

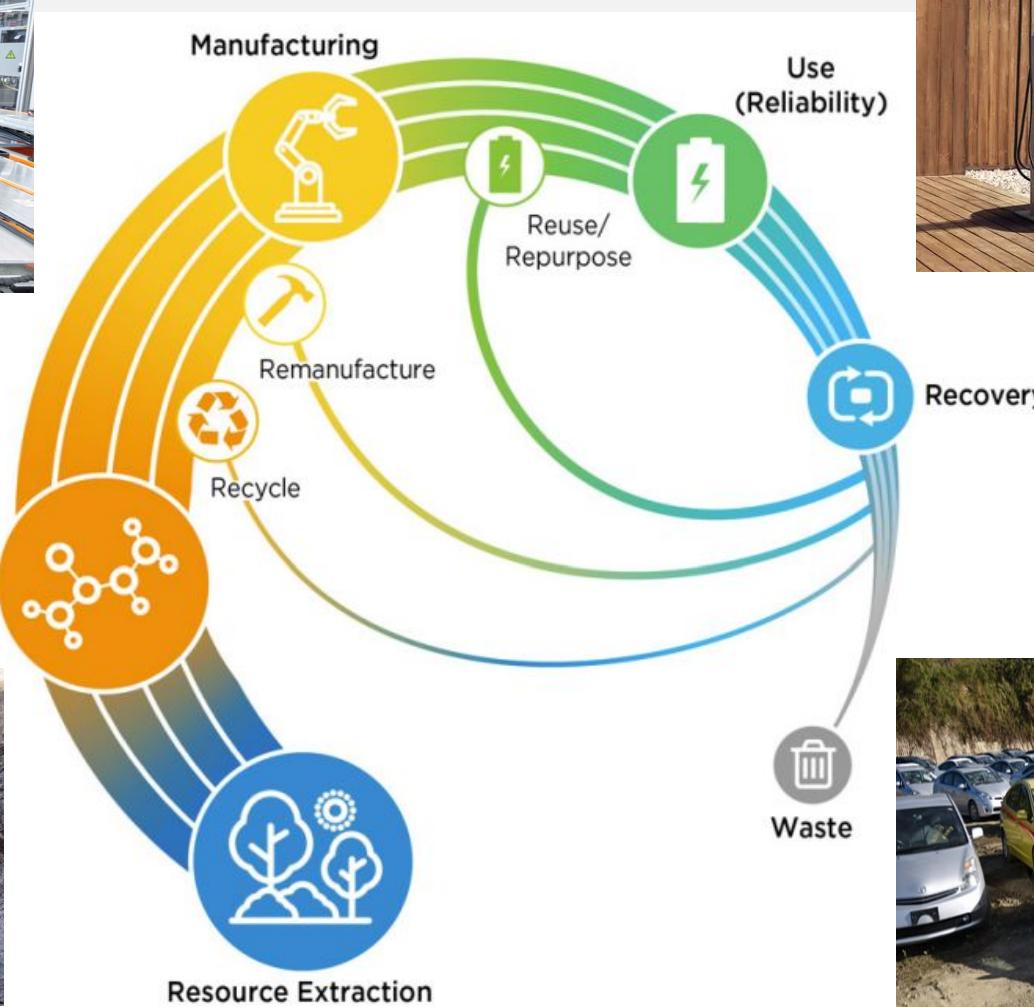
# ALOE ENERGY

*Healing your EV batteries for humanitarian use*



60 million EVs will be on the road by 2025





Closing the loop on the battery value chain is an  
**\$8B opportunity**

1

Accumulation of battery waste is a **toxicity hazard** in communities

2

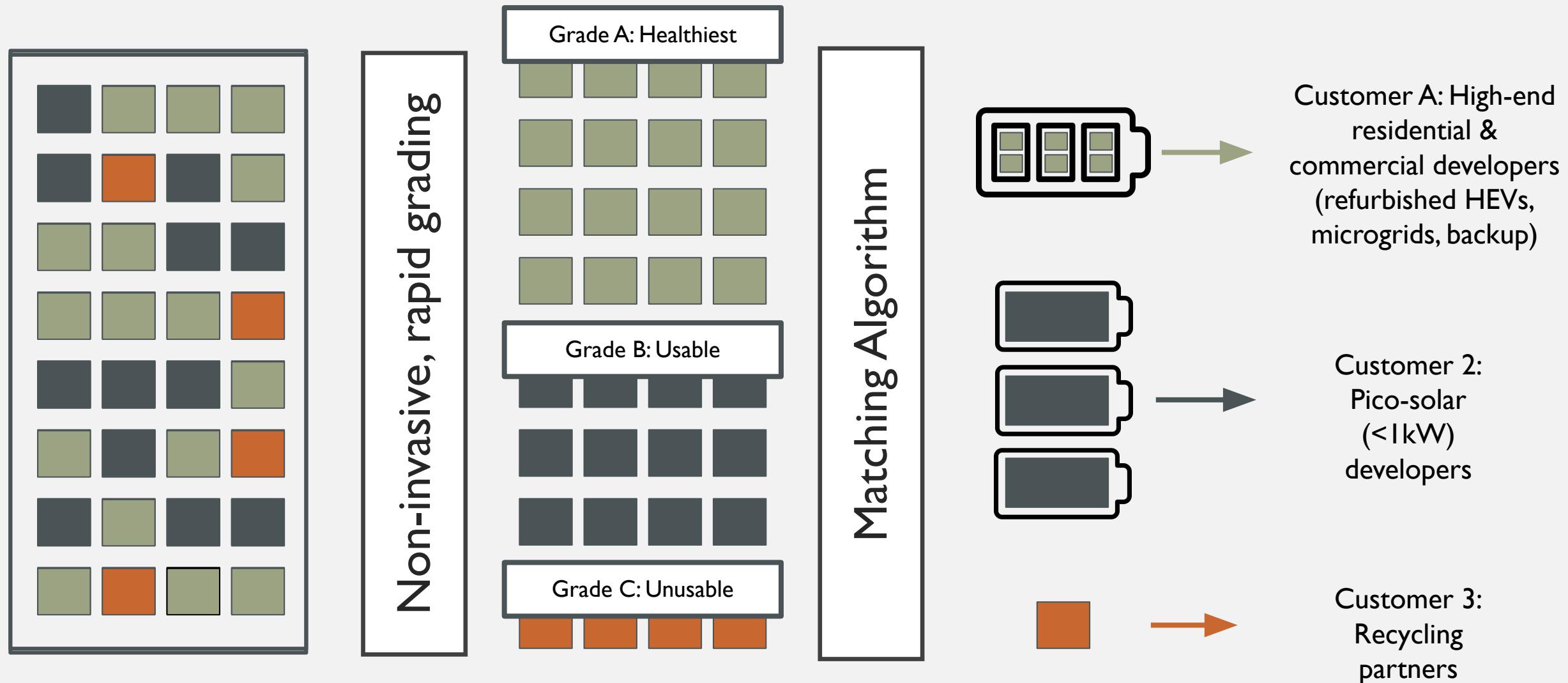
Battery characterization and repackaging is **time intensive** and **uneconomic**

