Innovative tariff designing for Mini-grids

Workshop: “Mini-Grids for Resilient Energy Supply: the Community of San Rafael as Case Study”

28 September 2023

Presented by:

Dipta Majumder

Mini-Grid Expert, INENSUS GmbH

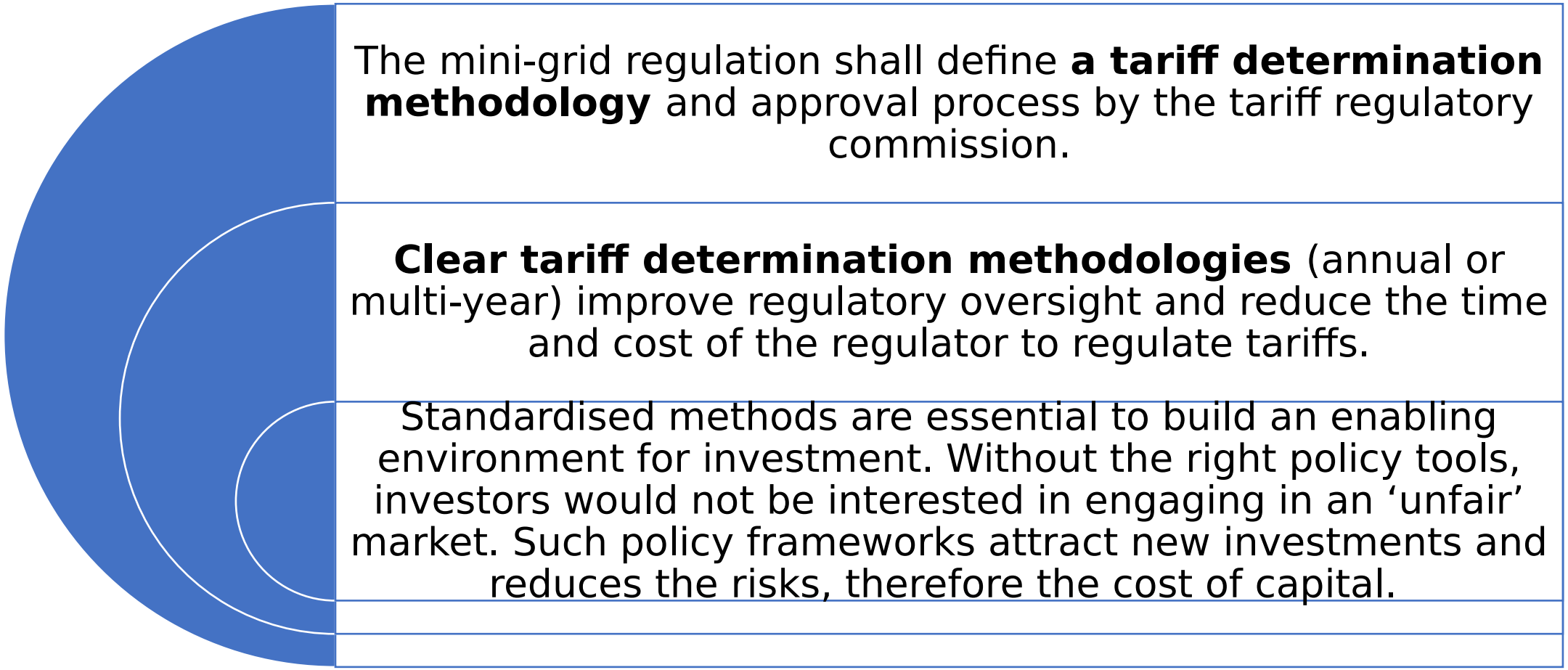
Outline

- Mini-Grid Regulations
- Tariff Regulations
- International Electricity Tariff Regulation Practices
- Mini-Grid Tariff Principles
- Different Tariff Setting Methodologies
- Tariff Reduction Strategies

Mini-Grid Regulations

- Mini-grid services are generally regulated by a Government authority e.g. in Sierra Leone- the Sierra Leone Electricity and Water Regulatory Commission (SLEWRC).
- Key areas covered by the regulations: market entry, **retail tariff,** technical and service standards, arrival of the main grid.
- Example: Mini-grid developers can have two types of licences:
  i. **Basic mini-grid licence** (for projects with distributed power of up to **100 kW** in aggregate)
  ii. **Full mini-grid licence** (for projects with distributed power of up to **10 MW** in aggregate)
- Full mini-grid licencee are required to apply the cost reflective tariff determination methodology and the developed tariff tool. This approach enables the private operators to generate risk equivalent profit margins through **cost-reflective tariffs**

