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What Explains the Allocation of Aid and Private Investment for Electrification?

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The IDS programme on Strengthening Evidence-based Policy works across seven key themes. Each theme works with partner institutions to co-construct policy-relevant knowledge and engage in policy-influencing processes. This material has been developed under the Pro-Poor Electricity Provision theme.

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WHAT EXPLAINS THE ALLOCATION OF AID AND PRIVATE INVESTMENT FOR ELECTRIFICATION?

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Abbreviations

ADB	Asian Development Bank
DRC	Democratic Republic of Congo
FDI	foreign direct investment
GDP	gross domestic product
GNP	gross national product
GW	gigawatt
IADB	Inter-American Development Bank
IEA	International Energy Agency
IEG	Independent Evaluation Group
IFC	International Finance Corporation
IPP	independent power producer
kWh	kilowatt hour
MW	megawatt
ODA	official development assistance
OLS	ordinary least squares
PPI	Private Participation in Infrastructure
UN	United Nations
VIP	vertically integrated monopolist
WDI	World Development Indicators
WEC	World Energy Council

Abstract

This paper aims to inform policy looking to step up investment in the electricity sector of developing countries and align it to other development goals such as universal access to energy or sustainability. Three questions guide the analysis: (1) How and why has private and donor finance for electrification changed across time? (2) What are the different motivations of private investors and donors as regards who and what gets financed? (3) Are sustainability and equitable access priorities for private and donor investment? These questions are addressed by describing finance flows during the period 1990–2010 and performing an econometric analysis to explain inter-country allocation.

1 Introduction

Providing access to electricity to the 1.3 billion people who currently live without it, and improving the quality and quantity of supply for those already connected in developing countries, will require a significant increase in finance for the electricity sector (Bazilian *et al.* 2010; IEA 2011; World Bank 2006; Pachauri *et al.* 2013). Broadly speaking, three sources can contribute to satisfy the 'voracious appetite for finance' of the electricity industry (Hausman, Neufeld and Schreiber 2014): official development assistance (ODA) from multilateral and bilateral donors; national governments (or state-owned utilities); and the private sector. The International Energy Agency (IEA) estimates that reaching universal access by 2030 would require a fivefold increase in the amount of finance jointly provided by these three sources (IEA 2011). International sources of finance, including ODA and foreign direct investment (FDI), will play an increasing role in developing countries with low electrification rates (mainly in sub-Saharan Africa), where domestic sources are simply insufficient for the investment required (Bazilian *et al*. 2011; IEA 2011).

Policymakers looking to step up investment in the electricity sector of developing countries and align it with other development goals such as universal access to energy or sustainability would benefit from an improved understanding of how these financial flows have performed in the past. This report shows trends of two sources, ODA and private investment, during the period 1990–2010, and performs an econometric analysis to explain the observed allocation of funds across developing countries. Three main questions guide our analysis:

1. How and why has the contribution to the electricity sector of private investors and donors changed across time?
2. What are the different motivations of private investors and donors as regards who gets finance and what is financed (hardware or software elements of the electricity system, renewable or non-renewable generation)?
3. Is the provision of access to electricity a priority for private and donor investment?

Data paucity has prevented the analysis of public domestic sources, even though these play a crucial role in electrification. For example, around 60 per cent of the conventional capacity in China and almost two-thirds in India are controlled by the state through direct control or a majority ownership stake (IEA 2014).

Previous research looking at these questions suggests that there have been major changes in the way in which electrification has been financed in recent decades. Hausman *et al*. (2014) follow trends in ODA for electrification between 1970 and 2001, noting a shift from almost entirely domestic electric utilities in the post-Second World War era to a worldwide movement of privatisation, liberalisation and restructuring of the sector beginning in the 1980s and accelerating in the 1990s as part of the neoliberal 'Washington Consensus'. By the 1990s, electrification aid had shifted towards countries that were relatively poorer (but not those in Africa), and also towards those with more attractive governance structures. In addition, Hausman *et al.* find that aid has increasingly flowed towards countries with high initial investment as a share of gross domestic product (GDP) and which have restructured their power sectors. Gualberti *et al.* (2012: 20) find that although development finance for electrification has risen significantly in the past decade, this funding has not been channelled towards the countries with the lowest energy access rates, leading them to conclude that energy access 'is not a priority' for donor countries. Literature on the role of private investment is limited. While there is extensive literature on the determinants of international private investment to developing countries (e.g. Albuquerque 2003; Asiedu 2002; Kim 2000; Kinda 2010; Noorbakhsh, Paloni and Youssef 2001), only a small number of studies specifically examine the electricity sector (e.g. Bazilian *et al.* 2011; IEA 2014).

As regards the different roles of public and private finance, existing studies show that the private sector tends to focus on high energy expenditure households and commercial consumers, mainly investing in large-scale on-grid generation. Public sector investment is required initially for market creation, research and development, planning, policies and regulations, and for the provision of network services through transmission and distribution infrastructure. Off-grid electrification has also often been financed, at least initially, through government programmes and ODA (Glemarec 2012).

This paper contributes to previous research on the topic by validating with data what is often presented as anecdotes and impressions, and drawing from a larger data set to provide a much wider picture of finance for electrification as regards: who the main providers and recipients are; how they have evolved through time; what is financed; whether sustainability (green electricity) and equity in access rank high in funders' agendas; and what makes some countries more likely than others to get different sources of finance for electrification.

The study proceeds as follows. Section 2 describes the data. Section 3 provides information on key trends in ODA and private investment in electrification between 1990 and 2010. Section 4 specifies an econometric model to explain aggregate electrification aid and private investment using economic, energy resources, governance, geographic and poverty-related covariates. Section 5 discusses the results, and Section 6 presents the conclusions.

2 Data

Our analysis is based on ODA data and private participation in infrastructure data, as provided by AidData[1] and the Private Participation in Infrastructure (PPI) database of the World Bank.[2] We included data only between 1990 and 2010, taking into account the availability of disaggregated data from both databases as well as data on independent variables for our econometric model.

AidData includes information from 1947 until 2013, although approximately 99 per cent of the data is from 1973 onwards (Tierney *et al.* 2011). It expands on previous efforts to bring all aid data together (e.g. the Organisation for Economic Co-operation and Development (OECD)'s Creditor Reporting System (CRS) database) in the following ways: a) it has made efforts to include contributions that may not have been reported every year; b) it includes the contributions by multilateral development banks, which had not been included previously; c) it includes bilateral donors whose contributions had not been included like Saudi Arabia and Kuwait; and d) it expands the number of sector codes to allow for a more precise disaggregation of different types of project (*ibid.*).

In total, it tracks flows from 42 bilateral and 44 multilateral donors and as of early 2013 it had data for 1,000,864 projects. By including projects that have received loans from development banks, including ones provided at market prices, it expands the definition of aid beyond simply ODA, leaving it with a larger overall estimate of the amount of 'aid' that has been transferred to developing countries since the 1940s.

