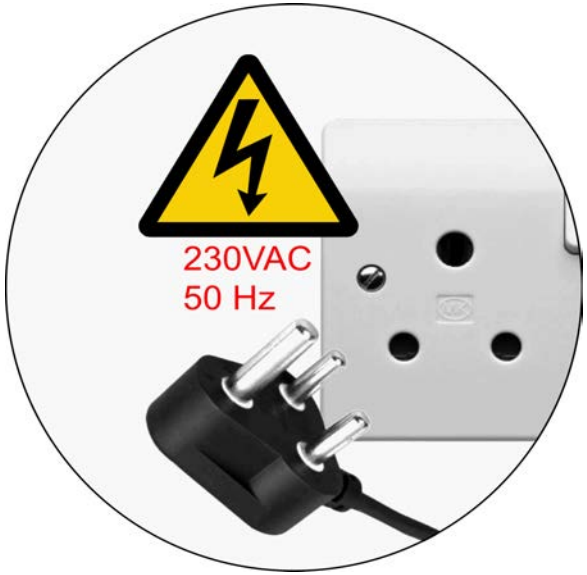
Data-Driven
Micro-Grid Design

Matt Orosz
PhD, President/Director
www.stginternational.org
info@stginternational.org

STG International

STG Vision

Delivering *energy services to the un-empowered* ***1 Billion***

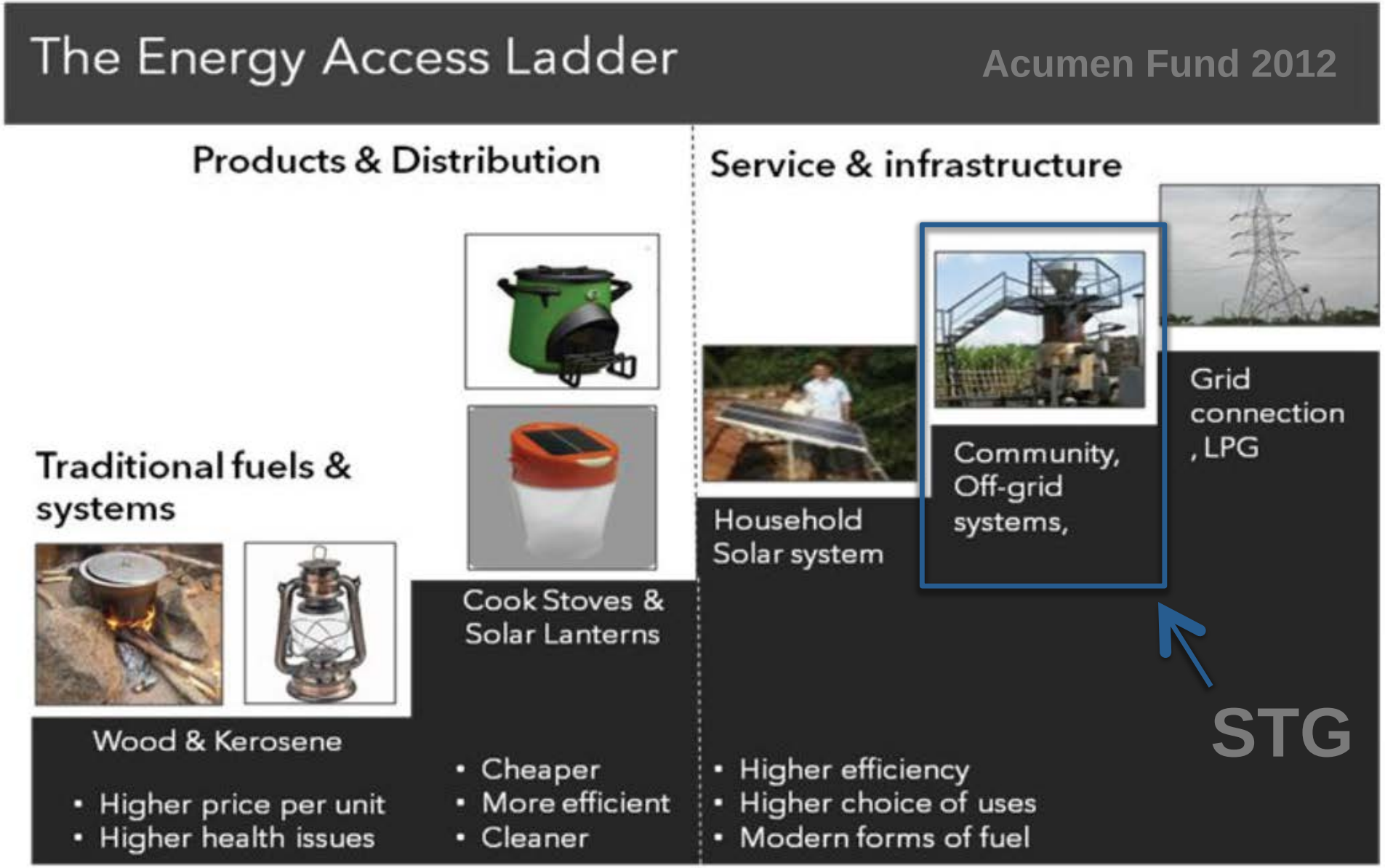


Energy access for ***households, institutions*** *and* ***businesses*** *means* ***standard (mains power)*** *available* ***24/7***

Optimized systems can improve ***affordability*** *and maximize use of* ***renewable resources***

Localized and energized businesses drive ***economic growth***

Market Context



High social impact energy services provide:

Electricity: area lighting, EMR, X-rays, diagnostics, communications, computer labs, lights for dorms/evenings

Cogen-Energy: hot water for hand washing, dorm showers, kitchens; building heating/cooling

Current Approaches & Shortfalls

Solar home systems (SHS):

power limited (<kW)
expensive ($2-5 per kWh)

Microgrids (PV or diesel):

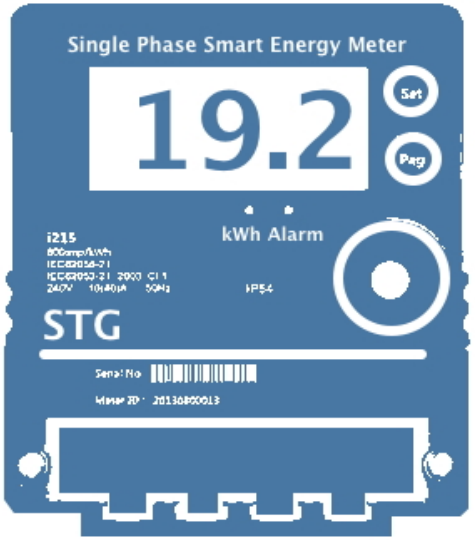
power limited and/or scheduled (not 24/7),
expensive (per kWh >$0.50),
no sustainable model

Stand alone "Own & operate":

lack of energy expertise - systems poorly sized (**cost inefficient**), **poor maintenance record**, tendency toward lowest capital cost (fossil fuels) rather than levelized cost

Microgrids Built, Owned and Operated as a Micro Utility Business

- **Local Independent Power Producer (IPP)** secures finance for generation equipment and **is responsible for maintenance**
- **Power Purchase Agreement (PPA)** with institutional customers (**high ability to pay)** provides **steady energy demand** (revenues) -> path to bankability
- **Smart Meter PAYG** (pay-as-you-go) connections for households and businesses **lowers repayment risk** and **transaction costs**



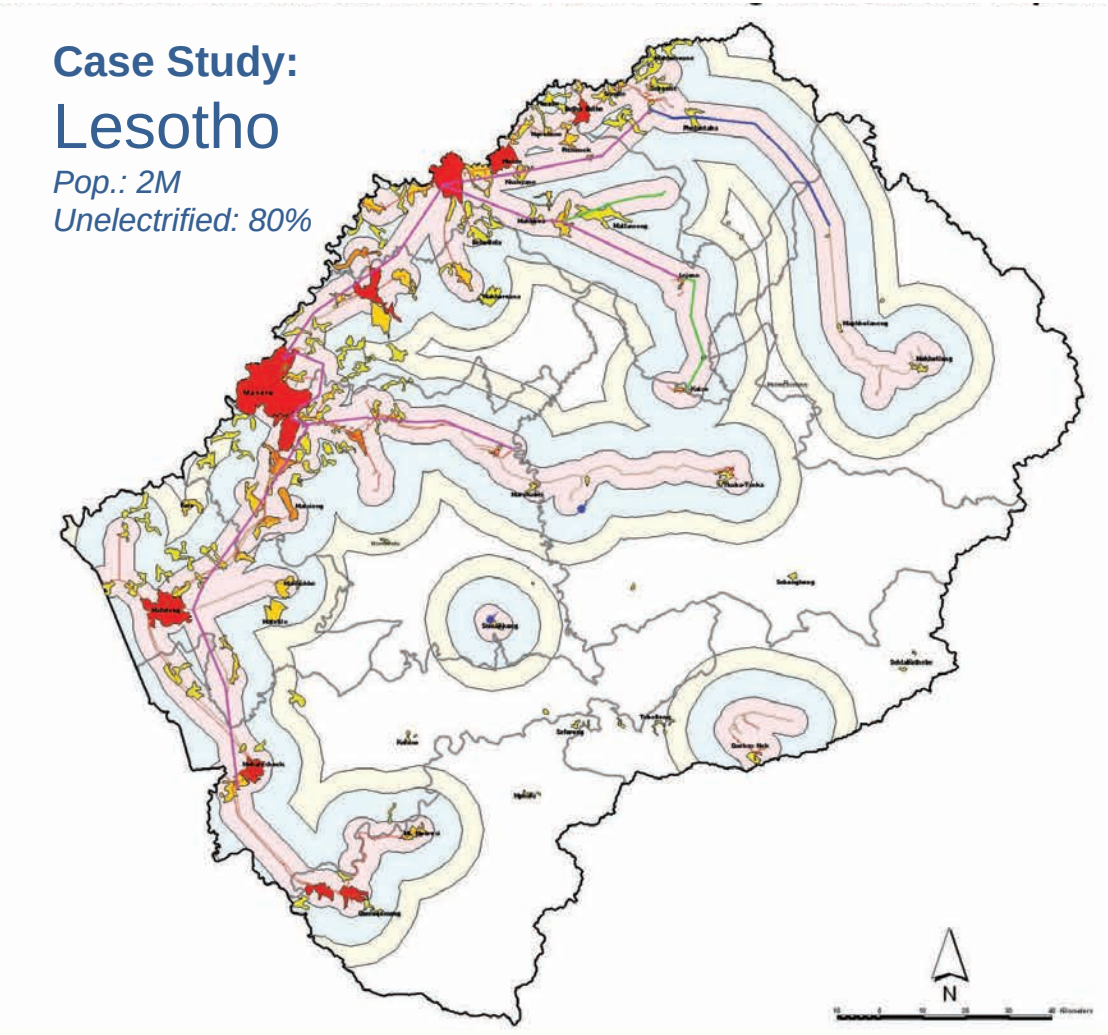
Households and Businesses purchase credits (kWhs) using their mobile devices when they need them, as they need them