Tariff Regulation



Tariff Determination

Mini-Grid Tariff

=

Total Allowed Revenue

÷

Total Demand

Tariff Determination

Mini-Grid Tariff

=

Total Allowed Revenue

÷

Total Demand

- Operation & Maintenance Expense
- Depreciation
- Taxes and Duties
- Expected Return on Investment

- Household demands
- Commercial demands
- Productive demands & others

Electricity Tariff Regulation Practices

- **Cost-of-Service based**

This model uses a tariff review procedure, known as the rate case, which is periodically conducted – at least once a year to arrive at an average tariff (allowed revenue divided by total aggregate demand). Calculations may vary from country to country.

- **Incentive based**

The most common form of incentive-based regulation is known as “CPI-X“ (or “RPI-X“) regulation. Under this scheme, the revenues and maximum prices that the utility can charge are set for a period of 4-5 years and do not need to reflect the actual cost in each year.

- **Cash flow based**

This model projects all cost and the demand for the full project duration (10-25 years) and the regulator and the operator agree on the targeted value of the project internal rate of return (IRR). To allow some flexibility the regulator needs to allow both the utility and the customers to request tariff reviews at undefined times.

Comparison of tariff calculation methods

Aspect	Cost of Service Method	Incentive Based Method	Cashflow Method
Tariff approval	Yearly	Every 4-5 years, and on request	On request
Real data vs. projections	• Minimum number of projections • if, then only for 1 year	Many projections for 3-5 years	• Maximum number of projections • for full project duration
Necessary projections (a) CAPEX (b) OPEX (c) Taxes (d) Financing (e) Inflation and FX rate (f) Demand	 No No No Yes No No	 Yes Yes Yes Yes Yes Yes (highly sensitive)	 Yes Yes Yes Yes Yes Yes
Timing of tariff control	At fixed yearly time intervals	Every 4-5 years at fixed time intervals	At unpredictable times
Investor security (a) default methodology is in legislature (b) default methodology is not in legislature:	 High Very Low	 High Low	 Medium Very Low

Mini-Grid Tariff Principles

- In Mini-Grids, different tariff mechanisms are used for different customer groups
- Tariff structure may include flat rate tariff, time of use tariff, etc.
- The regulator applies standard methodology as defined in the regulation as long as no other methodology is requested by the licensees and approved by the regulatory.
- **Cost of service tariff** – based on historic data.
- Approval of tariffs as long as the supporting rational is reasonable.
- Cost-reflective tariff does not mean that the **booked costs are approved automatically**. The regulator ensures that the proposed costs for the service **reflects prudency** of the incurred costs and a reasonable level of efficiency.
- Cost-reflective also does not mean that **estimated customer demand** is accepted automatically. The regulator ensures that the customer demand is based on either verifiable data or reasonable demand projections based on verifiable data.

Incentive based tariff setting

- Incentive based methods to regulate electricity tariffs are used to regulated well established monopolistic electricity markets.

- The most common form of incentive-based regulation is known as “CPI-X“ (or “RPI-X“) regulation. Under this scheme, the revenues and maximum prices that the utility can charge are set for a period of 4-5 years and do not need to reflect the actual cost in each year.

Incentive based tariff setting

- The revenue or price target is fixed (revenue cap or price cap) on the grounds of
  - the previous year´s target,
  - updated to adjust for inflation,
  - certain efficiency / productivity factor, and
  - adjustment factor for unforeseen events.
- Some key challenges of the incentive based method are:
  - The complexity of projections and corrections.
  - The weakening of the tariff and cost relationship.
  - The potentially weaker regulatory oversight and customer confidence.

Cash flow based tariff setting

- Some countries calculate mini-grid tariffs based on a cash flow based method.
- Cash flow models need to project both cost and demand for the full project duration (10-25 years) and the regulator and the operator agree on the targeted value of the project internal rate of return (IRR). To allow some flexibility the regulator needs to allow both the utility and the customers to request tariff reviews at undefined times.
- This method usually estimated the CAPEX investment, reinvestment, OPEX, inflation and currency exchange rate, demand.