The data are effectively disaggregated in terms of the source of funding (multilateral, bilateral, private or foundation), the type of funding (ODA grants, ODA loans, equity investment, other official flows, loans, export credit), the recipient country and the sector. It also disaggregates for the technology type indicating for electricity projects if the project has been to support electrical transmission and distribution, power generation with several renewable or non-renewable sources, combination of activities, energy policy and administrative management, energy research, or education and training. In addition, the data on the amount of finance are quite precise, differentiating between the commitment, disbursement, and overall project costs, where figures are presented in 2009 US$. In practice, however, information on the type of energy project is not filled in many cases, which required the search in the project title column of keywords 'electri*' and 'power' and the removal of irrelevant projects (those dealing with 'empowerment', for example). All projects were subsequently classified in three categories: 'generation', 'transmission and distribution' and 'policy, education and research'. Generation projects were further classified according to the energy source. The database was audited to confirm the relevance of the projects included. A total of 13,242 aid projects were identified between 1990 and 2010, a significantly higher figure than that of Hausman *et al*. (2014), which included 3,745 projects between 1970 and 2001.

Data on private sector investments was obtained from the PPI database, which is maintained by the World Bank (World Bank 2014) and contains data on private sector investments in infrastructure projects in developing countries. It covers the period between 1984 and 2012, and has data on more than 5,000 infrastructure projects in the developing world, including energy projects. Projects are included when private participation constitutes at least 25 per cent of the overall funding for the project, where a private company bears some of the risk and when the project has arrived at a certain level of financial closure, or has 25 per cent of construction completed. Moreover, electricity projects must have a capacity of at least 1 megawatt (MW) of electricity or be worth at least US$1m to be included. Data are

[1] http://AidData.org/
[2] http://ppi.worldbank.org/

disaggregated according to whether the project provides generation, transmission, distribution or a combination of these. Generation projects are also classified as renewable or non-renewable and additional information is provided on the type of energy source. The PPI database provides information on the capacity of each generation project and on the number of electricity connections provided by 'distribution' projects. Other interesting project data include the type of private investment (greenfield projects, divestitures or concessions), the type of multilateral support received and the revenue source.

Investments recorded by the database are those made or to be made by the project company under the PPI contract. When project companies are owned by both private and public parties, the database does not record private investment alone. Investments are recorded in US$m in either the year of financial closure or the year of investment but we show them in 2009 US$ for consistency with AidData (AidData 2.1 2014). A total of 3,052 electricity projects were identified between 1990 and 2010.

In practice, it is likely that there is some duplication between the PPI and AidData because the PPI database includes projects that have received multilateral support. We attempted to match both databases, but we could not identify any duplications because projects are given different names and different investment amounts are recorded in each database.

To complete our analysis we conducted interviews with experts so as to check reliability of sources and interpret the data. We carried out five interviews during November and December 2014 with: Andrew Barnett, from the Policy Practice; Stephen Spratt, from IDS; Dana Rysankova, from the World Bank; Roberto Schaeffer, from the Universidade Federal do Rio de Janeiro; and Hari Natarajan, from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

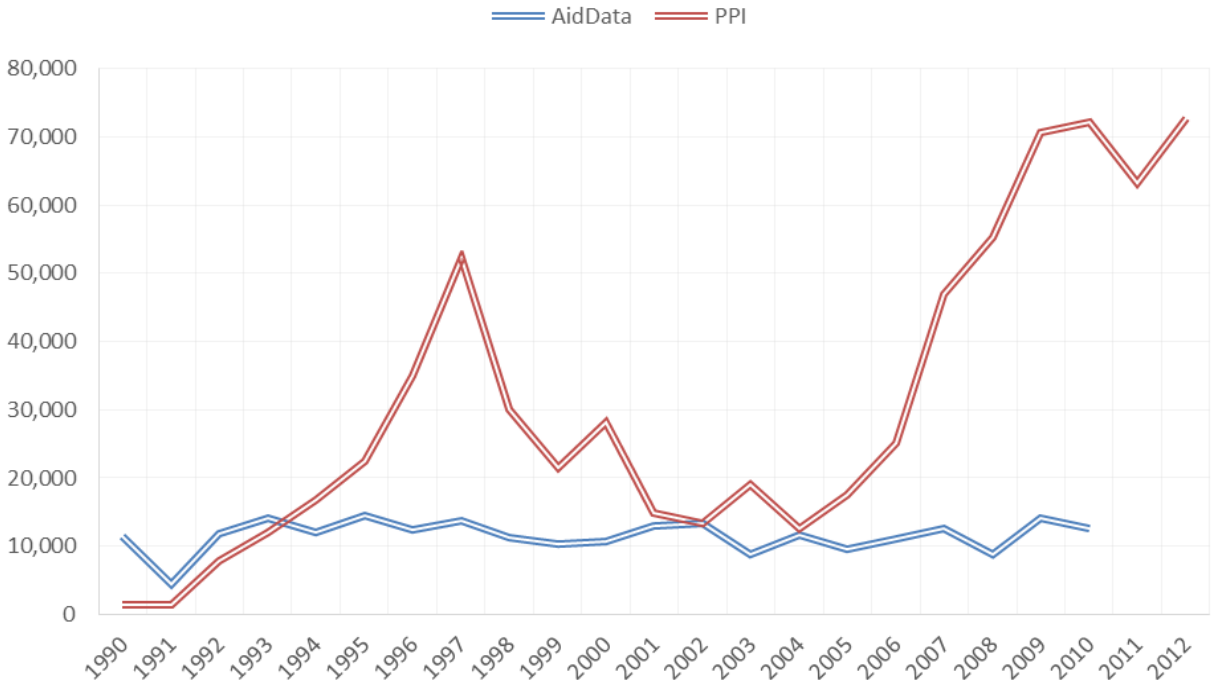
3 Trends in ODA and private investment flows for electrification

3.1 How much?

Figure 3.1 reveals the evolution of ODA and private investment for electrification between 1990 and 2010 (with two additional years of data in the case of private investment). ODA for electrification was reduced in the 1990s in response to policy changes. In particular, the World Bank shifted away from the idea of providing finance for public utilities, and towards the encouragement of privatisation reforms to facilitate private sector investment (Gualberti *et al*. 2012). As neatly explained in a paper about political considerations relevant to energy and economic growth (Barnett 2014), the move towards the attraction of private capital was initially a tactical one, driven by the realisation that ODA was not sufficient for an effective electrification programme in most developing countries. However, it also became an ideological necessity in the era of the Washington Consensus. Moreover, even though there are very clear associations between energy use and economic growth and development, evidence for the impacts of support for electrification *per se* on these goals was increasingly disputed within the World Bank (IEG 1994; World Bank 1995), leading donors to the conclusion that support for rural electrification, for example, was 'a bottomless pit of expense, which frequently added to the insolvency of state run utilities' (Lucas *et al.* 2003: 10). In conjunction with growing civil society opposition to the World Bank's role in supporting large-scale energy projects, there seemed little reason for the World Bank to continue supporting this area (*ibid.*).

