

# Asia Clean Energy Forum-2018

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## “Quantifying demand side opportunities to improve integration of renewable energy in mini-grids in Nepal”

Bhupendra Shakya<sup>1</sup>

PhD candidate

Anna Bruce<sup>1,3</sup> , Iain MacGill<sup>2,3</sup>

<sup>1</sup> *School of Photovoltaics and Renewable Energy Engineering,*

<sup>2</sup> *School of Electrical Engineering and Telecommunications*

<sup>3</sup> *Centre for Energy and Environmental Markets*

*University of New South Wales (UNSW),*

*Sydney, NSW 2052, Australia*

# Summary

- Integrating variable renewable energy into mini-grids increases the challenge of matching demand and supply.
- Current design practices for Renewable Energy Mini-Grid (REMG) systems are supply oriented and can miss some key opportunities on the demand-side to deliver low cost and reliable energy services.
- Users place different relative value on energy services, while some energy services have considerable flexibility due to inherent energy storage in the end-use equipment used, or user willingness to shift their usage, depending on affordability and reliability preferences.
- Present results of surveys of energy service characteristics across 154 households in five mini grids in Nepal in order to better understand and quantify these opportunities.
- Data presented includes energy consumption patterns, appliance ownership, energy service preferences and priorities and potential flexibility to move some loads across the day.
- Quantification of these characteristics can be used to design REMGs that are low cost and reliable.

# Key Barriers

- ‘UN SE4All’, REMG -High Impact Opportunity (HIO) to provide electricity access and 40% electricity from MG by 2030

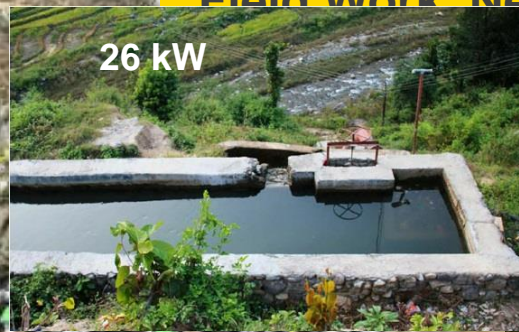
Key barriers in REMG deployment are

1. System design complexities (sizing): matching between variable supply and demand<sup>1</sup>
- High capital cost and uncertainties <sup>2</sup>

Energy Service Approach and opportunities:

- Key value of energy supply is in service provision (lighting, cooking, refrigeration) - not kWh delivered<sup>3</sup>
- Users assign relative value to energy services - preferences, capabilities
- Possible flexibility of energy services (inherent storage in appliances and services)
- Opportunity to better utilise RE at lower cost to meet most important energy service needs
  - Solar Home System (SHS) users very engaged to prioritise the Energy services
  - Grid users not very engaged
  - REMG users have opportunity to engage

# Field Work Nepal (Feb-May, 2017)



Source of electrification	House holds
Solar-Wind MG, Makawanpur	20
Solar-Battery MG, Tanahun	16
Solar-Diesel Hybrid MG, Okhaldhunga	17
Micro Hydro MG, Dhading	8
Mini Hydro, Ramechhap	93
<b>Total</b>	<b>154</b>

“Collaboration with Alternative Energy Promotion Centre/ Renewable Energy for Rural Livelihoods programme”

