

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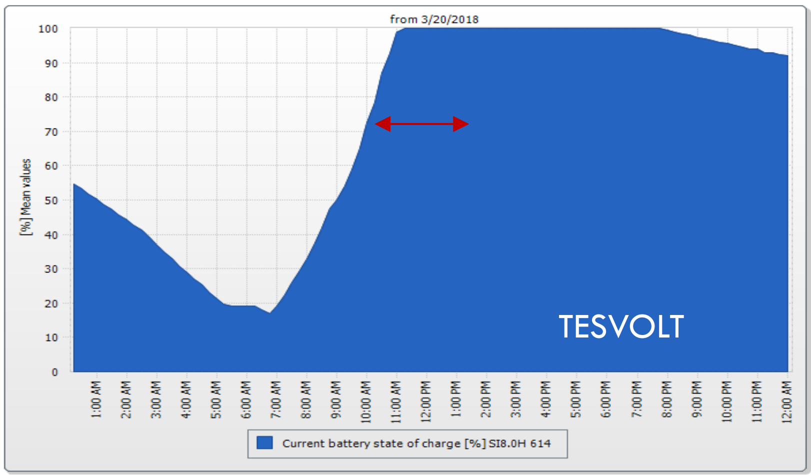
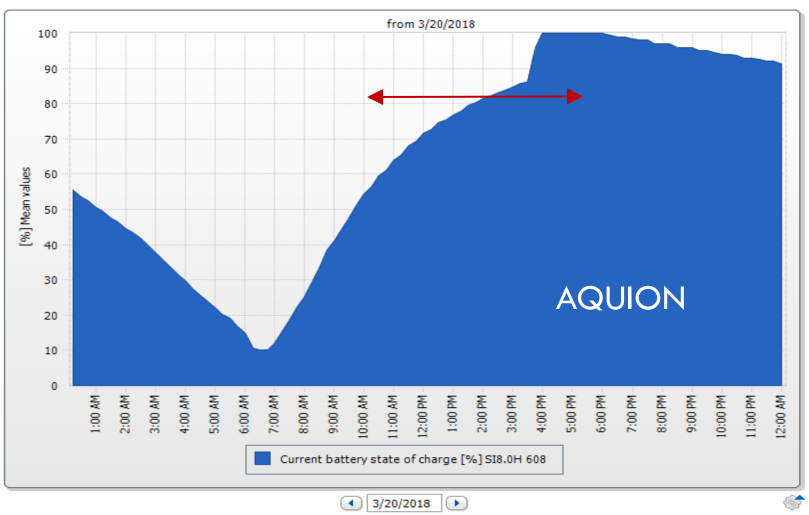
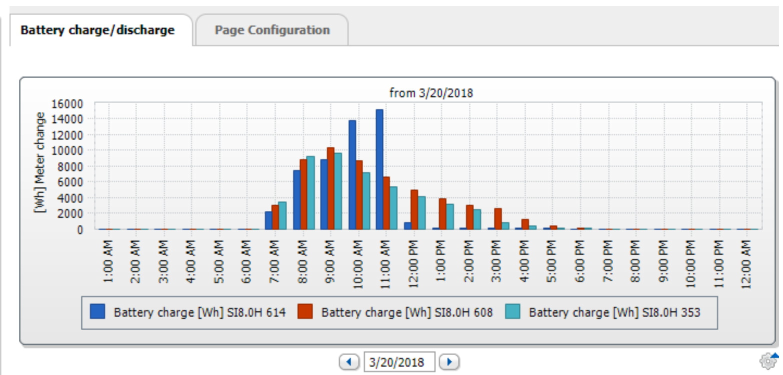
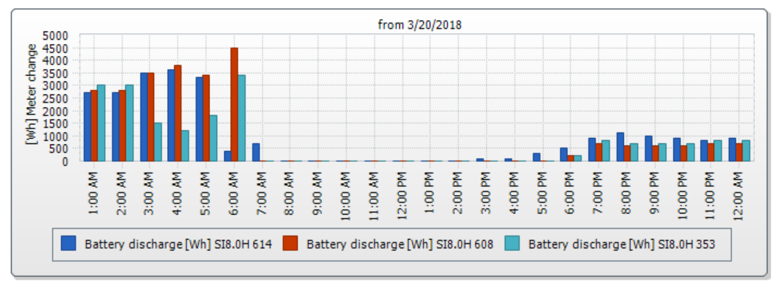
THE ENERGY STORAGE EXPERTS