The World Bank's shift away from support for electricity in developing countries had a demonstration effect on other bilateral donors as well, which reduced their support for electricity (*ibid.*).

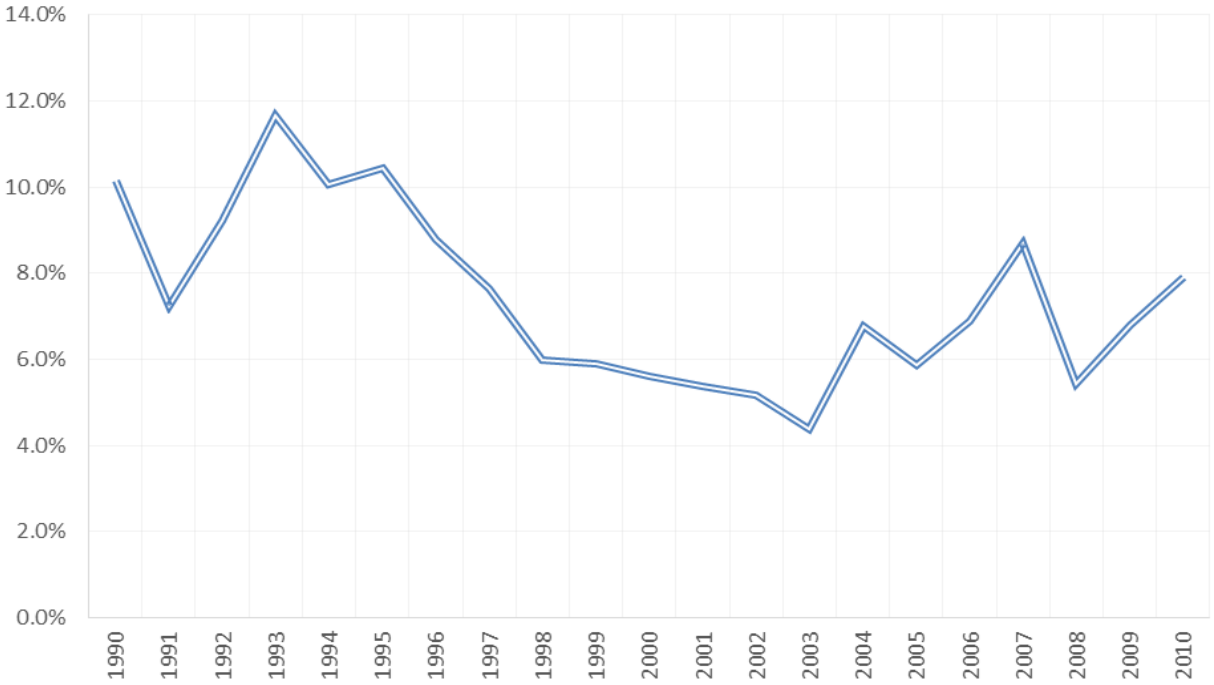
Figure 3.1 ODA and private finance for electrification (US$m), 1990–2010



Source: Authors' own, based on data from AidData 2.1 (2014) and World Bank (2014). All figures are in millions and in constant 2009 US$.

As a consequence of all of these factors, support for electrification as a share of overall development assistance also fell considerably from the levels of the 1980s until 2003, as can be seen from Figure 3.2. It is worth noting that much of this decline occurred within a broader context of falling international aid. Between 1991 and 1997, all major donors reduced their aid relative to their gross national product (GNP) as a response to the ending of the political pressure to provide aid which had been generated by the Cold War (Lucas *et al.* 2003).

Figure 3.2 Electrification finance as percentage of total development finance, 1990–2010



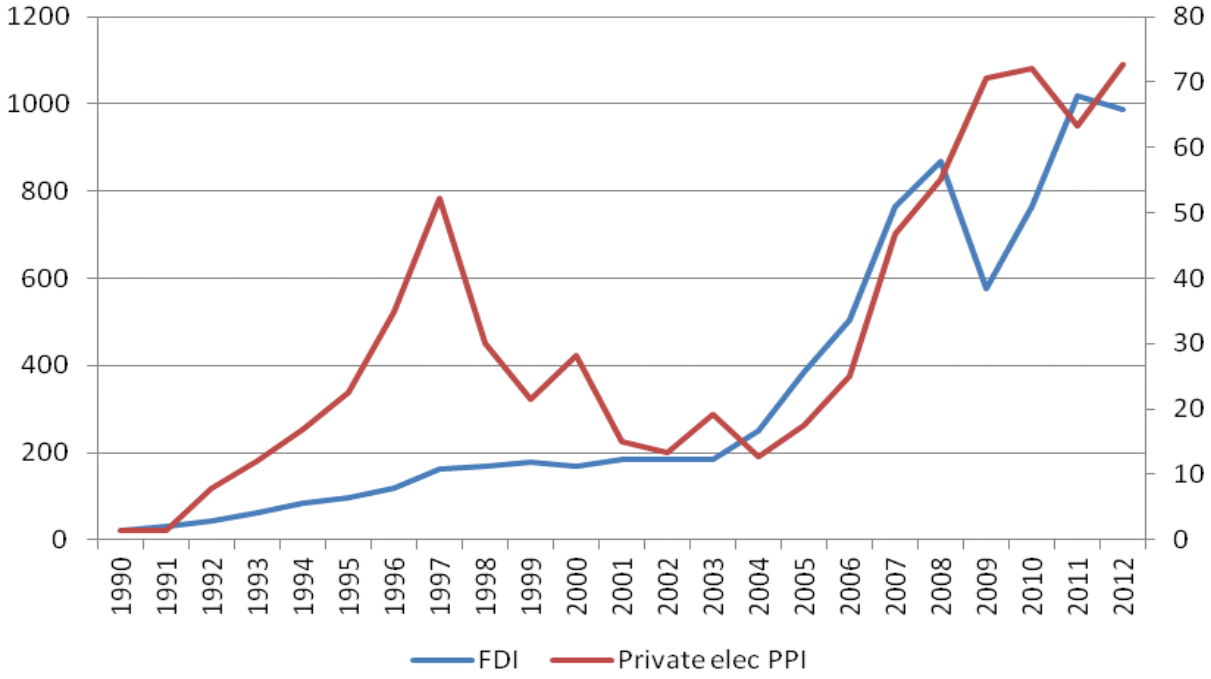
Source: Authors' own, based on data from AidData 2.1 (2014)

Finance for electrification has since risen in its share of ODA from 2003 onwards due to a revived emphasis on the importance of energy for development (Gualberti *et al.* 2012). This emphasis was partly in response to a reassessment of the assumption that the private sector could be relied upon to make the required investments in electricity after its own contribution fell markedly following the Asian financial crisis (Hausman *et al.* 2014). The 2006 World Bank publication *Infrastructure at the Crossroads* noted the decline in private sector investment and also, as a result, a growth in demand for World Bank support from developing country governments, as well as a broader reappraisal of the importance of infrastructure in development (World Bank 2006). Moreover, in a subsequent publication in 2008, the World Bank reassessed the economic case for investment in rural electrification on the basis of high willingness to pay exceeding the long-run marginal cost of supply (World Bank and IEG 2008). Although it emphasised the relatively weak evidence base behind many of the claimed development benefits of rural electrification, it also concluded that investments in this area can generate economic benefits (*ibid.*). The increased interest in energy supply and its links to poverty reduction culminated with the Sustainable Energy for All (SE4ALL) initiative, with 2012 being declared the United Nations (UN) year for Sustainable Energy for All.

