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Informing the Financing of Universal Energy Access: An Assessment of Current Flows

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Summary

Energy poverty is widely recognized as a major obstacle to economic and social development and poverty alleviation. To help inform the design of appropriate and effective policies to reduce energy poverty, we present a brief analysis of the current macro financial flows in the electricity and gas distribution sectors in developing countries. We build on the methodology used to quantify the flows of investment in the climate change area. This methodology relies on national gross fixed capital formation, overseas development assistance, and foreign direct investment. These high-level and aggregated investment figures provide a sense of scale to policy-makers, but are only a small part of the information required to design financial vehicles. In addition, these figures tend to mask numerous variations between sectors and countries, as well as trends and other temporal fluctuations. Nonetheless, for the poorest countries, one can conclude that the current flows are considerably short (at least five times) of what will be required to provide a basic level of access to clean, modern energy services to the “energy poor”.

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Abstract: Energy poverty is widely recognized as a major obstacle to economic and social development and poverty alleviation. To help inform the design of appropriate and effective policies to reduce energy poverty, we present a brief analysis of the current macro financial flows in the electricity and gas distribution sectors in developing countries. We build on the methodology used to quantify the flows of investment in the climate change area. This methodology relies on national gross fixed capital formation, overseas development assistance, and foreign direct investment. These high-level and aggregated investment figures provide a sense of scale to policy-makers, but are only a small part of the information required to design financial vehicles. In addition, these figures tend to mask numerous variations between sectors and countries, as well as trends and other temporal fluctuations. Nonetheless, for the poorest countries, one can conclude that the current flows are considerably short (at least five times) of what will be required to provide a basic level of access to clean, modern energy services to the “energy poor”.

1. Introduction

Large investments will be required to address the massive expected energy demand growth in developing countries while also providing full access to energy services. To inform the design of policy tools to incentivize greater financial flows into expanding access, we focus on the macro financial flows in the energy sector (primarily infrastructure investment in the power and gas distribution sectors) in developing countries. We then briefly consider the relationship of these flows to the issue of energy poverty (see IEA, 2010; Bazilian et al., 2010). We find that the financial flows related to the energy sector in developing countries are significant, but still inadequate to the task of delivering energy access to those who lack it. Ultimately, this research is presented to inform future more detailed analysis.

We build on the methodology devised to quantify the flows of investment in the climate change area (UNFCCC, 2007). This methodology relies on national gross fixed capital formation, overseas development assistance, and foreign direct investment. We begin by providing a sense of scale by considering recent and ‘iconic’ investment figures in the policy realm in section 2. We describe the methodology applied to estimate the financial flows in the energy sector in Section 3. In section 4, we present past trends. We then discuss some links with energy poverty in section 5. Section 6 outlines further work required to advance this research agenda.

2. ‘Beautiful Numbers’

Several iconic investment figures are informing policy decisions related to international energy and climate change policy. High-level aggregated figures like these are important to provide a general sense of scale. However, these ‘beautiful numbers’ are difficult to compare and thus often confuse ongoing discussions. Figure 1 depicts ten such global investment figures, ranging from present energy investments (on the left), to projections of future energy infrastructure investment, to estimates of the cost of delivering universal energy access and of meeting global climate change goals. We briefly consider these figures in order to provide additional transparency and clarity, and to help frame our financial flows analysis. The figure presents the power sector aspect of each analysis as this sector is closest to the data sets that we explore for financial flows¹.

¹ To provide a climate perspective, The Stern Review (2006) estimated that approximately one percent of global GDP will be needed to limit atmospheric CO₂ concentrations to 500-550PPM through 2050. We used IMF calculations for GDP growth to 2016 using current US dollars and extrapolated through 2035 to match IEA and other data; the

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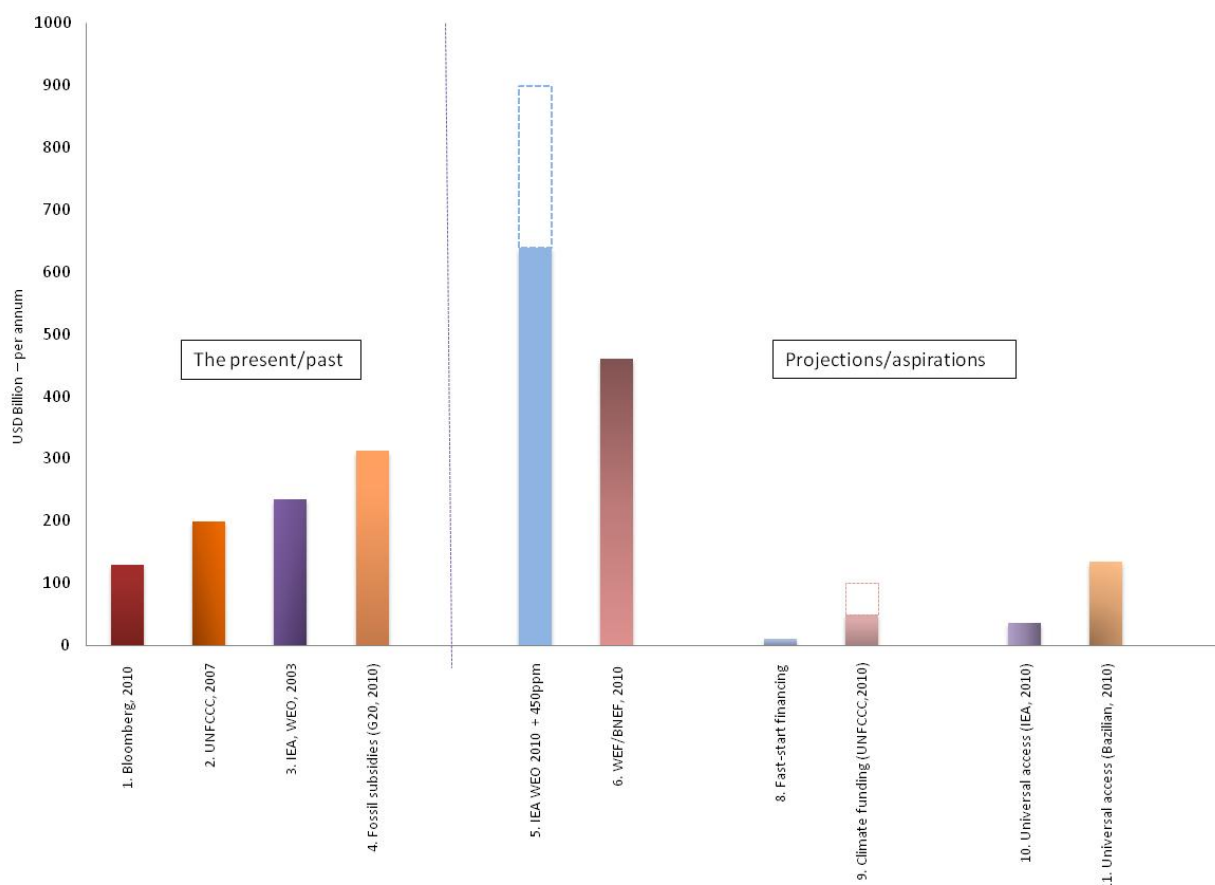


Figure 1: ‘Beautiful numbers’ in the energy and climate space. (Bar 1: New investment in renewable energy globally in 2009 amounted to USD 162 billion (UNEP, SEFI, and BNEF, 2010), including R&D and biofuels. The figure most closely related to the data on financial flows in the power sector is likely that of asset finance of new, utility-scale renewable energy projects. This was estimated at USD 100.9 billion in 2009. Bar 2: Global investment in electricity, gas distribution, and water supply in 2000 totaled USD 257 billion, of which USD 52 billion and USD 2.3 billion was invested in non-Annex I² and Least Developed Countries (LDC) (UNFCCC, 2007), respectively. We use a figure of USD 216 billion in the chart which (approximately) removes the water supply element from the total. Bar 3: IEA (2003) estimated investment in energy globally in 2000 at USD 431 billion for energy, including USD 235 billion for electricity. Bar 4: Fossil fuel subsidies were calculated to be USD 312 billion (G20, 2010)³. This estimate uses 2009 prices and thus differs from 2008 estimates of USD 558 billion (G20, 2010). The figure is USD 95 billion for electricity subsidies. Bar 5: Looking to the future, IEA (2010) projects the investment cost for energy supply infrastructure between 2010 and 2035 to be USD 32,816 billion globally under its “New Policy Scenario”⁴. To that, a further USD 13,500 billion would be needed for strong climate mitigation. For electricity alone, USD 16,606 billion is expected to be needed globally, with USD 6,477 billion in OECD and USD 10,130 billion and non-OECD countries. For the purposes of this graph we have simply converted these numbers to annual figures by averaging them across the

cumulative GDP for 2010-2035, inclusive, was USD 5,316 trillion, which is about USD 2,126 billion per year over the time frame. (No discounting was used.)

² Refers to countries that are Parties to the Kyoto Protocol but are not listed in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC)

³ The price-gap approach is the most common method for quantifying consumer subsidies. It captures the net effect of all subsidies that reduce final prices below those that would prevail in a competitive market. Estimates produced using the price-gap approach do not capture all types of intervention known to exist. They, therefore, tend to be understated as a basis for assessing the impact of subsidies on economic efficiency and trade. The method does not take account of revenue losses in countries where under-collection of energy bills (particularly for electricity) is prevalent, or where energy theft is rife (Koplow, 2009)

⁴ Generally, IEA’s New Policy Scenario assumes the introduction of new measures to implement the broad policy commitments that have already been announced.

time period⁵. Bar 6: The WEF/BNEF figures reflect future projections to 2030 for clean energy minus the projections for biofuels (See WEF, 2010 – Figure 4). Bars 7 and 8: The promised fast-start financing under the Copenhagen Accord represents USD 10 billion annually between 2010 and 2012. Further, developed country Parties committed to a goal of mobilizing jointly USD 100 billion per year by 2020 to address the needs of developing countries. (Roughly half that amount would go to adaptation). Bars 9 and 10: IEA, UNDP, and UNIDO (2010) estimate the cost of universal energy access at USD 756 billion between 2010 and 2035, whereas Bazilian et al. (2010) find a cumulative USD 1,500 billion to 2030 in their ‘high’ scenario. Again, both figures are averaged over the period to present annual figures.

These figures, as valuable as they might be, are difficult to interpret and compare for a number of reasons, including:

- different methodologies employed
- different country coverage
- different definitions for investments or flows
- different sectors covered
- different end years for analysis
- averages vs. individual years
- actual vs. projections

What is clear, however, is that current estimates of the investments required to provide universal access to energy services are considerably lower than projected investments in the energy sector in general or the estimated need for additional investment in ambitious climate change mitigation scenarios.

