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Variable RE integration into the grid – new opportunities?

Robert Towers

DFID

Department for International Development

Sustainable Energy team – DFID

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Sustainable energy helps to deliver: economic growth, poverty eradication, and climate and environment benefits.

The **International Climate Fund** aims to support international poverty reduction by helping developing countries to adapt to climate change, take up low carbon growth, and tackle deforestation.

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Projects across value chain

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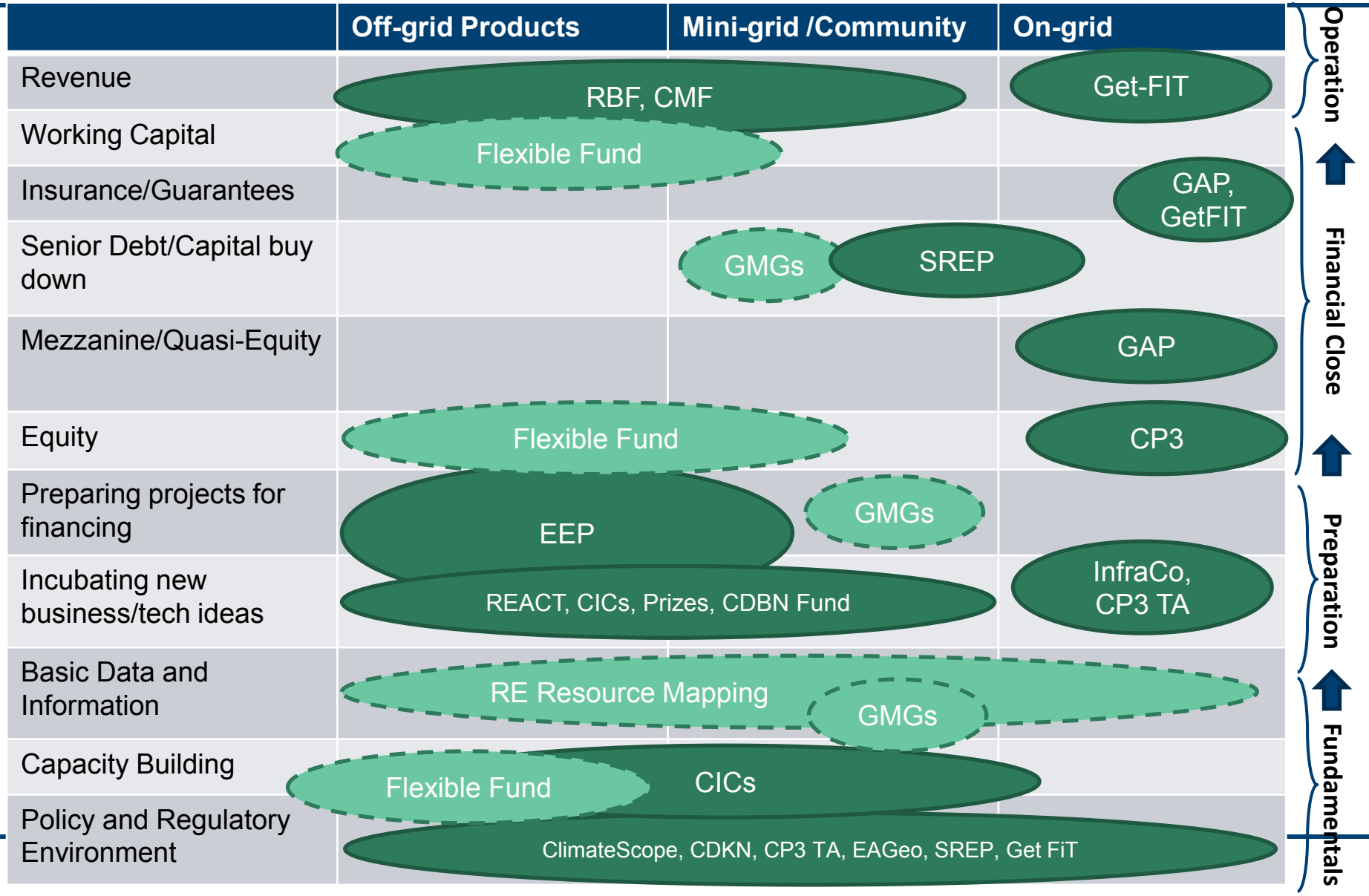

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Huge renewables potential especially in developing countries – off and on grid.