As illustrated by Figure 3.3, private finance for electrification grew much faster than total FDI during the first half of the 1990s until 1997. This growth was largely driven by the wave of privatisations during that decade, as previously described. During this period, the overall percentage of private investment in total infrastructure investment in developing countries rose to 53 per cent (Hausman *et al.* 2014) from a situation of almost total state ownership of

electricity infrastructure in developing countries. The boom, however, was relatively short-lived and ended with the 1997 Asian financial crisis, which brought about a sudden reduction in private lending for infrastructure projects. It is worth noting that this was not the case for overall FDI, which was relatively less affected by the crisis. The fact that the Asian financial crisis had this effect reveals the extent to which private investment had been dependent on international market conditions in the 1990s.[3] Private investments fell and stayed at low levels until approximately 2004. From 2004 onwards, however, private investment in electricity has risen substantially, while overall private investments in infrastructure have also risen from 2002 onwards, leading a World Bank report to describe them as 'a game changer in infrastructure financing' (World Bank 2011: 5).

Figure 3.3 Private finance for electrification and total FDI inflows to developing countries, 1990–2012 (US$bn)



Source: Authors' own, based on data from World Bank (2014). and WDI (2014). All figures are in billions and in constant 2009 US$.

By contrast with the 1997 Asian crisis, private investments in electrification have apparently not been affected by the 2008 financial crisis, and indeed have risen rapidly since then. There are a number of explanations for this. First, at the time of the crash, there was a perception in some circles that the emerging economies had decoupled from the developed world, meaning that the crash would not affect them. Although this assessment was highly debatable, the perception of it may have had the effect of encouraging investors to keep investing in the year following the crash. Moreover, the main emerging countries attracting private investment (i.e. China, India and Brazil) used their state development banks to drive investment, and enacted large stimuli in 2009. China's stimulus, for example, accounted for 14 per cent of its GDP, and it focused mostly on infrastructure, including the electricity sector.[4]

These trends reflect the increased use of blended finance type models in the multilateral agencies, where ODA is used to leverage private investment.[5] When it is structured correctly,

[3] Interview with Stephen Spratt, Research Fellow at IDS, 18 and 25 November 2014.
[4] *ibid.*
[5] *ibid.*

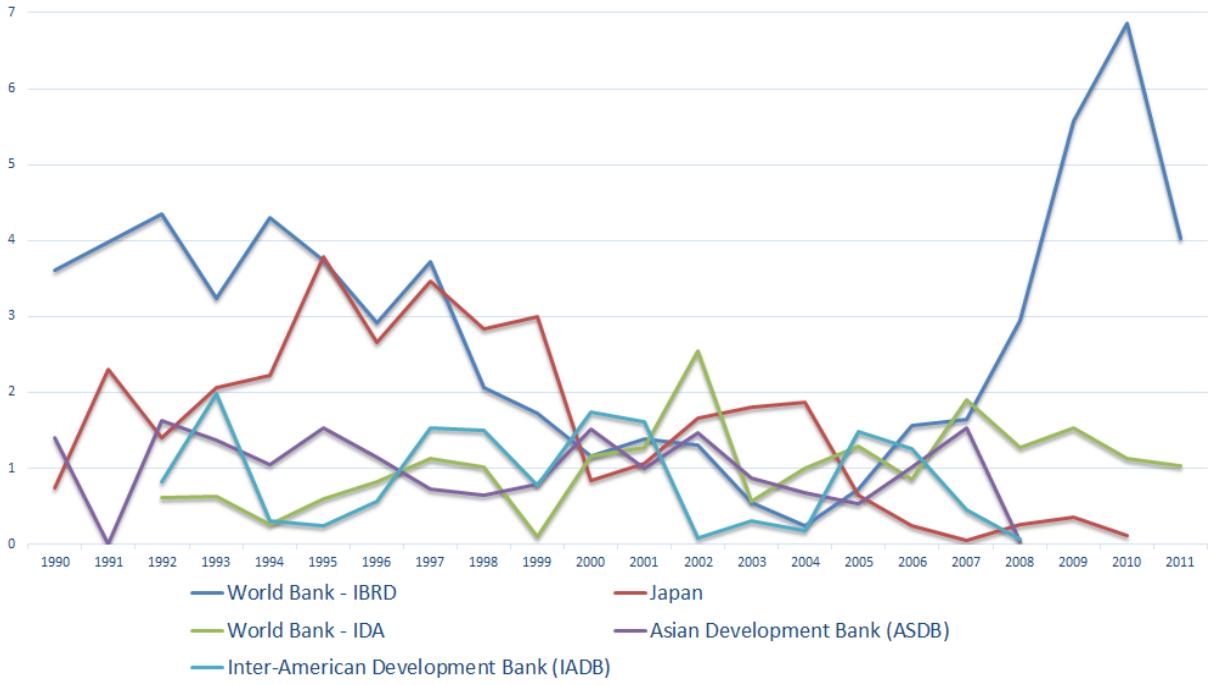
blended finance can assure private investors of a long-term return on capital, thereby 'potentially unlocking the trillions of assets controlled by institutional investors and sovereign wealth funds' (Griffith-Jones, Ocampo and Spratt 2012: 39). In addition, institutions such as the World Bank also guarantee private sector investments in generation, and as these guarantees are not costly, they do not show up as a large investment in ODA.[6]

3.2 From whom?

Figure 3.4, presenting the top five donors for electrification, illustrates the changing role of the World Bank, with a clear decreasing trend through the 1990s and until 2004, after which there is a large increase. As we have seen, much of the increased investments made by the World Bank in electrification after 2000 were channelled towards blended finance models rather than the traditional mechanism of directly investing in public utilities. Moreover, developing country governments have increasingly come to opt for these mechanisms as well. This may have allowed the World Bank to achieve greater impacts with its investments.[7]

Japan's contributions saw an increase for most of the 1990s, but then it curtailed its support considerably after 1999, due to economic problems, reaching a low in 2007 (Yamaguchi 2005). The Inter-American Development Bank (IADB) and the Asian Development Bank (ADB) show fluctuations along a slightly decreasing trend through the whole period.

Figure 3.4 Top five donors: contributions to electrification 1990–2011 (US$bn)



Source: Authors' own, based on data from AidData 2.1 (2014) and World Bank (2014). All figures are in millions and in constant 2009 US$.