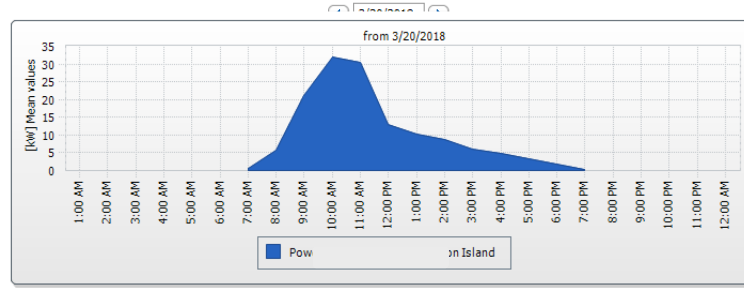
COMPARISON OF PERFORMANCE





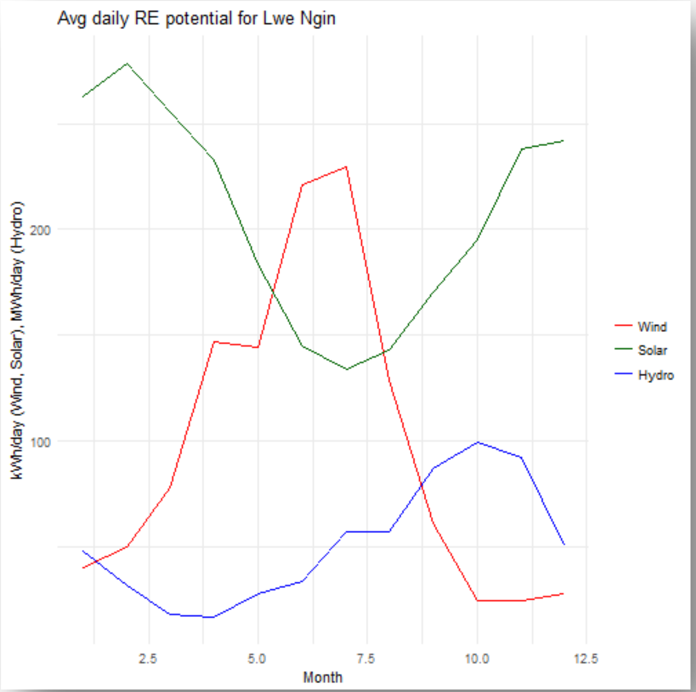




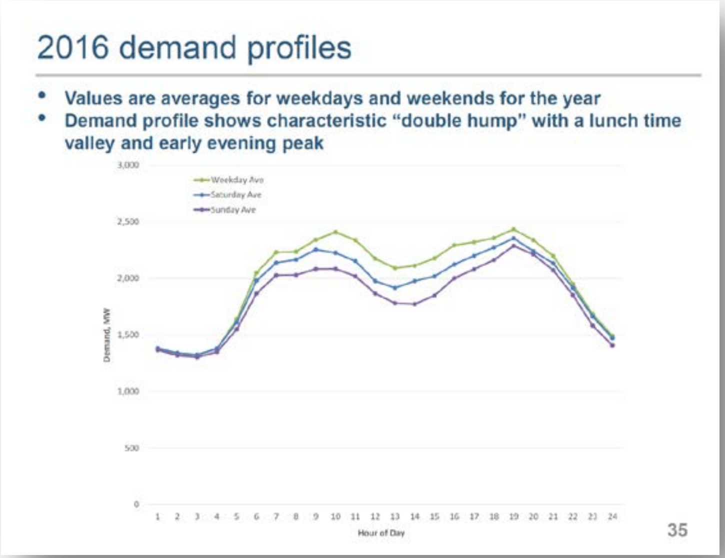


APPLICATIONS IN SEA ASIA

- The BIG challenge for mini-grids is getting the variable RE resource profile to match the varying load profile
- Initially we began exploring solar-hydro hybrids. This can help with seasonal reliability in some areas.. But not flexible.
- Hydro-battery systems have greater flexibility.
  - micro/mini hydro is the cheapest generation technology
  - Hydro can serve as a continuous base-load with BESS covering peaks.