A central database interfaces with the wireless service provider and updates the smart meter

Transactions are automated and usage data strengthens the infrastructure design process and informs maintenance schedule

Market Identification

Case Study:
Lesotho
Pop.: 2M
Unelectrified: 80%



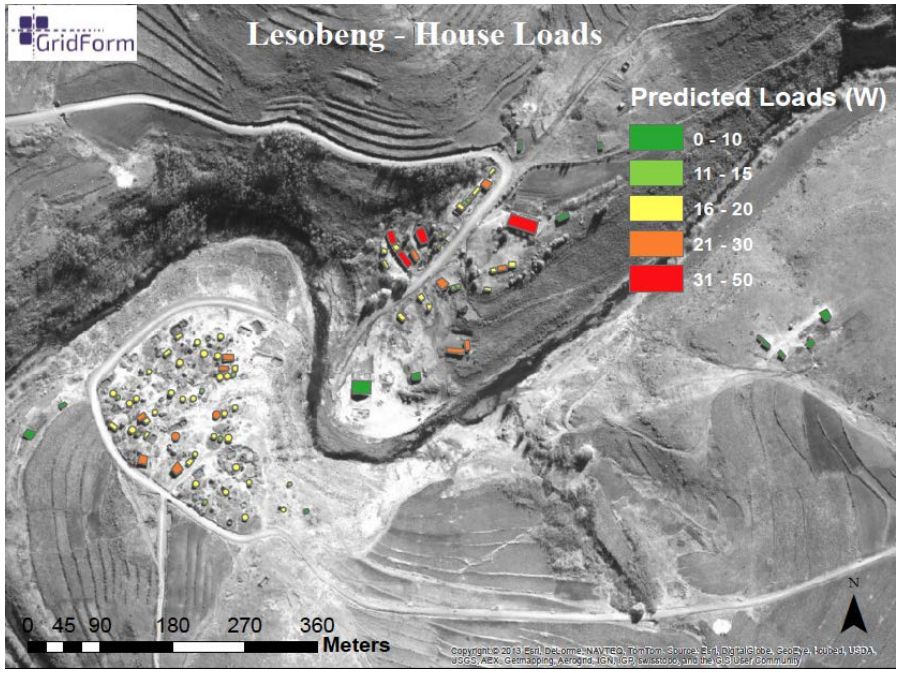
Use Utility Planning and GIS tools to identify target geographies and learn where the grid is headed:

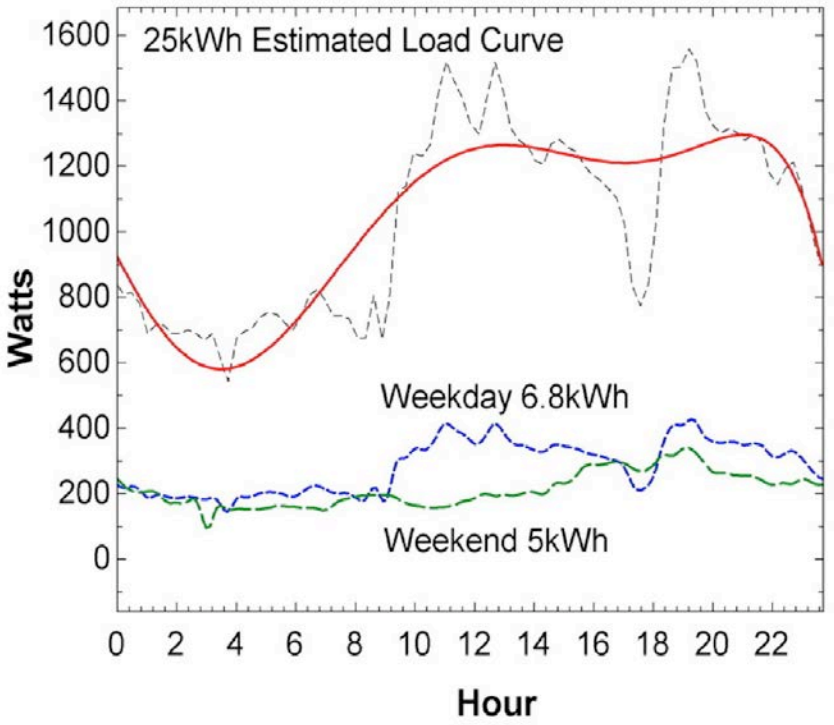
populations within 15km of the grid are likely candidates for grid extension in the next 5-10 years

Microgrids *are suitable for communities beyond this grid buffer zone*

Solar home systems (SHS) *should be deployed when settlement density is too low for microgrids (<200people/km^2 = high reticulation costs)*