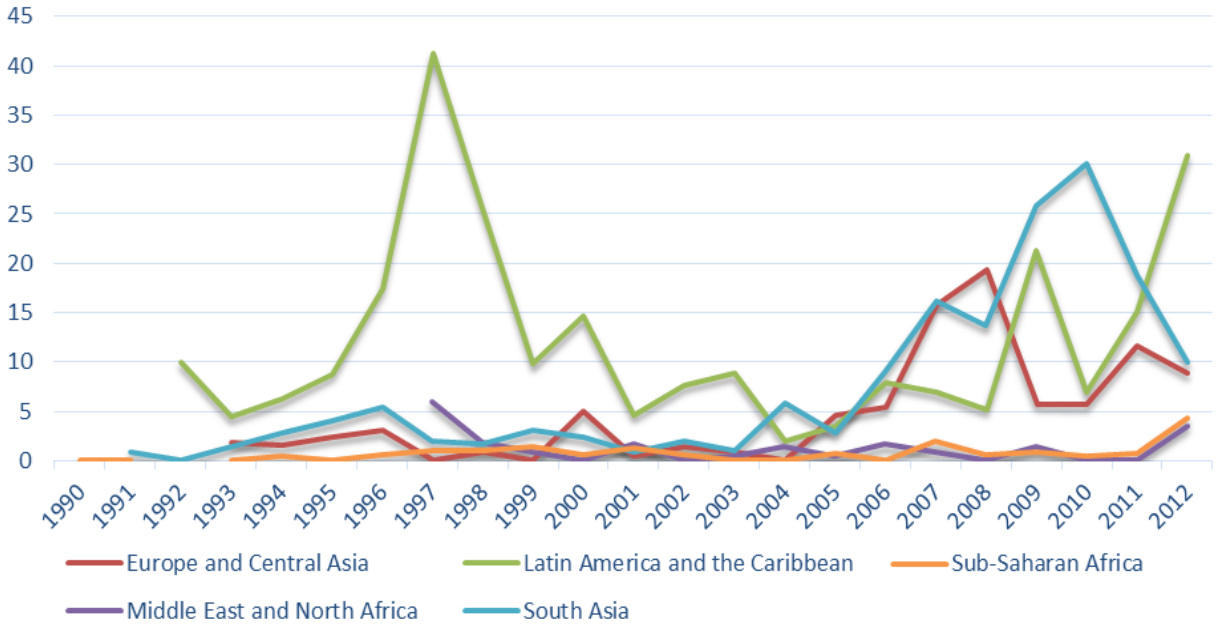
3.3 To whom?

Figure 3.5 reveals the trends in private finance for electrification according to the geographical area receiving it. Growth in private investment during the 1990s was largely driven by privatisation in Latin America. In particular, much of this investment was

[6] Interview with Dana Rysankova, World Bank Senior Energy Specialist, 4 December 2014.
[7] *ibid.*

concentrated in Brazil, which opened up its energy sector through privatisations in the 1990s, as well as bringing hyperinflation under control. Private investment in Brazil in the mid-1990s initially targeted the distribution sector and consisted mainly of the purchase of existing public assets or concessions by which private entities took over the management of state-owned enterprises. However, there was not much greenfield investment in the expansion of generation and transmission infrastructure, which, in addition to a drought in a country with over 80 per cent of hydroelectric capacity, brought Brazil to a severe energy crisis in 2001–02. The privatisation process was then brought to a stall. A system of energy auctions was implemented instead to attract competitive long-term private investment to the generation sector on the basis of a careful planning process based on demand forecasts. Transparent and secure long-term power purchase agreements succeeded in attracting large amounts of private investment, mostly for renewable generation. The expansion was linked to a fair return on investments and to universal service access, together with tariff adjustments.[8]

Figure 3.5 Regional split of private finance for electrification 1990–2012 (US$bn)



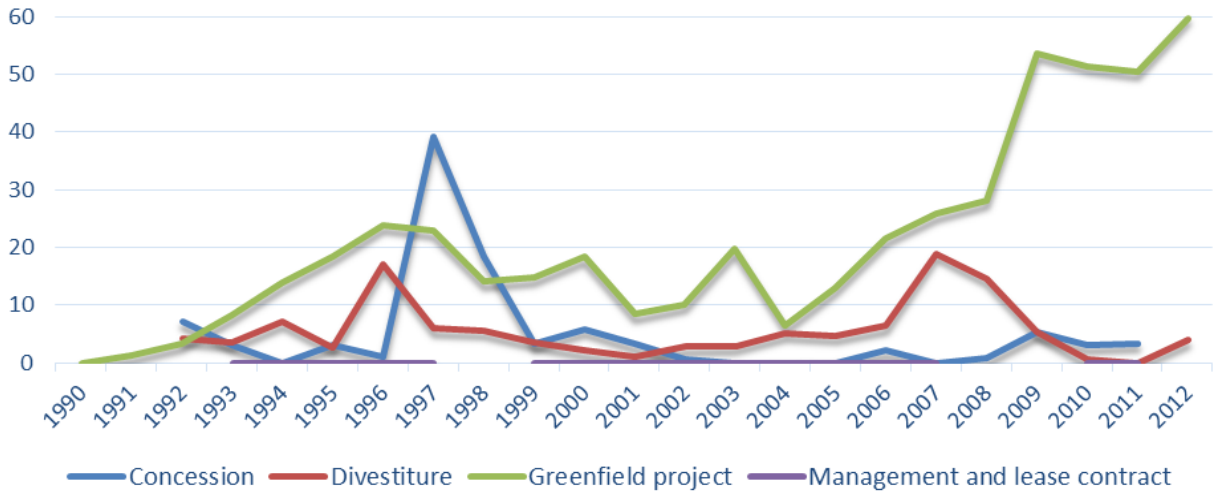
Source: Authors' own, based on data from World Bank (2014). All figures are in billions and in constant 2009 US$.

As is clear from Figure 3.5, strong growth between 2005 and 2010 was also mainly driven by investments in South Asia, mainly in India, responding to the 2003 Electricity Act which opened the Indian power sector up to private investors, which were encouraged to establish franchises (Pargal and Banerjee 2014). India's new Electricity Act aimed at increasing competition mainly in the generation sector, while the transmission and distribution sectors have remained mostly public.[9] The private sector was responsible for 2.5 gigawatt (GW) (3 per cent of generating capacity) in 1991, rising to 62.5 GW (29 per cent) in 2012. Finances for distribution, however, have been deteriorating, which the World Bank blames on the lack of creditworthiness of state power distribution utilities, as well as criticising ongoing state subsidies for state utility companies (*ibid.*). Others point at the large share of transmission and distribution losses as a consequence of illegal connections and the politicisation of rural electrification.[10]

[8] Interview with Professor Roberto Schaeffer, Energy Planning Program, Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE), Universidade Federal do Rio de Janeiro, 9 December 2014.
[9] Interview with Hari Natarajan, Senior Technical Advisor for the Indo-German Energy Programme, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 20 December 2014.
[10] *ibid.*

Figure 3.6 shows that during the privatisation wave of the 1990s, most private investment was not directed at greenfield projects but to the acquisition of state-owned assets or concessions for the management of public assets.

