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Financing Energy Access and Off-grid Electrification: Status, Options and Challenges

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Abstract

This paper provides a review of financing mechanisms used for energy access in general and off-grid electrification in particular. It reviews the literature on the subject and tries to find answers to issues like whether the funding has been adequate, whether sufficient funding for the future is likely to be available, whether states should take the lead or leave it to the private sector and so on. It also looks at the innovative approaches used in funding and indicates whether small-scale projects can benefit from such initiatives.

The paper finds that in general the state has played an important role in funding infrastructure investments in both developed and developing countries. But many developing countries faced difficulties financially and neglected this for a long time. The gap has been somewhat filled by international donor agencies but their scale of operation so far has been selective and limited and cannot ensure adequate funding for the future. The innovative mechanisms are also unfriendly towards small-scale projects and therefore, do not really provide much hope. The challenge of mobilising finance and ensuring its appropriate delivery and use remains a major issue and would require a co-ordinated effort of all relevant stakeholders.

Keywords: financing, off-grid electrification, barriers, options.

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1.0 Introduction

This paper provides a review of financing mechanisms used for energy access in general and off-grid electrification in particular. It reviews the literature on the subject and tries to find answers to issues like whether the funding has been adequate, whether sufficient funding for the future is likely to be available, whether states should take the lead or leave it to the private sector and so on. It also looks at the innovative approaches used in funding and indicates whether small-scale projects can benefit from such initiatives.

The paper finds that in general the state has played an important role in funding infrastructure investments in both developed and developing countries. But many developing countries faced difficulties financially and neglected this for a long time. The gap has been somewhat filled by international donor agencies but their scale of operation so far has been selective and limited and cannot ensure adequate funding for the future. The innovative mechanisms are also unfriendly towards small-scale projects and therefore, do not really provide much hope. The challenge of mobilising finance and ensuring its appropriate delivery and use remains a major issue and would require a co-ordinated effort of all relevant stakeholders.

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1.0 Introduction

As the global challenge of lack of energy access comes once again to limelight through the UN Secretary General's initiative, one factor that immediately catches attention is that of funding. As the countries are being encouraged to set targets for achieving sustainable energy supply for all, the issue of funding to ensure such provisions cannot be overlooked. Yet, it is not difficult to recognise that financing electrification projects or clean cooking energy supply will not be an easy task. The manifestation of severe energy access challenge at present and the likelihood of continuation of such a situation in the absence of any concerted policy interventions (IEA, 2011)[1] clearly indicate the inadequacy of existing efforts by governments, international financial agencies, donor agencies and even the private sector in funding energy supply provisions.

Yet, there has been a long tradition of supporting rural electrification programmes both at the national and international levels. Similarly, many initiatives have also been taken to promote clean cooking energies. The funding mechanisms have evolved over time due to changed economic paradigm, evolution of financial markets and arrival of innovative instruments, changes in the regulatory regimes, and emergence of new opportunities to address issues related to the environment and climate change. Further, the focus has also changed from supply-side to demand-side where micro-finance has emerged to cater to the financial needs of the users. Unfortunately, there is limited academic attention on this vital issue. Some studies focus on energy access financing from a macro perspective either by considering the funding needs and possible funding flow (e.g. IEA (2011)), or by identifying international financial flows to the energy sector (e.g. Bazilian et al. (2011)) or by identifying ways of ensuring public funds for private sector use (e.g. Glemarec (2012)). Others tend to focus on the micro picture. For example, Monroy and Hernandez (2008), Monroy and Hernandez (2005) present the stakeholder perspectives from a survey. Mainali and Silveira (2011), Miller and Hope (2006), ASER (2007) provide country case studies for Nepal, Sri Lanka and Senegal respectively. Delina (2011) and Martinot (2001) provide an overview of financing portfolio of Asian Development Bank and World Bank respectively. Yet, to the best of our knowledge, there is no systematic review of financing issues and options for electrification in developing countries. This paper bridges the gap through a comprehensive review.

[1] IEA (2011) indicates that in the absence of new policy interventions 1 billion people will still lack electricity access by 2030 while 2.7 billion will not have access to clean cooking energies by 2030.

The paper is organised as follows: the second section presents the scale of the challenge by considering the financing needs for energy access for all and by identifying the financial sources and financial flows; section 3 discusses financial options and financing challenges, section 4 explores financing mechanisms specifically for off-grid electrification. Finally, section 5 provides some concluding remarks.

2.0 Scale of the problem

2.1 Investment needs for Energy Access for All

This section provides an overall picture first, followed by specific details related to off-grid electrification.

2.1.1 Overall needs

The enormity of the financing challenge is directly related to the energy access problem itself. As indicated in IEA (2011)[2], there were more than 1.3 billion people in the world in 2009 without access to electricity and 2.7 billion without access to clean cooking energies. The report also estimated that $9.1 billion was invested in providing access to energy in 2009 – of which only $70 million went to provide advanced biomass cook-stoves (benefitting 7 million people) and the rest was used in providing access to electricity to 20 million people. The imbalance in priorities for electricity and clean cooking energy investments is clearly visible. IEA (2011) further estimated that 14% of the above investment came from bi-lateral official development assistance, and $3 billion (or 34%) were provided by multi-lateral agencies (such as international financial institutions, funds, etc.). The developing countries themselves invested about 30% of the above investment while the rest came from private agencies.

A number of estimates are available in the literature trying to capture the financial challenge in ensuring universal energy access. The level of details varies: for example: the UN Secretary General's Advisory Group on Energy and Climate Change (AGECC) indicated a single figure of $35-40 billion average annual investment to achieve basic universal energy access by 2030 (AGECC, 2010). Similarly, Behrens et al. (2011) quoted a figure of $36-41 for from an IIASA study (International Institute for Applied Systems Analysis, Austria). However, no further details are provided. As the origin and basis of these figures are difficult to identify, we have not considered them here.

[2] This report was released ahead of a high-level conference on Energy for All: Financing access for the poor in Olso organised by the Government of Norway and the International Energy Agency on 10 October 2011.

The International Energy Agency has been in the forefront of this initiative and has covered such costs in its World Energy Outlook publications. IEA (2011) provides the most recent cost estimates from IEA although IEA (2010) and earlier publications also provide some estimates. We first consider IEA (2011) estimates and subsequently consider some other key studies such as Bazilian et al. (2010). We do not include any study that focuses only on national cost estimates (e.g. ASER, 2007) or does not focus on universal energy access (Rosnes and Vennnemo (2008)[3] or Eberhard et al. (2011)[4]).

IEA (2011) estimates that $15 billion per year will be invested between 2010 and 2030 in its New Policy scenario to provide energy access (or a total $296 billion for the period). About $14 billion per year will go towards electricity access and just $1 billion per year will be invested in clean cooking energy provision. Out of $14 billion annual investment in electricity, 55% is likely to be invested in on-grid electricity supply while 45% will go to the off-grid sector. This investment is likely to connect 26 million people to electricity supply each year, while 860 million additional people will gain access to cooking energy by the end of 2030. Yet, such a level of investment will not be sufficient to ensure energy access to all – by 2030, about 1 billion people will still lack access to electricity and 2.7 billion will not have access to cooking energies. This implies that even with a 50% increase in investment in energy access provision, the gravity of the problem is likely to change marginally.

IEA (2011) also provides an alternative scenario to achieve universal energy access by 2030 as is envisaged by the UN Secretary General's call. This scenario, which makes necessary assumptions about the technology choices for electrification and cooking energy provision, requires an annual investment of $48 billion, a five-fold increase in the investment compared to that in 2009. The total investment need increases to $1 trillion in this case but this is still a very small amount compared to the overall energy sector investment needs globally, which has been estimated at $37 trillion by IEA (2010) for the same period. Electricity access will still have a larger share in the overall investment need (almost 90% of the total) but investment in cooking energy will proportionally increase and will require $95 billion over the next two decades.

In terms of technology choice, the above estimates are based on the following:

[3] This study focuses on Africa's electricity investment needs under different scenarios but does not consider universal energy access. The time horizon is also limited to 2015.

[4] This study uses Rosnes and Vennemo (2008) referred to above and focuses on overall sectoral investment but not on universal energy access.

- Grid extension will cater for 30% of the cases, whereas the rest 70% will come from mini-grids or off-grid systems in the proportion of 65:35.
- The largest share of cooking energy access will come from biogas plants while the rest will be shared between LPG and advanced cook-stoves.

Similarly, the regional pattern of investment will follow the pattern of lack of energy by region. Almost two-thirds of the investment for cooking energy access will be needed in Asia while for electricity access 60% of the investment will be needed in Sub-Saharan Africa.

Although the above estimate provides a detailed picture, it needs to be emphasised that like any estimate, this one is also based on assumptions of cost, rate of access, technology selection, etc. Also, these are point estimates and no range is given. Moreover, IEA estimate does not include the infrastructure related costs for cooking energy access and covers investment costs in stoves, digesters, etc. Therefore, these estimates should be taken as approximate figures and considered with care.

Bazilian et al. (2010) provided a review of various cost estimates for energy access and indicates the variation in the cost components and offered a new estimate for universal electricity access based on the life-cycle costs. They argue that most of the studies focus only on the capital costs and ignore the recurring costs. They found the cost for capital investment to vary between $5 and $40 per person. Similarly, there is wide variation in electricity connection costs and clean cooking energy supply costs. Their cost estimates for universal electricity access are based on the following assumptions:

- full levelised cost of generation is considered but transmission and distribution-related costs are not considered.

- the levelised generation costs are based on IEA studies;

- estimates are provided for three scenarios – low, medium and high where the consumption level varies from basic, to the current average residential consumption in Latin America.

- the electrification rates in 2008 is considered as the base level and universal electricity access for urban and rural population by 2030 is considered.

- Urban access is provided through grid extensions while rural access is provided through an arbitrarily chosen mix of grid extension, mini-grids and off-grid options.