Cash flow based tariff setting

- The main issues with the Cash flow based method are:
  - The **demand in mini-grids cannot be projected with any reliability** which is why the cash flow projections are usually not correct and the actual IRR lower than the projection.
  - The **complexity to check assumption** for the whole project duration leads to long and discussion rich meetings between the regulator and the operators.
  - Due to the complexity and the reliability this method provides probably the **lowest investor security, customer satisfaction and regulator efficiency**.

Cost-of-Service Tariff setting methodology (1/2)

- Cost-of-service method adapted to rural mini-grids
- The core of the cost-of service method is the tariff review procedure, known as the rate case, which is periodically conducted - every year (now available with digital tools)
- The allowed revenue (AR) is calculated by assessing for the last year the allowed O&M cost, the depreciation expense (DP), the allowed rate of return (s), the regulatory asset base (RAB) (net assets = gross assets – accumulated depreciation) and the tax expenses and projecting it into the next year.
- The formula to calculate the allowed revenue is:

  AR= O&M + DP + s*RAB + Tax

- Only privately financed cost (no public finance) shall be eligible costs for the calculation of the AR.
- Any cost fully or partially paid through other means than the electricity tariff need to be deducted.

Cost-of-Service Tariff setting methodology (2/2)

- Any O&M costs which are publicly financed (e.g. grants, viability gap funding, etc) are non eligible cost
- One of the biggest challenges in any review is to define prudently incurred cost at a reasonable level of efficiency.
- Independently verified benchmarks for O&M costs for mini-grids are not yet available

International Context for Solar Hybrid Mini-grids

		Madagascar	Tanzania	Nigeria	Sierra Leone
Regulation	**Market entry**	License < 500kW Concession > 500kW	Registration <100kW	Registration <100kW Permit 100kW – 1MW	Basic licence <100kW Full licence 100kW – 1MW
	Tariffs	Cost reflective with cash flow based calc. tool	Cost reflective >100kW	Cost reflective with incentive based MYTO	Cost reflective with incentive based MYTO
	Practice	Cost Reflective, Cashflow method	Cost reflective, Cost of Service method	Cost Reflcetive, Cost of Service method	Cost Reflcetive, Cost of Service method
Operation	**Contract type**	Concession and license contract	RBF contract with REA	PPP contract with state gov. / Grant or RBF contracts with REA	PPP Agreement with MOE
	Contract duration	License 15 years Concession 20 years	Unlimited	Unlimited	20 years
	Asset ownership	Private sector	Private sector	Private sector	PPP model (splits asset model)

Cost-of-Service settings

- The yearly rate reviews can be based on the financial year of the operator, and will be checked based on the audited financial statements and standardised chart of accounts
- The rate case will be based on historical data whenever and for whichever position possible.
- Example – Tariff review for Y3, at t0:

Cost-of-Service settings

- Cost reflective methodology has to be used for full mini-grid licencee (For example, >100 kW and up to 10 MW as per the Sierra Leone Mini-Grid Regulations).
- The regulator checks the following:
  - the proper filling by the operator
  - the confirmation from the auditor
  - if costs are prudently incurred at reasonable level of efficiency
  - the overall demand based on historic data (or reasonable projections in the first year)
  - To check customer group specific tariffs
  - **Use a digital tool** as the basis for determination of tariffs (and not negotiate or decree tariffs)

Cost-of-Service settings

- Grant financed assets shall not be considered as part of the regulatory asset base, thus no return can be claimed for grant financed assets
- Project Development cost should be capitalized and amortized over the project duration
- To offset the impact of huge investments on the RAB and avoid jumps in tariff, the following calculation methodology, calculating the average of the RAB from the start of the period and the end of the period, is proposed to even out any rapid changes:

- The regulatory Asset base at the end of year t-1 shall be determined by the following formula:

RAB_{t-1}	means Regulatory Asset Base at the end of year t-1 (last year)	S_{t-1}	Means asset disposal during year t-1, and
RAB_{t-2}	means regulatory asset base at the beginning of year t-1 (last year)	D_{t-1}	Means depreciation in the year t-1
$CAPEX_{t-1}$	Means privately financed capital additions (tangible or intangible assets) during year t-1		