Rapid, Semi-automated System Design



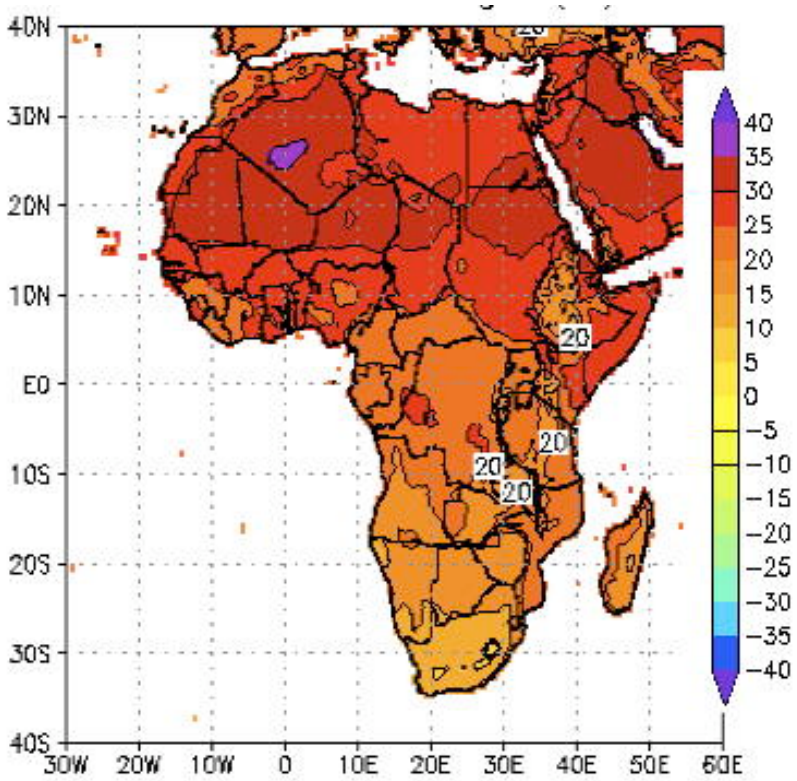


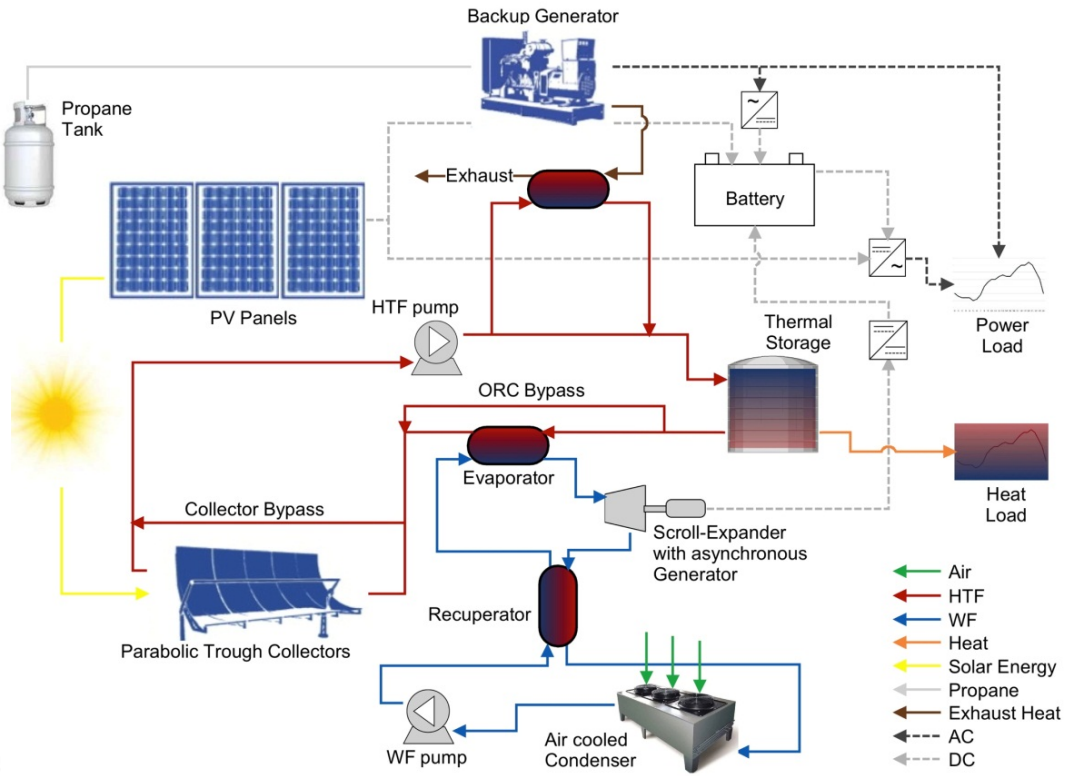
STEP 1: Use satellite imagery + image processing to identify village buildings by type (size, shape, distribution)

STEP 2: Use data for average demand profiles (homes, clinics, schools, etc.) to estimate total community need