Their results show that the annual investment requirement will be $12 billion in the low scenario, $60 billion in the medium scenario and $134 billion in the high scenario. While the

low estimate is comparatively lower than IEA (2011), the middle estimate is closer to the IEA's estimate while the other estimate is much higher than that of IEA. This suggests the possibility of significantly higher level of investment needs for providing access.

AfDB (2008) provides an indicative estimate of investment requirement for enhancing energy access in Africa with the assumption that 90% of the rural population in Sub-Saharan Africa and 100% of the rest (including urban population of SS-Africa) will have access to electricity by 2030. The estimation included cost of generation, transmission and distribution of electricity for the period between 2008 and 2030 and found that 265GW of new generation capacity will be required to ensure energy access. AfDB (2008) estimated that $547 billion (constant 2005 terms) will be required for this purpose, which results in an average annual investment need of $24billion approximately. This study did not focus on cooking energy needs and did not include costs related to fuel supply system improvements.

Thus, the investment requirement for universal energy access is likely to be substantial and the estimates have high levels of uncertainties. Moreover, they do not consider the demographic transitions, rural-urban migrations, effects of economic development and life-styles of people (e.g. emergence of the middle class income group by 2030 horizon in many developing countries), etc. Yet, in any case the financial need will be considerably higher than the present needs if energy access targets have to be realised.

2.1.2 Funding needs for off-grid electrification

Off-grid electrification has received attention in recent times as a possible electrification option for remote rural areas of developing countries. Szabo et al. (2011) using a spatial least-cost analysis framework identified that in many parts of Africa cost of decentralised off-grid options can be cheaper than grid extension and that if the affordability of consumers can be increased or cost of supply is reduced, off-grid options can surely play an important role. In a similar study, Bazilian et al. (2012) also suggest that to provide universal basic electricity access, most rural areas in Africa will need off-grid supply systems, either based on diesel generators or solar PV systems. Deichmann et al. (2011) also report that renewable energies are already cost-competitive in many parts of Sub-Saharan Africa.

REN21 (2011) also supports that the interest for off-grid technologies is growing in developing countries. The growing acknowledgement of off-grid as a cost-effective solution and the broadening of the focus to sustainable access and enhanced access have driven the growth of these technologies. It reports that a large number of solar lighting systems are

operating throughout the world: more than 500,000 solar PV systems were in use in 2007 in Africa, more than 400,000 SHS were sold in China by 2008, more than 600,000 SHS and 800,000 solar lamps were in use in India by 2010, 125,000 SHS in Sri Lanka and 30,000 SHS in Bangladesh (REN21, 2011).

As indicated in the general overview, the investment needs for energy access is dependent on assumptions of technology choice. IEA (2011) considered that mini-grids and off-grid technologies will be deployed in 70% of the rural areas. In its New Policies Scenario, IEA (2011) estimates that $6 billion per year will be required for mini-grid and off-grid electrification, but this level of investment will not ensure universal electricity access. The alternative scenario where energy access for all is considered, an additional annual investment of $20 billion is required for off-grid options between 2010 and 2030. However, the investment is likely to be back-loaded, implying a higher amount of flow required as 2030 approaches. Mini-grids are likely to have a major share in the off-grid systems, while isolated off-grid systems will cater to about 20% of the population without electricity access. About 60% of the investment would go to Sub-Saharan Africa where the electricity access is relative low at present.

Bazilian et al. (2012) provide an estimate of power capacity requirement and investment need for providing basic electricity access in Africa. It reports an investment requirement of $3.4 billion per year for off-grid systems to deploy approximately 12 GW of off-grid capacity. However, the above estimate is based on a basic level of access and is not comparable with IEA (2011) estimates directly.

The above clearly shows the looming financing challenge for energy access in general and off-grid electrification in particular. We now turn to financial flows to see how these needs can perhaps be met.

2.2 Financial flows to enhance energy access

Generally, four sources of funds can be identified: public sources, international development assistance, private capital and new sources of finance such as carbon finance (AGF, 2010). Bazilian et al. (2011) and IEA (2011) acknowledged that the data on financial flows to the energy sector of developing countries in general and that to enhance energy access in particular is rather limited, incomplete and often available at a highly aggregated level. In this section, an overview of overall investment in energy, foreign direct investment, development assistance and carbon finance is presented.

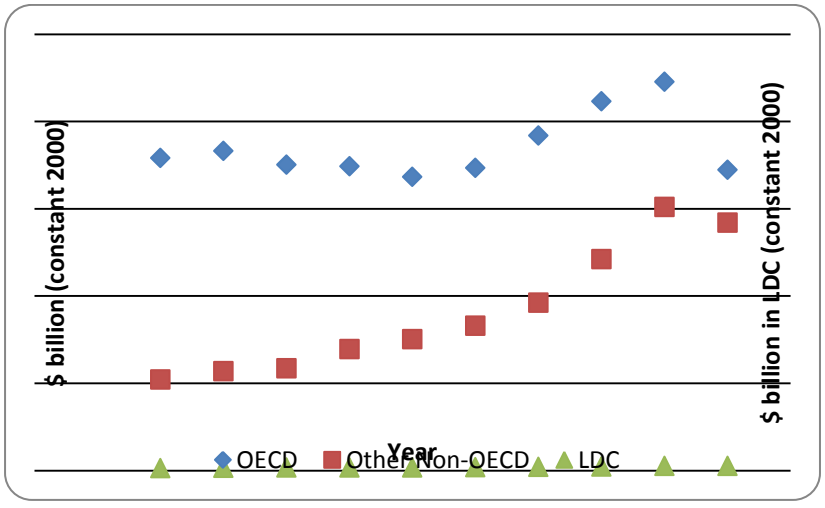
2.2.1 Overall energy investment

Bazilian et al. (2011) have compiled data on Gross Fixed Capital Formation (GFCF) for electricity and gas distribution, Foreign Direct Investment (FDI) and Official Development Finance (ODF) for a large set of countries. They found that GFCF for electricity and gas distribution has been rising steadily over the past decade (between 2000 and 2009, see Fig. 1). On a global level, the investment in electricity and gas distribution increased by 36% between 2000 and 2009 (or from $232.6 billion (constant 2000 terms) to $316.6 billion). The share of the developing countries has increased substantially during this period: in 2000, the developing country share was just 23% but in 2009, this has almost doubled to 46%, thereby indicating a higher proportion of investment. But the capital investment in the Least Developed Countries (LDC) remained very insignificant - $2.6 billion in 2009 (less than 1% of global investment).

2.2.2 Foreign Direct Investment

The data on Foreign Direct Investment (FDI) in energy was more patchy and covers a number of types of transactions (such as merger and acquisition, greenfield projects, lease, etc.) that do not necessarily lead to new asset creation. Delina (2011) contend that $3.65 trillion flowed to developing economies between 1997 and 2008. Bazilian et al. (2011) noted that the FDI flow has declined over time. Similarly, Delina (2011) indicated that FDI has benefitted only certain countries that provided the enabling environment and that the poor countries did not benefit from the FDI.

Fig. 1: Trend of Gross Fixed Capital Formation in electricity and gas distribution

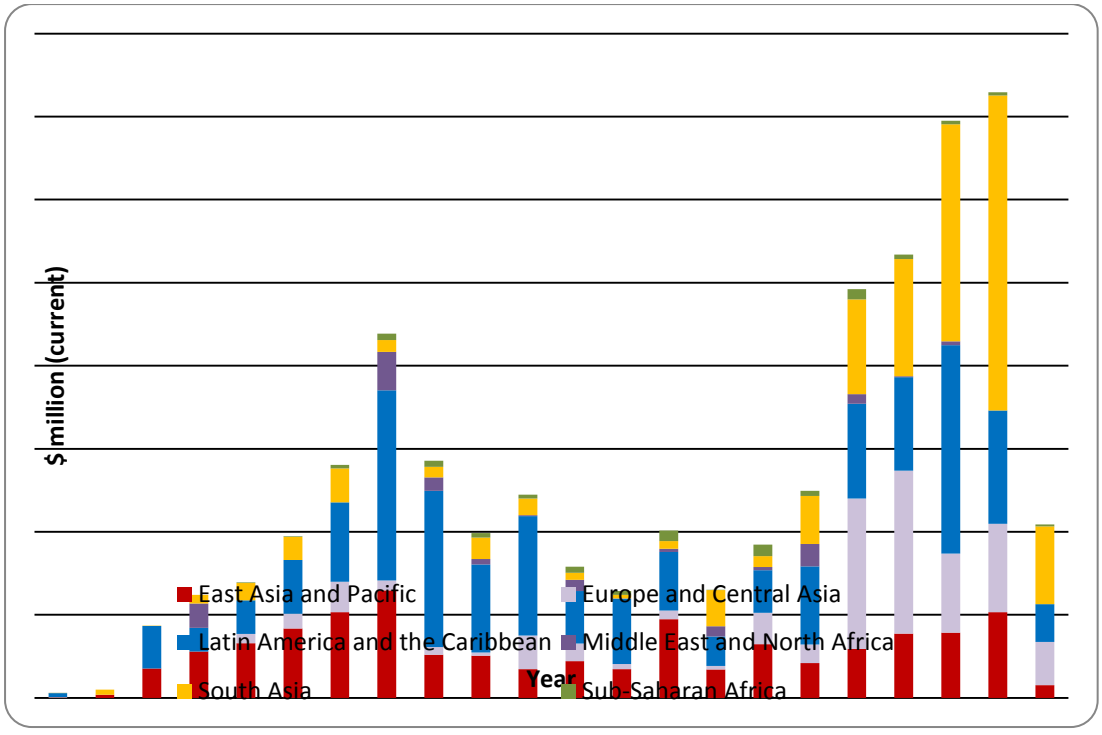


Data source: Bazilian et al. (2011).

Note: LDC – Least Developed Countries (as per UN categorisation). The data is presented using the right-hand scale.