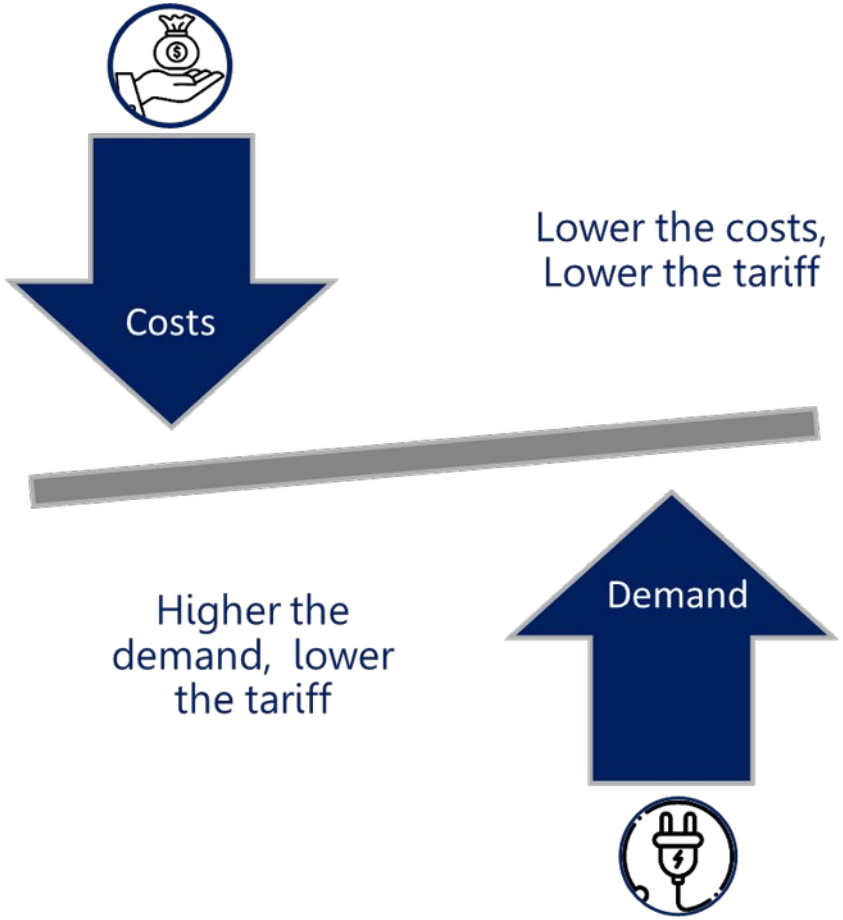
Tariff reduction strategies

In simplified terms, for the mini-grid tariffs to go lower-

Demand needs to go up

and/or

Cost needs to go down



Tariff reduction strategies

- Innovative ways to reduce tariffs are now available
- Usually, mini-grid tariff design assumes that customers will consume a certain kWh. This assumption is based on historic consumption data set (if available), GIS analysis and surveys (less used now-a-days).
- Tariff reduction strategy considers that **if tariffs are lowered, the consumption will increase in a way** that Average Revenue Per User (ARPU) level will reach a similar level with some time lapse!
- Experiments showed that if the tariff is reduced by 50 to 75%, the consumption level will increase by 1.5 to 3 times the baseline within two years Not universal
- **Full study link:** https://crossboundary.com/work/tariff-reduction-mini-grid-consumption/

Tariff reduction strategies

- **Key take aways**
  - The low-income earning customers benefits the most from this strategy
  - Mini-grid customers are price sensitive. The customers are likely to spend the same budget which means they will consume more if the tariff goes **down (‘Price Elasticity’ in action).**
  - This is only valid to a level until the consumers have reached the **saturation point of their demand** i.e. reducing the tariff would not motivate them to consume more.
  - This assumption is not the same for commercial customers. They will increase their consumption level more continuously.
  - Tariff reduction strategies are now **being tested in Tanzania and Sierra Leone**
  - This could help mini-grid developers to do demand stimulation from the beginning. Sizing of mini-grids could also be changed due to this.
  - Site capacity utilisation will increase

Thank you!
Any questions?

Dipta Majumder (Mini Grid Expert) | dm@inensus.com

INENSUS GmbH | Am Stollen 19D | 38640 Goslar | Germany | www.inensus.com
TEL +49(5321)38271-0 | FAX +49(5321)38271-99 | info@inensus.com