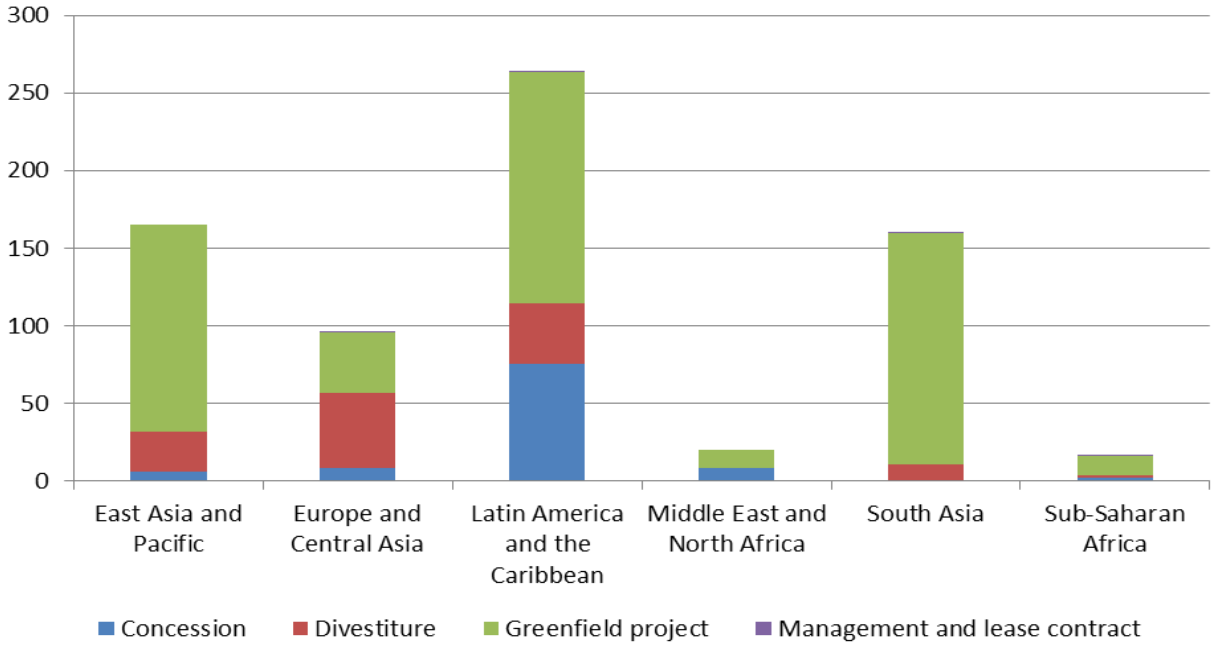
Figure 3.6 Private finance for electrification per type of finance (US$bn)



Source: Authors' own, based on data from World Bank (2014). All figures are in billions and in constant 2009 US$.

Figure 3.7 shows that Latin America and the Caribbean captured most of the proceeds for the acquisition of existing state-owned infrastructures. As a result, there was not an equivalent growth in capital formation, which led to the paradoxical situation of Brazil experiencing record inflows of private investment in electricity infrastructure followed by a severe crisis in electricity supply in 2001–02.[11]

Figure 3.7 Private finance for electrification per type of finance, 1990–2012 (US$bn)

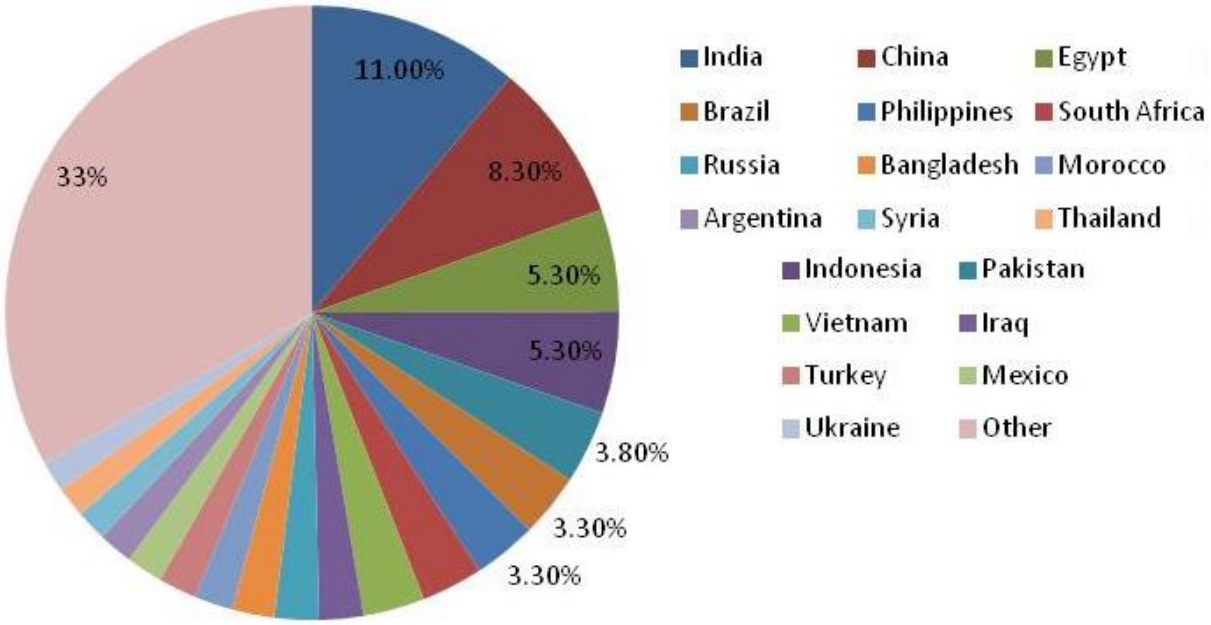


Source: Authors' own, based on data from World Bank (2014). All figures are in billions and in constant 2009 US$.

[11] Interview with Professor Roberto Schaeffer, Energy Planning Program, Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE), Universidade Federal do Rio de Janeiro, 9 December 2014.

At the country level, Figure 3.8 shows that 11 countries captured approximately 50 per cent of aid for electrification during the past two decades.[12] India was the main recipient of aid for generation with non-renewable sources, mainly coal and gas power plants, and received 13 per cent of all aid for non-renewable generation during the 1990–2010 period, followed by Egypt and China, which received 10 per cent and 7 per cent respectively. China was the main recipient of aid for renewable generation during that period, receiving 12 per cent of global aid in this area, followed by India, with 11 per cent, and Pakistan, with 6 per cent. Meanwhile, hydroelectricity was the dominant form of renewable generation.