The Private Participation in Infrastructure Database of the World Bank provides some details (see Fig. 2) on private investment in energy sector. This figure clearly indicates the variation in FDI over the years: the flow gradually increased until 1997 and then rapidly declined in the aftermath of the Asian financial crisis. It took a decade for the FDI flow to reach a reasonable level but again the global financial crisis has resulted in a major decline in the flow. Moreover, the FDI has only benefitted a selected set of countries (or regions). The Latin American countries received a steady flow in the pre-1997 period that was linked to their market opening and reforms. Asia (South Asia, mostly India and China) have also significantly benefited but FDI flow to Sub-Saharan Africa has remained insignificant. Also, the FDI tends to be related to large electricity supply projects and therefore may not be so relevant for energy access purposes.

Fig. 2: FDI flow in energy infrastructure

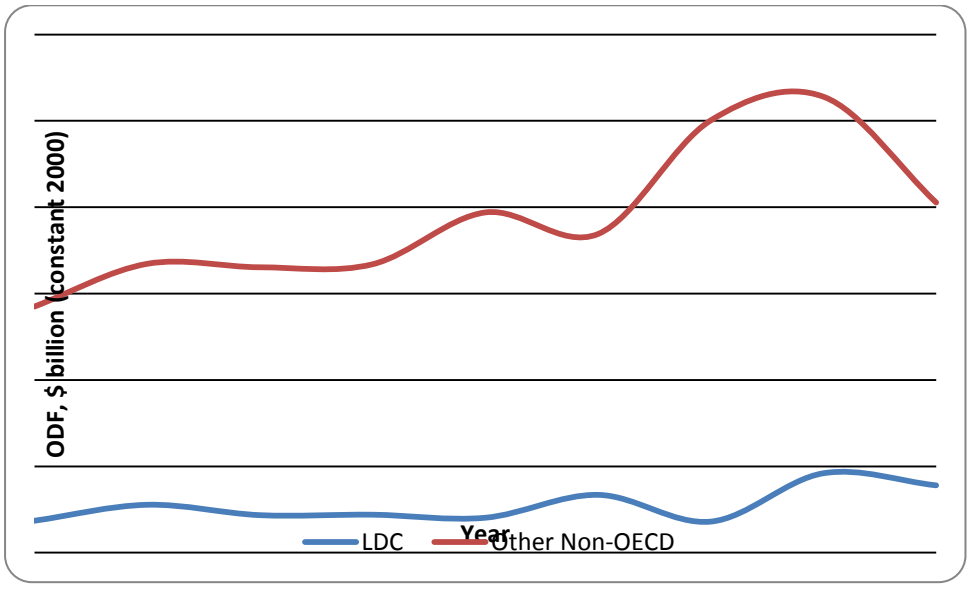


Data source: PPIAF database (World Bank).

2.2.3 Development assistance

Bilateral and multilateral donor support for the energy sector of developing countries started in the 1940s but until recently, there was a lack of co-ordination of aid policies amongst the donor agencies (Gualberti et al., 2012). Delina (2011) observed that between 1997 and 2008 OECD countries have provided almost $1 trillion as Official Development Assistance for various purposes and this remains an important source of funding for developing countries[5]. However, only a small share of this funding goes to the energy sector. According to Bazilian et al. (2011), the Official Development Finance for energy generation and supply declined in the 1990s amid widespread sector reform initiatives. Since 2000, the ODF has steadily increased and in 2008, ODF for energy represented $9.67 billion (constant 2000 terms) – see Fig. 3. A similar observation is made by Gualberti et al. (2012). Although, most of the ODF went to non-LDCs, the share of LDCs is showing an increasing trend: in 2000, LDCs received only 11% of the ODF while in 2008, it reached 16%.

Fig. 3: ODF flow for energy generation and supply



Data source: Bazilian et al. (2011).

Based on the above, it can be argued that only a fraction of ODF and FDI leads to new capital asset formation and that the foreign financial flows contributed partially towards countries' energy-related capital formation. The rest came from internal sources. Although the trend for each country is not clearly available, due to data constraints and inadequate focus on the issue in the academic literature, it is not difficult to imagine that financial

[5] Tirpak and Adams (2008) reported $490 billion for 1997-2005.

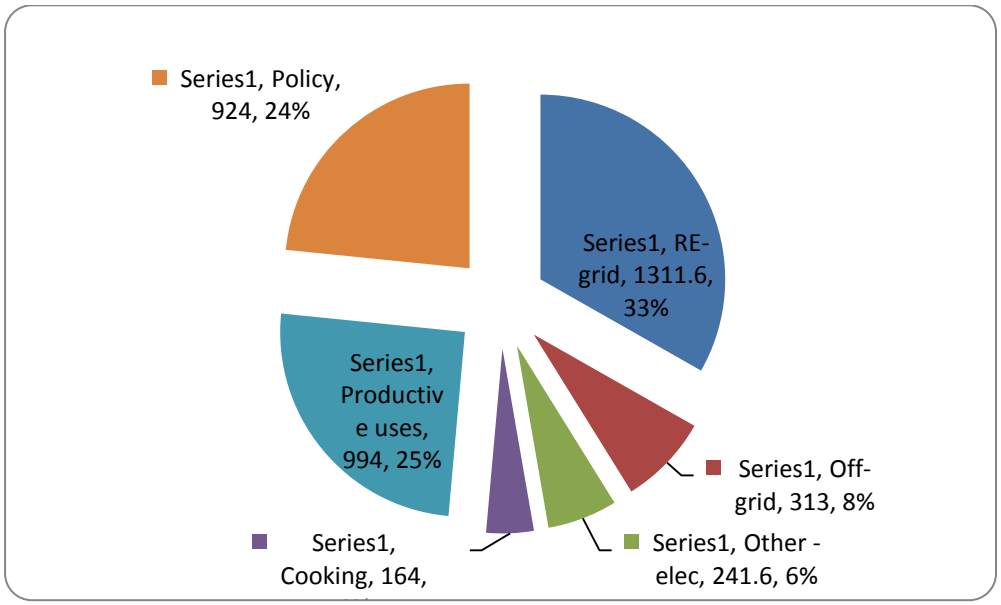
constraints of poorer countries act as a hindrance towards gross capital formation in energy generation and supply.

In addition to FDI and ODF, development assistance from multilateral agencies is another source of funding for developing countries. Multilateral development banks, agencies of the United Nations and some regional agencies come under this group. Delina (2011) reported that these agenceis provided $94 billion between 1997 and 2008 covering various development activities. The World Bank group leads the funding from this group contributing almost 40% of the support. Barnes et al (2010) reviewed the energy access portfolio of the World Bank group using Bank-financed project data. It reveals that the Bank has invested about $20 billion between 2000 and 2008 in energy-related projects but only about $4 billion (or one-fifth of the total) qualifies as energy access investments. The report indicates a steep rise in energy access funding in 2008: until 2007, the Bank invested between $250 and $520 million per year but in 2008, this reached $1.15 billion. Whether this rise is an abberation or not cannot be verified from the report.

About $1.1 billion each went to Africa and East Asia while South Asia received $0.7 billion, Eastern Europe $0.6 billion and Latin America $0.4 billion. The balance went to Middle East. Data provided in Barnes et al. (2011) reveals that about $1.4 billion went to the LDCs for energy access purpose, representing 35% of the total energy access finance by the Bank. 64% of the funding for energy access in LDCs went to Africa, and about 50% of this came between 2007 and 2008. This shows that only a small share of the energy access funding was directed to countries who need it the most and the attention to energy access in situation in Africa has received recent attention by the multilateral funding agencies. This imbalance in the funding is a major challenge for energy access funding.

In terms of investment by type of activity, household electrification received the highest amount – 47% of the total investment (see Fig. 4). Within electrification investments, grid extension was the preferred mode, whereas off-grid electrification is gaining in importance. The lowest amount of investment went to cooking energy solutions, which clearly indicates the Bank's bias for prestigious large projects and inadequate support to the most pressing challenge of the poor.

Fig. 4: World Bank's energy access portfolio



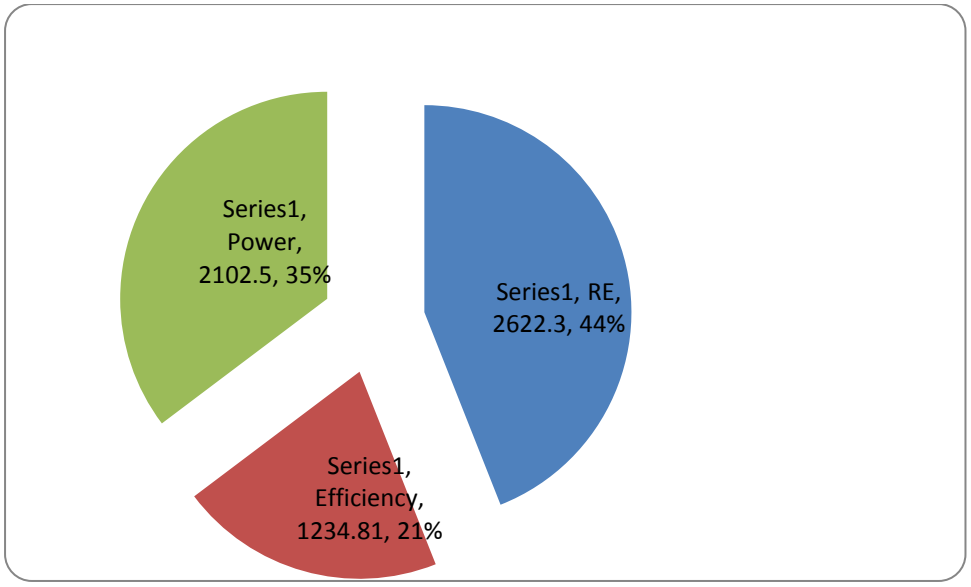
Note: the first figure is the investment amount in million dollars (current), and the second represents the percent share.