Optimized Infrastructure Design

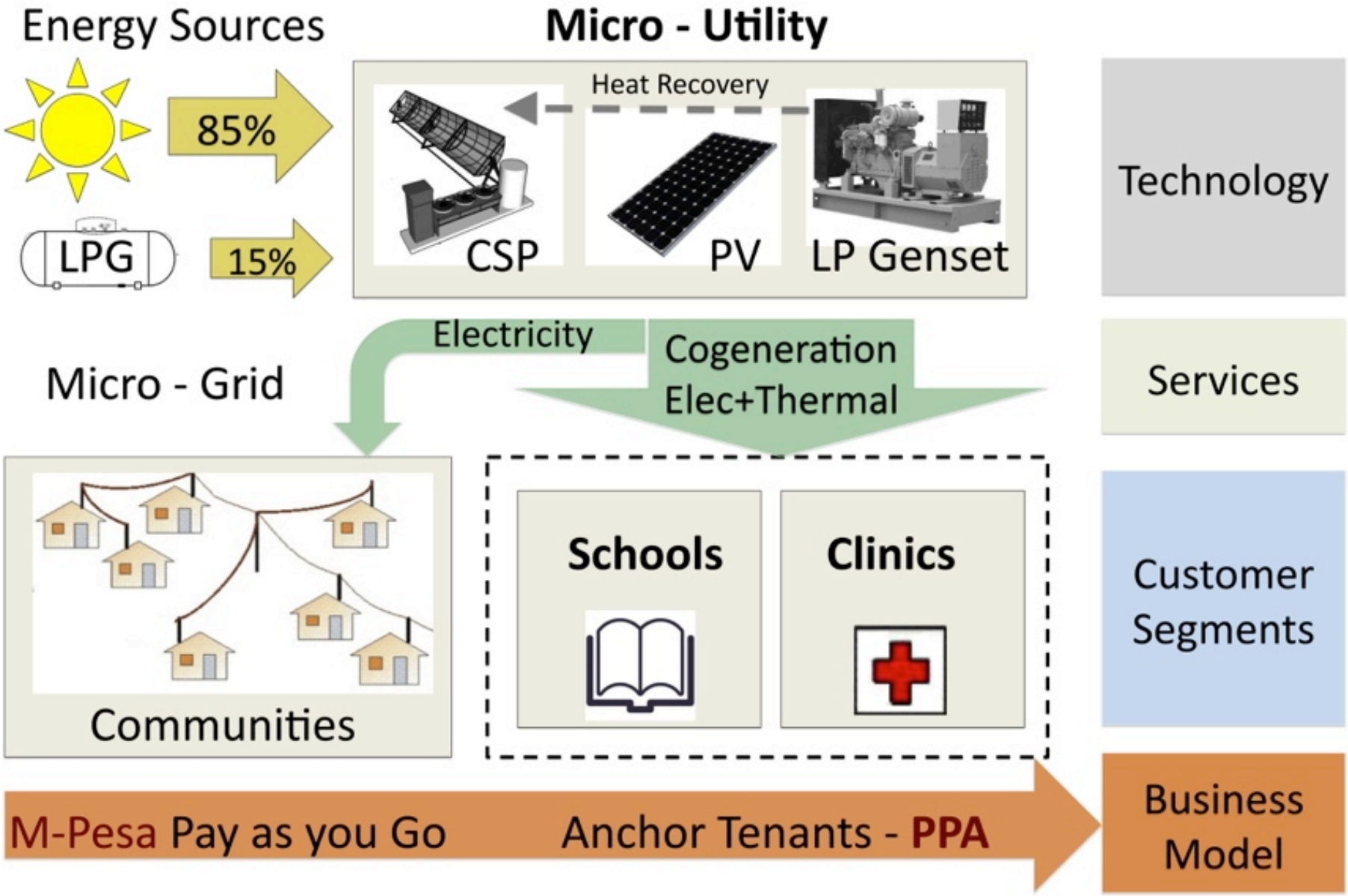
STEP 3: Combine with weather and solar data (e.g., NASA datasets)