Figure 3.8 Electrification aid by recipient 1990–2010



Source: Authors' own, based on data from World Bank (2014)

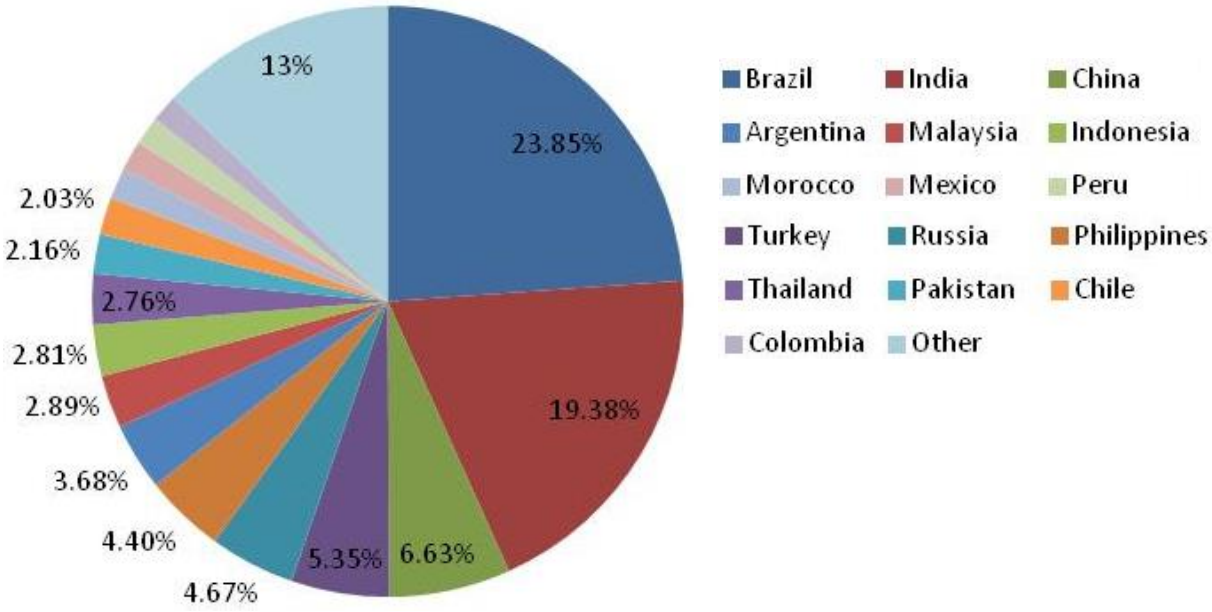
As illustrated by Figure 3.9, private finance for electrification is more strongly concentrated, with Brazil, India and China capturing half of it.[13] Brazil captured more than 50 per cent of global private finance for transmission and distribution, as a result of the privatisation of distribution companies during the 1990s. It was also the highest recipient of private finance for generation with renewable sources, mainly in the hydro sector, and received 39 per cent of global private finance for this concept during the 1990–2010 period, followed by India and China, which received 8 per cent and 7 per cent respectively. Meanwhile, India captured 32 per cent of global private investment in generation with non-renewable sources, mostly coal power plants, followed by China (9 per cent) and the Russian Federation (8 per cent).

Figures 3.10 and 3.11 show the countries that received the most and the least ODA and private investment for electrification in per capita terms. Figure 3.10 shows firstly a bias towards smaller countries, meaning that countries with smaller populations are likely to get higher levels of aid per capita. It also shows that the higher levels of aid per capita in the past two decades have not actually been channelled towards those countries with the highest gap in electricity access, particularly sub-Saharan African countries like Nigeria and the Democratic Republic of Congo (DRC), or countries with high levels of poverty (proxied with infant mortality rates), like Angola, Haiti, the DRC and Zimbabwe. Political drivers seem to be behind high levels of aid to the Iraqi electricity infrastructure, which received funding mainly

[12] Our data do not include for government finance and hence downplay the importance of China, which accounted for around 60 per cent of the growth of investment in power plants in non-OECD countries between 2000 and 2012 (IEA 2014).
[13] The fact that PPI might miss out on the undisclosed private investments that could be significant in China means that concentration of private investment could be even higher.

for the transmission and distribution networks that were destroyed after the war, or the low levels of aid provided to countries ruled by repressive regimes, such as Myanmar and the Democratic People's Republic of Korea. Other countries, like Iran and Cuba, already enjoy near universal access and would not require high levels of aid.

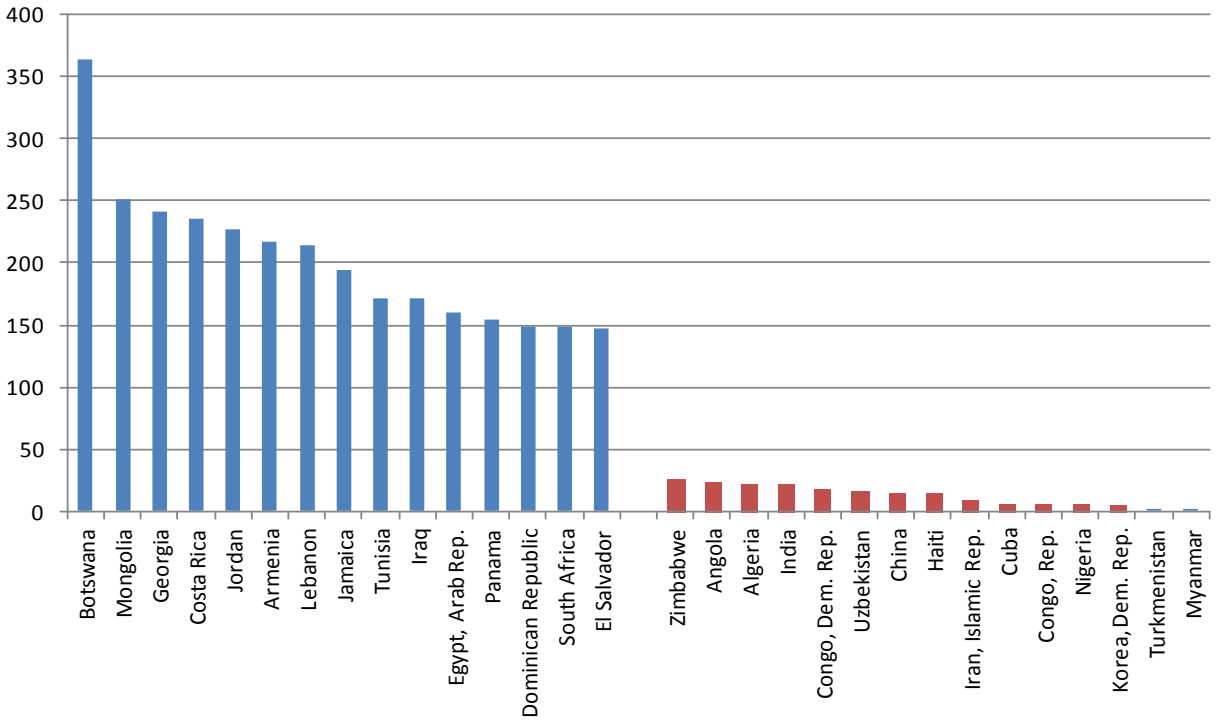
Figure 3.9 Private electrification finance by recipient 1990–2012



Source: Authors' own, based on data from World Bank (2014)