3. Methodology

There is an extensive literature on international financial flows to developing countries, mostly going beyond the core of this analysis (see e.g., Albuquerque, 2003; Asiedu, 2002; Bahmani-Oskooee, 1986; Barnett, 1993; Bird, 1981; Claessens and Schmukler, 2007; Fung, 2009; Gelos, Sahay, and Sandleris, 2011; Kasuga, 2007; Kim, 2000; Kinda, 2010; Knight, 1998; Laureti and Postiglione, 2005; McGillivray, 1989; Mishkin, 2009; Mody and Murshid, 2005; Munduch and Weinberg, 1979; Noorbakhsh, Paloni, and Youssef, 2001; Odedokun, 1996; Rao, 1997; Sadik and Bolbol, 2001; Singh and Zammit, 2000; Steel et al., 1997).

Data on current financial flows to the energy sector generally stem from either aggregated global or regional estimates, or scattered and un-processed datasets (Olbrisch et al., 2011). The principal obstacle in this analysis stems from data paucity, particularly in the case of developing and least developed countries (LDC). In particular, there is no comprehensive assessment of the current financial flows to address energy poverty. We utilise various sources to help address this analytical gap.

We focus on electricity production and gas distribution, which represents one of the dozen or so other sectors detailed in financial flow data sets⁶. Still, resource-rich developing countries are also the target of growing investments in the upstream energy sector of oil, coal and gas extraction and processing (see Section 3.2.1)⁷. These investments are targeted mainly to the export sector and are not directly linked with the energy access infrastructure, thus they are not considered in this analysis⁸.

⁵ This is a highly simplistic way to come to such average figures, but often the presentation of the figures precludes other methods.

⁶ The sub-sectors vary by dataset. They typically include, agriculture, hunting, forestry, fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; transport, storage and communication; financial intermediation, real estate, renting and business activities; wholesale retail trade, repair of motor vehicles, motorcycles, etc, hotels and restaurants; public administration and defence, compulsory social security; education, health and social work, other community, social and personal services; and dwellings

⁷ There is a wide literature on the relation between extractive industries and poverty reduction with a particular relevance of the Extractive Industries Review process of the World Bank (Salim, 2003; World Bank, 2004; Pegg, 2006).

⁸ On the specific topic of energy poverty in resource-rich countries, the WEO 2008 analyses ten Sub-Saharan oil exporting countries and concludes that the total additional cost of universal access to electricity and clean cooking stoves would be just 0.4% of the oil intake by the governments from 2006 to 2030 (IEA, 2008).

We draw heavily on the precedent created to evaluate the investment and financial flows in the climate change space, notably the methodology applied in UNFCCC (2007). We complement the existing literature by:

- Increasing the granularity in terms of geographical coverage and providing data at the national level for energy investments
- Refining existing estimates with additional information from various complementary sources
- Providing an update on the existing figures by using the most recent available datasets

3.1. Flows considered

Our estimates are based on data for a number of complementary flows: Gross Fixed Capital Formation⁹ (GFCF), Foreign Direct Investments¹⁰ (FDI), and Official Development Finance¹¹ (ODF). (Annex 1 provides detailed national energy-related GFCF accounts. Annex 2 provides supplementary information with regard to energy investments in the Clean Development Mechanism (CDM), merely as a point of comparison.) Table 1 presents a general overview of the financial flows considered in this analysis. GFCF represents the total investment flow. We include FDI and ODF to add richness to the analysis.¹²

Table 1: Overview of investment flow data¹³

Type of flow	Data source	Remark
Total		
GFCF	UNSTAT ¹⁴ and WDI ¹⁵	data include water
International		
FDI	UNCTAD	data include water
ODF	AidData ¹⁶	

National and international statistics offices do not generally record the yearly amount of domestic and international finance directed at the energy sector; available data thus present severe limitations. We apply basic statistical tools to estimate missing values, and employ several techniques to treat the available data. The section below provides a detailed overview of the data treatment for each flow. All data are converted

⁹ ‘Gross fixed capital formation is measured by the total value of a producer’s acquisitions, less disposals, of fixed assets during the accounting period plus certain specified expenditure on services that adds to the value of non-produced assets’. Source: EU, IMF, OECD, UN, and WB (2009, p.198)

¹⁰ ‘For associates and subsidiaries, FDI flows consist of the net sales of shares and loans (including non-cash acquisitions made against equipment, manufacturing rights, etc.) to the parent company plus the parent firm’s share of the affiliate’s reinvested earnings plus total net intra-company loans (short- and long-term) provided by the parent company. For branches, FDI flows consist of the increase in reinvested earnings plus the net increase in funds received from the foreign direct investor. FDI flows with a negative sign (reverse flows) indicate that at least one of the components in the above definition is negative and not offset by positive amounts of the remaining components’. Source: (UNCTAD)

¹¹ Official Development Finance data include: a) bilateral ODA; b) grants and concessional and non-concessional development lending by multilateral financial institutions; and c) those other official flows which are considered developmental but which have too low a grant element to qualify as ODA’. Source: OECD (2010a, p. 274)

¹² International debt is another source of financing for governments and corporations beyond FDI and ODF. The Bank for International Settlements (BIS) records the debt issued in 40 main lending countries. Unfortunately, it is impossible to distinguish the economic sector in which borrowed money is spent based on the datasets available. International debt is therefore not included explicitly in this analysis.

¹³ UNFCCC (2007) also includes international debt as a source of financing for the energy, gas and water sector and an estimation of the source of the investment (households, corporations, government) for the total of all sectors (tables IV-8 and III-2, respectively). These data are the results of an economic model built for the year 2000. We estimate GFCF as a time series to obtain insights on trends.

¹⁴ UNSD (n.d.)

¹⁵ WB (n.d.)

¹⁶ Findley et al. (2010)

into USD 2000 using GDP deflators and exchange rates¹⁷. We focus on the timeframe 2000–2009, and utilise data from project level databases (ODF and Private Participation in Infrastructure database¹⁸ (PPI)) and data from National Accounts (GFCF and FDI). We recognize that investment decisions in the project level database may not reflect immediately in the national accounts, or may generate multi-year flows.

3.1.1. GFCF

GFCF data are aggregated for specific sectors and/or for the entire economy. Here we are interested in the *electricity, gas distribution and water supply*, for which data are available only for selected countries¹⁹. For the countries with incomplete time series for this sector, we use the average national share from the years for which data is available and compute the missing ones based on the total GFCF for years where it is not. Where sector-specific data are missing altogether, we use a weighted average share of GFCF for electricity, gas distribution and water supply over the total (3.8% and 8.1% for OECD and non-OECD, respectively) and compute it as a best approximation for the missing national data²⁰. It is important to note that that GFCF data are based on national accounts' definitions of sectors, and therefore *electricity, gas distribution and water* are included in the same sector. Comprehensive datasets distinguishing the *water* component from *electricity and gas distribution* do not exist. We exclude the water component by subtracting it from the total based on the ratios²¹ available in UNFCCC (2007), which are based on OECD data.

Various investments in coal, oil and gas production, processing and transportation facilities are spread across other sectors in the national accounts - mining and quarrying, industry, and transportation etc - which also include other facilities. Therefore, compiling data on investment in coal, oil, and gas supply from national accounts is challenging. Also, the extractive sectors are often export-oriented, and the link with national energy access is therefore weaker. Nonetheless, cumulative investment in coal, oil and gas is roughly equivalent to power sector investment (see e.g., IEA, 2010). Finally, we have excluded a number of countries or sub-national entities²² from the analysis for various reasons (e.g. statistical anomalies, lack of data).

3.1.2. FDI

FDI data are available in aggregate and by sector, including for *electricity, gas distribution and water*. We only consider FDI inflows, as our interest lies in the investments in particular countries²³. In general, the datasets are relatively 'patchy'. Rather than trying to extrapolate the figures based on bold assumptions to

¹⁷ Data source: (WB)

¹⁸ Although the PPI database presents many project level details for the investments with private participation from international and domestic investors, the data do not precisely match the definition of Foreign Direct Investments, even if accounting only for the international part of the investments as we did. In particular, dis-investments, reinvested earnings (or repatriation of profits) and intra-company loans (positives or negatives) are not recorded and PPI, despite the obvious overlap with FDI data, cannot substitute it. The PPI data has been therefore used only to compare the share of water investments on the total energy plus water investment, a detail that is not included in the FDI statistics. The overall value of foreign investments recorded by the PPI for the period 2000–2008 for developing countries is 72% of the value recorded by FDI statistics. National shares may vary.

¹⁹ Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Botswana, Canada, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Iraq, Ireland, Israel, Italy, Jordan, Kenya, Republic of Korea, Kuwait, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Macao SAR, Macedonia, Malta, Mauritius, Namibia, Netherlands, Netherlands Antilles, New Zealand, Niger, Norway, Pakistan, Poland, Portugal, Qatar, Slovakia, Slovenia, South Africa, Spain, Sudan, Sweden, Syrian Arab Republic, Trinidad and Tobago, Tunisia, Ukraine, United Arab Emirates, United States, and Yemen.

²⁰ In a few cases and for selected years (Andorra, Bermuda, Burundi, Channel Islands, Greenland, Guinea-Bissau, Haiti, Isle of Man, Kiribati, Liechtenstein, Maldives, Marshall Islands, Micronesia, Monaco, Palau, Samoa, San Marino, Solomon Island, Suriname, Tanzania, Timor-Leste, Netherland Antilles, West Bank and Gaza) where the total GFCF data is missing, we estimate it using a weighted share of GFCF for electricity, gas distribution and water over GDP (0.8% and 2.5% for OECD and non-OECD, respectively).

²¹ Electricity: 77%; Gas distribution: 7%; and Water: 16%

²² Afghanistan, American Samoa, Cayman Islands, Democratic Republic of Korea, Faeroe Islands, Gibraltar, Guam, Mayotte, Myanmar, Northern Mariana Islands, Puerto Rico, Sao Tome and Principe, Somalia, Turks and Caicos Islands, Tuvalu, Sudan, and Virgin Islands (U.S.).

²³ FDI is an important factor for growth in developing countries as it brings about skills, know-how and market access (UNIDO, 2007).

cover for the missing data, we focus our analysis on a subset of countries for which the data is available²⁴. Thus we do not present an aggregated time-series, as we do for GFCF and ODF.

We use a complementary database, the Private Participation in Infrastructure Database²⁵ which collects data separately for projects in the *energy* and *water* sectors, to evaluate the proportion of investment in each of energy and water, which we then apply to isolate the water component. We find that at the global level, between 2000 and 2008, the investment in the water sector was approximately 10% of the total, although national shares can differ significantly. Unfortunately, UNCTAD does not differentiate between ‘greenfield’ and mergers and acquisitions flows; in other words, there is no means to distinguish between investments in new projects and financial transactions not leading to additional assets.