Data source: Barnes et al. (2010)

The Asian Development Bank (ADB), another multilateral funding agency, has provided energy-related assistance of $13 billion between 1997 and 2008 but the highest level of support reached $2.7 billion in 2008 (Delina, 2011). The energy sector investment has increased only recently but most of the investment went to large energy projects. India and Pakistan were two major beneficiaries of ADB energy finances, while Sri Lanka and Afganistan are two other major beneficiaries. However, very little funding went to LDCs of the region and countries with poor energy access such as Nepal, Myanmar, Cambodia, Lao PDR, Bhutan, and Bangladesh. No break-down is provided for energy access finance but the overall energy financing portfolio is shown in Fig. 5[6]. It shows that renewable energy has a higher share at 44% but conventional large power projects also received significant financing. It can be concluded from the above that energy access financing was not a major priority for ADB and the support did not reach the poor, less developed economies.

Fig. 5: ADB energy finance portfolio

[6] Delina (2011) could not reconcile the project-level data and aggregate financing information given in ADB Annual Reports. The break-down shown in this figure is based on Table 3 of Delina (2011). RE includes funds for combined RE and Efficiency projects also.



Data source: Delina (2011), Table 3.

The African Development Bank on the other hand reported that it has provided $3 billion to the energy sector between 1967 and 2007, representing 12% of the portfolio. 90% of the energy sector support went to power supply activities under two facilities: African Development Fund and African Development Bank window. The first facility supported rural electrification programmes while the second mainly supported large-scale power generation projects (AfDB, 2008). Like the World Bank, skewed preference for large projects and very limited attention to cooking energy supply can be observed.

2.2.4 Carbon finance

A number of financing mechanisms related to climate change mitigation and adaptation have emerged over the past two decades and they have supported promotion of renewable energies as well as sustainable development.

According to the State and Trends of the Carbon Market 2011 (World Bank, 2011), the global carbon market, which recorded rapid growth between 2005 and 2008, has stagnated at $142 billion in 2010. However, the emissions trading of the European Union is the most dominant player in this market and influences 84% of the market value[7]. The Clean Development Mechanism of the Kyoto Protocol which was one of the main mechanisms of involving the developing countries in the climate mitigation process through financial flow from the developed world has seen a major fall in its market value: 7.4 billion in 2007 to 1.5

[7] 97% if secondary transactions are considered.

billion in 2010. The uncertainties about the future of CDM post-2012, the restrictions imposed by the European Union on the usage of Certified Emissions Reductions (CER) as a compliance instrument for the Emissions Trading System (ETS) and a reduction in demand due to economic recession have eroded its worth substantially. The report indicates that there is little incentive for any investor in the CDM now due to these developments.

Moreover, only a few countries have benefited from the CDM so far. World Bank (2011) indicates that only 16,000 CER out of 605 million CER issued so far originated from the least developed countries. Consequently, Africa as a continent has not gained much from the CDM despite a number of corrective measures taken by the CDM Executive Board. Energy access projects, being small-scale in nature, face prohibitive transaction costs to access CDM benefits and given the marginal nature of the CDM financial support, the barriers outweigh the benefits. However, Glemarec (2012) suggests that the introduction of Program of Activities (PoA) and the decision to introduce standard baselines for such PoAs can help redress the problems. He indicates that as of January 2012, 58 PoAs for enhancing energy access of households have been designed – 3 of which have already been registered.

The Global Environment Facility (GEF) has been another source of climate finance over the past 20 years. The facility has invested $10.5 billion in 2700 projects in 165 countries and arranged $51 billion in co-financing (GEF, 2012). It has a dedicated fund for the least developed countries but most of the funding is directed towards climate change issues and not specifically for energy access.

UNDP (2009) highlighted the regional unevenness of flow of funds for clean energy investment. It indicates that the private sector has made about $150 billion new investment in clean energies in 2007 but only 22% of the investment went to developing countries. However, only two countries (China and Brazil) attracted most of this investment and only $1.3 billion went to Africa. 85% of the funds went to three technologies, namely wind, solar and biomass. It is not clear how much of this finance went for enhancing energy access but given the regional distribution pattern, it can be inferred that energy access did not really benefit much.

Therefore, despite a significant growth of the carbon finance market, it remains less accessible to small and poor developing countries and has not helped much in financing energy access.

2.2.4 Investment in energy access

The above discussion clearly supports the claim by Bazilian et al. (2011) that estimating the financial flow to energy access is not easy. IEA (2011) estimated that about $9.1 billion was invested in 2009 for enhancing energy access. This includes ODA, Multilateral organisational funding, private sector funding and state funding. IEA (2011) reported that 14% of the investment came from ODA, 34% from multilateral organisations, 22% from the private sector and 30% from the national governments.

While the estimates of the first two elements are based on cost allocation principles being followed by multilateral banks, the estimates for the private sector and national government funding are based on certain assumptions. IEA (2011) assumed that 50% of the Private Public Partnership funding for energy infrastructure came from the private sector and that between 5 and 20% of the private sector funds went to enhance energy access. However, we have noted earlier (while presenting the private public partnership investment data) that most of the projects were large power generation projects, which are unlikely to qualify as energy access investments. Therefore, this estimate is questionable. Similarly, one of the assumptions regarding government funding is that governments provided matching funds for every dollar of ODA support. This appears to be a bold assumption, to say the least. Clearly, the IEA (2011) estimate needs to be considered with caution.

2.3 Financing universal energy access

Based on the analysis of financial flows and investment needs for energy access, the magnitude of the challenge becomes quite clear. The present level of investment is much lower than what is needed to ensure universal energy access and the gap in funding will be significantly higher for low income countries.

Bazilian et al. (2011) suggest that for LDCs with high level of energy access problem, even investing the entire amount of capital now invested in the energy sector will not ensure universal energy access by 2030. They estimate that LDCs will need an annual investment of $11.6 billion as against $2.5 billion invested in 2008. Bridging this huge gap in finance is the main challenge. Moreover, the capital requirement will greatly increase if the medium and high scenarios of the Bazilian et al. (2010) study materialise in reality. The challenge becomes even more daunting considering the limited multilateral funding agency support for the least developed countries. IEA (2011) suggests a 30:30:40 split of funds from the private sector, national governments and development assistance (including multilateral funding support). This would turn out to $15 billion per year each for the private sector and

the governments, and $18 billion per year for the development assistance. The task becomes even more challenging due to economic recession in the developed world and donor apathy towards sustaining aid support over decades. Glemarec (2012) notes the dim prospects of additional development assistance in the near futrue. Thus a major change in the attitude of the funding agencies, development priorities of the states and the business strategies of the private sector will be required. It remains to be seen whether profound changes inherently assumed in the above suggestion are likely to happen or not.

Therefore, the challenge of financing universal energy access is a major global challenge. It will require unprecedented level of investments in a large number of countries, most of which are in the low and middle income group, and who have limited experience of dealing with such high level of investments. The level of financial resources would have to grow a few folds compared to the present level and even the traditional sources may not be sufficient to bridge the funding gap.

3.0 Financing options and challenges

The financing challenge, particularly in the climate change context, has received international attention in recent times, since the Copenhagen Accord in 2009 (in relation to the Conference of Parties of the United Nations Framework Convention on Climate Change) where a promise was made for investing $100 billion per year in the developing countries by 2020 towards climate adaptation and mitigation. While the emphasis was on climate change, an extension of the focus to include energy access was also noticed subsequently with the UN decision to designate 2012 as the Year of Sustainable Energy for All. Thus the twin challenges of climate change mitigation and energy access provision have shared concerns in this respect. This section reviews the literature on financing options and related challenges arising from such

3.1 Review of financing options

The UN Secretary General's High Level Advisroy Group on Climate Change Financing (AGF) in its report considered the issue of mobilising $100 billion per year by 2020 and considered four broad sources of funding: public sources, development bank finance, carbon market finance and private sources (AGF, 2010). The Group examined each source of finance to identify new sources of funds and estimated potential availability of funds. The public sources included potential revenues from carbon-related taxes, charges or auction proceeds. Development bank finances included contributions to dedicated carbon-related funds or new contributions to these agencies by countries. The money transferred to

developing countries as a result of carbon-offseting is captured in carbon market finance. Private finance is the flow from the private sector of developed countries.

Table 1 provides a summary of the estimates by the AGF (2010), which indicates that in the likely scenario developed countries could mobilise $100 billion annually by 2020 for investing in the developing world. In the high scenario, significantly higher finance mobilisation is possible while the targets would not be reached in the low scenario. This highlights the importance of future carbon price prevailing in the market. Public finance from the developed economies is suggested as the most important source of new finance and can account for 40-45% of the total funding. However, a prolonged recession in the OECD economies and the potential for carbon leakage or relocation to developing countries can easily affect this outcome.

Table 1: Summary of financing sources identified by AGF (2010)

Source	Sub-category	Low carbon price case	Medium carbon price case	High carbon price case
Public finance	AAU/ ETS auctions	US $2-8 billion	$8-38 billion	$14-70 billion
	Offset levies	$0-1 billion	$1-5 billion	$3 -15 billion
	Martime transport emission levies	$ 2 -6 billion	$4-9 billion	$8 -19 billion
	Air transport emission levies	$1-2 billion	$2-3 billion	$ 3- 6 billion
	Other carbon-related revenuew		$25-33 billion	
	Financial transaction taxes		$ 2 – 27 billion	
Development Bank finance			$11 billion	
Carbon market finance		$8 -12 billion	$38-50 gross; $ 8-14 billion net	$150 billion

Private finance			$20-24 billion	

Source: AGF (2010).

Further, carbon markets and development banks are identified as potential sources that can contribute another 20-25% while the rest will have to come from the private sector. Yet, based on the present carbon market and FDI trends, it remains doubtful that the required volume of finance will flow to countries who need it most.

Bloomberg New Energy Finance in association with UN Energy organised a Roundtable day in April 2011 to seek views of various stakeholders and thought leaders on the twin challenge on financing energy access and low carbon transition in developing countries. The results of the roundtable day reported in Bloomberg (2011) indicate that if private capital has to flow to enhance energy access, the business climate has to change and countries would need to ensure the "core tenets of business ecology". Also the need for capacity building, identifying local champions and providing information was highlighted.