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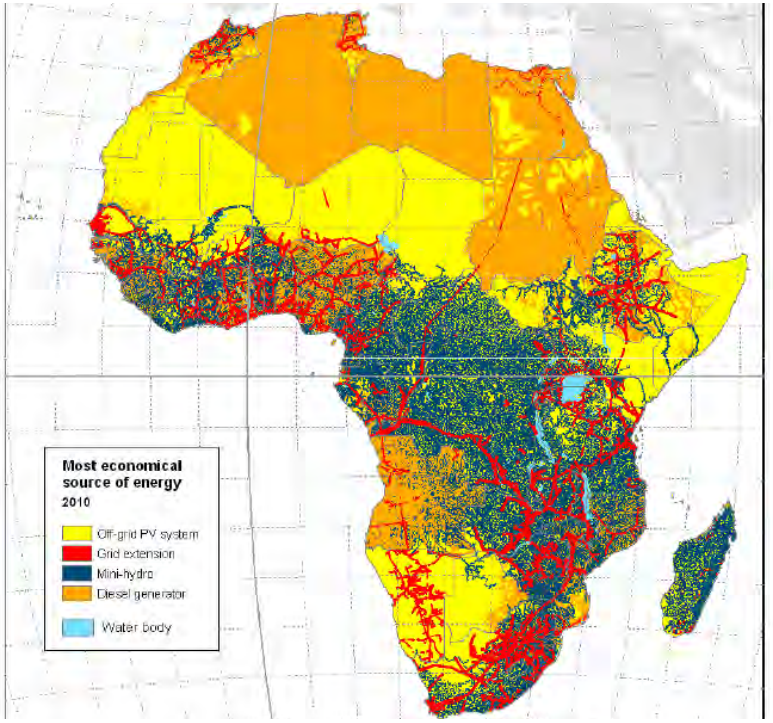
Photovoltaic solar power

	Customer segment	Cost comparison, 2011, ¢ per kilowatt hour (● Solar ▭ Other energy sources[1])	Cumulative market potential,[2] 2012–20, GWp (gigawatt peak)	Timing of viability
1	**Off grid:** applications in areas with no grids (eg, Africa, India, Southeast Asia, and parts of Middle East)	0 10 20 30 40	15–20	Now
2a	**Commercial and residential, good sunlight:** developed markets in sunbelts (eg, Australia, California, Italy, and Spain)	0 10 20 30 40	150–250	Now
2b	**Commercial and residential, moderate sunlight:** developed markets with moderate solar yields (eg, Canada, Denmark, Germany, Netherlands, and United Kingdom)	0 10 20 30 40	65–120	2012–13 and beyond
3	**Isolated grids:** small local grids primarily fueled by small diesel generators; large latent demand (eg, Africa)	0 10 20 30 40	25–30	Now
4	**Peak capacity in growth markets:** growth markets; large power investments (eg, Africa, China, India, and the Middle East)	0 10 20 30 40	150–170	2013–14 and beyond
5	**New large-scale power plants:** growth markets; large power investments (eg, China, India, and the Middle East)	0 10 20 30 40	Marginal	2025 and beyond

Total market potential = 400–600 gigawatts
(compared with 2011 installed base of 65 gigawatts)



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http://www.area-net.org/fileadmin/user_upload/AREA/AREA_downloads/AREA_Conference_12/presentatios/Session_4/Grid_vs_Distributed-PV-Diesel_in_Africa.pdf

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Why are networks an issue?