3.1.3. ODF

Official Development Finance data is available for the energy sector and its sub-components, including energy policy, renewable sources, non-renewable sources, and others. The source used, AidData (Findley et al., 2010), contains all the data included in the Creditor Reporting System (CRS) database of the OECD and adds greater coverage of multilateral organizations and of non-OECD donors²⁶. We include only projects related to the energy sector, following the methodology applied in OECD (2010)²⁷, and exclude refinancing loans. It must be noted that ODF (or ODA) are commitments proclaimed by the donors, not actual flows.²⁸

4. Financing energy: past trends

Financing for the energy sector is obviously contingent on trends in overall capital flows. The recent financial crisis affected developing countries in a number of ways. Notably, it hurt export revenues, caused remittances to decline, and ODA is likely to further suffer from the retrenchment of donor countries (UN 2011). While we focus on GFCF, Foreign Direct Investment, and Official Development Finance, other capital flows, in particular portfolio investments (debt and equity) and short and long-term private bank lending will provide additional finance to the energy sector.

4.1. Gross Fixed Capital Formation

To provide a sense of scale, it is useful to consider energy-related investment in relation to global investment. The share of GFCF for energy represented 2.8% of the total in 2000, with the largest shares being wholesale retail trade (34%), manufacturing (17%), and construction (11%)²⁹.

Global GFCF for electricity and gas distribution has been rising steadily throughout the past decade, with the notable exception of 2009 (Table 2). At the regional level, the trends are similar, although not quite as clear-cut. GFCF for electricity and gas distribution in the OECD was stagnant or decreasing between 2000 and 2005, before picking up sharply. In the LDCs, GFCF in electricity and gas distribution has doubled in a decade, although the absolute value remains low.

²⁴ It is likely that some GFCF will occur every year in the electricity, gas distribution and water sector in a country, so estimating data for years with missing data using data for the other years appears as a reasonable assumption. However, when extrapolating figures for FDI, no inward FDI in the electricity, gas distribution and water sector is possible. Thus, estimating values for the years with zero inward FDI from data for the other years could then be incorrect and misleading.

²⁵ WB (n.d.)

²⁶ The average yearly sum of ODF commitments for the energy sector of LDCs recorded in the CRS database is 2.1% inferior of the same data selection in AidData.org database. If we consider all recipients, CRS present on average a yearly total 22.8% lower than AidData.

²⁷ ODF data is coded under CRS purpose codes. We have included in our analysis the following sub sectors and codes: 23010 Energy policy and administrative management; 23020 Power generation, non-renewable sources; 23050 Gas distribution; 23061 Oil-fired power plants; 23062 Gas-fired power plants; 23063 Coal-fired power plants; 23030 Power generation/renewable sources; 23040 Electrical transmission/distribution; 23065 Hydro-electric power plants; 23066 Geothermal energy; 23067 Solar energy; 23068 Wind owe; 23069 Ocean power; 23070 Biomass; 23064 Nuclear power plants; 23081 Energy education/training; 23082 Energy research.

²⁸ Disbursements are recorded only for a part (around half) of the records. For the projects for which both data exist, recorded disbursements are in average 30% inferior to commitments.

²⁹ Data from UNFCCC (2007, p. 33)

Table 2: Overview of GFCF for electricity and gas distribution (USD billion) constant 2000 prices

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009 ³⁰
OECD	179.1	183.0	175.1	174.3	168.3	173.3	191.8	211.6	222.7	172.2
Non-OECD ³¹	53.5	58.3	60.1	71.2	77.0	84.8	98.1	123.4	153.4	144.5
LDC	1.3	1.4	1.6	1.6	1.7	1.9	2.0	2.3	2.5	2.6
Global	232.6	241.3	235.2	245.5	245.3	258.1	289.9	335.0	376.1	316.6

By means of comparison, IEA (2003) estimated the world investment in electricity and gas³² in 2000 at USD 315 billion. UNFCCC (2007) estimated, based on UNCTAD and OECD data, the investment in electricity and gas distribution reaching USD 216 billion in 2000. Eberhard et al. (2011) also provide very useful analysis on investment in 24 countries of sub-Saharan Africa (SSA)³³.

Figure 2 shows the relative evolution in energy-related GFCF in selected³⁴ developing countries. The country datasets are normalized in 2000 to reveal the trends in the recent years. The curves for Namibia and, to a lesser extent, Armenia, urge for caution in interpreting the data, since the flows are subject to significant fluctuations, particularly if they are relatively small in absolute terms. Also, wide variations urge for caution in the interpretation of the datasets.

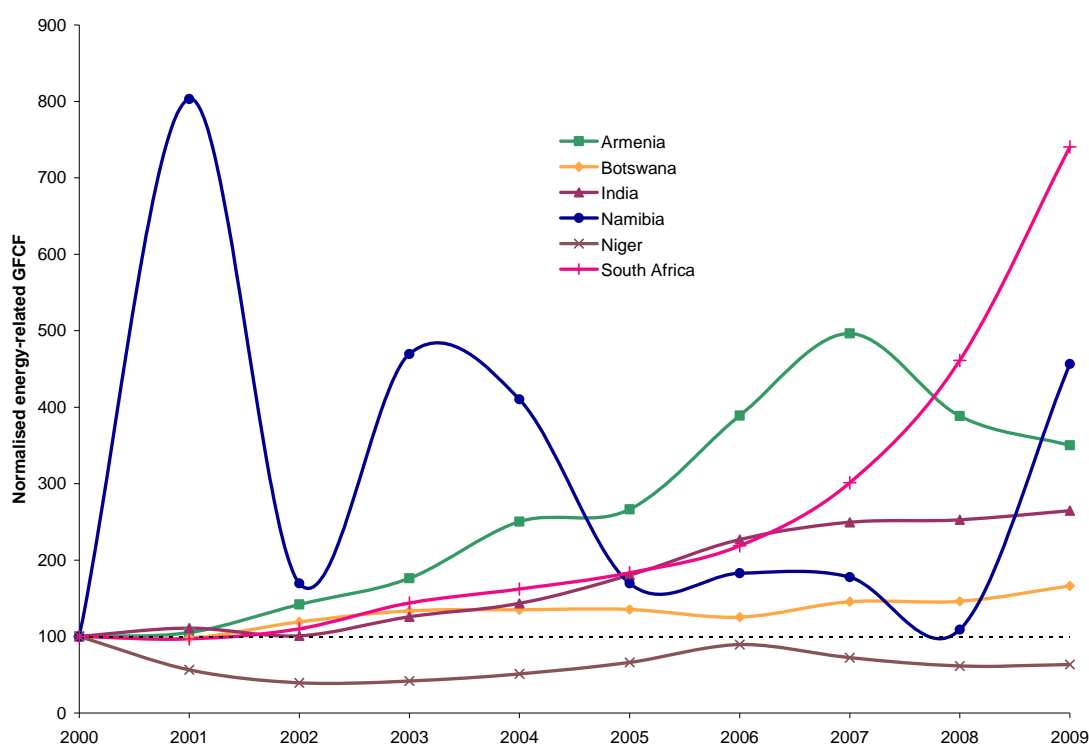


Figure 2: Relative trend in energy-related GFCF in selected developing countries [constant 2000 USD]

³⁰ Incomplete; the sharp decrease is due to the economic crisis as well as to the fact that the dataset is incomplete at the date of writing

³¹ This row includes the LDC figures

³² Includes not only distribution, but also exploration and development, liquefied natural gas facilities, transmission pipelines, and underground storage facilities.

³³ Table A7.1 of Eberhard et al. (2011) estimate a yearly average capital expenditure of 2.2 billion (USD current, for the period 2001-2005, excluding Nigeria). As a comparison, for the same years and countries our estimation is 2.1 billion (USD 2000 constant) with the water sector, and 1.8 billion excluding it.

³⁴ The countries highlighted in Figures 2 and 3 were selected to provide illustrative examples of various trends, they are not necessarily a representative sample.

This notwithstanding, the analysis indicates a clear positive trend overall. That being noted, the rate of increase varies greatly between the countries (+60% and +160% for Botswana and India, respectively, over 10 years). Interestingly, the trend is in some cases negative, like in the instance of Niger. Noteworthy is also the case of South Africa, where energy-related GFCF increased exponentially in recent years. Incidentally, South Africa is one of the often-quoted success stories with regard to rapidly increasing the rate of access to electricity.

4.2. Foreign Direct Investment

Electricity, gas and water represents one of 15 sub-sectors in FDI data sets, including, *inter alia*, financial intermediation; paper and paper products; food beverage and tobacco. As noted, because of the difficulty in the robustness of the FDI data sets, we do not present a time-series of aggregated figures. However, as an example, we estimated the total 2000 flows to be 30 USD billion³⁵. Foreign direct investment grew steadily for developed and developing economies over recent years until the global financial crisis of 2008. The effect of the crisis on FDI was evident in 2009, and was more pronounced in richer nations than for developing economies. About half of global FDI inflows now go to developing countries and transition economies (UNCTAD, 2010). While the overall trends for FDI inflows in LDCs have been on the rise for the last decade (UNCTAD, 2011), our analysis shows a downward tendency for energy-related³⁶ FDI inflows in those countries (see Figure 3 for several examples).

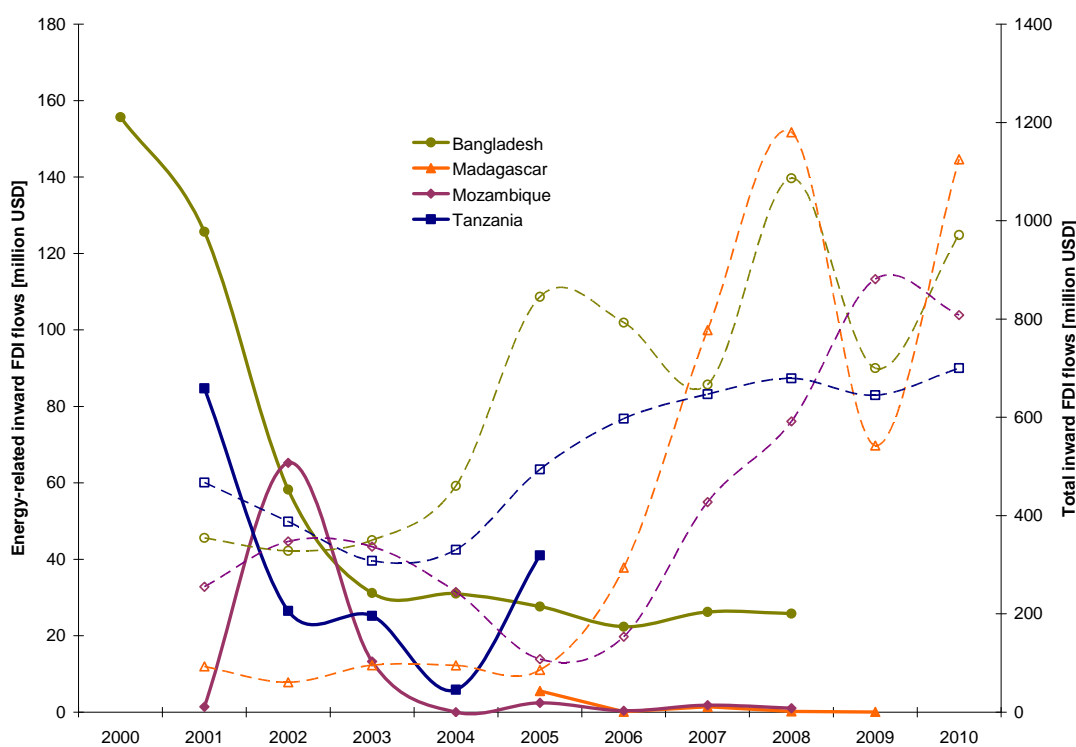


Figure 3: Energy-related (plain lines) and total (dotted lines) inward FDI flows for selected LDC countries (constant 2000 USD)

Providing insights on trends by region over time is challenging given the data paucity; no clear pattern can be derived from an analysis across developing countries, as the energy-related FDI inflows vary widely between the years. Indeed, the flows have little “inertia” and are strongly influenced by individual projects.