Source: CORE-KIT, 2018



Source: USTDA, 2017

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RUN-OF-RIVER HYDRO EXAMPLE

- Run-of-river hydro mini-grid
- Household demand (morning and evening) (6-8hours total)
- Some productive end uses during day time

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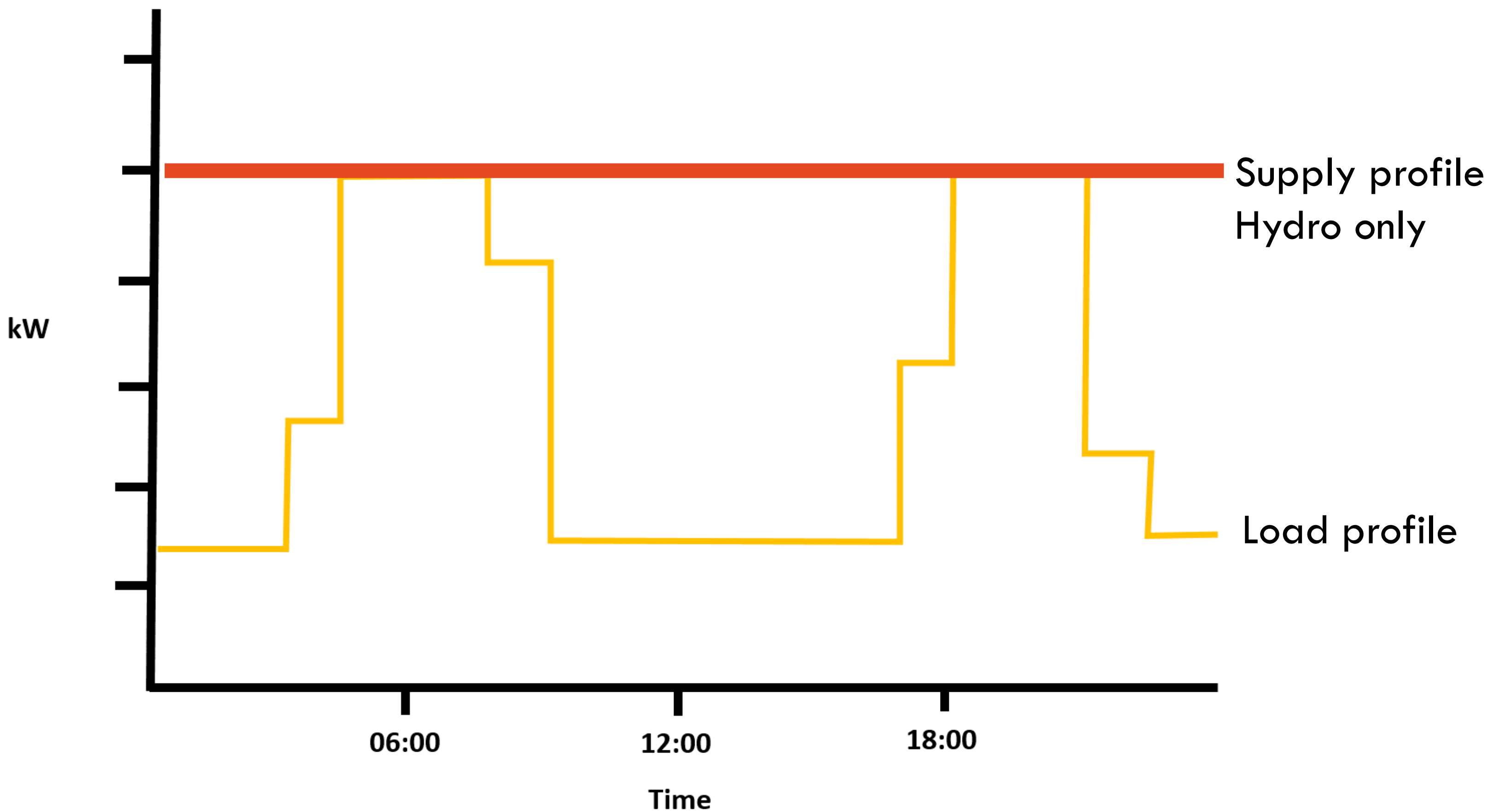
OPTIMISING THE MATCH BETWEEN SUPPLY AND LOAD PROFILES WITH BESS



