“Identifying the gaps and building the evidence base on low carbon mini-grids”

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OUTLINE

- Objectives of the Study
- Economics
- Potential for GMG
- Challenges: financial
- Challenges: developers
- Technology Aspects
- Country Characteristics
- Conclusions and Recommendations

OBJECTIVES OF THE STUDY

a) Identify the key gaps to scale up in the low carbon mini-grids sector, with a focus on Africa.

b) Provide an evidence base and benchmarks against which to assess specific low carbon mini-grid proposals.

c) Point to possible additional targeted interven-tion strategies to accelerate renewable and/or hybrid mini-grid sectors.

OBJECTIVES OF THE STUDY

Not clear from ToR whether the focus of DFID's planned intervention should be :

- on green mini-grids (GMGs) or
- small green power plants.

Promotion of small green power plants by feed-in tariff schemes in place in many countries. In most such schemes the investor does not set up a mini-grid.

STARTING POINTS

- Few green mini-grids exist in Africa.
- Difficult to obtain data of existing GMGs.
- Much easier to obtain data of planned projects

Problem: The performance of existing projects is usually not as good as planned.

ECONOMICS

- GMGs are economically viable electrification technologies in the sense that:

discounted economic benefits	>	discounted economic cost

- But that is also true for other electrification technologies (grid connection, diesel generators).
- GMGs are often least-cost supply solution compared to alternative supply option (diesel, connection to main grid)

ECONOMICS

GMG economic least-cost solution but usually expensive in absolute terms (high levelized economic cost).

Examples (US$/kWh, 10% discount rate):

- **Gasifier, rice husks: gasifier 0.20 – 0.35, mini-grid ≈ 0.20. Total : 0.40 - 0.55.**
- **Diesel-PV, no storage (*): hybrid system ≈ 0.26, mini-grid ≈ 0.20. Total: 0.46.**
- **Diesel-PV, with (little) storage capacity (*): Total: ≥ 0.50.**
- **Hydro plants, without mini-grid: Mwenga 0.053; ENNy 0.17.**

(*) Calculated with economic cost of diesel of 0.60 US$/liter.

ECONOMICS

- Willingness-to-pay and avoided costs are incomplete measures of economic benefits. Useful for financial analyses but of limited value for economic analyses.
- Share of distribution grid costs and connection costs high in levelized economic costs of GMG systems (system = plant + distribution grid + connection).
- Benefit of avoided GHG emissions lower than electrification benefit.

ECONOMICS

- Green power plants create more jobs than diesel units, but do not always create ”many” jobs in operation phase. Varies widely depending on technology.

  Examples:

  - Mwenga hydro, Tanzania (3.5 MW, mini-grid) ≈ 20
  - ENNy hydro, Rwanda (500 kW, no mini-grid) ≈ 11
  - Wood-fuel. gasifier, Namibia (250 kW, no mini-grid) ≈ 20
  - Rice-husk-fuel. gasif., Cambodia, (70 kW, no mini-grid) ≈ 11

ECONOMICS

- Construction of green power plants with and without mini-grid:
  - Planning and design capacity increasingly locally available.
  - Civil works done by local companies.
  - Some equipment locally purchased (some thereof imported) but most imported.

POTENTIAL FOR GMGs

Each African country has an economic potential for GMGs. (Sort of) off-grid electrification plans exists in most countries. The plans are of little help for the real challenge, the implementation = business model.

- **Contractual and regulatory framework**
- **(Project) financing instruments.**
- **Technically and managerially sound project proponents / investors and operators**

CHALLENGES - FINANCIAL

1. **Upfront Subsidies always required to make developers implement GMG projects and to make tariffs affordable.**

Examples – Tariffs without subsidies and small profit of 3% Return on Equity (ROE) at constant prices (US$/kWh)

- **Gasifier, rice husks: ≈ 0.50**
- **Diesel-PV, no storage: ≈ 0.65**
- **Diesel-PV, with (little) storage capacity: ≈ 0.67**
- **ENNy hydro plant in Rwanda selling under FiT scheme. FiT would have to be ≈ 0.15 US$/kWh without grant for 3% ROE. FiT is 0.13 US$/kWh but 28% grant financing yields 3% ROE.**

CHALLENGES - FINANCIAL

2. Small local banks no capacity for other than short-term lending.
3. Large banks prefer Balance Sheet financing. Not much interested in Project Financing – relatively high transaction costs for small investments (< 5 M$) - and demand solid guarantees.
4. Initial operation years most difficults as loans have to be repaid and demand still developing. High risk that injection of funds necessary in those years to avoid cash shortfalls.

CHALLENGES - Developers

Public Utilities or Public Agencies

Advantages

- Contribution to funding.
- Operational know-how → Sustainability.
- Tariffs can be same as in main-grid (cross-subsidization)

Disadvantages

- Slow implementation (tedious procurement procedures).
- Costs can be high (red tape).
- Not really interested if costs > revenues .

CHALLENGES - Developers

Communities and non-profit organizations

Advantages

- Close relationship with beneficiaries.

Disadvantages

- Can only make in-kind contributions to investment cost.
- High risk of insufficient technical know-how and unsatisfactory management (Exception: religious institutions).

CHALLENGES - Developers

Private Sector

Advantages

- Contribute to funding of investment cost.
- Efficient operation and sustainability.

Hurdles

- Reluctant to become involved as developers of GMGs because of many risks and low returns.
- High preparatory costs (studies, permits).
- Long lead-times (several years for hydro plants).
- Obtaining loans difficult.

CHALLENGES - Developers

Private Sector

- Private sector developers of GMGs seldom profit maximizers.
- Those interested in making a decent profit usually prefer selling under feed-in tariff scheme (IPP model). Want payment guarantee if off-taker (public utility) is financially weak.