4.3. Official Development Finance

Aid for energy has been part of bilateral and multilateral aid effort for many years. Its level was relatively constant in the 1980’s before decreasing deeply the following decade and reaching a minimum around the year 2000; it has been on the rise again since (see Figure 4). For the years 2000-2008, the categories that

³⁵ UNFCCC (2007) shows that figure as USD 27 billion.

³⁶ Based on available PPI data, the share of water is negligible for the 4 countries assessed

received the bulk of the energy related development finance were *Energy Policy*³⁷ (35%), followed by *Electrical Transmission* (26%), and *non-Renewable Energy* (17%).

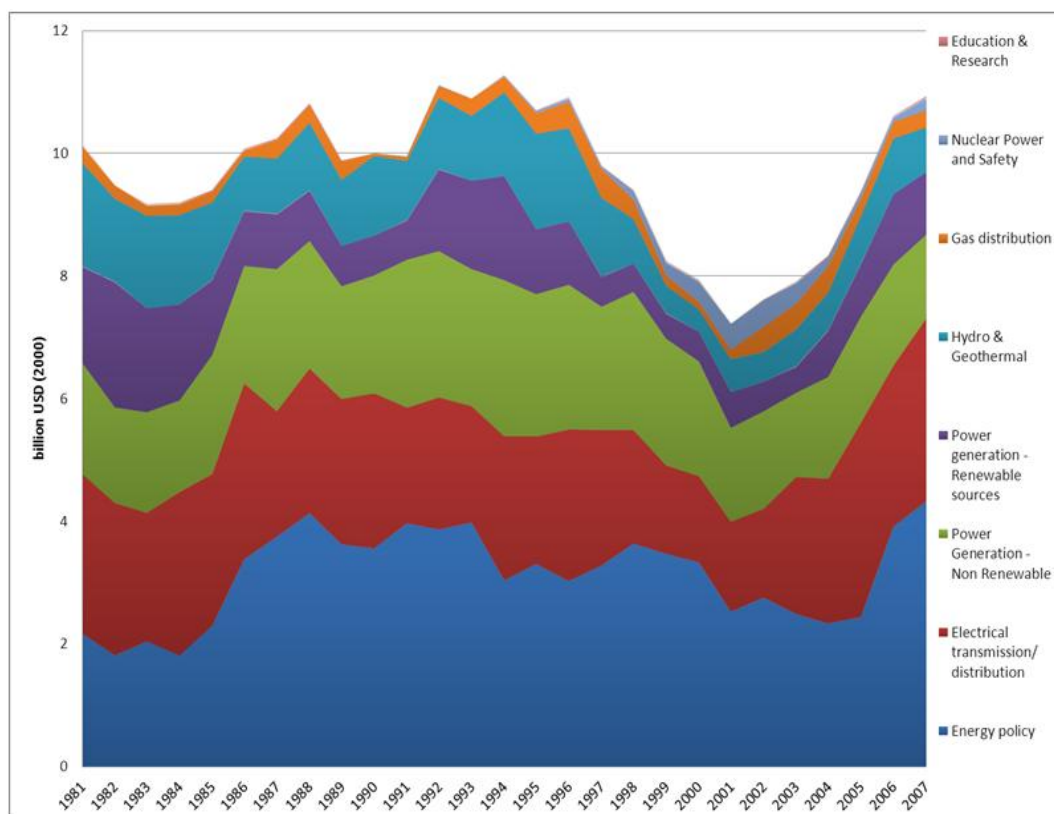


Figure 4: Development Finance for the Energy Sector by purpose; commitments, 1980-2008, using 3-year moving averages [constant 2000 USD].

There has been an almost continuous increase in electricity-related ODF in non-OECD countries during recent years. However, ODF to LDCs has varied widely over the years; it is nonetheless also on an increasing trend (Table 3).

Table 3: Overview of ODF for energy generation and supply (USD billion, constant 2000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
LDC	0.74	1.11	0.87	0.88	0.81	1.34	0.72	1.84	1.56
Other non-OECD	5.63	7.60	7.33	7.51	8.43	8.58	10.02	12.15	9.07
Global	6.44	7.80	7.48	7.56	8.69	8.72	10.73	12.40	9.67

4.4. Relationship between GFCF, FDI, and ODA/F

A number of scholars have looked into the relationship between ODA/F, FDI and GFCF. Obviously, the effect of FDI on capital formation largely depends on whether FDI is directed to ‘greenfield’ projects as opposed to cross-border Mergers and Acquisitions. Several authors have investigated the relation between FDIs and Official Development Assistance. UNCTAD notes that, especially in Least Developed Countries, FDIs tend to concentrate on the primary sector (mining) until a sufficient level of capability and infrastructure are built. In this context LDCs could leverage ODA for improving the conditions in their respective economies to attract more FDI and enhance their impact (UNCTAD 2010, 62).

³⁷ Includes: Energy sector policy, planning and programmes; aid to energy ministries; institution capacity building and advice; unspecified energy activities including energy conservation

While empirically examining FDI and GFCF for the economies in transition, Krkoska (2001) found that a 1% increase in FDI flows translated into 0.7% increase of GFCF in the recipient country. FDI represented an average 15% of the Gross Fixed Capital Formation (UNCTAD, 2010), but its share can be higher for some developing countries (the average for African countries is above 20%). The relationship between ODA/F and gross fixed capital formation is much more ambiguous. First, ODA/F can finance a variety of activities that do not necessarily translate into any increase of fixed assets. Secondly, ODA/F statistics measure the declarations of the donor countries rather than actual flows (both for commitments and for disbursements). During the last couple of decades, FDI increased whilst ODA decreased in 13 LDCs (UNCTAD, 2011).

While still below the level of ODA flows, FDI inflows for energy appear to have represented the major external private capital flows for LDCs in the past decade (UNCTAD, 2011). Our analysis suggests that more than one third of the energy-related investment in LDCs stems from foreign sources, mainly from ODF. Although that share is high, the flow in absolute terms remains low (about 1/10th with respect to other non-OECD countries, or 4% of the estimated world total) compared to other groups of countries.

5. Energy Poverty

Our interest in exploring macro financial flows is to set a context for finance for energy access. Energy poverty, the lack of access to modern, reliable and affordable energy services, affects billions of people. More than a fifth of the world's population does not benefit from access to electricity. It is well recognized that energy is a necessary ingredient for human development and the achievement of the Millennium Development Goals (Modi et al., 2005). Projections indicate that these issues will persist or worsen in the foreseeable future without dedicated action (IEA, UNDP and UNIDO, 2010).

In 2010 the UN Secretary General's Advisory Group on Energy and Climate Change (AGECC) suggested two bold, yet achievable global objectives, one of which urges the international community to work towards achieving universal energy access by 2030 (AGECC, 2010). While, at the regional, national, and local levels, significant efforts are underway to address the lack of energy access, the issue of "unlocking" the requisite financing is paramount.

5.1. Energy inequality

Poor data make it extremely difficult to determine the fraction of energy-related investment that goes to expanding access rather than to, say, increasing generation. One approach to better understanding the relationship between overall investment in expansion of access is to develop Lorenz curves and Gini coefficients, which are widely used in economics to estimate income inequality (Gastwirth and Glauber, 1976). These metrics can help to estimate distributions of energy consumption. The Lorenz curve is a ranked distribution of the cumulative percentage of the population of recipients plotted against the cumulative percentage of the resource distributed. The Gini coefficient is a numeric measure of inequality that reveals the difference between a uniform distribution and the actual distribution of a resource³⁸.

Figure 5 shows the Lorenz curves and energy Gini coefficients (inset) for five countries computed by Jacobson et al. (2005). The curve for Kenya, where energy access is most inequitable (and where grid-based energy access is lowest at ~ 20% of the population) highlights the differences in services and consumption in nations with large fractions of the population using biomass as their primary means of energy. We can postulate that, *ceteris paribus*, increased investment in energy will benefit the poor most strongly in cases where electricity consumption is relatively equitable. Unfortunately, those countries with the worst energy access problems are usually among those with the most inequitable access to energy (cf Kenya in Figure 5).

³⁸ The greater the distance this curve is from the diagonal line extending from the origin to the point with coordinates $x=1$ (or 100%), $y = 1$ (or 100%), the greater the inequality in energy consumption. It is calculated from the Lorenz curve by taking the ratio between (a) the portion of the area enclosed by the diagonal line and the Lorenz curve and (b) the total area under the diagonal line of uniform distribution. The Gini coefficient ranges from perfect equity among all members of the population ($G=0$) to complete inequity ($G=1$). As more than one Lorenz distribution of a resource can lead to the same Gini value, it is often instrumental to view both metrics simultaneously.

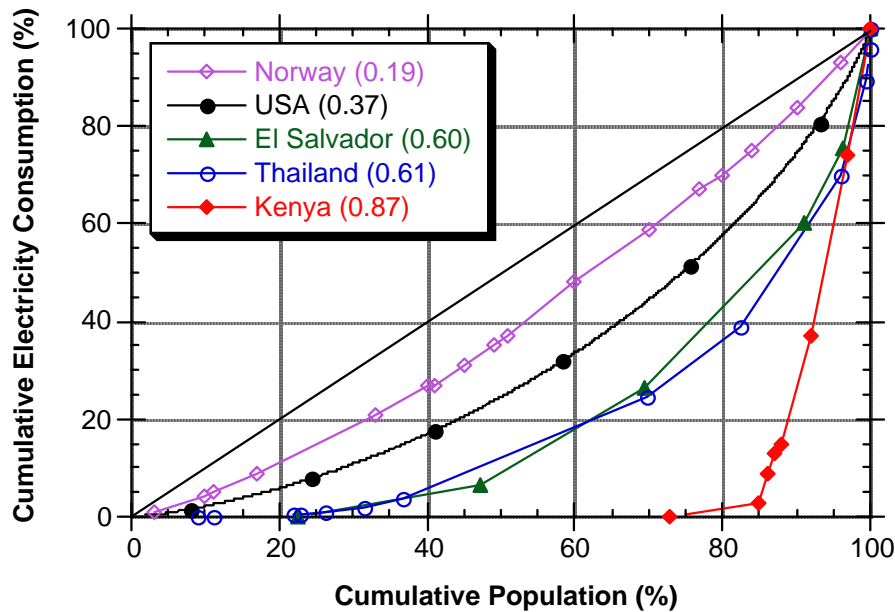


Figure 5: Lorenz curves for residential electricity in five countries. The Gini coefficients for residential electricity consumption presented in the legend of the graph (in parenthesis) provide a single quantitative measure of the distribution of consumption across the population for the respective countries (Jacobson et al., 2005).