3

Energy access in emerging markets is still **unreliable**



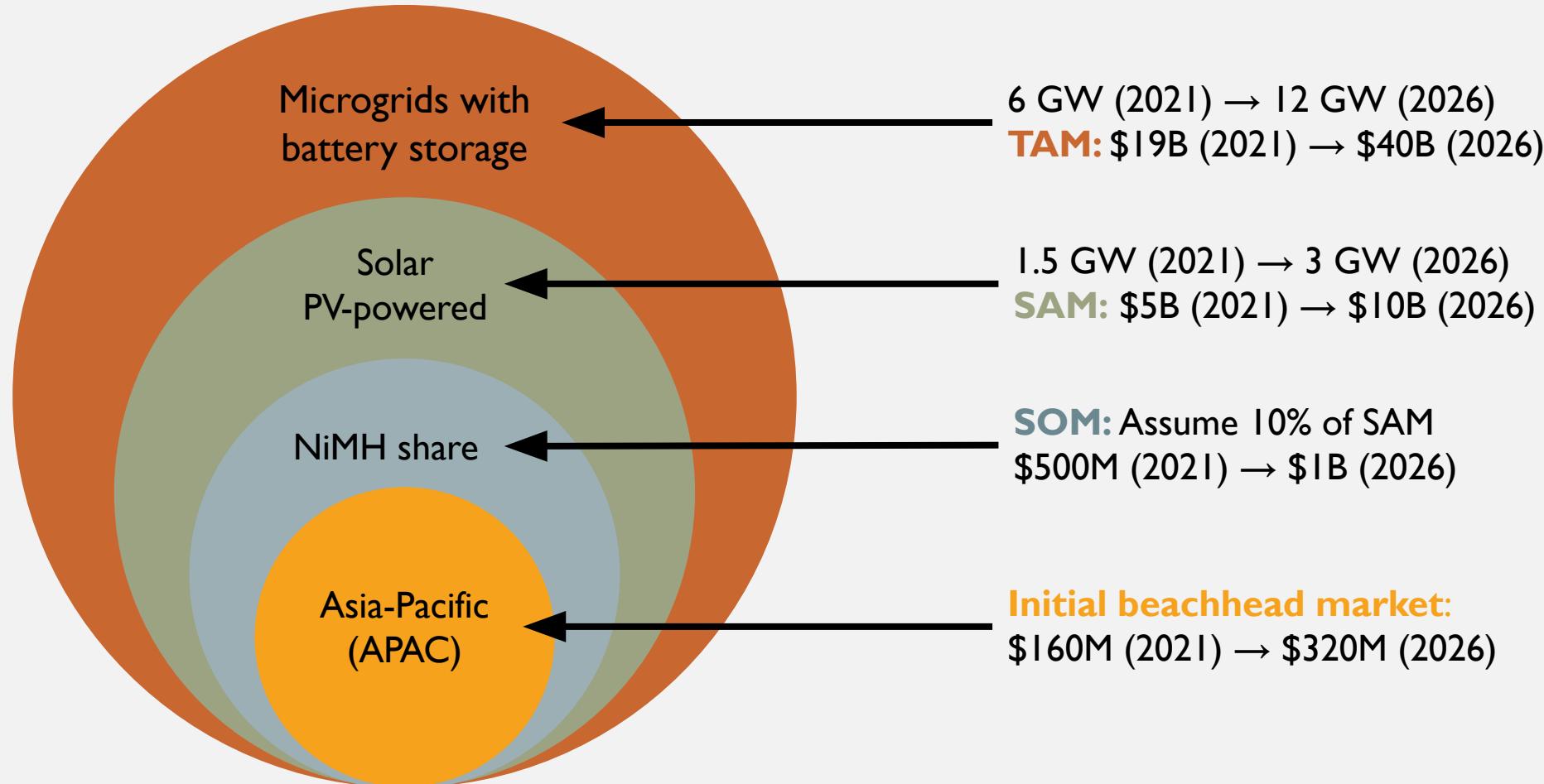
# Aloe has a **user-friendly process** to enable **local waste-to-wealth solutions**



# Our Vision

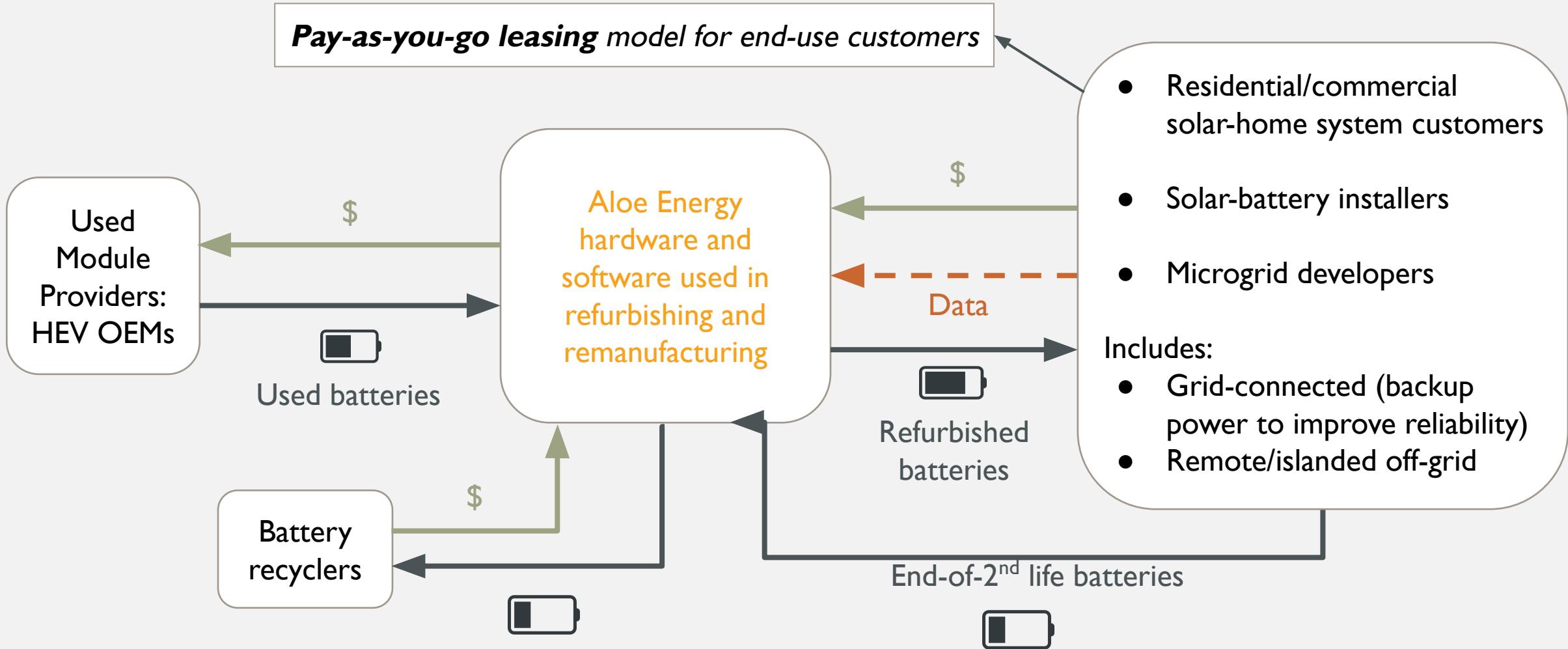


# Market Opportunity - Demand



Source: BCC Research

# Business Model: B2B2C



# Pilot Rationale



Pilot in Fiji

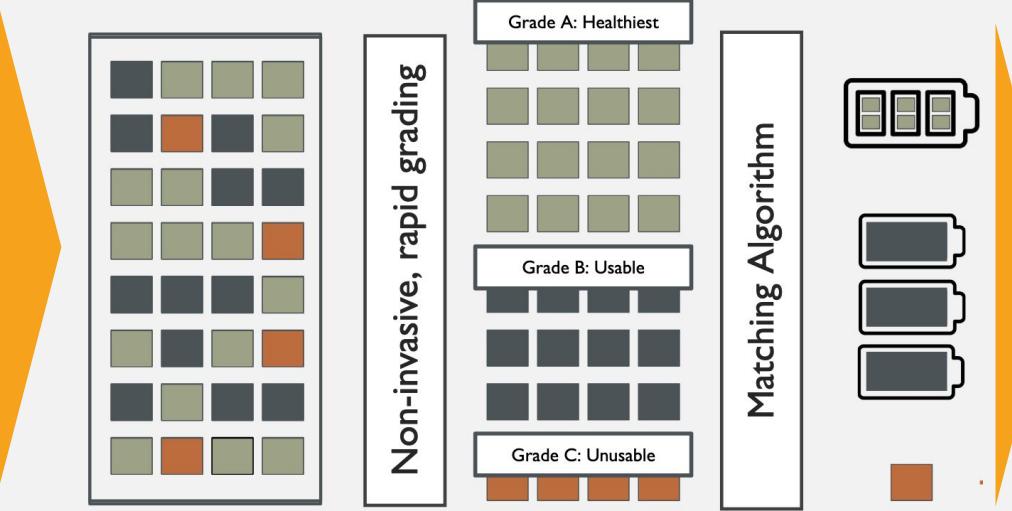
- **Why Fiji?**

- Lack electricity access for communities in SE Asia  
→ Solar + battery microgrids
- Poor reliability for grid-connected customers → Backup power
- Existing supply of used HEVs from local landfills

- **Why NiMH?**

- Safer to operate than other batteries
- Safer to stack modules → Packs
- Untapped market