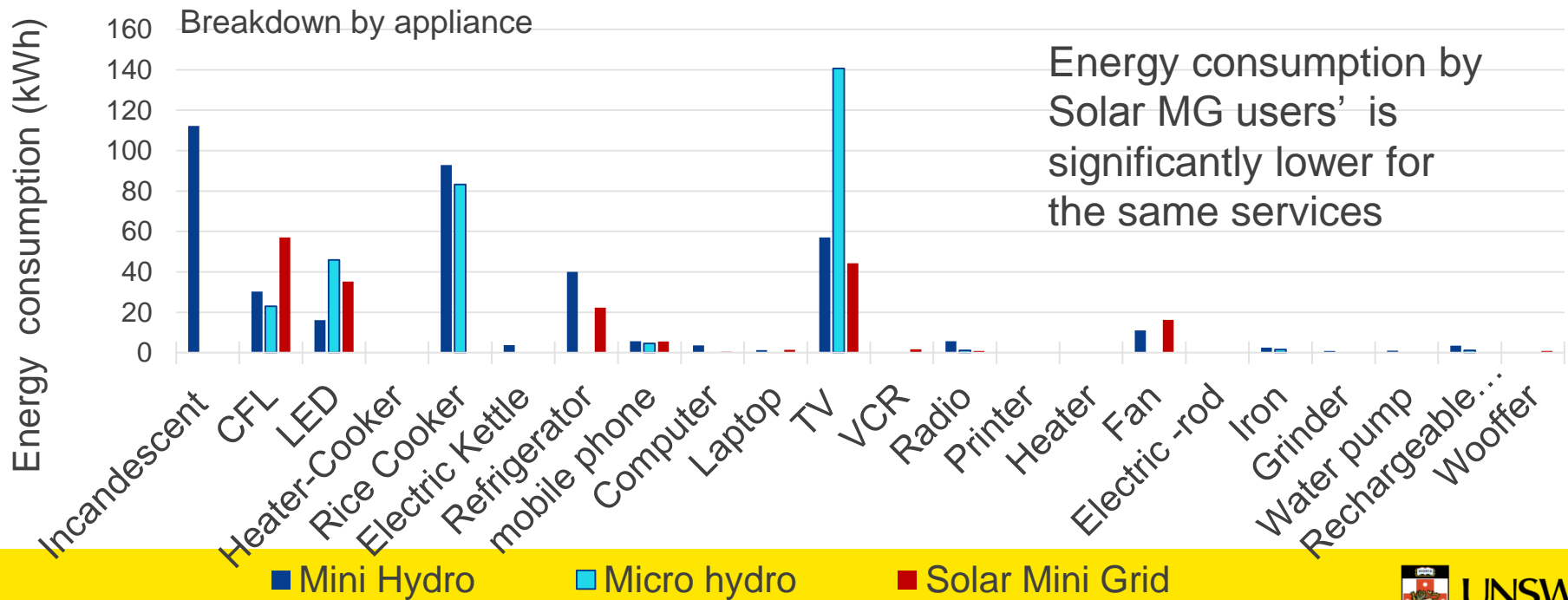
- Detailed Consumer Survey for access to electricity, demand assessment , consumer preference
- Key informant Interview (Plant operator, manager)