An important aspect of any energy access program is thus to examine, address, and plan for the differences in not only total funding needed, but also in approaches for populations that have and do not readily have access to on-grid energy. In the case of Kenya, for example, grid extension, mini-grids, and off grid lighting options are all important technologies to examine, which in turn changes the funding needs to provide modern energy services. Further work in this area is now underway.

5.2. Energy poverty vs. investment in energy

There does not appear to be a distinguishable relationship between investment in energy infrastructure and degree of energy poverty (see Figure 6). While GFCF appears to be positively correlated with the total number of people without access to electricity, that correlation disappears once one controls for total population. (For Figures 6 and 7, we selected the LDC countries for which we had the most confidence in the national data sets)

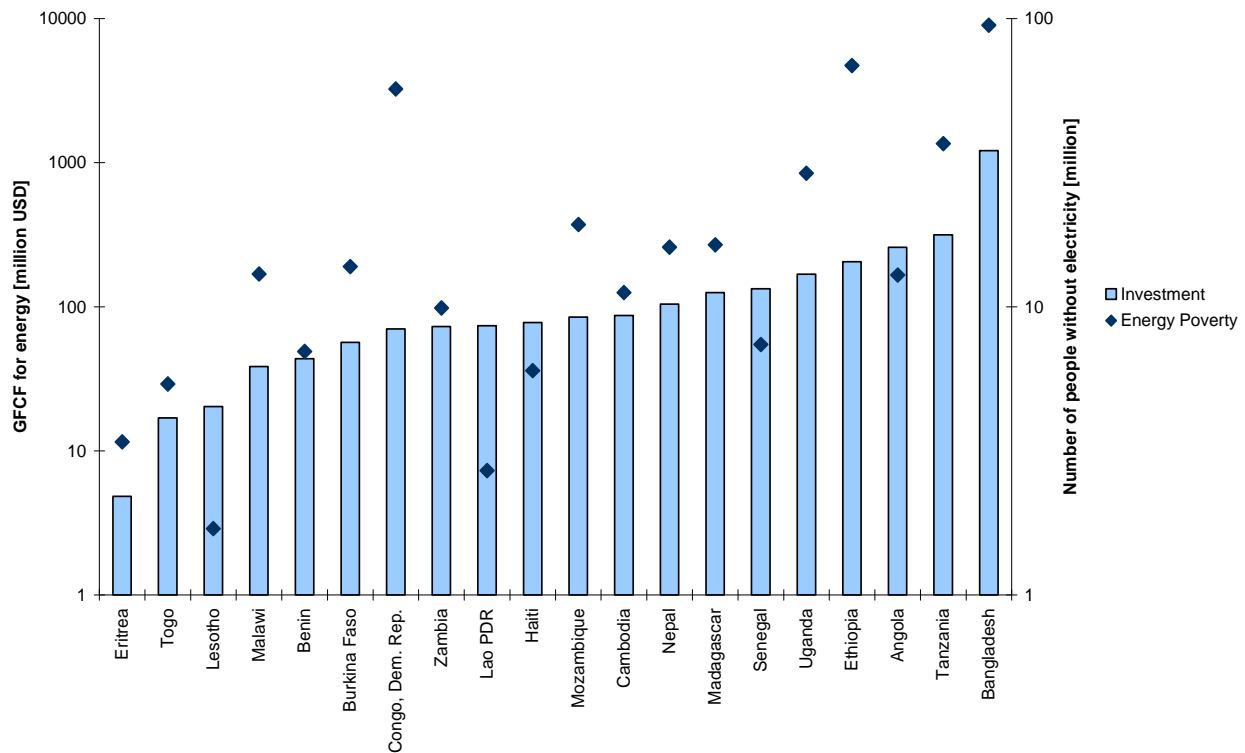


Figure 6: Magnitude of the financial flow in 2008 (primary ordinate axis) [USD 2000] compared to the number of people without access to electricity (2nd ordinate axis) sorted by investment (note: both axes in log scale) for selected LDCs.

Still, it is clear that existing country-specific investment flows in the energy sector are generally not sufficient to meet the needs of providing electricity services to those 1.4 billion people who currently lack any access— even if all investment was directed toward expanding access. In practice, of course, much of any investment will be directed toward increasing supplies (and quality) to those who already have some access.

Bazilian et al. (2010) estimate that the total cost of universal access to electricity for household uses and modern energy services for cooking could exceed USD 70 billion per year on average to 2030³⁹. Focusing on countries with very low electrification rate, we compare (see Figure 7) energy-related GFCF in 2008 with the estimated annual average cost of universal household electrification in Least Developed Countries (LDCs) by 2030⁴⁰.

³⁹ This figure does not include the full investment required for all sectors of an economy as it focuses solely on household demand.

⁴⁰ Based on Bazilian et al. (2010); using the high scenario, and removing O&M and fuel costs from the original methodology

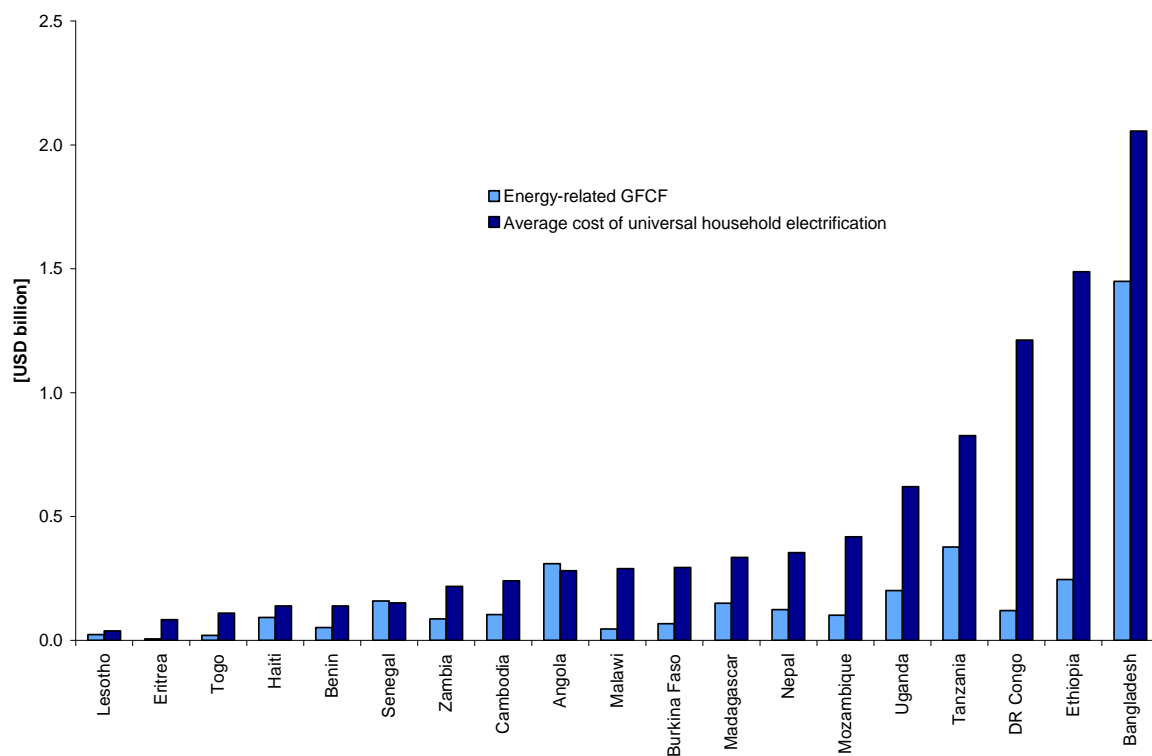


Figure 7: Comparing 2008 energy-related financial flows (GFCF) [USD 2000] with yearly average estimated investment needed for full household electrification in LDCs

Figure 7 indicates that even if all investment in energy capital was redirected to expanding access, it would be insufficient to bring about full household electrification by 2030 for most LDCs analyzed. For several countries (e.g. Democratic Republic of the Congo, Eritrea, Ethiopia, Malawi, Togo), the gap is huge (greater than fivefold). In aggregate, the total energy-related financial flow to LDCs compares poorly with estimated needs to reach universal access. Overall, and using the methodology for household energy from Bazilian et al. (2010)⁴¹ we find an estimated need of a yearly average over the time period between 2011 and 2030 of USD 11.6 billion for LDCs compared to the total estimated flow of USD 2.5 billion in 2008, a gap that is similar to other recent estimates⁴². It must be noted that estimations of this gap would increase significantly if one were to include energy needs that go beyond household poverty alleviation (or that assume significantly higher per capita consumption over time).

Finally, considering data on international financial flows and comparing them with estimated requirements for universal energy access, implicitly suggests that significant funding for energy access will need to be sourced internationally. Traditionally, the bulk of investment for a country’s power infrastructure has come mainly from domestic sources. Thus, new approaches will be required.

6. Further Work

Efficient strategies to overcome energy poverty in the near future will require the careful consideration of the financial vehicles needed both in terms of the actual mechanisms and associated institutions. Both areas also require significant capacity development as a foundation. We briefly describe areas for possible further work in those areas.

- **Refining the analysis:** There is significant scope for refining our analysis. Notably, assessing dynamic aspects could provide valuable insights of policy relevance. Also, the paucity of the data

⁴¹ Based on Bazilian et al. (2010); using the high scenario, and removing O&M and fuel costs from the original methodology to better equate to financial flows data sets.

⁴² Eberhard et al. (2011) provide a detailed analysis of the “funding gap”.

represents a significant hindrance – especially in relation to providing insights about the relationship between macro financial flows and energy access issues. Therefore, improving the information base, both in terms of quantity and quality of the data, is crucial.