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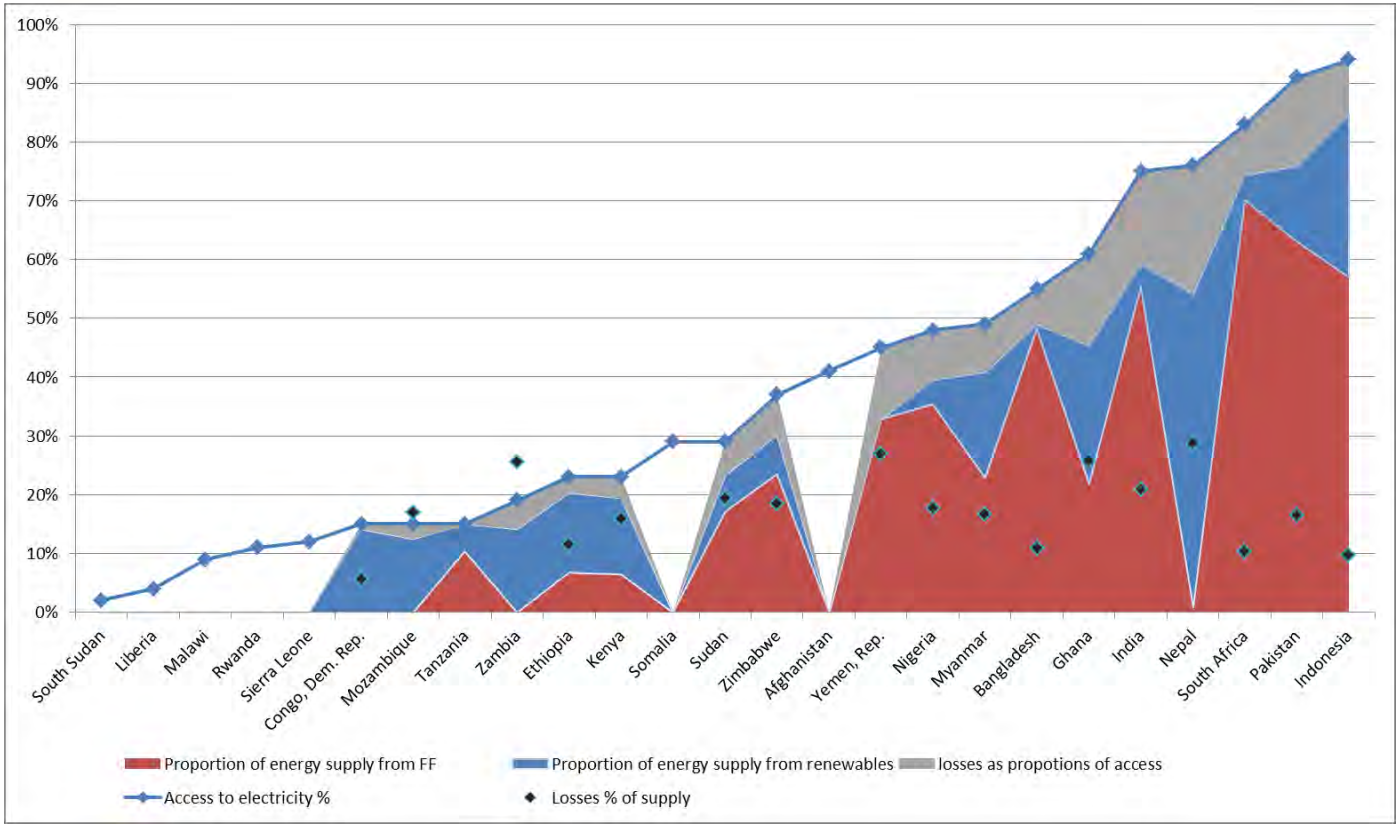