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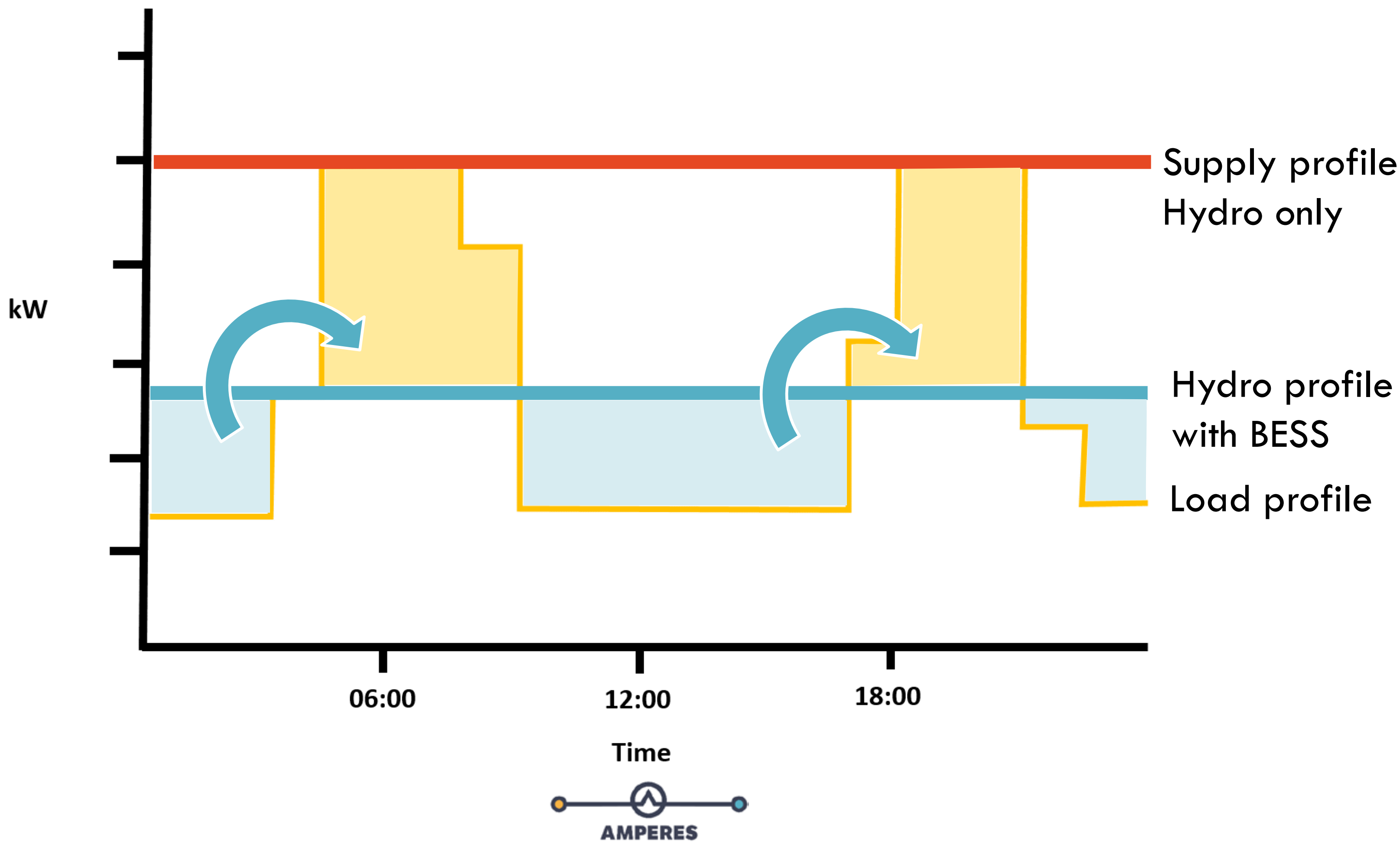