- **Delivery mechanisms:** This paper demonstrates that the gap between current and required flows is enormous in several cases. Securing political commitment and putting in place effective policy and regulatory frameworks are crucial elements to improve the investment climate for energy access. These include policies that are technology or sector specific, remove existing market distortions (e.g., fossil fuel subsidies), and work across sectors (education, health, water, agriculture, industry), as well as financing mechanisms to increase funding along the project spectrum (e.g. pre-feasibility studies, feasibility studies, seed capital, debt, equity, and insurance). There is a growing literature in this area, such as: UNDP, 2009; UN-Energy/Africa, undated; Kammen and Kirubi, 2008; Prasad, 2008; Moner-Girona, 2009; Solano-Peralta et al., 2009; Williams and Ghanadan, 2006; DB, 2010; Arc Finance, 2009; Bloomberg New Energy Finance, 2010; UNEP, 2009; Laan et al., 2010; MacLean and Siegel, 2007; Morris et al., 2007; Practical Action, undated; SELCO, undated.
- **Actors and institutional mapping:** Financial flows for the energy sector are of various types, origin and destination, and vary from multi-million dollar projects for large infrastructure to the few dollars necessary for an improved cookstove or for a solar panel. Significant experience has been gathered from decades of successful and less successful initiatives to address energy poverty at various levels. The lessons should be distilled and fed into new strategies. The literature reports on some of those issues (e.g., Casillas and Kammen, 2010; Howells et al., 2010; Morris and Kirubi, 2009).
- **Sources of financing:** The additional financial resources required to achieve goals like that of universal energy access will stem from various sources. A useful area of further investigation would be to improve the understanding related to the share of those “catalytic” investments that is expected to be provided by the public sector. This is the kind of information that government policy can be built upon.

7. Conclusion

We have provided an updated and refined estimate of macro financial flows to the energy (power) sector in developing countries using several data sets and analytical techniques. The results are primarily ‘high-level’ aggregates which provide a sense of scale. Of the 2008 total GFCF, LDCs comprise approximately 0.7%. We then compared those flows to national investment needs and to electrification rates. The “funding gap” is, at a minimum, a factor of five less than that required for universal household access to electricity. Data paucity remains a significant obstacle to further, more refined analysis. This small contribution was presented to improve understanding of the “decision space” of energy poverty and help inform policy design.

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Annex 1 : Energy-related⁴³ GFCF

Table A1.1: Country data [constant 2000 USD, million]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Albania	61.7	73.6	67.3	68.1	73.3	76.6	85.4	106.3	125.2	115.9
Algeria	767.1	862.5	974.2	1023.8	1080.4	1052.1	1101.3	1285.7	1335.1	1705.1
Andorra	23.2	26.0	27.5	29.4	31.3	33.1	35.4	35.9	37.1	
Angola	93.0	85.4	91.7	95.5	76.4	81.6	135.7	201.8	258.5	265.0
Antigua and Barbuda	21.6	22.9	24.2	25.7	26.6	32.7	46.3	49.1	54.1	47.4
Argentina	3116.0	2608.3	1960.5	2700.5	3728.1	4556.3	5379.3	6056.7	6221.5	5637.1
Armenia	31.7	33.3	44.9	55.9	79.3	84.3	123.2	157.2	123.0	110.9
Aruba	31.3	29.1	32.5	35.3	442.4	519.8	551.8	545.5	542.4	
Australia	3544.1	4060.6	3948.7	4283.3	4761.7	5526.2	6727.3	8243.4	5979.9	5968.6
Austria	1057.8	997.7	886.8	925.0	997.0	1232.4	1349.8	1222.7	1313.5	1108.1
Azerbaijan	110.9	90.8	137.5	150.3	48.8	186.8	407.2	366.9	373.5	309.0
Bahamas, The	126.5	114.0	106.8	105.1	99.6	127.5	154.0	155.9		
Bahrain	72.9	75.3	111.5	127.1	163.0	166.7	199.9	221.1	284.0	2612.6
Bangladesh	734.2	775.1	811.4	863.6	941.9	1019.0	1092.0	1153.4	1212.0	1291.7
Barbados	31.8	34.8	35.1	449.3	523.5	537.2	480.1	500.4	510.5	480.8
Belarus	158.7	141.5	182.5	223.2	276.8	281.0	321.8	356.0	464.2	500.0
Belgium	1110.5	545.3	1070.9	816.6	1183.4	856.4	1302.7	1541.4	1705.2	1208.5
Belize	16.1	14.9	14.0	12.9	12.6	13.6	14.2	15.0	20.5	
Benin	28.9	30.8	30.4	31.4	31.5	34.9	35.0	43.0	43.7	54.8
Bermuda	44.6	73.3	30.0	30.0	36.6	37.2	35.4	94.8	95.5	
Bhutan	14.6	16.7	20.0	21.1	23.4	23.1	21.3	21.2	26.6	32.6
Bolivia	101.7	80.5	92.7	77.1	74.1	85.8	91.0	117.1	132.8	131.2
Bosnia and Herzegovina	76.6	74.3	76.1	80.3	78.5	103.0	124.6	159.6	160.0	107.4
Botswana	43.9	43.0	52.4	58.7	59.3	59.6	55.1	63.9	64.1	73.0
Brazil	7333.6	7532.2	7439.5	7016.0	7814.2	7981.9	8554.1	9632.5	10839.2	9697.2
Brunei Darussalam	52.7	61.1	91.9	66.9	60.2	51.1	49.2	61.3	1239.7	
Bulgaria	137.9	165.5	173.6	191.6	217.1	302.1	341.4	382.2	462.9	317.9
Burkina Faso	33.1	27.6	33.9	37.2	43.0	46.1	52.0	54.2	56.7	85.3
Burundi	2.9	3.0	3.1	5.4	6.9	5.6	9.2	17.6	18.4	19.1
Cambodia	45.3	42.4	54.3	57.8	62.6	73.0	82.9	93.3	86.9	102.9
Cameroon	109.2	144.4	147.0	139.4	146.0	144.7	140.8	149.3	161.7	89.7
Canada	4161.2	4804.8	4684.8	4798.1	5233.5	5653.3	6105.6	6330.3	6388.2	5880.6
Cape Verde	7.1	6.8	8.2	7.8	15.4	17.2	20.6	24.2	28.4	32.5
Central African Republic	6.2	5.4	5.8	3.7	3.7	5.5	5.9	5.9	7.9	7.4
Chad	19.6	38.3	67.8	63.3	39.6	34.1	27.1	34.9	48.9	69.6
Channel Islands	132.0	130.0	127.9	123.8	124.0	125.8	131.9	139.7		
Chile	490.4	531.3	532.8	523.3	531.2	615.2	591.2	652.4	784.7	696.1
China	27681.9	30259.1	34766.6	41537.3	47296.6	51878.4	59225.6	65050.7	74356.6	90735.9
Colombia	971.9	1070.6	1173.7	1307.4	1413.2	1538.5	1766.9	1956.9	1891.3	1903.2
Comoros	1.4	1.4	1.6	1.6	1.4	1.5	1.6	2.2	2.6	3.1

⁴³ Electricity and gas distribution

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Congo, Dem. Rep.	10.1	14.9	26.4	38.2	42.6	50.4	48.6	77.4	100.3	128.9
Congo, Rep.	45.6	59.4	53.4	60.8	54.1	58.3	68.9	78.9	70.3	84.5
Costa Rica	192.0	199.7	211.8	229.0	231.9	247.2	285.7	337.1	517.1	417.4
Cote d'Ivoire	78.9	69.8	75.6	66.5	68.6	68.7	66.3	62.7	74.9	87.0
Croatia	271.9	290.6	334.8	414.1	426.2	443.2	493.0	522.0	561.5	474.1
Cuba	245.8	247.7	221.1	199.8	226.7	301.4	379.8	388.8	402.8	
Cyprus	44.2	38.1	33.2	55.2	66.0	97.0	107.9	120.3	132.2	
Czech Republic	996.9	942.8	772.7	849.2	684.9	746.1	835.7	882.4	919.3	850.8
Denmark	833.0	674.4	873.5	907.4	805.1	714.1	997.9	1102.2	1161.7	800.0
Djibouti	3.3	3.0	3.9	5.8	9.0	8.2	13.4	17.8	15.2	16.0
Dominica	5.2	4.2	3.5	4.3	5.0	5.5	5.9	6.1	6.9	6.4
Dominican Republic	332.3	314.1	339.3	257.9	260.9	316.2	390.7	435.9	443.6	371.0
Ecuador	221.2	243.2	276.1	262.0	286.2	309.0	331.3	335.8	387.7	461.5
Egypt, Arab Rep.	259.1	611.1	661.9	3577.1	1166.4	1061.4	1197.1	1066.2	1416.6	1624.8
El Salvador	150.6	148.6	153.6	158.0	151.0	152.0	167.1	172.7	165.6	135.3
Equatorial Guinea	52.1	98.9	53.2	77.8	104.5	106.7	90.0	116.2	109.4	134.4
Eritrea	10.2	17.1	14.4	13.2	10.6	9.0	6.1	5.2	4.8	
Estonia	94.1	88.7	164.4	184.8	150.6	178.7	189.5	154.2	185.3	116.1
Ethiopia	112.3	128.7	145.7	130.1	172.3	174.0	203.2	219.2	205.5	252.4
Fiji	17.5	17.8	23.0	26.0	23.6	27.0	26.5	23.2	27.1	12.3
Finland	655.1	705.9	695.5	656.2	899.3	842.2	863.5	916.8	1231.0	835.1
France	5787.5	5033.4	5048.9	4740.9	5130.8	4254.4	5942.0	6702.6	6716.8	6043.8
French Polynesia	35.8	461.6	536.6	516.5	530.9	522.2				
Gabon	75.2	90.1	85.7	85.8	88.5	79.7	97.9	103.4	99.6	115.0
Gambia, The	5.0	5.2	6.2	6.0	8.3	15.5	18.0	17.2	12.8	13.3
Georgia	52.7	59.1	56.0	67.8	73.9	82.8	82.4	93.2	79.7	51.4
Germany	9865.6	9367.7	9078.8	8438.4	8740.6	8858.8	9765.1	9937.5	10169.2	8864.9
Ghana	77.8	95.1	68.8	88.4	115.5	125.0	159.0	160.6	191.1	176.5
Greece	829.6	751.1	536.7	500.6	502.5	506.6	502.1	478.7	491.8	513.9
Greenland	21.9	22.2	22.0	21.9	22.5	22.9	23.9	25.2	25.3	
Grenada	12.1	9.5	8.7	12.0	11.7	16.3	12.0	10.7	9.4	7.2
Guatemala	210.6	244.7	268.0	265.7	269.3	277.4	321.3	333.4	316.7	271.1
Guinea	39.7	32.9	31.1	47.0	47.9	46.4	42.6	36.2	42.3	43.3
Guinea-Bissau	1.6	2.2	1.3	4.1	4.2	4.3	4.3	4.5	4.6	
Guyana	11.5	10.9	10.5	10.4	12.0	16.2	23.8	22.1	22.7	
Haiti	75.1	74.3	74.1	74.4	71.8	73.1	74.7	77.2	77.9	80.1
Honduras	124.0	118.3	110.3	122.9	154.2	150.5	176.0	216.6	230.8	154.3
Hong Kong SAR, China	3018.9	2950.0	2624.4	2557.5	2787.6	2932.7	3282.2	3215.1	3213.4	
Hungary	591.0	483.8	505.6	544.6	515.4	469.7	482.0	407.0	422.7	464.2
Iceland	132.9	160.7	150.4	257.0	310.2	434.5	416.5	369.7	318.9	169.7
India	7516.7	8334.4	7593.0	9467.8	10779.8	13562.1	17047.2	18757.5	18997.1	19906.1
Indonesia	2218.1	2278.2	2351.3	2473.4	2989.8	3327.7	3583.6	3939.9	4634.4	5437.0
Iran, Islamic Rep.	1813.1	1989.8	2166.6	2352.8	2458.6	2429.6	2512.4	2647.5	3182.7	3240.0
Iraq	128.0	238.4	142.4	465.3	585.8	673.3	1063.5	2239.9	798.9	832.4