Electricity access remains low and losses are high in many DFID priority countries – thus limiting economic development and poverty reduction – but it is not just a generation issue

Any action on networks should be about **energy access as well as energy efficiency and balancing**:

- SE4ALL
- Integration into the grid of RE vs off-grid

Figure: authors calculations using IEA and WB data

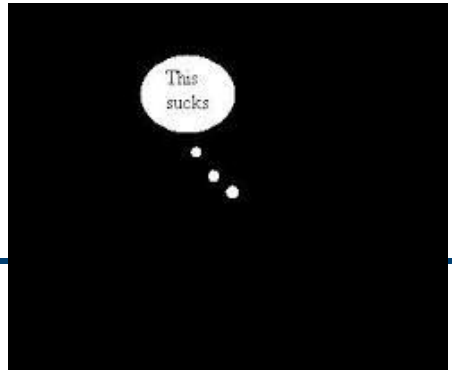
Why is variable renewable Energy an issue?

In developed countries

- Balancing issues – forecasting supply Vs demand difficult
- Constraints – spilling
- Energy price fluctuations

In developing countries

- Energy access – usually demand will outstrip supply anyway – already lots of power cuts
- Efficiency
- Large fluctuations



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UK activity (DECC)

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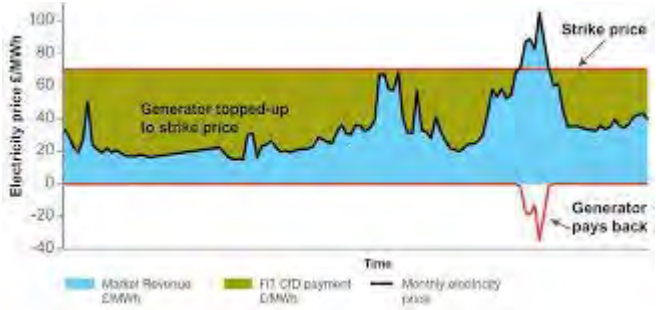
UK policy to achieve affordable, sustainable and secure energy includes:

- Electricity Market Reform – including:
  - contracts for difference, and
  - capacity mechanism
- Small Scale Feed-in Tariffs



This results in more low carbon (including variable renewables) on the grid

Policies working to influence electricity demand include:

- Smart Meter programme
- Electricity demand reduction
- Energy efficiency programmes

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UK activity (DECC/ Ofgem)

Department of Energy & Climate Change

ofgem

UK policies/regulations which will change the operating of the grid, some help to improve the intergradation of low carbon technologies on the grid:

- Innovation fund (supporting electricity storage and network innovation, etc.),
- Connect and manage (help facilitate excess to the grid for wind)
- Project TransmiT to change TNUoS charging regime
- Cash out reform to amend the balancing market
- Price controls, which require smarter operating of networks
- Interconnection
- Innovative off-shore grid approaches

Industry forum:

- Smart Grid Forum

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What more could DFID be doing?

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Can we use climate finance to help with projects in countries?

Are there technologies/ approaches that can leverage private finance to help countries to leap frog electricity management technologies and techniques

DFID commissioned a report with Vivid Economics and Arup - to improve knowledge sharing and dissemination of potential technology, management and economic incentives that could be used in developing countries to help improve electricity network efficiencies.

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Methodology – potential technologies

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Approach:

- Highlight all of the potential technologies and techniques
- Undertake a high level literature review and assessment
- Rank them against a set of criteria including:
  - Value from further research;
  - Ability to leverage private finance;
  - Leapfrogging potential and
  - Abatement potential.
- Focus on the few that meet the criteria and undertake further literature review, engineering assessment and case studies
- Discussion of key lessons for each priority application;
- Development of the diagnostic schematic for potential donor support

Table 1. A matrix of technologies and contexts suggests fifteen distinct applications