CHALLENGES - Developers

How to increase participation of private sector as developer of GMGs?

- Awareness campaign.
- Provide (grant) funding for preparatory costs and technical assistance for feasibility studies.
- Clear, simple and transparent regulations.
- Support handling of administrative procedures by one-stop shop.
- Help banks provide long-term loans with reasonable conditions.
- Provide guarantee for bank loans.

Technology Aspects

GMGs supplied by hydro plants

- Long lead times (≥ 4 years).
- Available data on potential insufficient for planning purposes. Must be supplemented by site investigations, studies →High preparatory cost.
- Production seldom year round.
- Economic capacity often exceeds demand in near-by mini-grid. Solution: sales under FiT or combination of mini-grid / FiT.

Technology Aspects

GMGs supplied by biomass-fueled plants

A. Combustion technology

- Use predominantly by industries (sugar producer, sawmills, etc.).
- Supply of excess capacity usually limited to public utility (FiT scheme) and mini-grid supply of employee households.

Technology Aspects

GMGs supplied by biomass-fueled plants

B. Gasifier technology

- Many in India and South-East Asia; mainly using rice husks as feedstock. Very few in Africa.
- Investment costs of ”clean” gasifiers ≥ 2,500 $/kW.
- High water consumption.
- Lifetime rather 10 than 20 years.
- Feedstock costs important for total costs.
- Operation and feedstock supply require good management and large storage facilities.

Technology Aspects

GMGs supplied by diesel – PV systems

- Retrofitting (adding PV to existing diesel) ongoing in many countries.
- Research on least-cost dimensioning (relation PV capacity : diesel capacity) ongoing. Main issues:
  - How to manage short-term fluctuations of PV systems (diesel or batteries)?
  - How much storage capacity to add (batteries) for use of PV power when the sun is not shining. Storage capacity expensive.

Country Characteristics : KENYA

- Electrification ratio in rural areas 26% in 2012.
- Average price paid in 2012 about 0.20 US$/kWh (taxes incl.).
- About 10 existing mini-grids owned and operated by public sector: 5 diesel-PV, 1 diesel-wind, 1 diesel-PV-wind, 3 diesel only.
- About 15 mini-grids under construction by REA; all diesel powered. PV or wind will probably be added.

Country Characteristics

KENYA

- Few private or community-owned mini-grids exist.
- Not clear whether GoK interested in private development of mini-grids. Seems to favor private sector involvement as IPPs under the FiT scheme.

Country Characteristics

TANZANIA

- Electrification ratio in rural areas about 7% in 2012.
- Tariffs not cost covering. Social tariff ≈ 0.045 US$/kWh; general usage ≈ 0.15 (incl. VAT and levies)
- Several mini-grids exist, owned by communities, convents, or the private sector. Most supplied by small hydro plants.
- Construction of GMG projects ongoing or planned. Most supplied by hydro plants, often with bulk of production sold to TANESCO under FiT scheme.

Country Characteristics

TANZANIA

Government interested in both private sector development of GMGs and private sector involvement as IPPs (FiT scheme).

Promotion of (small) renewable energy projects by:

- Matching grants for project preparation. Finances up to 80% of costs; 29 project ideas currently financed; almost all for development of small hydro plants with or without mini-grid.
- Grants for investment costs (Rural Energy Fund).

Country Characteristics

TANZANIA

Promotion of (small) renewable energy projects by:

- **Credit line facility. Funds given to banks for onlending for renewable projects. Banks finance ≈ 30%, credit line ≈ 70%. TEDAP and AfD facility. Banks demand guarantees.**
- **Performance grant. 500 US$/connection; TEDAP facility.**

Mini-grid tariffs must be approved by EWURA but can be different from main-grid tariffs.

Country Characteristics

MOZAMBIQUE

- Electrification ratio in rural areas about 3%.
- EDM tariffs: Social tariff ≈ 0.035 US$/kWh; other tariffs 0.08 – 0.12 US$/kWh. Flat rate ≈2.50 US$.
- Many mini-grids exist. More than 75 public-sector mini-grids funded and partly also implemented by FUNAE. Most (≈ 70) supplied by diesel generators; 3 by hydros, 4 by diesel- PV.
- Number of non-FUNAE mini-grids not known; 7 hydro-based mini-grids constructed by GIZ.

Country Characteristics

MOZAMBIQUE

- FUNAE scheme: Investment funded and usually managed by FUNAE, project later leased to local management committee. Tariffs normally same as EDM tariffs.
- GIZ scheme: Investment funded and managed by GIZ. Then transferred to local champion (private person) who becomes owner(?) and operator. Tariffs different from EDM's.
- Role of private sector in electrification policy not yet clear. FiT does not yet exist.

Country Characteristics

RWANDA

- Electrification ratio in rural areas about 10%.
- High tariffs. Average price paid in 2012, about 0.25 US$/kWh including VAT.
- Policy: Country's emphasis is on grid extension. Government wants private sector involvement as IPPs under FiT scheme. Not clear how much Government is interested in private sector development of mini-grids.

CONCLUSIONS - RECOMMENDATIONS

- GMG projects highly site specific (”green” resources, costs, demand, ...). Makes benchmarking impossible.
- While there are many fields for DFID’s intervention, providing finance (grants, credit facility) for projects and a loan-guarantee facility could be most rewarding.

CONCLUSIONS - RECOMMENDATIONS

- Targeted countries (seven) vary in factors conducive for GMG development. No clear champion.
- DFID office in country highly recommended.
- If project approach: Focus on projects in densily populated areas promises higher benefits.

Thank you for your attention

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