AfDB (2010) recognises that the financing gap in Africa is enormous. Against an annual investment need of $41 billion in the power sector, the continent is typically investing $11.6 billion. Closing the gap will be a challenge due to insufficient national public finances, limited benefits from the CDM, and poor private sector participation. While donor and multilateral funding agency support can help, the financing challenge cannot be underestimated.

Glemarec (2012) suggests that the development assistance is unlikely to meet the financing needs of energy access as there is the possibility of reduced flow of development assistance in the future due to economic downturn. The developing country governments will also be hardpressed for funds despite their commitments to energy access. This will by default imply a higher reliance on private capital to ensure energy access. He also highlights the new arrangements like Green Investment Fund, Energy+ initiative and stresses on the need for leveraging different funding mechanisms to achieve the energy access objectives. A summary of various new financing instruments is given in Box 1.

Box 1: New financing mechanisms

Green Investment Fund – This is a fund created by the decision of COP 16 (Cancun in 2010) to address the funding issues of developing countries for climate change mitigation and adaptation. This is managed directly by the UNFCCC. The modalities of Fund operation was approved in Durban in 2011 but funding for energy access was not included. However, Glemarec (2012) suggests that it can support scaling-up of energy access projects by allowing governments to aggregate small-scale projects under a single umbrella initiative.

Climate Investment Funds – These were created in 2008 by a group of developed countries to fund climate-smart development in developing countries. The funds are managed by five multilateral development banks collaboratively. The CIF has a funding pledge of $7 billion through the Climate Technology Fund (CTF) and the Strategic Climate Fund (STF). The Climate Change Fund has an allocation of $4.8 billion for renewable energy technologies, energy efficiency and sustainable transport while the Strategic Climate Fund has an allocation of $2.2 billion in low-income countries in forestry, renewable energy and strategic climate resilience programmes (CIF, 2011). The Strategic Climate Fund has a programme for Scaling-up of Renewable Energy in low-income countries (SREP) which focuses on renewable energies and energy access (Behrens et al., 2011).

Adaptation Fund – As per the provisions of the Kyoto Protocol, an Adaptation Fund was created by the UNFCCC to provide financial support to vulnerable developing countries who are parties to the Kyoto Protocol in adapting to the effects of climate change. The Fund, on a temporary basis, is being managed by the GEF Secretariat and the World Bank is acting as the Trustee. The fund receives 2% of the proceeds of CER sales from the CDM mechanism and from other sources. So far, 15 projects have been approved for funding of $104 million and 11 other projects have been endorsed[8]. Most of these relate to agriculture, water, coastal area management and do not have any direct impact on energy access.

Bird et al. (2011) indicate that the direct access to funding is emerging as a new concept in climate financing. The term means accessing international finance by developing countries for climate mitigation and adaptation. The Adaptation Fund under the Kyoto Protocol first used the concept and allowed the governments or the project implementing or executing agencies to approach the Fund directly. However, Bird et al. (2011) report that only one project using this mechanism is under implementation and therefore, its success cannot be easily assessed. However, multilateral access is more widely used under GEF and CIF and even in the Adaptation Fund.

A review of energy access projects in Asia and the Pacific (UNDP, 2011) suggests that a firm commitment from the government for financial support through appropriate budgetary allocations was a key element in all successful cases. Embedding the projects in the overall

[8] For details see http://unfccc.int/cooperation_and_support/financial_mechanism/adaptation_fund/items/6668.php.

rural development programme is also found to be another feature of successful programmes. It reports that two energy access projects in Nepal have successfully accessed CDM funding – one of them is based on biogas and the other is a micro-hydro project. At the end-user level, a combination of funding and financing mechanisms have been used, including capital subsidies, micro-finance and donor assistance for market development. It suggests that a set of locally appropriate financing options, use of micro-credit options to expand the market and reliance on productive use of energy as an alternative financing mechanism could be used to enhance energy access.

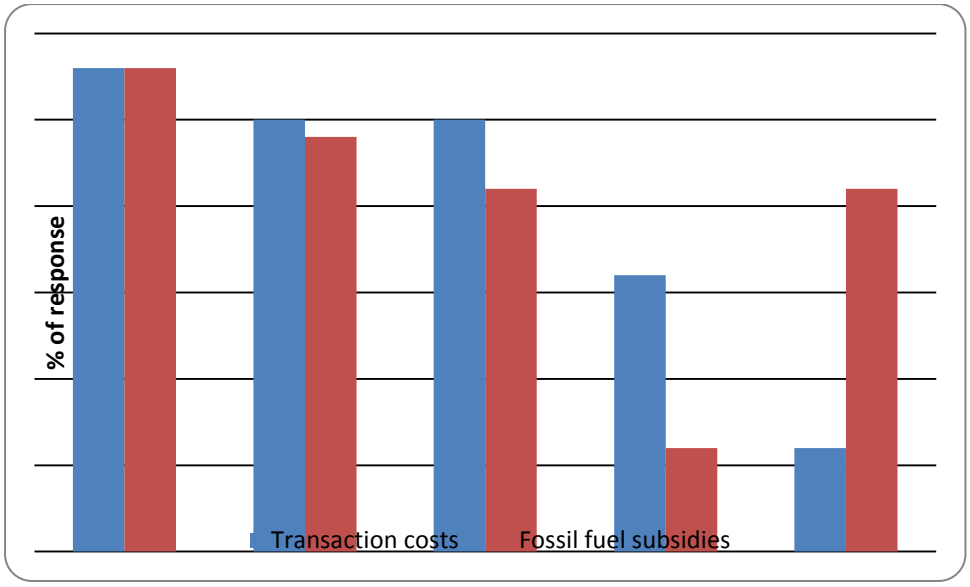
3.2 Financing barriers

A recent study, UNEP (2012), provides a number of barriers based on a survey of 38 financial institutions with experience of financing renewable energy projects in developing countries. The barriers are organised under three main heads: level-playing field, easy market access, and political and regulatory investment risks.

It is generally recognised that renewable energies face undue competition from subsidised fossil fuels and transaction costs related to renewable energy project development. The survey results indicate that the practioners consider transaction costs related to renewable energy development and subsidies on fossil fuels as major barriers to level-playing fields (see Fig. 6). Almost 80% of the respondents considered transaction costs as an important barrier while more than 70% of them thought fossil fuel subsidies also affected the renewable energy promotion adversely. A corrolary from the above is that the CDM is just perceived as “icing on the cake” that is unlikely to play an important role in promoting renewable energies for electricity supply.

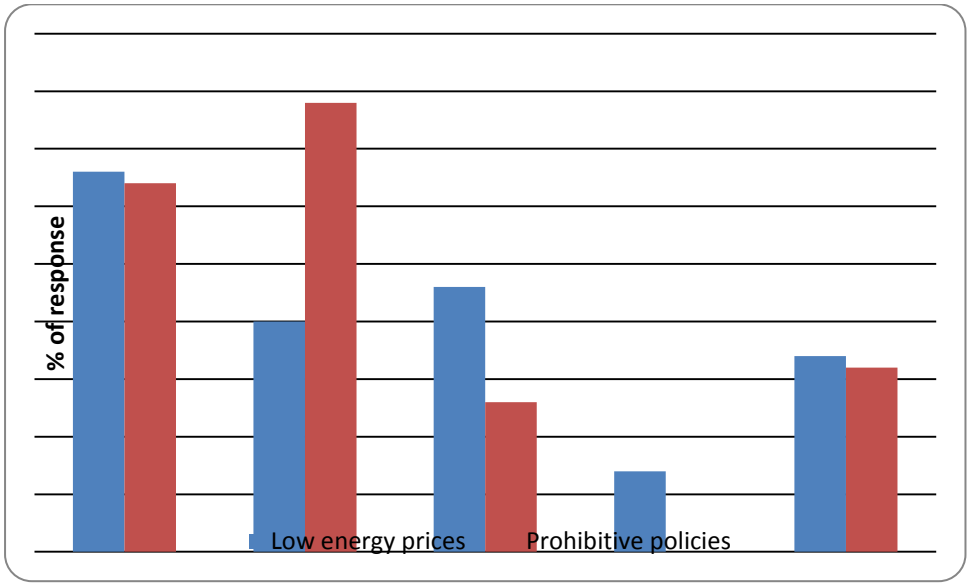
In addition, the electricity sector in most developing countries is highly regulated and does not offer easy entry. The survey reveals that unsustainably low energy prices and protective, non-competitive and innovation-strifling electricity sector policies in developing countries have detrimental effects on private finacial capital flows to renewable energy development. As indicated in Fig. 7, between 75 and 85% of the respondents consider that politically-motivated low prices and distortive sector policies as important barriers.

Fig. 6: Perception about transaction costs and fossil fuel subsidies



Data source: UNEP (2012)

Fig. 7: Detrimental factors to market access

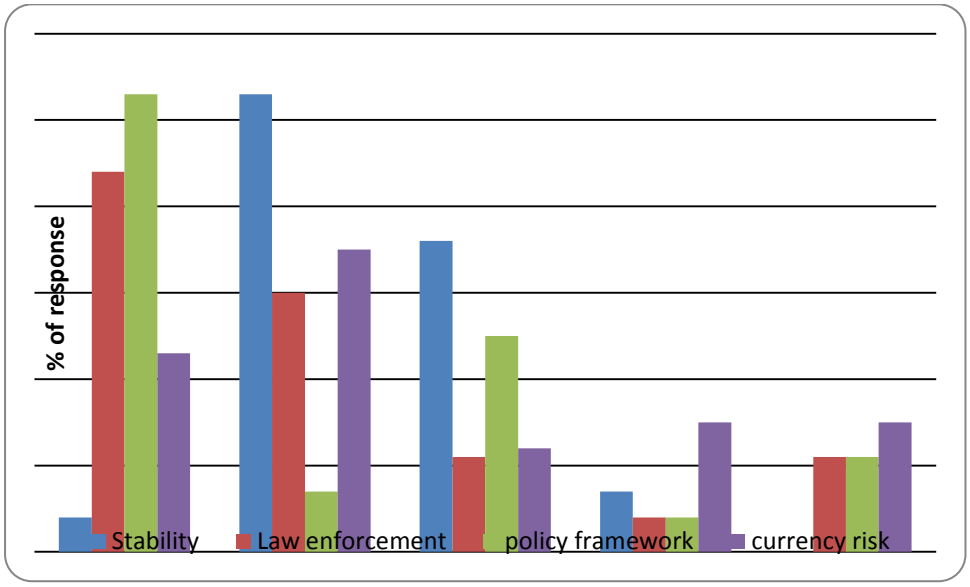


Data source: UNEP (2012).