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ireland	819.0	930.7	1224.6	1218.7	1282.5	1257.8	1234.3	1062.1	1056.5	772.0
Isle of Man	10.3	10.8	11.4	12.2	12.8	13.6	14.6	15.7		
Israel	829.5	849.5	909.9	1190.2	1112.8	978.9	848.0	737.9	876.9	1070.4
Italy	6682.9	7078.5	7625.6	8320.1	7366.2	7583.5	8136.9	8527.9	7856.4	6843.5
Jamaica	142.4	160.7	170.3	171.6	175.9	180.1	192.9	185.0	159.3	139.6
Japan	36967.1	36295.6	34322.4	34101.6	34905.9	36503.2	37332.7	37537.3	37695.6	31648.8
Jordan	152.6	171.5	140.2	187.1	183.2	231.2	111.7	106.5	257.6	168.1
Kazakhstan	214.5	333.6	370.8	388.7	463.8	567.2	678.1	734.0	678.0	785.3
Kenya	5.0	4.7	4.6	4.6	138.2	168.3	182.6	199.3	203.3	206.0
Kiribati	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.7
Korea, Rep.	6978.9	7224.3	6941.9	6722.6	6193.2	6638.9	7030.0	7760.0	7738.4	8393.8
Kosovo	37.9	48.1	47.8	50.4	34.0	35.0	47.1	50.1	57.8	58.6
Kuwait	962.7	1069.3	1158.1	1286.8	1215.4	966.3	887.3	1126.2	17920.9	
Kyrgyz Republic	6.2	12.6	12.7	29.7	28.1	23.8	21.2	29.5	29.8	31.5
Lao PDR	33.2	33.7	34.9	39.1	47.4	54.9	53.0	71.2	74.0	64.2
Latvia	123.7	137.9	137.1	171.8	234.5	243.0	202.9	222.6	205.3	149.3
Lebanon	245.7	252.4	243.6	256.6	292.1	312.3	325.1	408.1	493.8	526.3
Lesotho	21.4	20.0	18.2	18.7	15.3	14.9	15.2	16.8	20.3	21.3
Liberia	0.0	1.9	1.9	2.6	3.8	4.9	0.0	0.2	0.2	12.0
Libya	301.5	275.6	289.6	239.3	354.3	444.5	616.1	788.8	913.7	1012.1
Liechtenstein	50.9	50.5	50.0	49.1	50.6	53.0	57.6	59.5	60.6	
Lithuania	156.6	177.7	191.6	186.9	204.3	210.1	321.7	322.8	291.5	249.6
Luxembourg	131.1	132.7	167.4	212.3	129.4	133.9	155.6	115.5	128.1	136.2
Macao SAR, China	41.8	61.2	56.7	47.2	58.3	59.6	35.3	29.2	122.5	
Macedonia, FYR	45.2	38.5	39.2	49.4	53.5	34.9	58.6	49.5	112.3	70.8
Madagascar	39.5	51.5	34.7	47.7	65.7	65.2	78.1	90.7	125.4	121.3
Malawi	14.5	15.5	14.5	18.5	21.9	26.5	27.7	35.0	38.5	34.2
Malaysia	1606.2	1603.7	1579.9	1595.2	1592.5	1642.3	1758.4	1946.2	1843.2	1876.9
Maldives	11.1	12.3	12.9	14.9	21.1	30.7	40.4	22.0	23.3	22.6
Mali	40.3	57.0	35.6	49.9	44.1	50.5	53.7	54.8	47.1	52.0
Malta	47.6	39.8	35.2	59.0	40.1	19.5	20.4	20.9		
Marshall Islands	2.2	2.3	2.4	2.4	2.5	2.5	2.6	2.7	2.6	2.6
Mauritania	14.2	16.6	16.0	20.8	39.2	40.0	23.2	26.3	31.9	31.5
Mauritius	61.2	47.5	40.8	48.1	44.7	66.1	73.0	44.2	16.5	34.5
Mexico	3906.9	3651.2	3543.0	3534.2	3824.8	4006.9	4393.2	4639.6	4826.0	4495.5
Micronesia, Fed. Sts.	4.6	4.7	4.7	4.8	4.6	4.8	4.7	4.7	4.6	3.9
Moldova	13.5	12.5	16.3	19.7	24.2	30.2	36.5	45.2	48.6	34.5
Monaco	54.3	55.5	56.0	56.6	58.0	59.1	62.1	71.2	78.3	
Mongolia	18.5	16.5	19.0	27.3	28.9	30.7	35.4	44.7	47.0	63.4
Montenegro	11.2	11.8	10.0	9.4	12.6	13.8	18.2	29.8	37.6	24.8
Morocco	651.2	669.8	702.4	743.7	815.6	879.8	969.1	1105.4	1233.2	1211.0
Mozambique	89.0	64.3	104.9	82.7	74.7	81.2	83.3	81.7	84.8	120.4
Namibia	16.4	131.9	27.8	77.1	67.4	27.8	30.0	29.2	17.9	75.0
Nepal	71.9	74.0	76.4	80.8	86.4	87.3	94.1	95.7	104.4	110.0

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Netherlands	1242.5	1023.0	938.0	1037.6	1139.9	1086.0	1425.3	1611.6	1351.5	1203.7
Netherlands Antilles	50.3	23.4	78.8	130.3	108.3	158.4	144.5			
New Caledonia	50.5	642.5	722.2	909.3	850.3	997.8	1325.5			
New Zealand	326.9	350.9	387.7	463.7	470.4	578.5	550.3	526.3	491.5	436.3
Nicaragua	70.8	74.6	68.1	70.3	79.3	88.3	90.7	100.1	107.2	90.8
Niger	45.7	25.9	18.0	19.2	23.3	30.2	40.8	33.0	28.0	28.9
Nigeria	220.4	223.7	228.5	356.1	294.0	228.8	367.9	434.8	415.4	1564.4
Norway	518.2	492.7	680.4	780.4	861.7	857.2	867.6	989.9	1043.9	959.4
Oman	160.6	182.8	278.8	332.3	393.4	370.2	408.6	551.1	604.1	
Pakistan	1089.1	1013.5	831.7	806.2	328.5	486.4	767.4	750.6	780.4	524.1
Palau	2.5	2.5	2.4	2.4	2.5	2.6	2.7	2.8	2.7	2.7
Panama	166.7	120.2	109.7	143.9	150.3	163.4	192.9	260.5	289.6	319.4
Papua New Guinea	48.7	50.4	46.2	44.1	45.2	46.8	48.0	51.2	56.4	58.8
Paraguay	84.0	84.9	85.0	96.2	98.6	104.9	108.0	105.2	112.9	88.8
Peru	729.1	671.4	666.4	703.0	741.8	812.2	922.2	1124.2	1487.1	1420.8
Philippines	1088.6	938.0	962.1	965.3	981.5	921.0	946.4	1062.4	1101.2	1114.7
Poland	1908.2	1983.5	1739.6	1777.0	1707.9	1686.3	1892.3	2317.7	2600.4	2519.8
Portugal	1005.8	792.6	753.2	870.2	925.5	1302.3	1408.3	1031.5	1024.8	867.7
Qatar	125.8	76.5	134.6	119.2	448.7	530.3	357.7	15904.2	20505.7	19225.6
Romania	474.3	547.7	594.0	627.7	687.5	762.3	840.9	1090.2	1289.4	1150.3
Russian Federation	2965.5	3490.6	3466.1	3816.4	4088.3	4203.0	4723.1	5788.5	6452.2	5756.9
Rwanda	21.5	24.3	25.0	26.4	30.4	34.6	35.0	38.9	49.7	49.0
Samoa	4.7	5.1	5.3	5.6	5.8	6.1	6.2	6.3	6.7	6.3
San Marino	22.5	28.9	33.4	33.0	32.3	32.7	32.7	20.1	20.5	
Saudi Arabia	2226.8	2357.2	2326.7	2545.4	2424.6	2542.2	2766.2	3284.2	3308.7	4196.0
Senegal	71.1	75.5	83.0	75.5	85.7	118.4	115.4	132.5	133.6	122.9
Serbia	52.4	46.4	56.0	77.1	96.2	100.5	117.1	142.8	145.9	146.6
Seychelles	10.5	16.5	10.5	4.0	4.8	10.0	11.5	14.2	12.1	10.7
Sierra Leone	3.0	3.4	6.6	9.8	8.0	13.9	13.3	12.3	14.5	15.5
Singapore	1920.4	1829.7	1617.9	1574.3	1677.6	1684.9	1884.7	2192.6	2638.5	2726.2
Slovak Republic	823.2	692.0	661.0	481.8	541.8	560.2	908.6	2168.8	1072.3	943.9
Slovenia	256.6	205.8	201.8	201.8	208.2	248.9	321.0	367.0	347.3	265.5
Solomon Islands	1.8	1.7	1.3	2.6	3.0	3.9	4.4	11.1	11.9	11.7
South Africa	652.3	632.3	719.2	938.2	1058.1	1195.8	1427.3	1963.9	3007.7	4830.1
Spain	3579.7	3583.5	4128.9	3964.0	5041.8	5249.3	6230.0	5600.9	5362.0	4340.4
Sri Lanka	310.0	239.5	227.2	240.3	286.2	314.0	359.7	381.8	413.8	403.0
St. Kitts and Nevis	11.1	12.2	11.8	10.4	10.8	11.0	10.4	12.0	11.9	10.7
St. Lucia	12.3	11.3	10.2	9.8	10.6	12.5	16.3	15.5	15.0	13.1
St. Vincent and the Grenadines	6.2	6.8	7.0	8.3	8.5	8.6	10.5	11.6	11.6	11.1
Suriname	7.5	18.3	14.6	16.0	16.9	19.8	25.0	26.3	27.7	
Swaziland	17.5	22.7	20.9	20.5	17.9	17.4	16.4	16.8	18.8	21.0
Sweden	1734.7	1641.9	1659.0	1845.6	1994.0	2584.0	3222.8	3549.5	3811.4	2435.9
Switzerland	1781.3	1740.8	1703.2	1635.9	1701.3	1776.4	1850.5	1940.0	1949.3	1929.0
Syrian Arab Republic	352.7	332.9	375.3	483.0	561.7	602.4	480.8	417.2	439.6	537.6