# Techno-economic and Social Characteristics

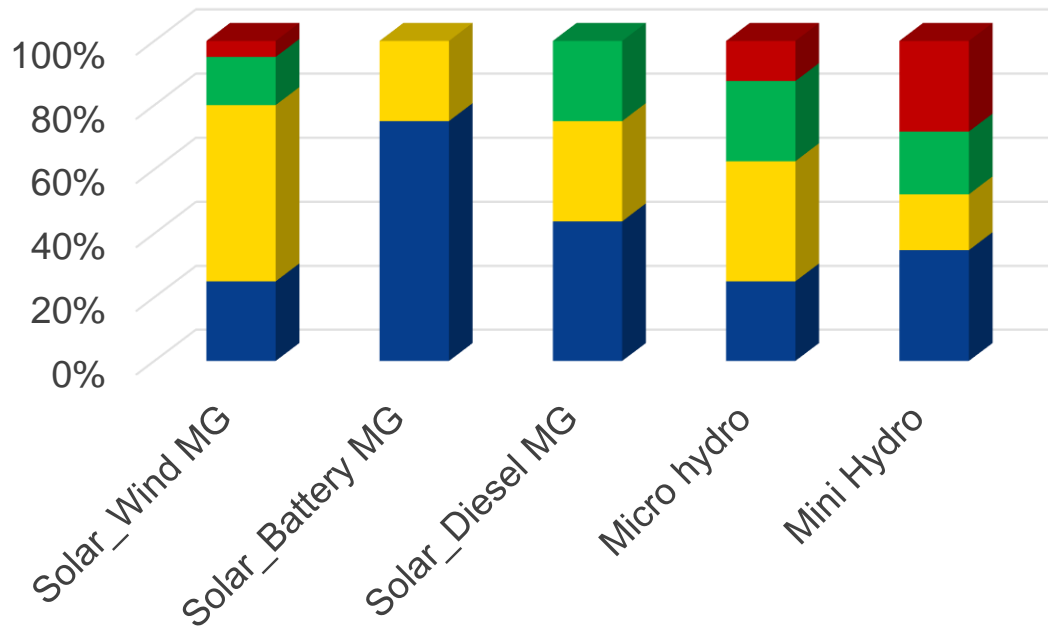
	<b>Solar-Wind-MG</b>	<b>Solar-Battery</b>	<b>Solar-diesel MG,</b>	<b>Micro-hydro MG,</b>	<b>Mini hydro MG</b>
Generating Capacity (kW)	25 (15 PV+10 Wind)	18 PV	63 (31 PV + 40 DG)	26	1030
<b>Settlement</b>	<b>Rural Market centre</b>	<b>Rural Market centre</b>	<b>“Commercial” centre</b>	<b>Rural Market centre</b>	<b>Rural / “Commercial centre”</b>
Ownership structure	Community	Private/ community	Private / community	Community / Cooperative	Cooperative
<b>Adequacy of supply</b>	<b>Access Deficit</b>	<b>Spare power</b>	<b>Access Deficit</b>	<b>Access Deficit</b>	<b>Adequate</b>
Metering	No meter, power limiter (MCB)	Smart meter	Smart meter	Traditional meter	Traditional meter
<b>Tariff (US c/kWh)</b>	<b>4 - 13</b>	<b>16 - 75</b>	<b>31 - 98</b>	<b>4 - 7</b>	<b>4 - 5</b>
Productive end-uses	Poultry, Eatery	Poultry, Eatery	Telcom tower, Petrol pump, Health Centre	Agro-processing Mill, Furniture, Metal workshop	Agro-processing Mill, Furniture, Bakery, Metal workshop

# Annual household energy consumption

Consumption depends on:  
types of supply sources,  
settlement, tariff structure