Moreover, investors face significant macro-economic, regulatory and political risks while making investment decisions in a developing country. High risks make return expectations prohibitively high, making investments unviable. The study confirms this for four risks under the regulatory and political risk category by finding that respondents perceive effective law enforcement, reliability of policies and support mechanisms, and political stability as major threats to viable investments.

The survey also indicates that the respondents considered national renewable targets and feed-in tariffs as the most important incentives for renewable energy promotion. The CDM did not figure as a favourite incentive. UNEP (2012) recommends that countries should ensure create a level-playing field, provide easy access to their electricity market and mitigate risks by setting national renewable energy targets, removing fossil-fuel subsidies, providing incentives for investors, reforming political, economic and societal structures, and by adopting international risk-mitigation instruments. However, this is easier said than done but can energy access wait for satisfaction of such pre-conditions?

Fig. 8: Perception of political and regulatory risks



Data source: UNEP (2012).

Woerlen (2011) presents another interesting study of identifying barriers using a meta-study of evaluation of 17 GEF projects. Using the Theory of No Change that uses four sets of stakeholders, namely consumers, suppliers, financiers and policy makers and consideres seven generic barriers, namely igonorance, lack of motivation, lack of expertise, lack of access to technology, lack of cost effectiveness, lack of business model or demand and lack of affordability, she identified 20 barriers for energy efficiency projects. The barriers are grouped in four categories in terms of their severity, namely show-stopping barrier,

significant barrier, not so important barrier and no barrier. The evaluation of the barriers for each type of stakeholder is shown in table 2.

Monroy and Hernandez (2005 and 2008) also present the stakeholder views on private capital flows to energy access. They contacted 800 experts for an email survey and received 185 responses (21.6% response rate). They found that 85% of the respondents considered financial sustainability of projects is the essential factor ensuring long-term viability of rural electrification projects. 67% of the respondents considered that a public-private partnership would strengthen the financial sustainability of such projects. In respect of financing, micro-finance and linking electrification with productive activities was highlighted as a very important factor. 72% respondents considered renewable energy funds "the most suitable financial instrument to deal with renewable electrification projects". Revolving funds were identified as the best option for end-user financing, followed by productive uses and micro-finance. Lease instruments were considered least suitable for these markets.

Table 2: Key barriers to market development

Barriers	Consumer	Suppliers	Financiers	Policy
Show-stopping barrier	Ignorance Lack of access	lack of cost effectiveness	lack of cost effectiveness	
Significant barrier	Lack of affordability	lack of expertise Lack of affordability lack of business model	lack of expertise	lack of expertise
No important barrier		lack of access		
No barrier	lack of interest lack of expertise lack of cost effectiveness	Ignorance	ignorance lack of business model	Lack of interest Ignorance lack of affordability

Source: Woerlen (2011).

Simon et al. (2012) highlight the barriers faced by cook-stove promotion programmes in accessing climate finance. They report that the CDM has recently approved a methodology for emission reduction from small-scale cookstove projects. In order to benefit from the CDM funding mechanism, projects have to undergo the registration, verification and validation processes. In addition, improved cookstove programmes face further barriers as follows: there is no ready additional finance available for the implementation of such projects; the rigid requirements of the CDM in terms of verification and performance requirements can hinder such programmes; in addition, measurement and verification of emissions, possibility of leakage, and changes in the climate policy or carbon finance policy can also affect the programmes.

UNDP (2011) also underlines the difficulties in accessing carbon finance for energy access projects. Lengthy processes and high transaction costs act as disincentives but the greatest barrier is the uncertaintly prevailing in respect of post-2012 situation.

Based on the experience of Asia and the Pacific in promoting renewable energies for energy access, UNDP (2008) reported that through a process of trial and error, most countries of the region have an understanding of the "first generation barriers" and ways of resolving them. These barriers relate to initial barriers faced by an investor and include low returns on investment, high transaction costs, lack of experience with energy access financing, and unsuitability of existing credit facilities for financing these projects, etc. However, the scaling-up experience is quite limited and there is poor knowledge about successful scale-up models. This leads to the second generation barriers to ensure an effective transition from projects to programmes.

Radulovic (2005) presents an analysis of market barriers in using solar PV for productive uses and provides an example from the Indian agricultural sector. The author suggests that the call by neo-institutional economists (NIE) for getting institutions right is not sufficient to address the problem because it does not offer viable solutions for political interference in the barrier removal process. A case study in Punjab was used to show the shortcomings of NIE. A programme of PV in the agricultural sector has succeeded here with government providing subsidies to agricultural users, although such subsidies are not recommended by NIE. The author suggests that state policymakers should look beyond NIE and try to improve and expand PV markets by considering the market barriers, political constraints, and cultivating locally appropriate service models.

To conclude, mobilising financial resources to ensure universal energy access remains a major challenge. The financial needs of poorer countries are likely to be beyond their own financial means and the governments of budget-constrained developing countries may not be able to contribute much to finance such demands. International support will be required but the public finance may not be easily forthcoming and may not reach the countries that need it the most. The present support of the multilateral finance organisations is biased towards large-scale energy projects and often disproportionately benefits large developing countries. This trend needs to change so that poorer countries receive the required finance. Moreover, the developing countries need remove major barriers that hinder large-scale mobilisation and use of funds. Whether such corrective actions can be taken in the short-term or not remains an issue requiring further investigation.

4.0 Specific financing approaches for off-grid electrification

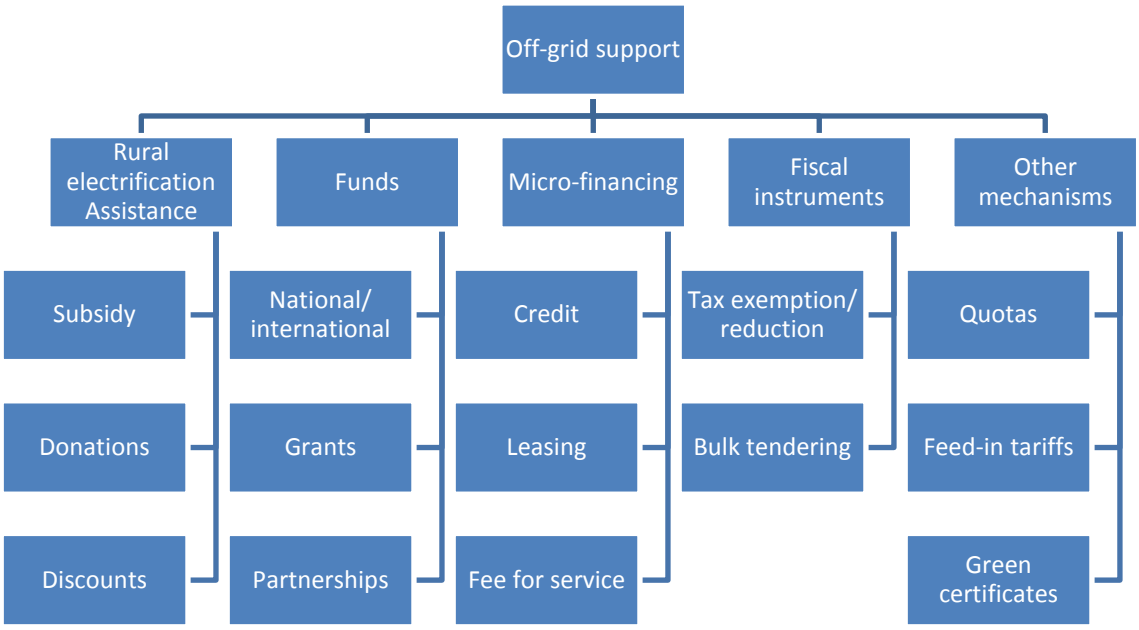
Sonntag-O'Brien and Usher (2004) posit that for a new off-grid business, capital is required at various stages of the business – upstream of the project, for running the project and even downstream to support the customer or the business transaction. Ortiz et al. (2007), on the other hand, presented the financial instruments by their nature: assistance, funds, micro-finance, fiscal instruments and others (see Fig. 9). Accordingly, this section is divided into project-level financing and end-use level financing.

4.1 Project-level financing

Off-grid projects have often relied on finance from donor agencies and budgetary support from the state. For example, electrification programmes such as Energising Development by Dutch-German governments (EnDev)[9] and World Bank projects in China, Bangladesh, Ethiopia and Sri Lanka are providing access to clean energies. In many countries, the national government provided the funding. For example, in China the decentralized electrification is either fully financed by the central government or through a cost-sharing scheme where the provincial government contributes a share. In the Philippines, where a co-operative or a franchisee finds it unviable to provide electricity, the Missionary Electrification project is undertaken, which receives a continuous flow of subsidy from a fund created by levying a universal charge, set by the electricity regulator, on electricity users.

[9] EnDev is a joint programme of the Dutch and German governments to enhance access of energy in developing countries. EnDev aims to provide access to 5 million people in rural areas and is being implemented by GTZ and SannterNovem. The programme started in 2005 and has undertaken 23 projects covering cooking energy, lighting, energy for productive use and for social infrastructure. More information is available at http://www.senternovem.nl/energising_development/general_information/index.asp.