# Pilot in Beachhead Market: Nickel-Metal Hydride (NiMH) Batteries in Fiji



## Source HEVs from landfills

- Communication with non-profit underway to facilitate sourcing

## Characterize and repurpose batteries

- Set up local facility for the Aloe process

## Sell to microgrid energy providers

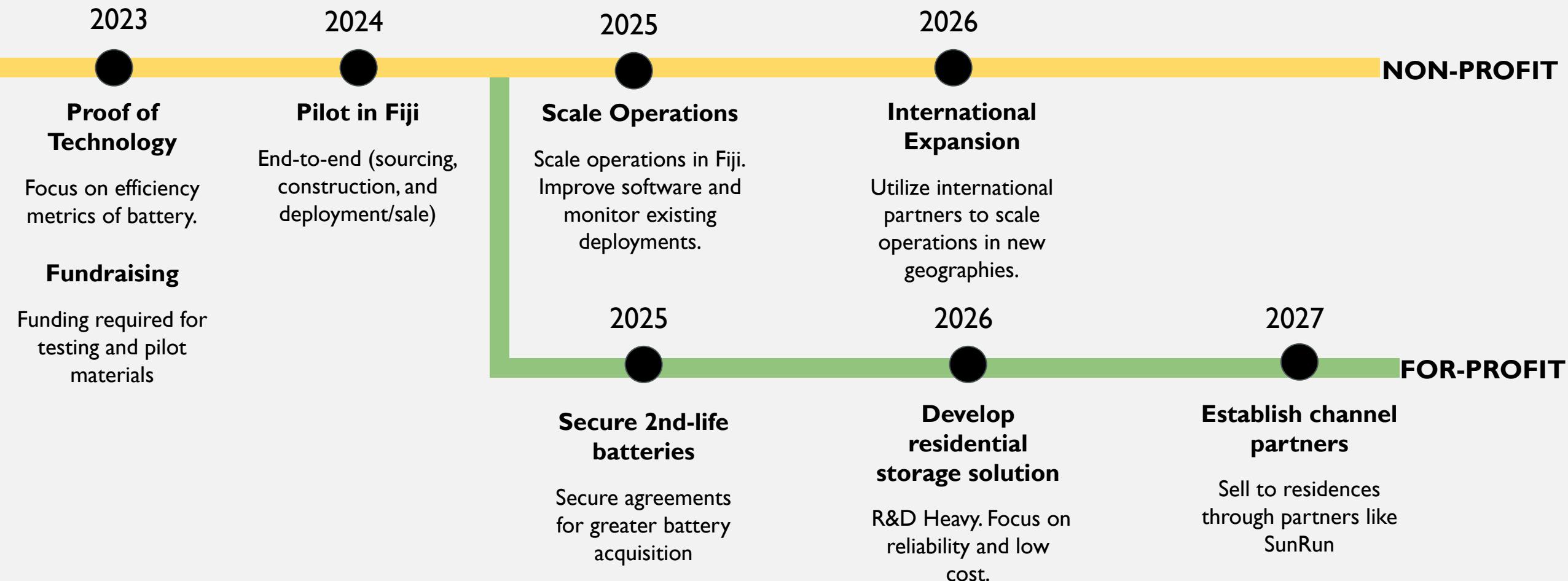
- Provide energy access to remote areas of Fiji by supplying power for microgrids



# Competitive Landscape

				
Company	Moment Energy	Connected Energy	Enel	Evyon
Location	Canada	UK	Multinational	Norway
Funding	\$15-20M, Series A	\$15.7M, June 2022	Market Cap: \$55B USD	6.57M, Pre-Series A
Description	<b>C&amp;I battery energy storage systems</b> from 2nd-life battery modules from Nissan & Mercedes-Benz.	2nd-life battery specialist focusing on <b>commercial storage solutions</b> . Developed E-STOR software to aggregate batteries.	Collaboration with Nissan, the battery provider, and Loccioni, systems integrator, to improve <b>grid reliability</b> .	Developed an integrated hardware-software platform to build a ‘Battery Cloud’, a 2nd life battery-agnostic optimization software.
Traction	Sourcing agreement in place with Mercedes (7/2022) and Nissan (9/2020).	Using funding round to move into utility-scale storage. 16 operational systems across Europe.	Built a C&I storage subsystem for a conventional power plant operated by its subsidiary.	Focused on <b>construction sites and EV-fast chargers</b> . Secured a sourcing agreement with Mercedes.

# Go-to-market





## Brandon Simons

Co-Founder  
MS Sustainable Engineering



## Lisa Liu

Product development  
MIT MBA & M.S. MechE



## Vineet Nair

Product development  
MIT PhD Computation for  
Energy & Climate

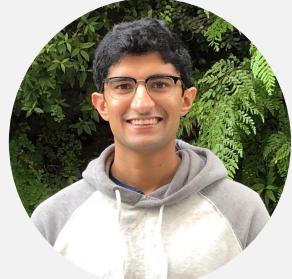
## Serena Patel

Co-Founder  
SM MIT Tech. & Policy



## Alex Steckmest

Head of Finance, Strategy  
MIT MBA



## Rohin Lohe

Business development  
Harvard MBA



HARVARD  
BUSINESS SCHOOL



Berkeley  
UNIVERSITY OF CALIFORNIA



MITei  
MIT Energy Initiative





Thank you!

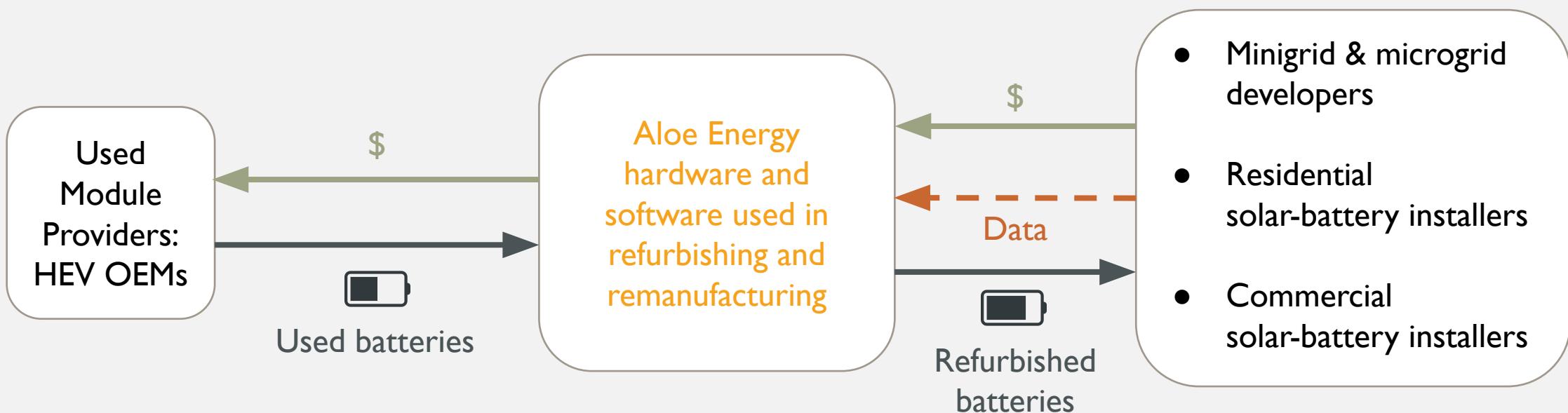
[aloeenergy.org](http://aloeenergy.org)

[serenap@aloeenergy.org](mailto:serenap@aloeenergy.org)

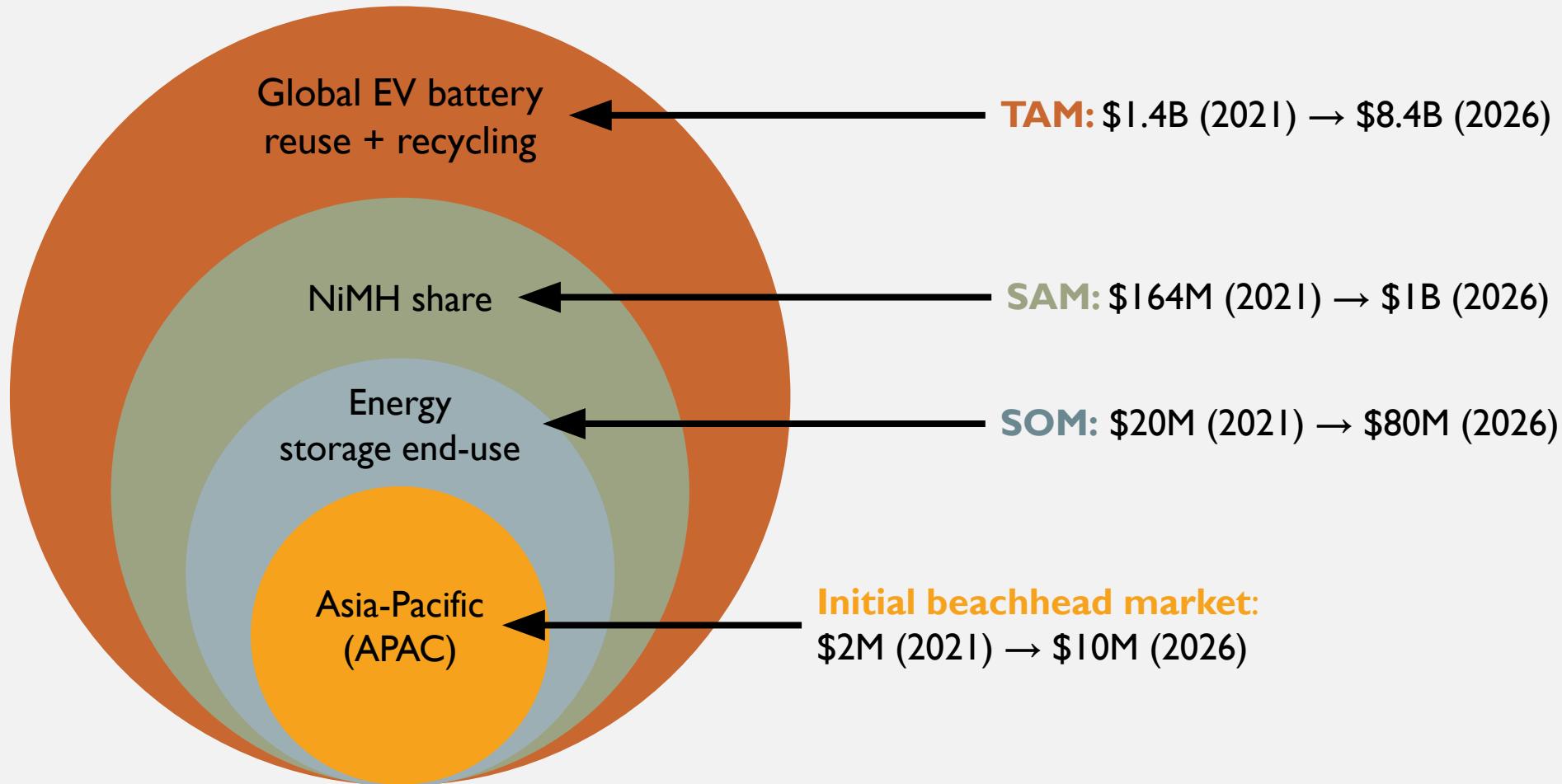
[brandons@aloeenergy.org](mailto:brandons@aloeenergy.org)