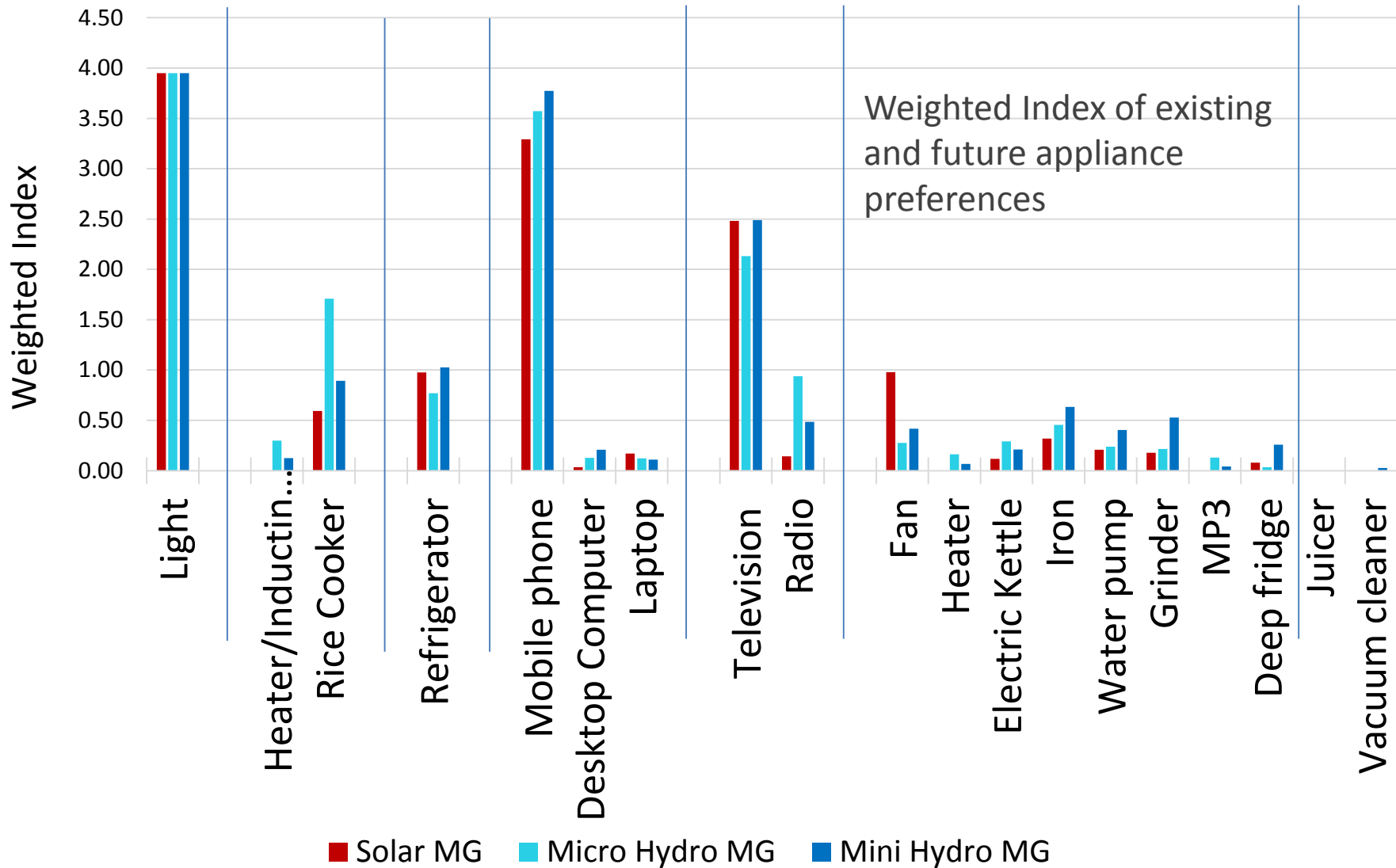
# Access Status: Multi-tier framework-service



- Tier 5: Tier 4+ high power appliances
- Tier 4: Tier 3+ Electric kettle, Water heater+ Heater-cooker
- Tier 3: Tier 2+ Rice cooker, electric food processor, Refrigerator, Water pump
- Tier 2: Tier 1+ Fan, TV, Laptop, Computer, Printer
- Tier 1: Lighting, Phone charging, Radio

	Solar Wind MG	Solar Battery MG	Solar Diesel MG	Micro Hydro	Mini Hydro
Reliability, interruption/ week (index)	<14 (4)	<3 (5)	<14 (4)	<3 (5)	<3 (5)
Duration, hours/ day (index)	<8 (2)	23 (5)	<16 (3)	<22 (4)	23 (5)
Quality, appliance under perform due to over/ under voltage)	14% (4)	0% (5)	29% (4)	60% (3)	26% (4)
<b>Access Index</b>	<b>1.75</b>	<b>1.25</b>	<b>1.81</b>	<b>2.13</b>	<b>2.41</b>