Fig. 9: Financial instruments for off-grid electrification



Source: Adapted from Ortiz et al. (2007).

Any investor intending to enter the off-grid business would need the start-up capital and the ability to take risks in the new business. The seed capital is an early stage finance mechanism for this purpose that is used to convert an idea to a new business, particularly in the case of small and medium sized businesses. Sonntag-O'Brien and Usher (2004) reported that E+Co is a specialized entity in respect of renewable energy business. Although venture capitalists play an important role in industrialized countries in taking risks of innovative businesses, the prospect of persistently low returns in the off-grid businesses restricts the potential of venture capital. Sonntag-O'Brien and Usher (2004) recommended that the donor agencies should fill this gap instead.

In addition, Cabraal et al. (1996) indicate that private investors or agencies involved in the service also used the following sources:

- Equity or debt financing by the government – In Mexico, the government provided for the initial capital required for the equipment either through an equity contribution or through a loan.
- Asset-based lending – Investor borrowed funds from banks or financial institutions by mortgaging its PV assets or other assets. The limited size of these assets however

restricts the loan amount. Banks often require other security to reduce its risk exposure, thereby making the borrowing unattractive for the investor.

- Non-recourse financing – This follows from the project finance literature where the company borrows money based on its project cash flows instead of relying on the parent company's balance sheet. However, it is noted that this option has been rarely used but the Rural Electrification Co-operatives in the Philippines raised funds through this mechanism from the National Electrification Administration.
- Supplier credits – PV suppliers offer credits to dealers or aggregators to improve the cash flow for a short period. Generally, these credits tend to be short (six months or so). Indonesian PV companies received such supplier credits.

Once a business starts operating, its operating capital needs increase to meet the short-term and long-term capital needs. Sonntag-O'Brien and Usher (2004) indicate that very few commercial lenders provide funds to off-grid electricity businesses and consequently, support mechanisms are required in the form of "lines of credit, credit enhancements for loan provision and SME growth capital funds."

Reiche et al. (2000) present a review of off-grid rural electrification experience in developing countries especially through the World Bank initiatives. They suggest that if governments want to reach the poorest section of the population, subsidies perhaps cannot be avoided but these have to be well targeted and appropriately designed to avoid market distortions. Based on a case study of Nepal, Mainali and Silveira (2011) argue that there is still a huge affordability gap amongst rural poor and therefore subsidy plays an important role. But the subsidies may be attracting new suppliers in the market and may not be creating a sustainable business model.

World Bank (2008) suggests that to become sustainable an off-grid project has to be beneficial to all main stakeholders – consumers, service providers, financiers and government. It should consider the government's intentions, subsidy commitment, and regulatory rules; promote productive and institutional energy use that generates income opportunities; and take the possibility of international co-financing into account.

World Bank (2008) acknowledges that designing an off-grid system is not an exact science – it is made more complex by a combination of factors including among others high cost,

poorer consumers and new technologies. It also suggests that the question that requires investigation is how and when an off-grid investment complements grid expansion. It recognizes that although a few off-grid operations are commercially viable (example include PV in China and Kenya, some PV operations in India, pico-hydro in Laos and Vietnam and micro-wind in China and Mongolia), most off-grid electrification may require subsidies. Therefore, enhancing affordability through subsidies, consumer financing, low-cost technology options and policies and business practices is important. Further, financing arrangements can complement subsidies. International co-financing such as through GEF, CIF, and CDM can help. By increasing the size of the consumer base through micro-finance, the affordability and viability of projects can be enhanced. Duty or import tax waiver or reduction and avoidance of multiple taxes are commonly used in this respect.

4.2 End-use level financing

The issue of end-use financing is not a new one. Cabraal et al. (1996), Wang (1998) and Reiche et al. (2000) provide a review of practices in the 1990s and discussed alternative types of financing arrangements. Sonntag-O'Brien and Usher (2004) also provide a review of alternative end-users financing options. These include:

a) Small-scale lending: where multilateral lenders provide funding to organizations/ agencies with adequate institutional arrangements for administering the financing programme. UNDP/ World Bank, GEF and other government funds (e.g. Netherland's project Finesse) come under this category. Under Finesse, multilateral lenders provide loan to a local agency that retails the loan to end-users.

b) Micro credit – Because the cost of SHS is generally high compared to a rural household income, availability of consumer credit facilities is an important aspect. Wang (1998) reported that an Indonesian company, Sudimara Solar operated customer financing scheme and achieved a 100% pay-back record. See Box 2 provides further details on micro-financing[10].

c) Leasing arrangements – Here the company supplies the SHS with upfront investment and receives a monthly charge from the consumers towards recovery of the cost. The system remains the property of the company. Wang (1998) reported that such a system was operated by a company called Soluz in Dominican Republic. Often Energy Service Companies (ESCO) follow this approach as through aggregation of demand

[10] See Morris et al. (2007), Morris and Kirubi (2009), Lipp (2001) for country cases and examples.

the company obtains a better deal from the lenders and appliance suppliers while the consumers benefit low rental charge.

d) Revolving funds: These funds are generally provided by philanthropic organizations or donors and are operated by community-based organizations that lend funds to individuals often at a favourable rate than the banks do. Initial seed funds are provided to install systems and repayments are then used to finance more systems. This has been generally used in the initial stages of projects such as Enersol NGO in the Dominican Republic; Solanka NGO in Sri Lanka; and the BANPRES project in Indonesia.

Box 2: Micro-finance schemes

Commercial banks and formal financial institutions often do not reach rural and remote areas. An alternative has arisen in the form of micro-finance to fill the gap. There is now considerable experience in using micro-finance for development purposes and in enhancing energy access in developing countries. More than 500 million people in the world now have access to micro-finance (Morris et al., 2007). Microfinance organisations have developed a number of arrangements (Morris et al., (2007)):

a) Financing provided hand-in-hand with technical support: In this arrangement, the micro-finance organization enters in an association with the service provider and work towards a common goal of providing a complete package of product sale backed by a tailored financial service. This arrangement has been used in SELCO (an India solar energy provider) and SEWA (a micro-finance organization).

b) Energy companies lending directly – Some energy service companies provide micro-finance directly to consumers by availing financial support/ resources from third-parties. This has been used in some Latin American countries and in the Caribbean. The Soluz enterprises used this model.

c) Subsidies linked with microfinance – Micro-finance organizations often receive subsidies or grants for onward lending to final users. Micro-finance is also used to bridge the project cost and subsidies. SEEDS uses this model and is participating in a World Bank supported project where it provides 25-30% of the energy access project costs.

d) Conventional loans – In this case, the micro-finance organization plays the role of a conventional bank and provides small credits to consumers. Amret in Cambodia relies on this form.

e) Bulk purchase of equipments for onward lending – Here an umbrella organization procures the equipment in bulk and lends them to local micro-finance organizations.

However, microfinance organizations also face a number of risks: finding a suitable partner is not easy; as consumption-oriented loans are normally based on credit-worthiness of recipients, mass-scale penetration of energy consumption loans may be difficult; and the risk of non-recovery of energy equipment cost.

Moreover, many countries do not have proper regulatory arrangements for the microfinance sector. While such organizations emerge as informal activities, there is also the risk of misappropriation of consumer money and quality of services. Accordingly, Morris and Kirubi (2009) recommend that governments should create enabling environment for microfinance sector and strengthen monitoring, evaluation and disclosure of microfinance activities for energy.

UNDP (2011) reported that the projects reviewed in the report used a combination of end-user financing mechanisms. Table 3 presents a summary. It can be seen that projects tend to rely on a combination of instruments that are appropriate locally. In most cases direct subsidy (capital and in some cases energy-related) forms an integral part of the end-user financing mechanism for enhancing energy access. However, the issue of ensuring financial sustainability of the business enterprises and the burden on government budget cannot be overlooked.

Table 3: End-user financing mechanisms used in energy access projects

Project name	Financing mechanism					
	User contribution	Direct subsidy	Micro-financing	Loan	Retailer finance	Fee for service
DPBURC China project	X	X		X		
StoveTec	X		X		X	
Tide India	X			X	X	
RGGVY	X	X				X
IWM Nepal	X	X	X	X		X
BSP Nepal	X	X	X	X		
REDP Nepal	X	X	X	X		
RERED Sri Lanka	X	X	X	X		
Sunlabob Lao PDR	X					X

Source: UNDP (2011).

There is also some suggestion that a premium renewable energy tariff scheme along the lines of feed-in tariff can be used in rural mini-grid systems. Moner-Girona (2009) provides such an argument and shows that it can be a viable alternative. However, it is not known whether such a system has been applied in reality yet.

To conclude, both upstream and downstream financing options play an important role for off-grid electricity supply. Rapid expansion of off-grid electricity supply in remote rural areas would require expansion of financial services and financing options. While upstream finance receives greater attention, sustainability of the electrification efforts would also require a greater attention to downstream activities. Balancing these challenges would require involvement of multiple stakeholders – government, financial organizations, microfinance organizations and energy suppliers.

Conclusion

Renewed focus on universal energy access in recent times has necessarily brought the underlying financial challenge to limelight. Although the estimates vary from a low of $11 billion per year to $ 120 billion per year with a mid-range value of $50-60 billion for the next two decades, the size of investment required is significantly higher than traditional levels for energy access provisions. The funding gap will be more acute in least developed countries where the energy access level is very low and where the traditional barriers to investment are more profound. This review highlighted that even the multilateral funding agencies actively involved in development of poorer countries have not paid adequate attention to energy access funding and have focused on large projects and large countries. There is an urgent need to redress this bias.

Our review also highlights that the development assistance will not be sufficient for promoting energy access. Despite pledges for support to noble causes, the developed country funding constitutes only a small fraction of the overall financial resources. Given the unfavourable economic condition in many developed countries at the moment and aid fatigue, one cannot solely depend on such sources. Developing country governments and the private sector will have to play an important role. Governments would have to commit not only funds but also create an enabling environment for private businesses, micro-finance organizations, and management and implementation of energy access activities in a timely and orderly manner. Removing barriers to investment and business promotion, and supporting innovative approaches through collaboration, learning from others and experience sharing will be very essential.