# APPENDIX

# Beachhead Business Model: B2B



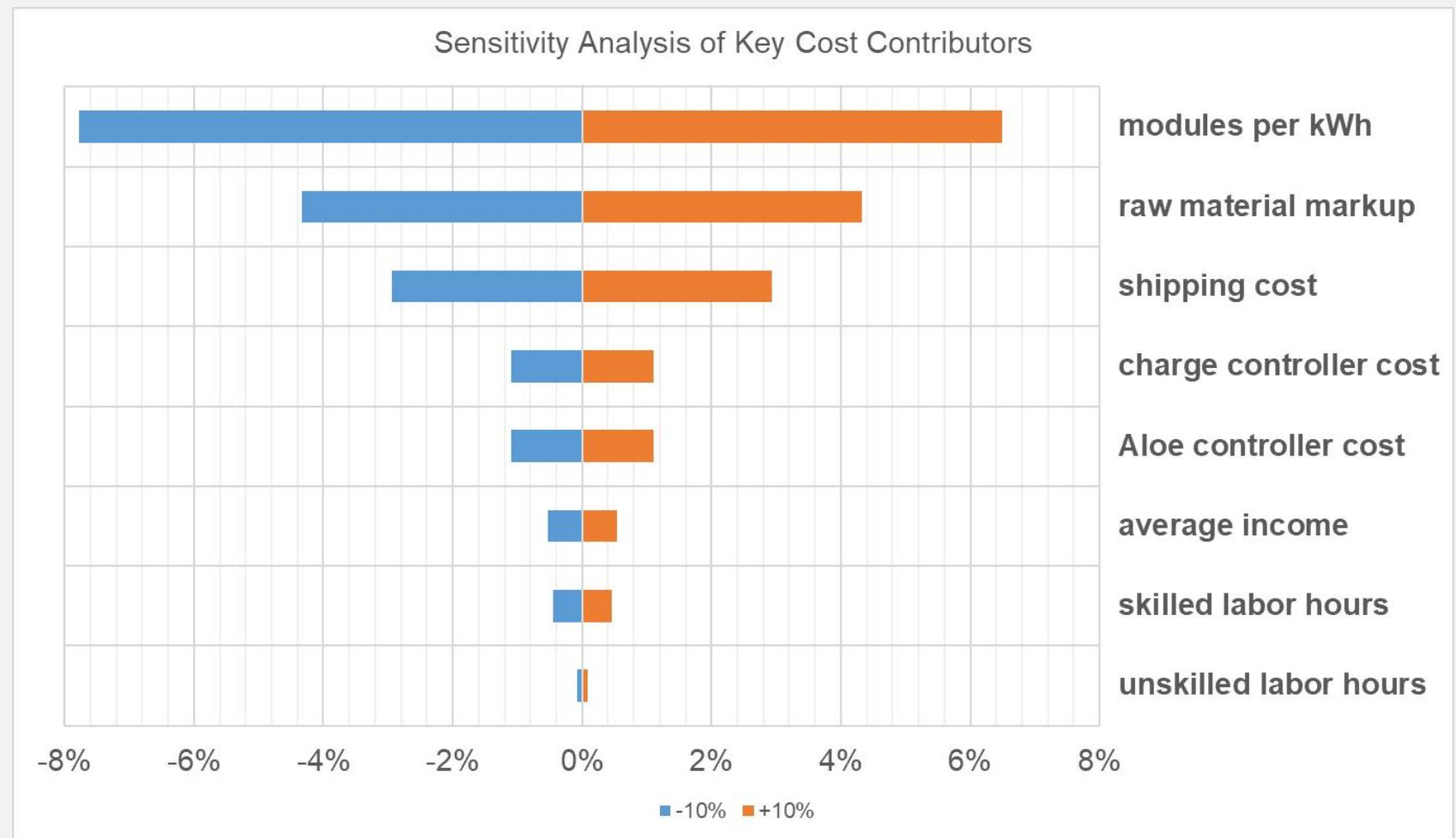
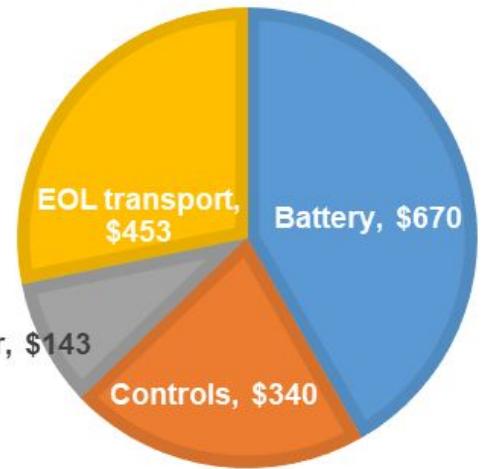
# Market Opportunity - Supply



Start with Nickel-Metal Hydride (NiMH) and eventually expand to **other battery chemistries** (Li-ion, Na-based etc.) & **applications beyond microgrid storage** (e.g. consumer electronics, passenger EVs)

# Techno-economic Analysis: Highlights & Sensitivity

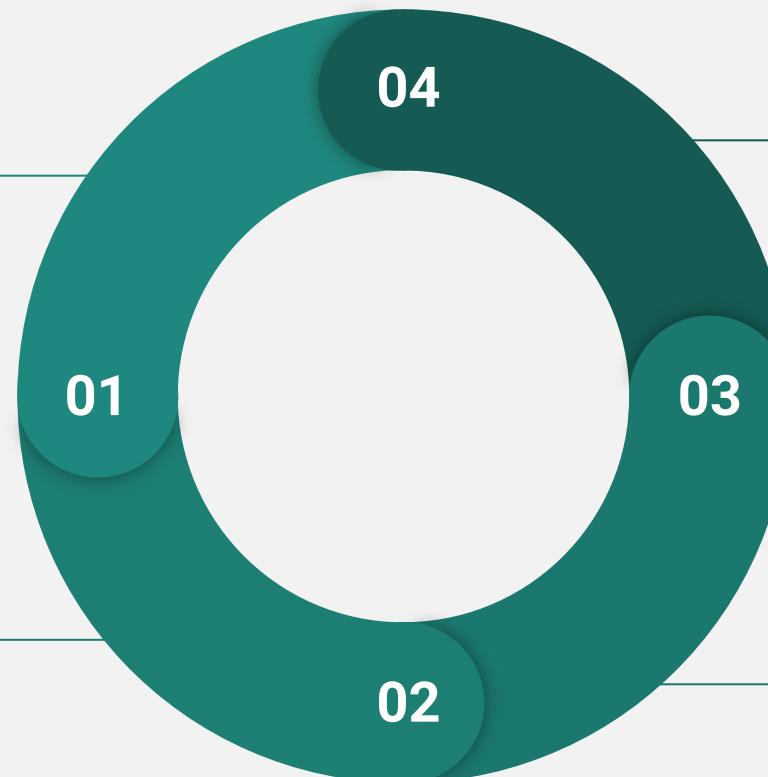
**TOTAL UNIT COSTS: \$1606**



# Milestones

## Traction: 10+ customer interviews

- Microgrid & solar-home developers
- International nonprofits
- Standardization, logistics & safety



## Testing key assumptions through TEA

- Input costs
- Quality of refurbished batteries

## Building relationships with key stakeholders/partners

- ReJoule: Battery grading startup
- PowerWell: Startup repurposing laptop batteries for small solar-home)
- SolarBuddy: Social enterprise for small solar-home systems

## Technology milestones

- Sourcing used NiMH batteries
- Prototyping grading system
- Connecting with researchers to run initial tests & gather data

# The Ask

	<b>Seed</b>	<b>Non-VC funding sources</b>
<b>Amount</b>	\$300,000	<ul style="list-style-type: none"><li>● Philanthropic capital</li><li>● Private foundations (e.g. Gates, MacArthur, Rockefeller)</li><li>● Impact investors</li><li>● Blended finance funds (e.g. IFC)</li><li>● Climate adaptation &amp; resilience grants for developing nations</li></ul>
<b>Timing</b>	2023-2024	
<b>Use of Funds</b>	Funding initial pilot in Fiji: local employees, real estate, and equipment	