Technology or technique	Grid-connected	Unconnected near-grid	Unconnected remote rural
Investment in network assets	Grid-to-grid interconnection (#1)	'Conventional' grid extension (#2) Grid extension augmented by 'smart' technologies (#3)	N/A
Investment in generation assets	Large-scale centralised generation (#4) Distributed generation (#5) Grid-connected mini-grid (#6)	Grid support for smart grid extension (#3) Off-grid mini-grid (#7)	Off-grid mini-grid (#7)
Storage	Grid-connected mini-grid (#6) Large-scale storage (#8) Decentralised storage (#9)	Grid support for smart grid extension (#3) Off-grid mini-grid (#7)	Off-grid mini-grid (#7)
Smart meters and other smart (ICT) devices	Grid-connected mini-grid (#6) Smart metering and ICT for demand side response (#10) Direct load control and smart appliances (#11) Smart meters to manage non-technical losses (#12) Outage management and grid management (#13)	System sizing and load management for smart grid extension (#3) System sizing and load management for mini-grid (#7) Outage management and grid management for mini-grid (#7)	System sizing and load management for mini-grid (#7) Outage management and grid management for mini-grid (#7)
Operation, maintenance and planning	Technical assistance – operations and maintenance (#14) Technical assistance – planning and system balancing (#15)	N/A	N/A

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Areas of focus for the work

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Application	Value from further research	Ability to leverage private finance	Leapfrogging potential	Abatement potential	Overall assessment
(#3) Grid extension augmented with smart technologies	✓	~	~	~	✓
(#5) Distributed generation for grid support	✗	~	~	~	~
(#6) Grid-connected mini-grids	~	✓	✓	~	✓
(#7) Off-grid mini-grids utilising smart technologies	~	✓	✓	~	✓
(#8) Large-scale storage	~	✗	~	~	~
(#9) Decentralised storage	✓	✗	~	~	~
(#10) Smart metering and ICT for demand side response	~	✗	~	~	~
(#11) Direct load control	~	✗	~	~	~
(#12) Smart metering and ICT to address non-technical losses	~	✓	~	~	✓
(#13) Smart metering and ICT for outage and general grid management	✓	✗	✓	~	~

Some applications may warrant further investigation but are out of the scope of this work – specifically those that were felt did not provide ability to leverage private finance but might be worth while from a regulatory or Government point of view, especially if they can be combined with other investments.

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Case study work

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Region	Income group	Grid-connected mini-grids	Grid-ready mini-grids	Smart metering and ICT to address non-technical losses
Africa	LIC	Mwenga hydro plant and mini-grid (Tanzania)		
Africa	MIC	Batteries to support solar-powered ATMs (Lagos, Nigeria) Battery to support petrol stations (Nigeria)		
Asia	LIC			
Asia	MIC	DESI Power (India) Mini-grid for cotton mill (India) Telecom towers with battery storage (India)	Darewadi mini-grid (Maharashtra, India) Athureliya community village (Sri Lanka) Sagar Island, (West Bengal, India)	Smart metering and ICT in North Delhi (India)
LAC	LIC	Solar power and battery storage to support grid connection at charity run-hospital (Cap-Hatian, Haiti)		
LAC	MIC			Ampla smart meters (Rio de Janeiro, Brazil)

Detailed case study analysis is currently being undertaken for these 4 groups. Developed country examples will be used as well – especially for application #3 (grid extension augmented with Smart technologies) as there are limited developing country examples.

If there are any suggestions for further case studies – please let us know.

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Next steps for the project / work

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- Completion of literature review through more detailed discussion of priority applications, including more detailed technical input from Arup
- Deeper analysis of case studies and discussion of key lessons for each priority application;
- Development of the diagnostic schematic;
- Report finalisation and final presentation.

The work will be published and used to consider potential intervention activities to help improve the efficiency of networks in DFID priority countries – thus helping to **improve electricity access, the integration of renewables, economic development, poverty reduction and opportunities for women and girls**.

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