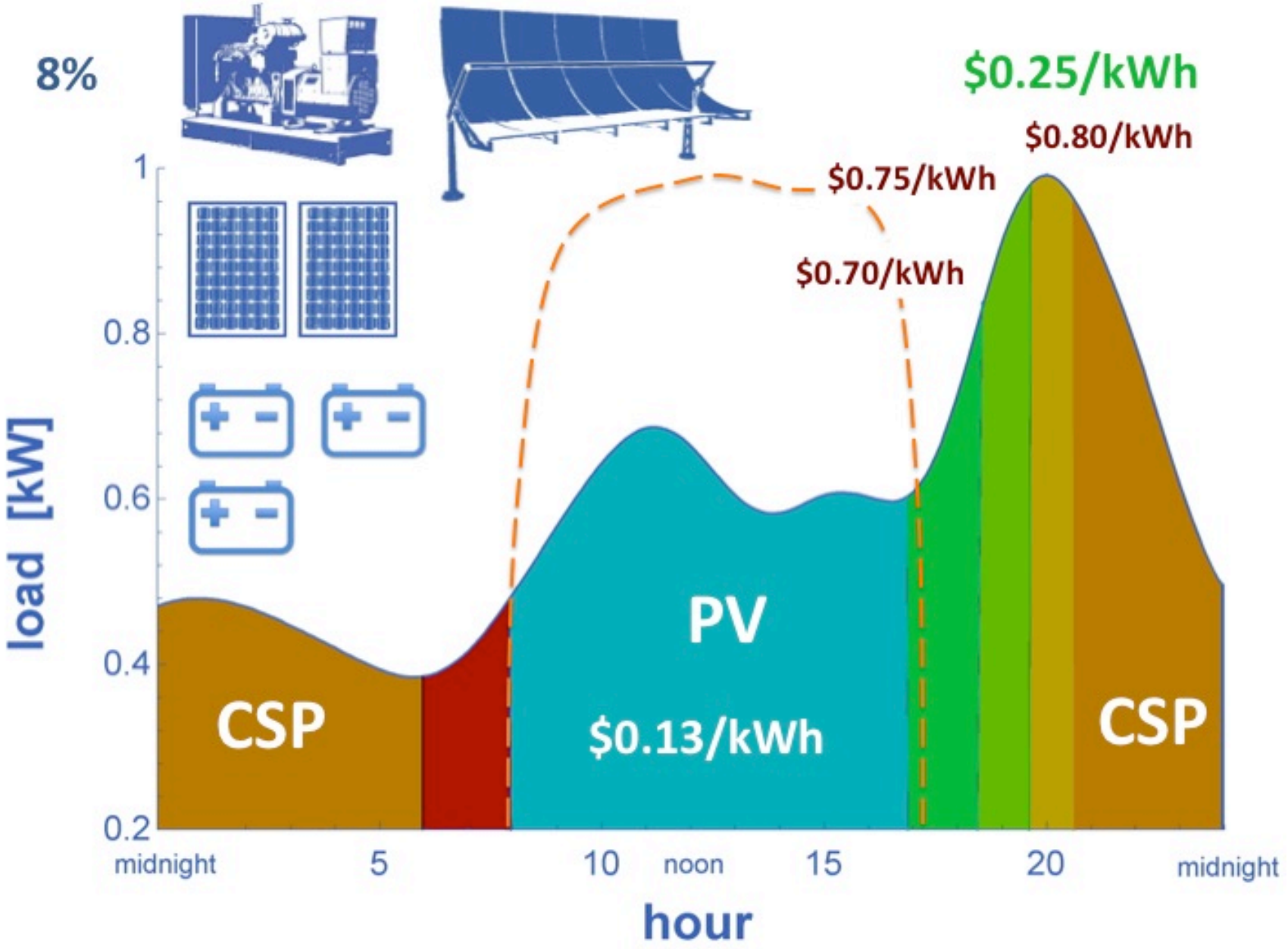


STEP 4: Allocate generation infrastructure and derive control strategy dynamically to achieve minimum tariff for positive project cash flows