# Learnings

## What we've learned

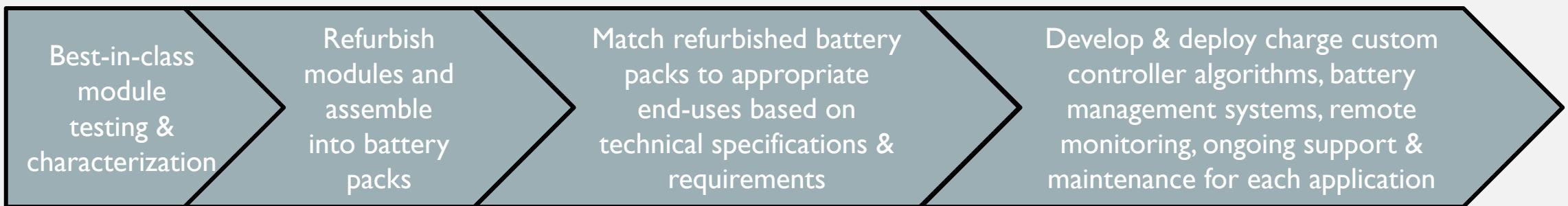
- After market & financing explorations, we realized that we're not a venture-scale company in our current form
- NiMH batteries are a small market - we need to think bigger!
- Many players in this market, but most are focused on C&I solutions in North America / Europe.
- Regulation plays a role in where second-life batteries are concentrated.
- Robust data for second-life batteries is still a nascent solution and closed-source.
- Working with a beachhead market abroad is hard.
  - Customer discovery, willingness to pay, financing solutions

## What we still need to answer

- What are the economics for residential and commercial second-life battery solutions?
- Refine go-to-market strategy to discover early adopters in APAC?
- Is an open data strategy defensible? Can we build a software platform on data we open-source?
- What is the right corporate structure (e.g. non-profit with a for-profit arm)?
- Appropriate financing strategies

# UNIQUE PROCESS

*Aloe Energy repurposes NiMH batteries for 2<sup>nd</sup> use applications such as stationary energy storage, providing **end-to-end** services*



Electrochemical impedance spectroscopy, thermal imaging & machine learning to improve speed and accuracy of characterization over time with more data

Module matching algorithm

Charge Controller algorithm

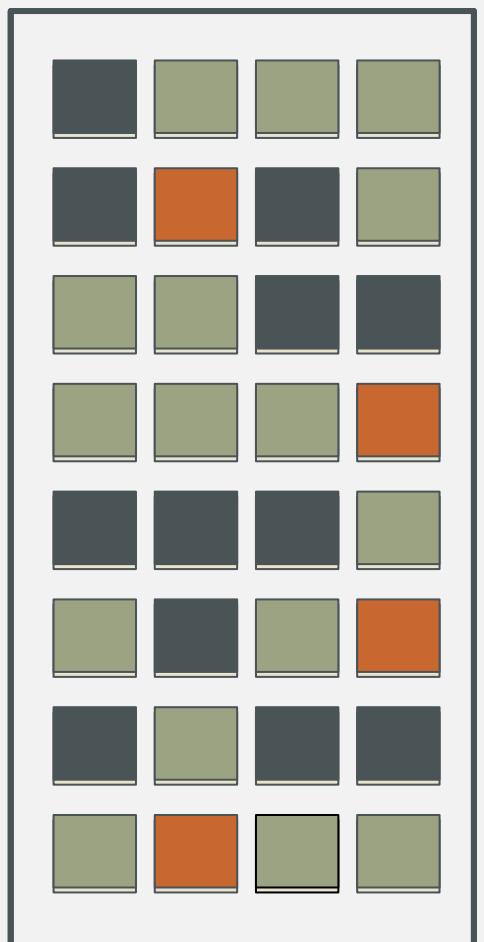
# We tackle key barriers to reusing batteries by developing a user-friendly process to enable local waste-to-wealth solutions

Electrochemical impedance spectroscopy, thermal imaging & machine learning for improved performance



Sort and Refurbish modules

Match refurbished battery packs to appropriate end-uses based on technical specifications & requirements

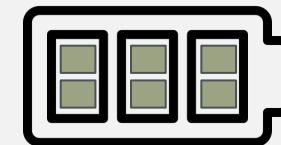


Grade A: Healthiest

Grade B: Usable

Grade C: Unusable

Matching Algorithm



Develop & deploy charge custom controller algorithms, battery management systems, remote monitoring, ongoing support & maintenance for each application



# Product Market Fit

## Market Gaps

Nickel-Metal Hydride (NiMH) battery modules in HEVs are deposited in landfills



## Aloe Solution

Aloe sources NiMH battery modules from landfills to reduce environmental impact

Several raw materials required to manufacture new NiMH batteries



Reduction in raw materials and costs

Grid reliability & resilience issues in emerging economies



Refurbished battery storage for backup power & other grid services

# TRACTION: 10+ CUSTOMER INTERVIEWS

## Off-grid & solar-home developers

- Batteries are the **most challenging** part of such systems:
  - **Lack of standardization** with chemistry, management, regulations
  - Issues with battery management systems, control & inverter interface
  - **Transportation**, sourcing & shipping to remote areas
  - General trend toward LFP-based batteries (**fire hazard, safety**)

## Technology

- Data for batteries below 70% capacity is rare and valuable because degradation of batteries are an **open research question**
- The need for different **safety requirements & testing standards** for degraded batteries with an alternate end-use, and different chemistries

# DEFENSIBILITY

- **Low IP venture:** Utilize existing technologies to characterize, refurbish & repackage used batteries
- **End-to-end services:** Aloe provides services throughout used battery lifecycle & value chain
  - Sourcing → Testing → Refurbishing → Charge control → Monitoring → Recycling
  - Serve as one-stop shop for both (i) used battery providers & (ii) refurbished battery users
- **I<sup>st</sup> mover advantage:** Existing battery repurposing/recycling companies focus only on Li-ion based battery chemistries (from EVs and storage)
  - Large untapped market for used NiMH batteries from HEVs
- **Barriers to entry for competitors:** Most used HEVs end up in non-OECD countries
  - Aloe will leverage unique partnerships with battery suppliers, nonprofits, local governments & customers (e.g. solar home providers) in these regions (e.g. Fiji, Madagascar)
  - Allow us to scale up our product/technology & go-to-market faster
- **Innovative end-uses:** Humanitarian/social-impact driven applications in developing nations
  - Most battery repurposers focus on for-profit uses in developed countries
- **Regulatory edge:** Our team is equipped to navigate regulatory hurdles encountered in countries and with battery & data ownership

## **HEV Market Sizing: Top-Down**

- Total Addressable Market: Global market for EV battery reuse and recycling will grow from \$1.4B (2021) to \$8.4B (2026) at a 43.1% CAGR.
- Serviceable & Addressable Market: HEV battery reuse and recycling will grow from \$169.2M (2021) to \$820.5M (2026) at a 37.1% CAGR.

# HEV Market Sizing: Bottom-up

- 3.1M HEVs sold in 2022<sup>1</sup>
- Raw material value of 1 NiMH battery pack in a hybrid vehicle: \$91.04<sup>2</sup>
  - This represents the minimum value of a NiMH battery pack today.
- Full battery replacement in a Prius is between \$2200 and \$4100 MSRP.
  - Represents a 24-45x multiple on the value of the raw materials in the battery
- Adoption of HEVs is still increasing, so we can assume that in ten years, no more than 3.1M HEVs will be reaching end-of-life. At that point, the value of the raw material of the battery packs will be around \$282M.

2. Solene Marie Ludivine Chabanet. "Recycling of Ni-MH batteries from hybrid vehicles." July 2019.

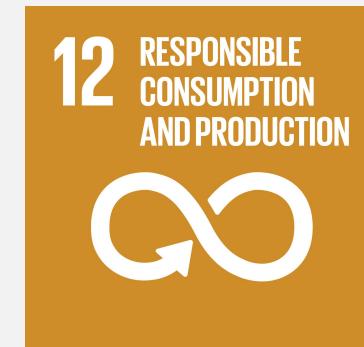
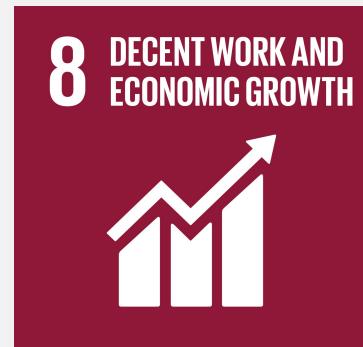
## Application 2: Off-grid storage for energy access

- **770 million** people still lack access to electricity globally [[IEA, 2021](#)]
- Need to provide electricity access to **930 million** people in emerging economies between 2022-30
- At least **490 million** of these can be served by 217,000 mini-grids using off-grid solar PV + storage systems
  - Requiring total investment of **\$127 billion**
  - 10-15 GW of solar PV installed by 2030
  - **50-110 GWh** of batteries
- Total installed capacity of off-grid renewables = **11.2 GW** (2020) [1]
- For off-grid communities that aren't connected to main grid
  - Too expensive to build out grid infrastructure