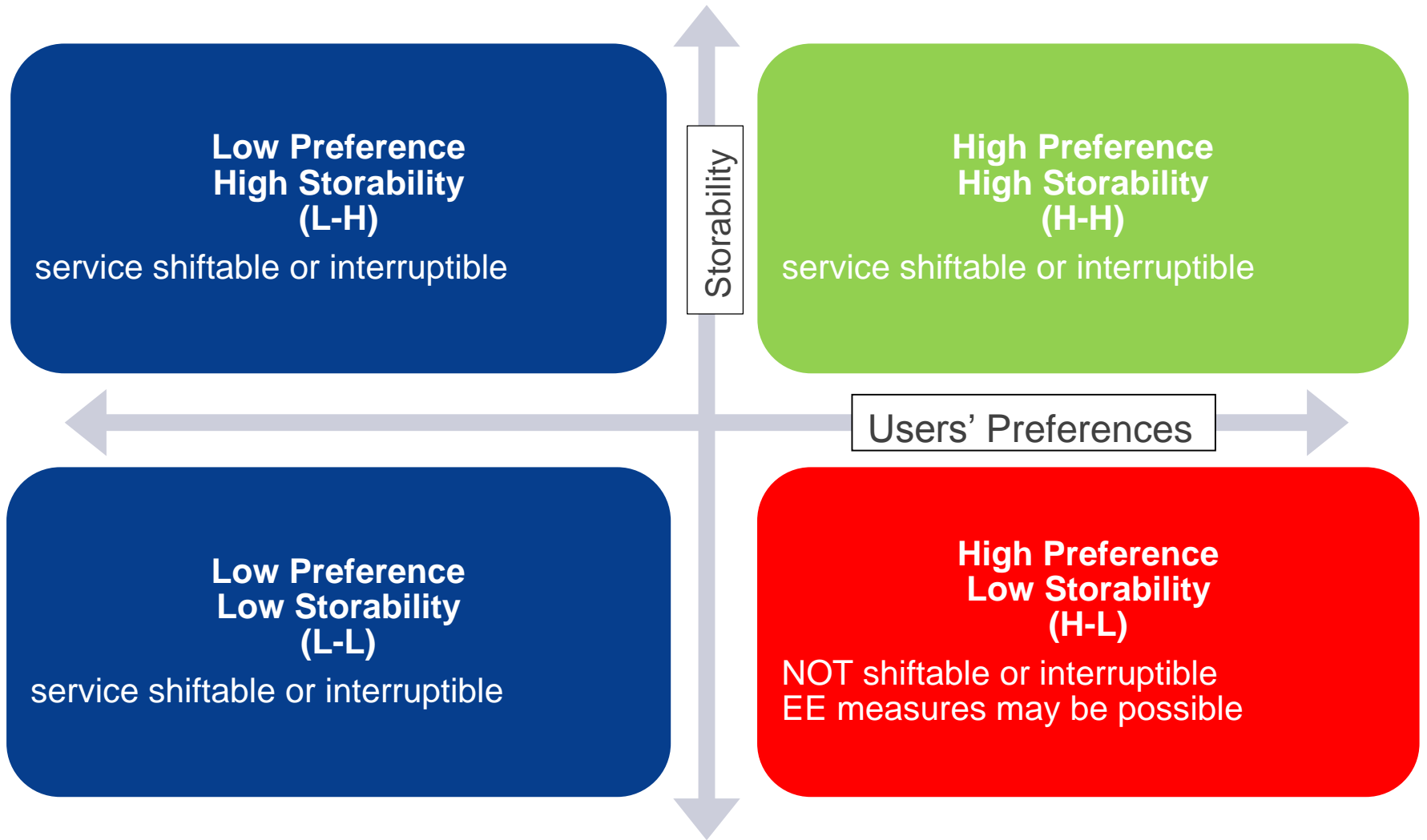
# Appliance Preferences



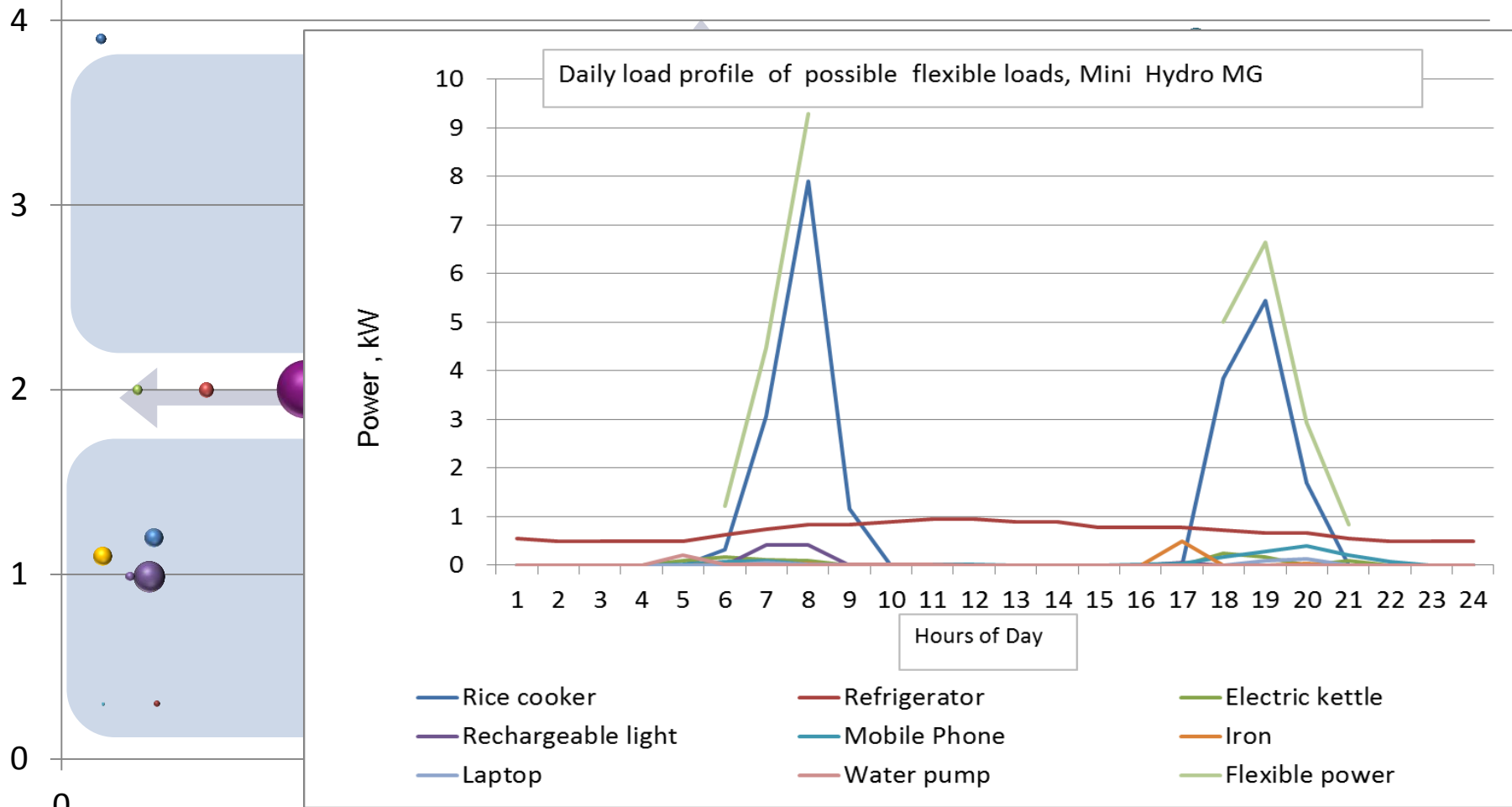
Order of preferences- Light, Mobile phone, Television, Rice cooker , Refrigerator



# Energy service characterisation framework



# Service Characterisation of Mini Hydro MG



- Light
- Rechargeable Light
- Heater-Cooker
- Rice Cooker
- Refrigerator
- Mobile phone
- Desktop Computer
- Laptop
- TV
- Radio
- Fan
- Electric Kettle
- Iron
- Water pump
- Grinder
- MP3
- VCR
- Printer

Area of bubbles represent the Energy Consumption

# Conclusion

Supply	Energy efficiency	Demand Management Possibilities
Mini Hydro MG	Light, TV, Refrigerator	<b>Rice cooker, refrigerator,</b> (mobile phone, iron, rechargeable light, water pump, laptop)
Micro Hydro MG	TV	<b>Rice cooker,</b> (mobile phone and rechargeable light)
Solar MG	Refrigerator	<b>Refrigerator,</b> (mobile phone, laptop and rechargeable light)

- Proposed energy service characterisation framework and load profile can be used to develop an effective load shifting strategy
- Provides a basis for designing REMGs to provide important services at reduced cost
- Users are generally aware of or positive towards energy efficiency measures and load shifting
- Financial incentives, awareness, metering and load control mechanisms are possible options for implementation of demand side management

# Thank you!

(ADB, supervisors)

(Questions Please ?)