STG IPP Micro-Grid: Hybrid Strategies



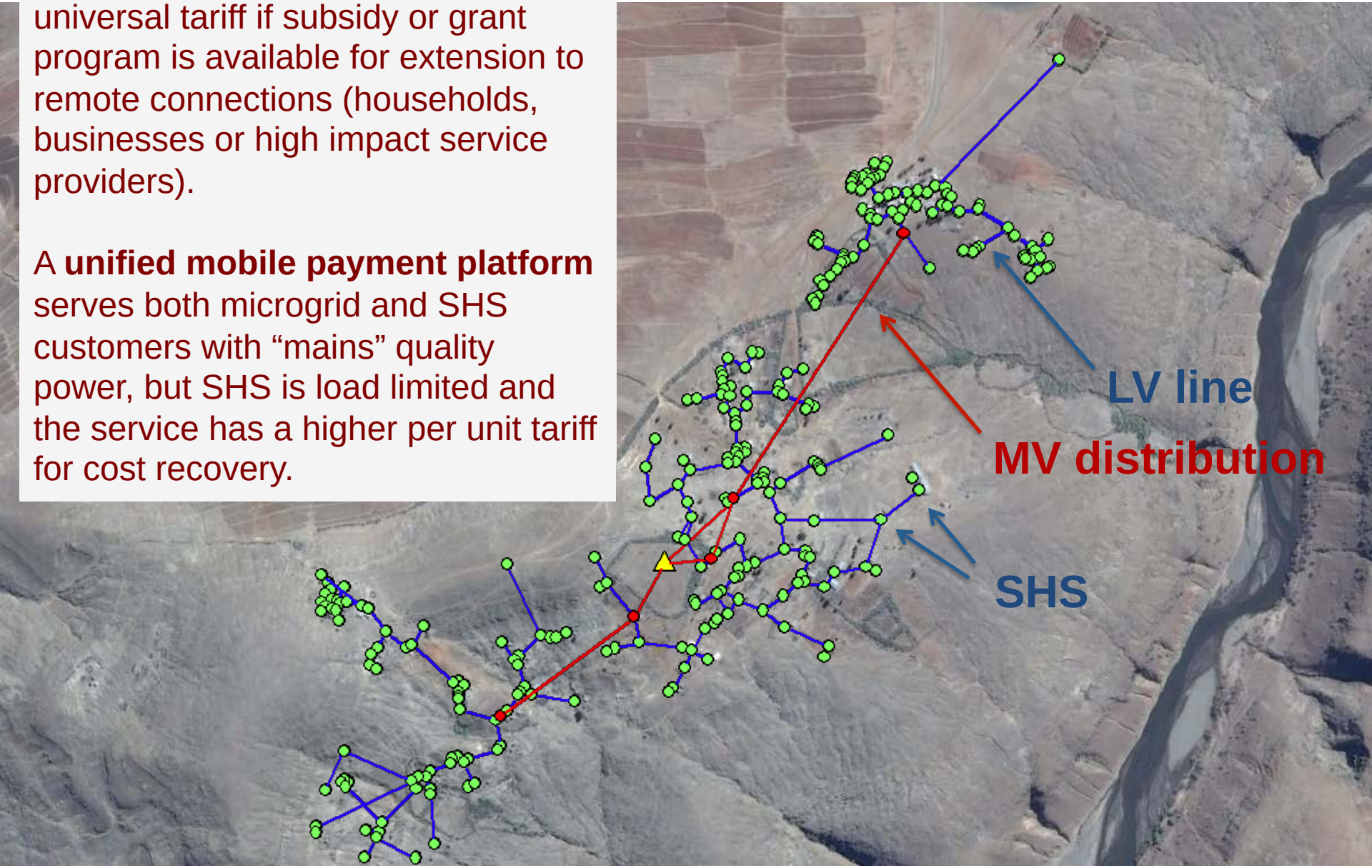
Cost of Meeting 100% of Demand



System Rollout Strategy

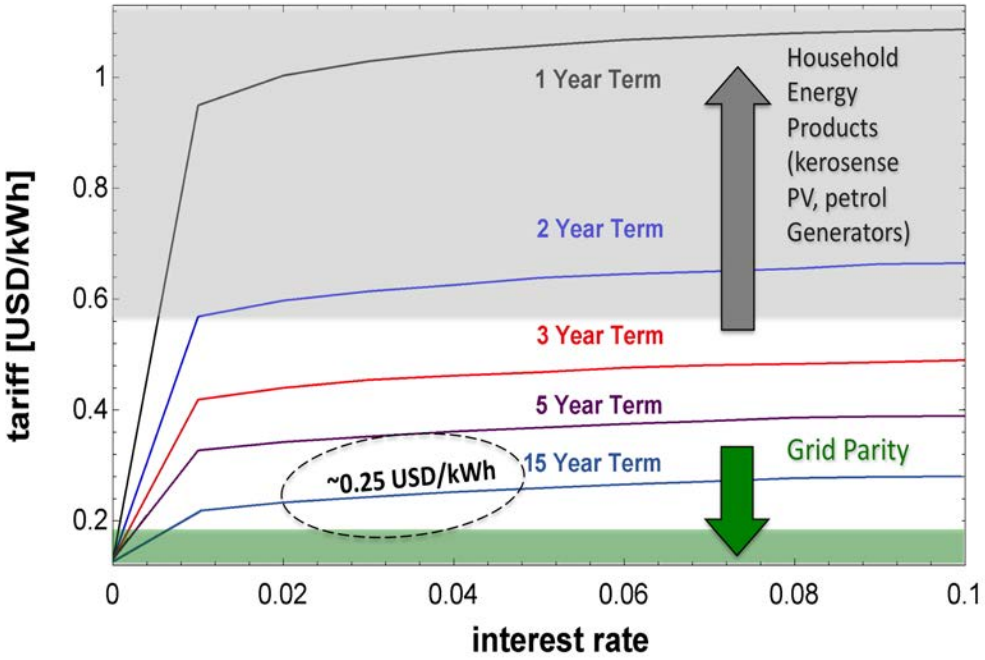
Micro grid network can be designed for high coverage factor and universal tariff if subsidy or grant program is available for extension to remote connections (households, businesses or high impact service providers).

A **unified mobile payment platform** serves both microgrid and SHS customers with “mains” quality power, but SHS is load limited and the service has a higher per unit tariff for cost recovery.