[1] [IRENA Renewable energy statistics 2022](#)

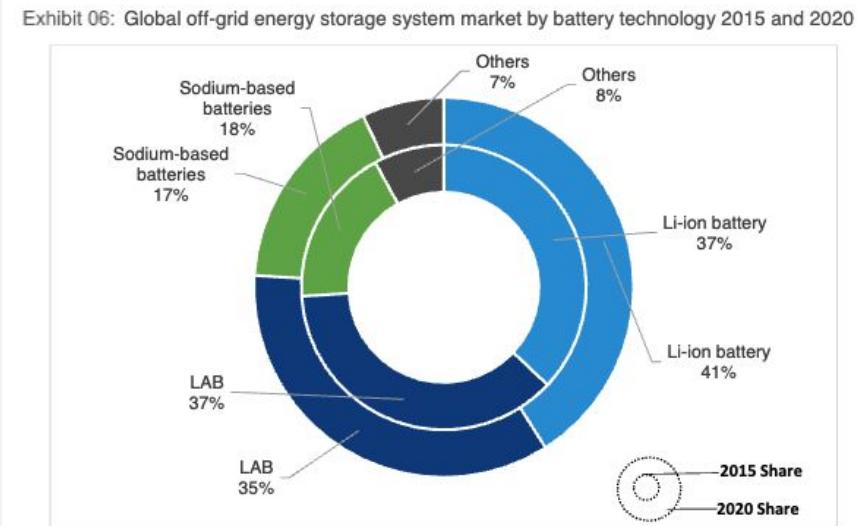
# IMPACT

- Economic productivity
  - Livelihoods & SMEs
  - Reduced outages, blackouts & brownouts
- Emissions
  - Increase PV penetration
  - Displace diesel & gas generators
- Environmental
  - Reduce toxic leaching to soil & water
  - Improve local air quality & health outcomes
- Circularity & supply chain
  - Reduce landfill waste
  - Capture value of battery materials
  - Reduce need for metal mining/extraction
- Social
  - Access to clean, affordable & reliable energy



# Top-down market sizing & segmentation

- **Total addressable market (TAM)**
  - = Off-grid battery energy storage = \$31 billion (2021)  
→ \$59 billion (2027) @ CAGR 7.5% [2]
- Dominated by Li-ion and lead-acid chemistries
  - "Others" = 7% in 2020 [3]
  - Assume 1% is currently NiMH chemistry (from HEVs)
- **Serviceable addressable market (SAM)**
  - Portion that can be met by NiMH batteries from HEVs
  - **Conservative SAM estimate:**  
1% of TAM → \$310 million (2021) → \$600 million (2027)
- **Ambitious SAM estimate:** Also aim to displace some market share from other chemistries by competing on cost (\$/kWh)
  - Hypothesis: Refurbished NiMH cheaper than new Li-ion/Lead acid/Sodium-based
  - Reach 5% of TAM → \$1.55 billion (2021) → \$3.1 billion (2027)



[2] <https://www.marketdataforecast.com/market-reports/off-grid-energy-storage-market>

[3] <https://www.technavio.com/report/global-energy-storage-global-grid-energy-storage-system-market-2016-2020>

# Geographic segmentation

- Focus on Asia Pacific + Africa as initial target markets
- **Beachhead market:** Asia-Pacific off-grid solar + storage
  - 21.5% of SAM = \$333 million (2021) [3]

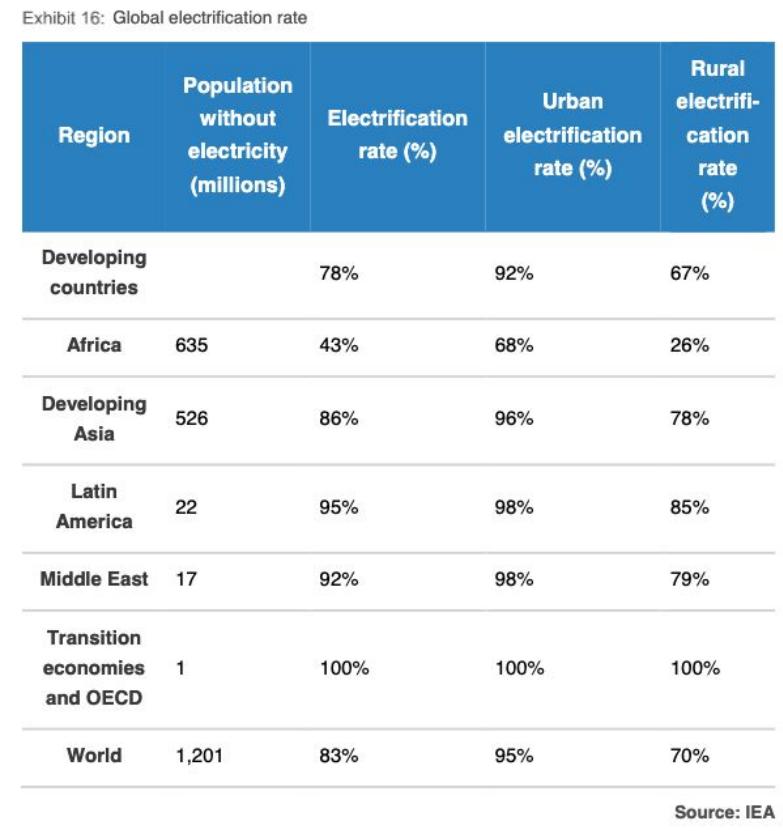


Exhibit 11: Global off-grid energy storage system market by geography for 2015 and 2020

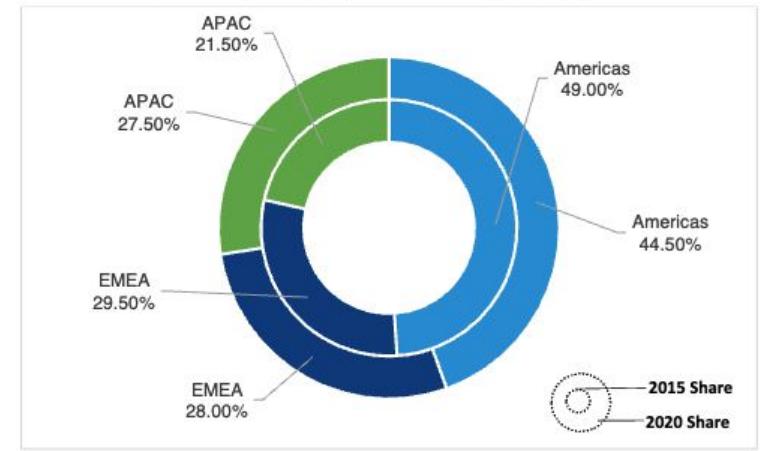
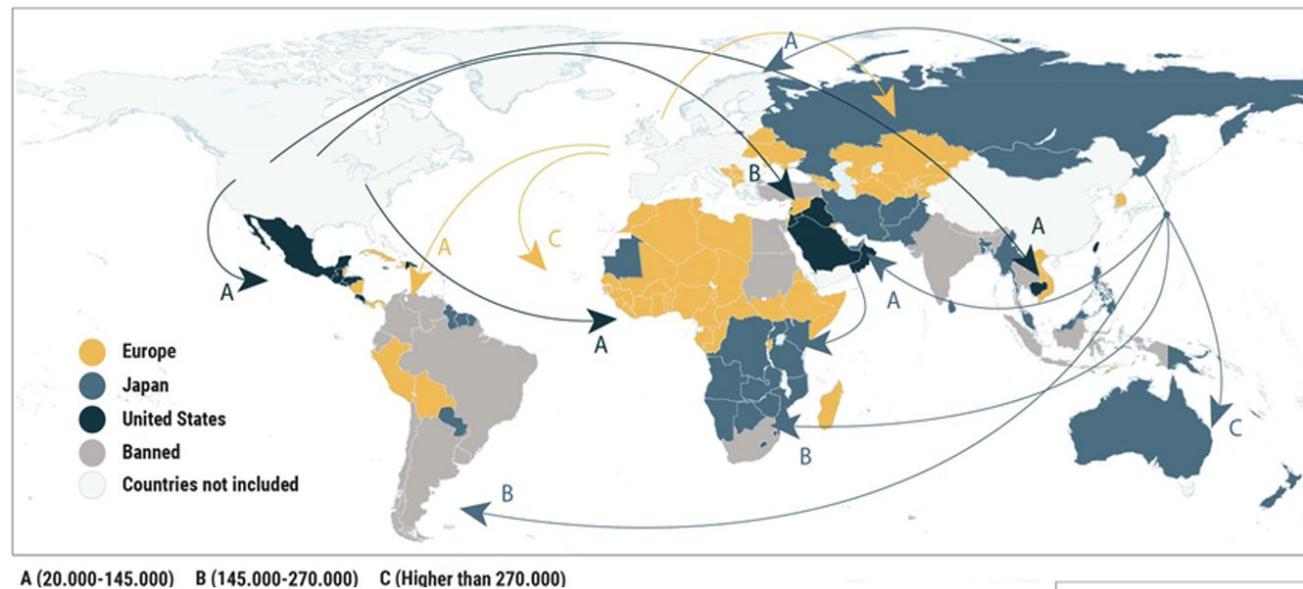