In this respect, the issue of south-south co-operation cannot be overlooked. A lot of experience and innovative approaches are being used in the developing world that can be easily tried and replicated in other contexts. Similarly, the financial support from developing countries itself can be an additional source of finance. Already, China has been actively involved in many infrastructure development projects in Africa. Although China's investment is flowing to resource-rich countries (often rich in petroleum resources), some future support to energy access from China and other developing countries may be possible.

Although carbon finance and such innovative mechanisms have not played a major role in energy access so far, the carbon market is likely to grow in the future. Creation of new climate funds (such as Green Investment Fund or Climate Investment Fund) and inclusion of energy access of least-developed countries in some of their remit can help but the barriers related to transaction costs and complex processes cannot be overlooked either.

Overall, the challenge to financing energy access remains a major global issue and requires a concerted effort of all stakeholders to find tangible solutions to the problem.

References

AfDB, 2008, Clean Energy Investment Framework for Africa: Role of the African Development Bank Group, Operation Policies and Compliance Department, African Development Bank, Tunis.

AfDB, 2008, Clean Energy Investment Framework for Africa: The role of the African Development Bank, African Development Bank, Tunis, Tunisia.

AfDB, 2010, Financing of sustainable energy solution, African Development Bank, Tunis. (see http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/C-10%20Note%203%20English%20%28final%29_for%20posting.pdf).

AFG, 2010, Report of the Secretary General's High Level Advisory Group on Climate Change Financing, United Nations, New York (http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGF_reports/AGF%20Report.pdf).

AGECC, 2010, Energy for a sustainable future, The Secretary General's Advisory Group on Energy and Climate Change, UNIDO, Vienna.

ASER, 2007, Costing for national electricity interventions to increase access to Energy, Health Services and Education, Senegal Final Report, Agence Senegalaise d'Electrification Rurale, World Bank, Washington D.C

Barnes, DF, B. Singh and X. Shi, 2010, Modernising energy services for the poor: A World Bank Investment Review – Fiscal 2000-2008, World Bank Energy Sector Management Program, World Bank, Washington D.C.

Bazilian, M., P. Nussbaumer, E. Haites, M. Levi, M. Howells, KK Yumdella, 2010, Understanding the scale of investment for Universal Energy Access, Geopolitics of Energy, 32(4): 21-42.

Bazilian, M., P. Nussbaumer, G. Gualberti, E. Haites, M. Levi, J. Siegel, DM Kammen, and J. Fenhann, 2011, Informing the financing Universal Energy Access: An assessment of current financial flows, The Electricity Journal, 24(7): 57-82.

Bazilian, M., P. Nussbaumer, HH Rogner, A. Brew-Hammond, V. Foster, S. Pachauri, E. Williams, M. Howells, P. Niyongabo, L. Musaba, BO Gallachoir, M. Radka, and DM Kammen, 2012, Energy access scenarios to 2030 for the power sector in Sub-Saharan Africa, Utilities Policy, 20(1): 1-16.

Behrens, A., J. Nunez Ferrer, M. Carraro, G. Lahn and E. Dreblow, 2011, Access to energy in developing countries, European Parliament, Brussels, Belgium.

Bird, N., S. Billet and C. Colon, 2011, Direct access to climate finance: experiences and lessons learned, Discussion Paper, UNDP/ODI, New York. USA.

Cabraal, A., M. Cosgrove-Davies and L. Schaffer, 1996, Best practices for photovoltaic household electrification: lessons from experiences in selected countries, World Bank.

Deichmann, U., C. Meisner, S. Murray, and D. Wheeler, 2011, The economics of renewable energy expansion in rural sub-Saharan Africa, Energy Policy, 39(1): 215-27.

Delina, L., 2011, Clean Energy financing at Asian Development Bank, Energy for Sustainable Development, 15(2): 195-99.

Eberhard, A., O. Rosnes, M. Shkaratan, and H. Vennemo, 2011, Africa's power infrastructure: Investment, integration, Efficiency, The World Bank, Washington D.C.

GEF, 2012, Behind the numbers: A closer look at GEF achievements, The Global Environment Facility, GEF Secretariat, Washington D.C.

Glemarec, Y., 2012, Financing off-grid sustainable energy access for the poor, Energy Policy, in press.

Gualberti, G., M. Bazilian, E. Haites, and MG Carvalho, 2012, Development finance for universal energy access, Fondazione ENI Enrico Mattei, Milan, Italy.

Lipp, J., 2001, Micro-financing solar power: The Sri Lankan SEEDs model, Refocus, October, pp. 18-21.

Mainali, B. And S. Silveira, 2011, Financing off-grid electrification: country case Nepal, Energy, 36(4): 2194-2201.

Moner-Girona, M., 2009, A new tailored scheme for the support of renewable energies in developing countries, Energy Policy, 37(5): 2037-41.

Monroy, CR and ASS Hernandez, 2005, Main issues concerning the financing and sustainability of electrification projects in rural areas: international survey results, Energy for Sustainable Development, 9(2):17-25.

Monroy, CR and ASS Hernandez, 2008, Strengthening financial innovation in energy supply projects for rural exploitations in developing countries, Renewable and Sustainable Energy Reviews, 12(7): 1928-43.

Morris, E. and G. Kirubi, 2009, Bringing small-scale finance to the poor for modern energy services: What is the role of government? Experiences from Burkina Faso, Kenya, Nepal and Tanzania. UNDP, New York, USA.

Morris, E., J. Winiecki, S. Chowdhary and K. Cortiglia, 2007, Using microfinance to expand access to energy services: Summary of findings, The SEEP Network, Washington, D.C, USA.

Ortiz, B., M. Vetter, S. Golz and G. Bopp, 2007, Concepts for hybrid PV village grids to make their operation a local business, 22nd European Photovoltaic Solar Energy Conference and Exhibition, 3-7 September, Milan, Italy.

Radulovic, V., 2005, Are new institutional economics enough? Promoting photovoltaics in India's agricultural sector, Energy Policy, 33, pp. 1883-99.

REN21, 2011, Renewables 2011: Global Status Report, REN21, REN21 Secretariat, Paris.

Rosnes, O. And H. Vennemo, 2008, Powering up: Costing Power Infrastructure Spending Needs in Sub-Saharan Africa, Background Paper 5, Africa Infrastructure Country Diagnostic, World Bank, Washington D.C.

Simon, G., AG Bumpus and P. Mann, 2012, Win-win scenarios at the Climate-Development interface: Challenges and opportunities for stove replacement programmes through carbon finance, Global Environmental Change, 22(1): 275-87.

Sonntag-O'Brien, V. and E. Usher, 2004, Mobilising finance for renewable energies, Thematic Background Paper 05, International Conference for Renewable Energies, Bonn 2004, Bonn, Germany.

Szabo, S., K. Bodis, T. Huld, and M. Moner-Girona, 2011, Energy solutions in rural Africa: mapping electrification costs of distributed solar and diesel generation versus grid extension, Environmental Research Letters, 6, pp. 1-9, IOP Publishing, U.K.

Tirpak, D. and H. Adams, 2008, Bilateral and multilateral financial assistance for the energy sector of developing countries, Climate Policy, 8(2):135-151.

UNDP, 2008, Financing options for renewable energy: Country experiences, UNDP Regional Centre in Bangkok, Thailand.

UNDP, 2009, Charting a new low-carbon route to development, United Nations Development Programme, New York.

UNDP, 2011, Towards an energy plus approach for the poor: A review of good practices and lessons learnt from Asia and the Pacific, UNDP, New York, USA.

UNEP, 2012, Financing renewable energy in developing countries: Drivers and barriers for private finance in Sub-saharan Africa, United Nations Environment Programme Finance Initiative, Geneva, Switzerland.

Wang, X., 1998, The best practices for off-grid solar energy: A case study on China, Yale University.

Woerlen, C., 2011, Meta-evaluation of climate mitigation evaluations, GEF Evaluations Office, Washington, D.C.

World Bank, 2008, Designing Sustainable Off-Grid Rural Electrification Projects: Principles, World Bank, Washington D.C., USA.

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Disclaimer

The views expressed in this report are those of the authors and do not necessarily represent the views of the institutions they are affiliated to or that of the funding agencies.

OASYS South Asia project

The Off-grid Access Systems for South Asia (or OASYS South Asia) is a research project funded by the Engineering and Physical Sciences Research Council of UK and the Department for International Development, UK. This research is investigating off-grid electrification in South Asia from a multi-dimensional perspective, considering techno-economic, governance, socio-political and environmental dimensions. A consortium of universities and research institutes led by De Montfort University (originally by University of Dundee until end of August 2012) is carrying out this research. The partner teams include Edinburgh Napier University, University of Manchester, the Energy and Resources Institute (TERI) and TERI University (India).

The project has carried out a detailed review of status of off-grid electrification in the region and around the world. It has also considered the financial challenges, participatory models and governance issues. Based on these, an edited book titled "Rural Electrification through Decentralised Off-grid Systems in Developing Countries" was published in 2013 (Springer-Verlag, UK). As opposed to individual systems for off-grid electrification, such as solar home systems, the research under this project is focusing on enabling income generating activities through electrification and accordingly, investing decentralised mini-grids as a solution. Various local level solutions for the region have been looked into, including husk-based power, micro-hydro, solar PV-based mini-grids and hybrid systems. The project is also carrying out demonstration projects using alternative business models (community-based, private led and local government led) and technologies to develop a better understanding of the challenges. It is also looking at replication and scale-up challenges and options and will provide policy recommendations based on the research.

More details about the project and its outputs can be obtained from www.oasyssouthasia.dmu.ac.uk or by contacting the principal investigator Prof. Subhes Bhattacharyya (subhesb@dmu.ac.uk).

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