NEED A HIGH PERFORMANCE BATTERY

- Capacity to recharge quickly in off-peak hours
- Capacity to discharge quickly to meet productive loads
- Robust to deep-cycling and multiple cycles per day.
- Longer life span.
- Compact to be transportable to site.
- Energy dense
- Future cost reductions due to Evroll-out and economies of scale.

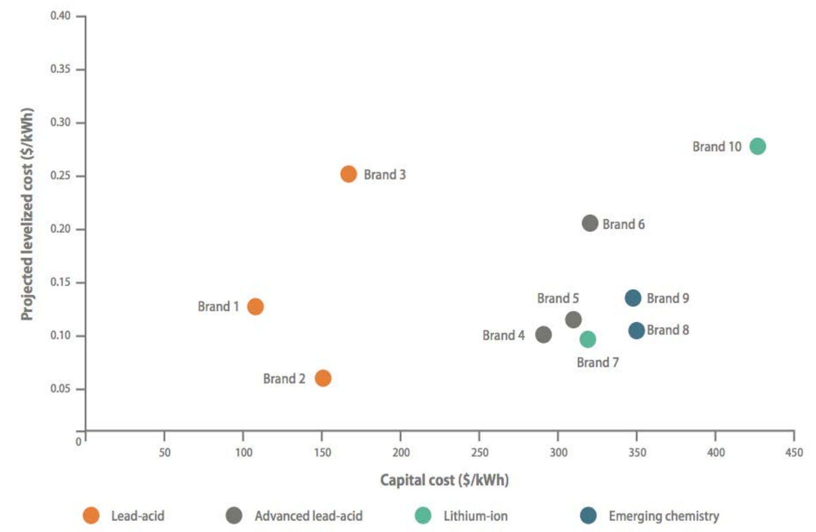
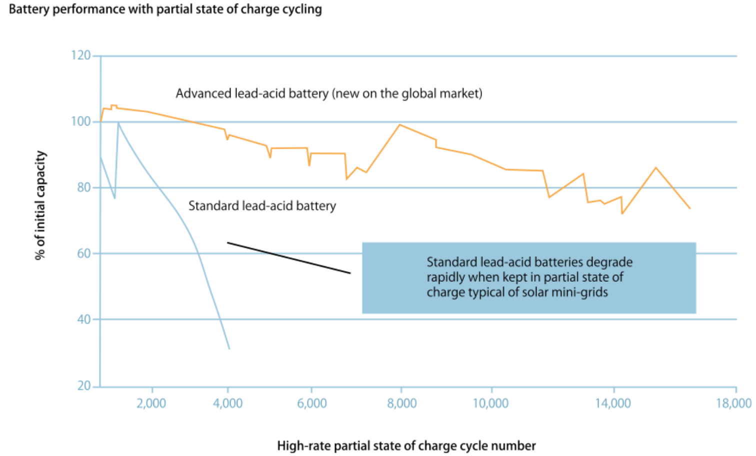


Exhibit 2. There are a number of batteries on the global market that can be used for mini-grids. However, they vary dramatically with respect to initial purchase price as well as projected levelized cost over their lifetime. Please note that the brand names have been redacted in order to preserve confidentiality.



Source: Sandia National Labs, 2008.

Exhibit 14.
Lead- acid batteries, the leading choice for power storage for solar mini-grids in India, offer low initial costs. However, they degrade rapidly when subjected to deep cycling, high ambient temperatures, and extended operation in a partial state of charge. This increases their overall levelized cost. This exhibit compares standard on-the-market lead-acid batteries to an early-stage technology ("advanced" lead-acid batteries).

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THANK YOU!

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