Exhibit 15: Off-grid energy storage system market in APAC 2015-2020 (\$ billions)



[3] <https://www.technavio.com/report/global-energy-storage-global-grid-energy-storage-system-market-2016-2020>

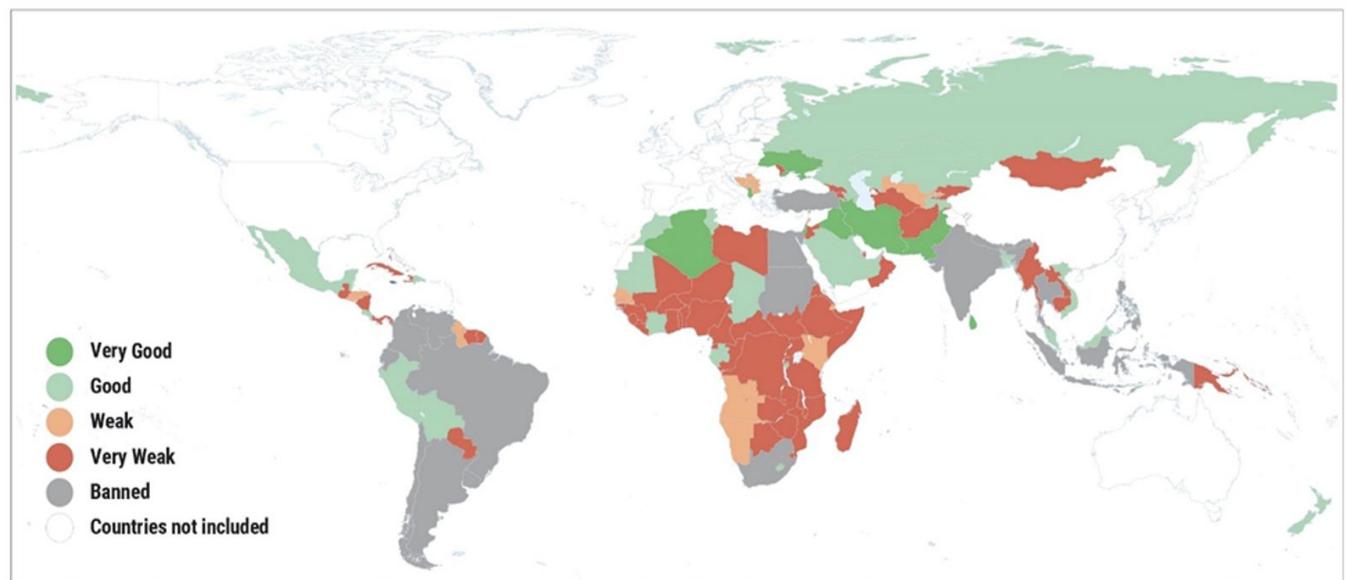
# Mega-trend: Global Used Vehicle Trade



Global fleet of light duty vehicles expected to at least double by 2050, 90% of this growth in non-OECD countries  
([UN Environment Program](#))

Strong or weak regulations influence which kinds of used vehicles enter countries.

[UNEP](#)

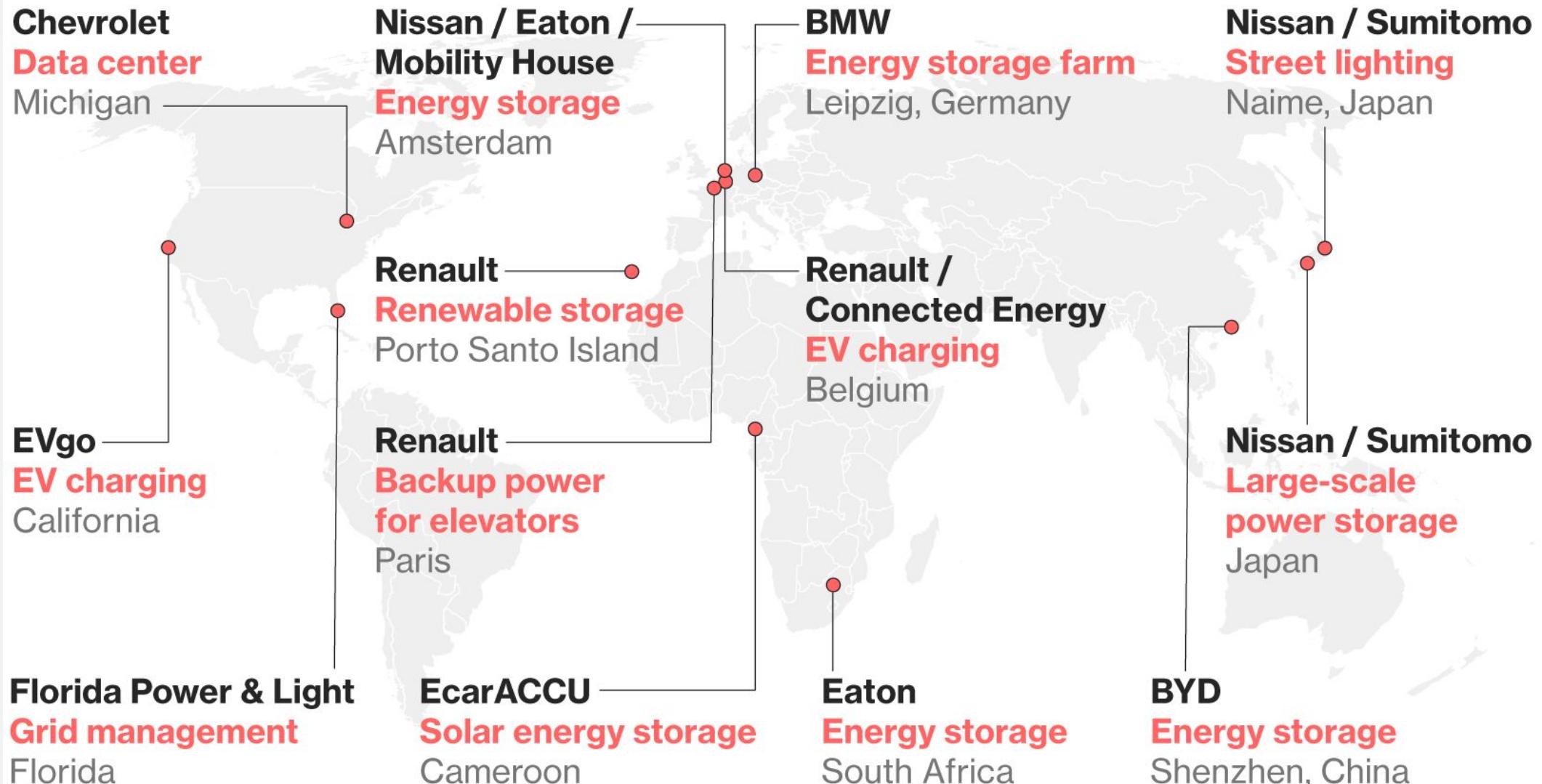


## Policy mega-trend: Industry

- **Technology shifts:** Battery storage companies moving to LFP chemistry for EVs and stationary storage ([LFP](#), [Tesla](#))
- **Recycling and Repurposing:** Toyota's battery buy-back program (not yet available in Fiji) and [partnerships with recycling companies](#)
- **Knowledge:** Tesla Corporation developed an educational program partnered with universities around the world ([Electrek, 2018](#))
- Technical Standards for stationary storage: [UL 1973](#) (not always used, depends on the country)

# A New Lease on Life

Where electric-vehicle batteries are being used and tested for new roles



# Policy frameworks

- **Promoting Urban Mining Indirectly:** Inflation Reduction Act in U.S. ([CTVC](#))
  - Battery manufacturing Production Tax Credit: \$35/kWh for battery cells, \$10/kWh for battery module, 10% PTC for production of critical minerals or battery components
  - Boost toward local production: Elimination of tax credit up to \$7,500 for plug-in hybrid and electric vehicles that are imported and sold in the U.S.
- **Extended Producer Responsibility (EPR)**
  - Canada has EPR systems in place for certain products such as batteries, electronics, beverage containers, paint and recently paper and packaging ([Rila, 2021](#))
  - EPR has a working history in the U.S. at the state level for products such as paint, batteries, carpet, mattresses, and electronics ([Rila, 2021](#))
  - China (half the world's EVs are sold here) is implementing rules to make carmakers responsible for expired batteries and to keep them out of landfills ([Rila, 2021](#))
  - EU has regulations for EPR, U.S. is expected to follow ([Bloomberg](#))