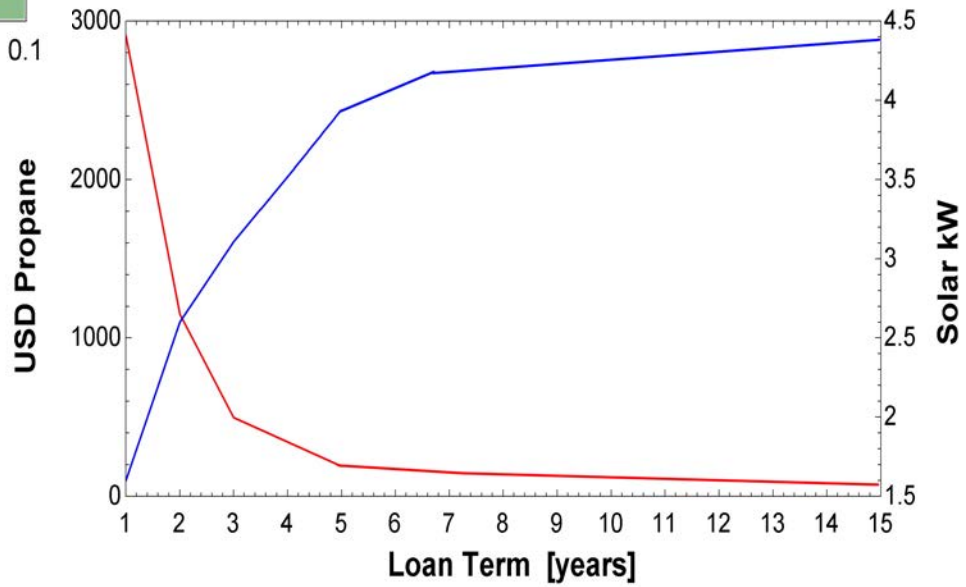
Nkau, Lesotho

Patient Capital Matters

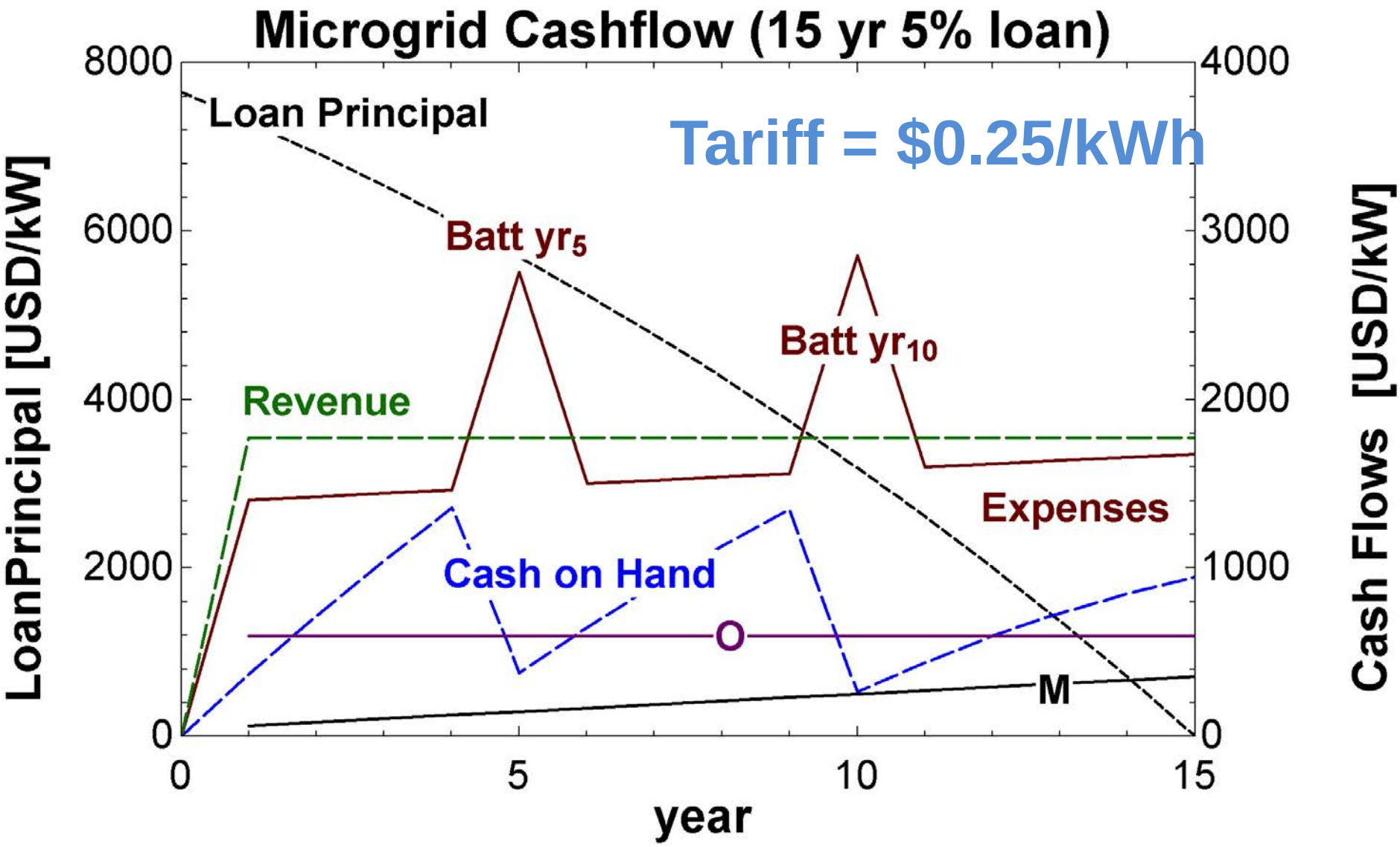


Cost of capital is main driver of cost recovery tariff – **affordability depends primarily on loan tenure, *not* rate**

Renewable fraction is also determined by cost of capital – short payback period = low solar fraction and high fossil fuel usage



Fuel Costs as a function of finance term period for cash flow optimized system (Left Y axis)
Solar capacity as a fraction of 1kW peakload, optimized cash flow, at finance term period (Right Y axis)



year	Cash	Costs	Loan Principal	Maintenance	Operations	Revenue
0			7650			
5	[illegible]	[illegible]	[illegible]	135.5	608.2	[illegible]
10	[illegible]	[illegible]	3190	232.4	608.2	2030
15	[illegible]	[illegible]	0	329.2	608.2	[illegible]

Leverage Technology and Cloud Computing

Hybrid Generation Infrastructure

- Load following and high availability (meet 100% of unconstrained demand)
- Minimize tariff to residential consumers
- Maximize use of solar resources *and* minimize battery storage, fuel costs and CO_2 emissions

Optimized Design Tools

- Near-automated system design for any village (reduces project design overhead)
- Cost-optimize system based on **solar resource availability** and **expected demand**

Commit to Technology Transfer & Training

- Localize energy system manufacturing
- Localize system integration and installation
- Train local operations and maintenance team
- Catalyze local IPPs (Independent Power Producer)

How we support these goals

- Classroom & hands-on trainings with partners
- Internships & skilled labor pipeline
- Building enterprise systems, upgraded factories

STG Management Teams

Lesotho Field Team Management




Kopano Ts'enoli, President (STG-Lesotho)
Lengeta Mabea, Supervising Engineer
Matt Orosz, PhD, Director, System engineering
Amy Mueller, PhD, Automation/Finances


Boston USA STG Management

Bryan Urban, Business Development/Fundraising
Matthew Osborne-Smith, MBA, Strategy

STG Background

- 8 Years of experience in solar energy, R&D, and technology training in Lesotho, including:
- 3 Prototype micro-CSP plants, 1 PV-diesel microgrid integration
- Currently expanding partnerships to India (R&D) and scoping partnerships in Tanzania (implementation)
- 2 active field demonstration sites (Eckerd College and Lesotho)
- Manufacturing capacity established in Lesotho, first commercial sale in 2014

Partners & Sponsors

Government of Lesotho
Ministry of Science and Technology
Ministry of Health

gef GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

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Extra Slides

www.stginternational.org
info@stginternational.org

Installing Manufacturing Equipment

Solar Manufacturing in Lesotho

STG brought the first CNC Mill to Lesotho

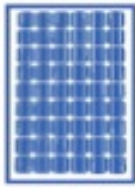
- trained 25 people on rapid prototyping methods in 2014

STG Training University Partners

STG Solar Collector Design:

Built in Lesotho for use in University Courses

Hybridization leverages strengths within a generation portfolio



	PV	CSP	Generator
Capital cost			
Storage cost			
Fuel cost			
Availability			
CO_2 emissions			