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tajikistan	4.3	5.8	4.4	6.2	8.9	12.5	12.4	23.1	23.2	20.1
Tanzania	107.2	109.8	132.9	136.8	143.8	136.3	148.9	283.3	315.4	332.8
Thailand	1825.5	1953.7	2039.3	2305.7	2640.2	3079.7	3145.8	3101.3	3303.9	2873.5
Timor-Leste	4.7	9.8	8.0	6.8	6.1	6.4	6.1	6.5	7.4	7.5
Togo	16.0	19.2	17.6	20.1	21.0	22.3	17.5	15.4	16.9	20.1
Tonga	2.7	3.2	4.0	3.5	3.3	3.0	2.6	2.7	3.5	3.7
Trinidad and Tobago	124.6	26.8	57.4	43.6	21.2	32.8	40.0	48.7	42.9	67.0
Tunisia	280.0	283.4	208.7	216.1	278.3	244.0	792.2	1096.8	214.6	519.8
Turkey	1710.1	1260.6	1403.8	1503.4	1966.0	2203.4	2496.3	2559.7	2347.3	1893.1
Turkmenistan	68.3	75.1	75.6	81.6	86.8	97.5	92.4	96.3	79.1	72.2
Uganda	80.7	83.8	93.5	103.1	106.4	125.9	131.5	148.7	168.2	190.0
Ukraine	265.4	290.3	386.5	418.1	489.9	370.6	412.8	434.2	592.7	352.6
United Arab Emirates	1020.0	1276.1	1279.3	1243.6	1413.0	1352.2	1534.2	1516.7	1688.6	1782.5
United Kingdom	7957.4	8006.8	8162.7	8189.8	8559.2	8779.9	9253.4	9876.4	9239.1	7746.4
United States	58994.5	65380.5	58806.2	57708.9	47417.7	47403.1	54718.7	68017.4	82349.5	49862.2
Uruguay	221.3	203.9	164.1	169.9	218.1	267.8	313.8	336.6	398.4	386.9
Uzbekistan	223.5	271.1	223.4	226.6	266.9	266.5	234.2	297.7	392.8	438.1
Vanuatu	3.5	3.3	3.1	3.0	3.5	3.8	4.5	5.2	7.7	7.7
Venezuela, RB	1667.1	1972.4	1638.9	1066.7	1495.7	1826.5	2150.3	2546.9	2240.8	2395.3
Vietnam	583.5	657.7	752.4	865.0	929.6	996.4	1094.2	1361.7	1314.1	1386.1
West Bank and Gaza	91.0	53.1	55.5	60.6	60.1	65.8	982.7	778.3		
Yemen, Rep.	166.6	202.4	314.0	278.1	269.7	282.5	295.3	408.5	371.6	341.0
Zambia	35.1	40.6	48.6	60.1	60.7	62.3	66.4	74.5	73.0	72.6
Zimbabwe	0.1	0.1	0.0	0.1	0.1	0.1	120.1	0.0		

Annex 2: The Clean Development Mechanism (CDM)

Most CDM project descriptions include the estimated investment⁴⁴. Where available, the investment is expressed in dollars per tonne of CO₂ reduced for each of over 140 project types. These values are then used to estimate the investment for all CDM projects. The investment is reported for the year in which the project is registered. The investment may occur later for projects registered late in a year.⁴⁵ The first CDM projects were registered late in 2004. The source of the investment is not known, but is likely to be mainly domestic because the share of ‘unilateral’⁴⁶ projects (those without a foreign partner) has risen from about 70% in 2005 to about 95% in 2010.⁴⁷ LDCs host only a small share of CDM projects, in part because they were slow to implement their national approval processes.

Of the 2400 registered project of the types and sub-types related to electricity generation (a few biogas and efficient stoves project are also included)⁴⁸. The total investment in these projects was about USD 101 billion (89% of the investment in all the 3034 registered projects) over seven years. The investment has been increasing every year since 2004. These flows generally do not increase energy access. In most cases, developers must demonstrate that their projects will displace greenhouse gas emissions. Moreover, projects are dominated by China, which already enjoys near-universal electricity access. Nor should the investment figures be read as representing additional investment due to the CDM.

Table A2.1 shows the time series for investment in registered CDM projects in all countries. Out of 3034 projects registered, 24 are in LDCs. Of a total investment of USD 11780 million, USD 18 million is in LDCs.

⁴⁴ CDM projects sell emission reduction credits (CERs) to developed countries. The value of the CERs may be much larger (in the case of HFC reduction projects for example) or much smaller (in the case of renewables for which most of the revenue comes from the sale of electricity) than the investment. Emission reduction purchase agreements may include initial payments prior to a project being registered, usually at a discount to the market price of CERs. Additional payments and sales occur over the over the crediting period (up to 21 years).

⁴⁵ Of the 2400 registered power supply projects, only 794 have had CERs issued; indicating that they are operational. Some of the remaining registered projects may not be implemented.

⁴⁶ A unilateral project is one whose project participants are all from the host country; no foreign partners. The sources of the funds project participants invest in the project are not known. Clearly some of the funds must be their own and hence are domestic. They may enter into an emission reduction purchase agreement (ERPA) with a foreign buyer. An ERPA often involves one or more payments prior to implementation of the project and a commitment to buy a specified quantity of CERs (typically at a discounted price) once they have been issued. The project participants own any remaining CERs and can sell them at the market price. Thus an ERPA provides some initial funding and can serve as security for loans (based on the revenue from the commitment to purchase CERs). Other possible sources of foreign funding for the investment are: (1) credit provided by foreign equipment suppliers and (2) loans from foreign lenders. So for unilateral projects the sources of the funds invested are likely to be primarily domestic, with the main exception being any initial payments under an ERPA. See Lütken and Michaelowa (2008) for further justification of this assertion.

⁴⁷ UNFCCC (2010).

⁴⁸ Since this article focus on energy access the following project types were excluded: Agriculture, Cement, CO₂ usage, Coal bed/mine methane, EE industry, EE own generation, EE service, Forests, Fugitive, HFCs, N₂O, PFCs, SF₆, and Transport. For Fossil fuel switch only new natural gas power plant are included; for Landfill gas, and Methane avoidance only power producing projects are included (however, the 6 household projects producing biogas for cooking are included).

Table A2.1: Time series for investment in registered CDM projects in all countries

Host country (Rejected projects excluded)	Registered projects	All years									
		2004	2005	2006	2007	2008	2009	2010	2011	2012	
		Million US\$									
Latin America	518	8436	18	434	2581	1606	1572	1259	545	421	
Argentina	21	213		34	32	25	57	1	55	10	
Bahamas											
Bolivia	4	127		2		50		1	74		
Brazil	190	2127	18	30	1144	242	244	211	180	57	
Chile	46	834		26	277	98	104	69	60	199	
Colombia	28	706			438	32	67	105	53	11	
Costa Rica	7	106		8	2	27	8			60	
Cuba	2	81				75		6			
Dominican Republic	2	89			79				10		
Ecuador	16	269			113	2	89		2	62	
El Salvador	6	167			73	40			54		
Guatemala	11	256		34	67		143	12			
Guyana	1	15					15				
Honduras	17	95		54	10	13	2	2	4	9	
Jamaica	1	33			33						
Mexico	126	2153		207	122	869	599	323	32	2	
Nicaragua	4	206			120	10		77			
Panama	6	152		22	13	8		110			
Paraguay	2	2						0	1		
Peru	23	780		17	58	111	231	343	20		
Uruguay	5	25				2	12			11	
Asia & Pacific	2398	102013		254	3751	10123	12578	24730	39687	10891	
Bangladesh	2	15		4	11						
Bhutan	2	178		0					177		
Cambodia	4	18			10		4	4			
China	1354	78305		61	1409	5582	10949	19304	30762	10239	
Fiji	1	9									
India	645	18833		109	1356	4110	1284	4436	7117	422	
Indonesia	64	1323			312	44	179	91	626	71	
Lao PDR	1	3				3					
Malaysia	90	632			245	51	41	232	46	18	
Mongolia	3	23			2	21					
Myanmar											
Nepal	3	34		19					14		
Pakistan	11	273			24			170	79		
Papua New Guinea	1	100			100						
Philippines	50	257			71	24	84	38	26	13	
Singapore	2	16					3		13		
South Korea	55	938		13	138	159	14	238	368	8	
Sri Lanka	7	64		39	2			18	5		
Thailand	47	301				128	19	74	50	30	
Vietnam	56	691			70			125	405	91	
Europe and Central Asia	29	266		6	123	5	5	83	44		
Albania	1	3							3		
Armenia	5	18		6	2	1	5	3			
Azerbaijan											
Cyprus	6	56			46			2	8		
Georgia	2	9				4		5			
Kyrgyzstan											
Macedonia	1	21						21			
Malta											
Moldova	4	101			74			26			
Serbia											
Tajikistan											
Uzbekistan	10	58						26	32		
Africa	58	1921		117	394	300	73	336	675	25	
Cameroon	2	5							4	2	
Cape Verde											
Congo DR	1										
Côte d'Ivoire	2	12						4	8		
Egypt	8	509			35	158	21		290	5	
Equatorial Guinea											
Ethiopia	1	4						4			
Ghana											
Kenya	3	162					44		117		
Lesotho											
Liberia	1	5							5		
Libya											
Madagascar	1	16							16		
Mali	1	67							67		
Mauntius											
Morocco	5	264		117	135	1		11			
Mozambique											
Nigeria	5	499			152			285	61		
Rwanda	1	3							3		
Senegal	1	13							13		
South Africa	19	231			53	123	7	31	17		
Sudan											
Swaziland											
Tanzania	1	6				6					
Togo											
Tunisia	2	19			19						
Uganda	3	32				13		1		18	
Zambia	1	75							75		
Middle-East	31	1296			3	302	65	457	27	443	
Iran	1	47						47			
Israel	21	567			3	48	21	27	27	443	
Jordan	2	46					45	2			
Lebanon											
Oman											
Qatar	1	254				254					
Saudi Arabia											
Syria	2	4						4			
United Arab Emirates	4	378						378			
Yemen											
Total (76 countries)	3034	113932	18	811	6852	12335	14293	26865	40978	11780	
Least Developed Countries (LDCs have this	24	468		24	22	22	4	9	370	18	

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