## Fiji specific policy landscape

- **Vehicles:** Fiji seeks to introduce electric cars within 15-20 years (National Development Plan 2017, [Fiji Low Emission Development Strategy 2018-2050](#))
- **Importation of Used Vehicles:** Fiji tax credits for the importation of hybrid cars (HEVs) causes a major increase in end-of-life HEVs in the country
- **Waste Management:** [A Green Growth Framework for Fiji \(2014\)](#) includes waste management
- **Knowledge:** Basic training program developed by Fiji National University to address the need for skilled technicians, but it's not accredited. General support for [Capacity Building to strengthen sustainable implementation of renewable energy technologies for rural energy access](#)

## Extra: Battery recycling players / potential competitors

- **Recycling:** NiMH batteries are “zero landfill” products. Whatever can't be recycled is consumed in the recycling process, leaving no trash behind. The primary metals recovered are nickel, copper and iron. The principal rare earths are neodymium and lanthanum.
- **Actors:**
  - The Kinsbursky Brothers' Toxco operation appears to be the recycler most widely used by companies that sell hybrids and EVs in North America. Also receives batteries from Europe
  - Umicore is the European leader and is expanding in the U.S.
  - Each operation uses a proprietary system and both now are concerned mainly with recycling nickel-metal hydride batteries.
  - London-based Circular Energy Storage Research and Consulting
  - Box of Energy, London-based Powervault Ltd. and Melbourne-based Relectrify Pty. are among those helping develop the second acts.
  - BYD's battery group. The Warren Buffett-backed company uses secondhand packs to power wireless transmission towers and to help run one of China's biggest energy-storage systems in Shenzhen.

[Source](#)

# Extra: Grid reliability still an issue across Asia-Pacific

## Key grid events across Asia Pacific

### Mainland China

- Load shedding/blackout (Guangdong province) – May 2021

### Pakistan

- Load shedding/blackout (country wide) – June 2021

### India

- Seasonal wind curtailment (Tamil Nadu, Andhra Pradesh) – June to August
- Load shedding (Punjab, Delhi, Haryana, Uttar Pradesh) – June/July 2021
- Grid frequency violations have increased from 20% in 2018 to 25% in 2021
- Curtailment of ROR hydro and RE ("9pm-9min" event on 5 April 2020)

### Australia

- Grid frequency violations (West Murray zone and Northern Queensland) – January 2020 to May 2021
- RE curtailment and "out-of-merit-order" dispatch (South Australia) – March 2021
- High prices in spot market (evening hours) – 2020 and 2021

### South Korea

- Low reserve margins: 10 times in 2016, 7 times in 2018, two times in 2019, three times in 2021 (until end of June)

### Japan

- Low reserve margins (January 2021)
- Low reserve margins (Winter season 2021, expected)

### Taiwan

- Load shedding and low reserve margins ("513" outage – May 2021)

### Philippines

- Grid frequency violations (Northern Luzon region and Western Visayas region)
- RE curtailment (island of Negros)

— International boundary

▨ Claim, dispute, estimate, or unilateral boundary

▫ UN buffer zone

Note: ROR = run-of-the-river; RE = renewable energy; The 9pm-9min event refers to the prime minister of India's call for everyone to switch off their lights for nine minutes at 9:00pm on 5 April 2020.

0 1,020 km  
0 600 mi



Source: IHS Markit: 2003662

Provides motivation for hardening grid infrastructure via lower cost refurbished battery storage

Source: [IHS Markit](#)

## THE TEAM

Brandon Simons – **Co-Founder**, Battery Engineer @ ReJoule, MS in Sustainable Engineering

Serena Patel – **Co-Founder**, Dual S.M., MIT Technology and Policy & EECS

Lisa Liu – Leaders in Global Operations Fellow @ MIT | MBA & MS MechE Candidate

Rohin Lohe – MBA Candidate @ Harvard University | Associate at Voyager Ventures

Vineet Nair – PhD Candidate @ MIT | Computation for Energy and Climate

Alexandra Steckmest – Investment Fellow at Azolla Ventures | MBA Candidate at MIT

Kailin Graham – **Policy Lead**, Dual S.M, MIT Technology and Policy & EECS

## ADVISORS

[Andrew Lamb](#) - Internet of Production, Local Procurement Learning Partnership, Massive Small Manufacturing, Humanitarian Making

[Dr. Pritpal Singh](#) - Villanova University, Professor & IEEE HAC Committee Member, EIS Specialist

[Steven Chung](#) - Rejoule Inc, Co-Founder / CEO / CTO, Rapid Battery Grading & Diagnostics, EIS Specialist

[Joe Merrill](#) - 2nd Life Battery LLC, Founder / CEO, Prius Battery Reconditioning / Remanufacturing

[Brad Clair](#) - PowerWells Co-Founder

[Claudio Vergara](#) - VP R&D at ZOLA Electric

# AFFILIATES

## Associates

**Paul Sevigny** – JD Candidate at Boston College Law School, RPCV Zambia

**Ryan Lemon** – MS Sustainable Engineering at Villanova University

**Alex Jurcoi** – Research Chemist at pH Matter, LLC

**Hannah Brigham** – Sustainability Consultant at ClimatePartner

**Elliot Harrison** – Mechanical Engineer

## Mentors

**Arjun Gupta** - CEO of Smart Joules

**Yunus Sevimli** - MIT Sandbox Group Mentor

**Joanna Cantwell** - Chief Development Officer at SolarBuddy

# IDEAL HIRES

*Passion for sustainability & climate justice | Responsive, team player, clear communicator*

## **Hardware**

- Electrochemical impedance spectroscopy skills
- Power electronics background
- Prototyping experience

## **Software**

- Data science, ML expertise
- Proficient in python, C/C++
- Domain knowledge in batteries, charge control algorithms

## **Business/Operations**

- Project management
- Customer engagement
- Partner / stakeholder engagement
- Knowledge of global electronic waste flows, urban mining, preference for automobiles

## **Finance**

- Grant writing
- Business model development experience
- Capital planning

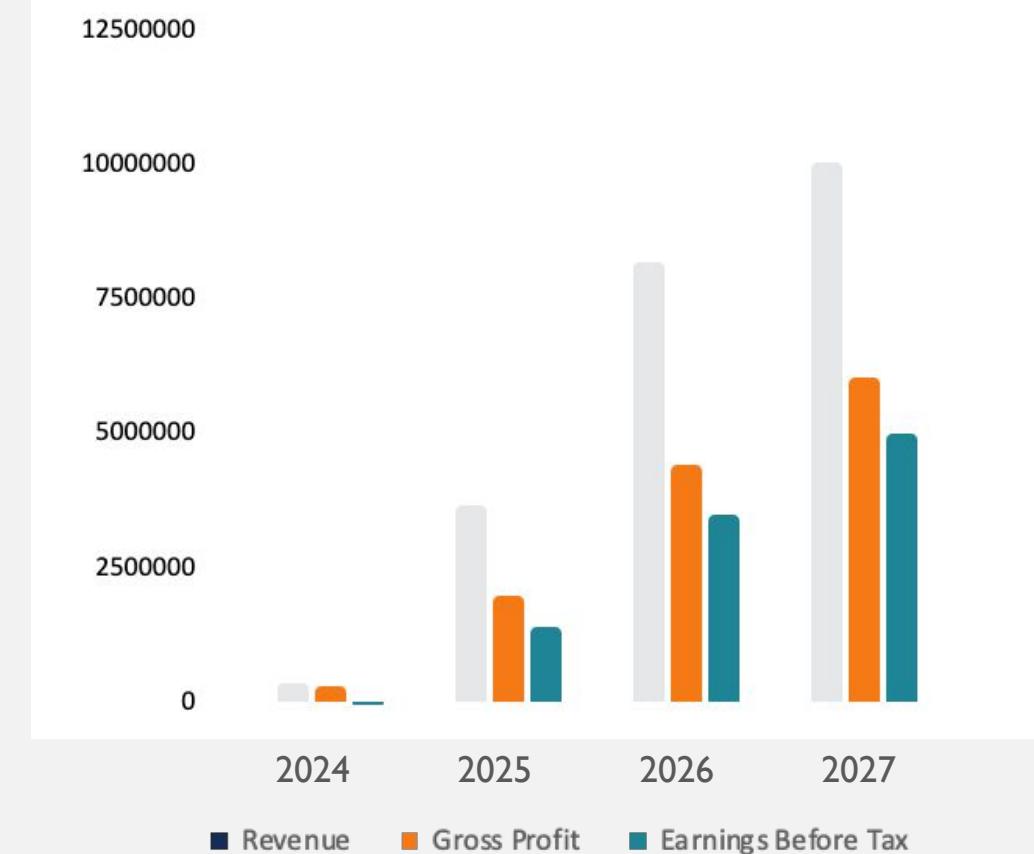
# FINANCIAL PROJECTIONS

## Timing assumptions:

- Go-to-market timeline expected to be ≈6 mo in 2023
- Sales lifecycle in Fiji is projected to be 3 months

## Growth:

- Growth from 2024-2027 is based on operations in Fiji and the availability of HEVs to be acquired at no cost
- Post 2027, the assumption is that Aloe will expand operations to other developing countries with high volume of HEV sales and demand for microgrids



# Next Steps