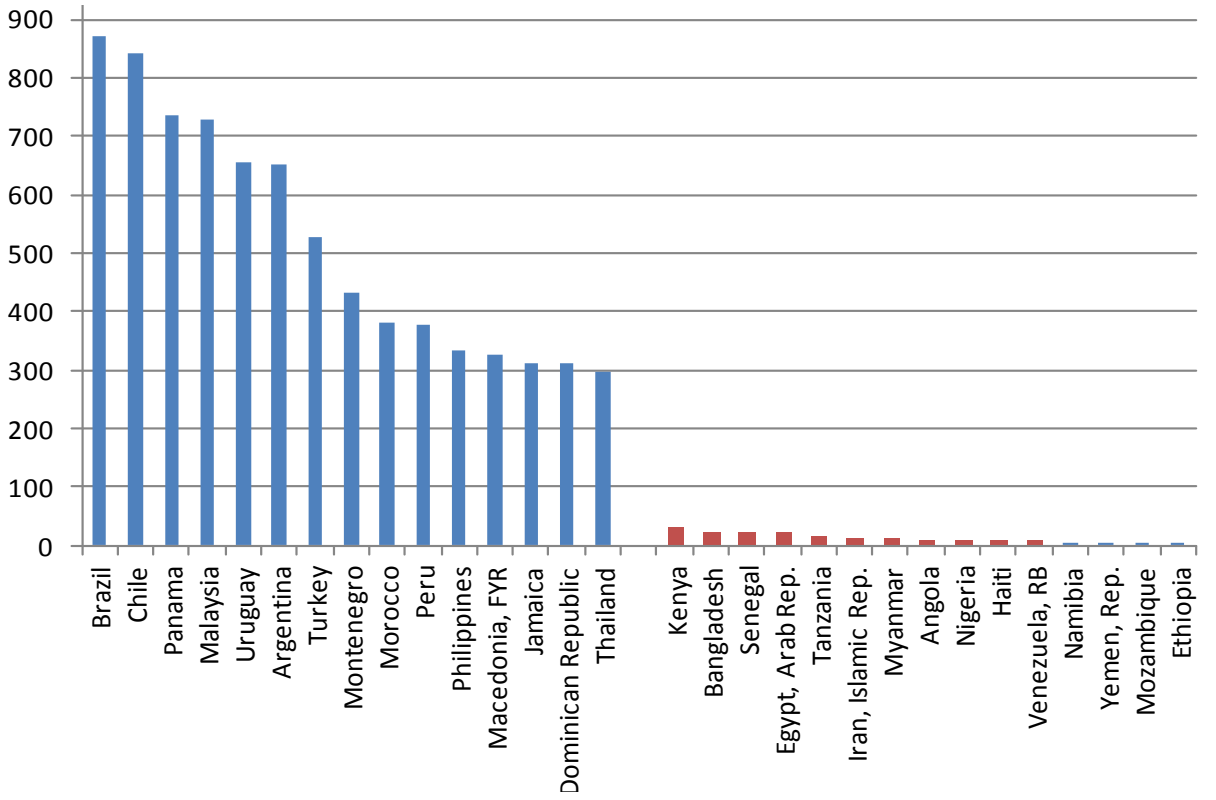
As regards the countries that received the greatest and smallest levels of private investment per capita, it can be seen in Figure 3.11 that South American countries that embraced the privatisation wave starting in the 1980s are at the top of the list, mainly Brazil, Chile and Argentina. As with aid, two Caribbean countries, Jamaica and the Dominican Republic, have captured significant inflows per capita. Meanwhile, the private sector has left behind sub-Saharan African countries with low access rates such as Ethiopia, Mozambique, Nigeria, Tanzania and Kenya.

Figure 3.10 Top and bottom 15 country recipients of electrification aid per capita 1990–2010 (US$)



Source: Authors' own, based on data from WDI (2014) and AidData 2.1 (2014)

Figure 3.11 Top and bottom 15 country recipients of private electrification finance per capita 1990–2010 (US$)



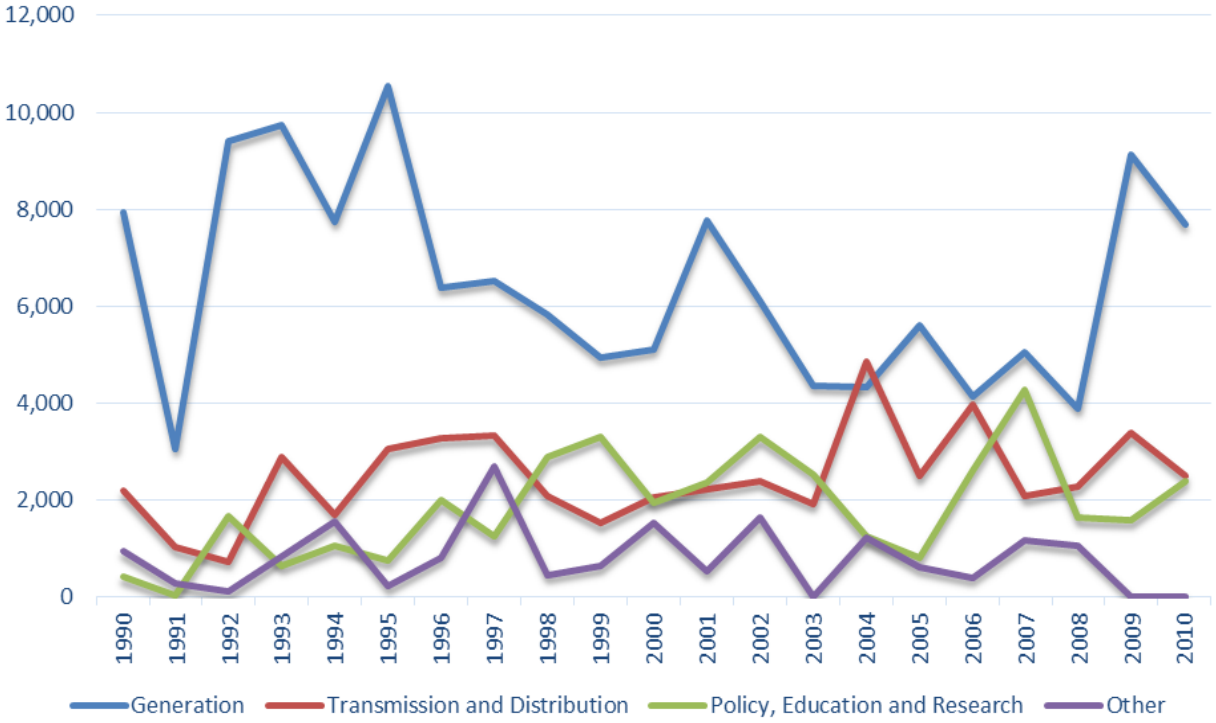
Source: Authors' own based on data from WDI (2014) and World Bank (2014)

3.4 What for?

This subsection shows the allocation of funds across the hardware elements of generation, transmission and distribution infrastructure and the software elements related to policy, management and capacity building.

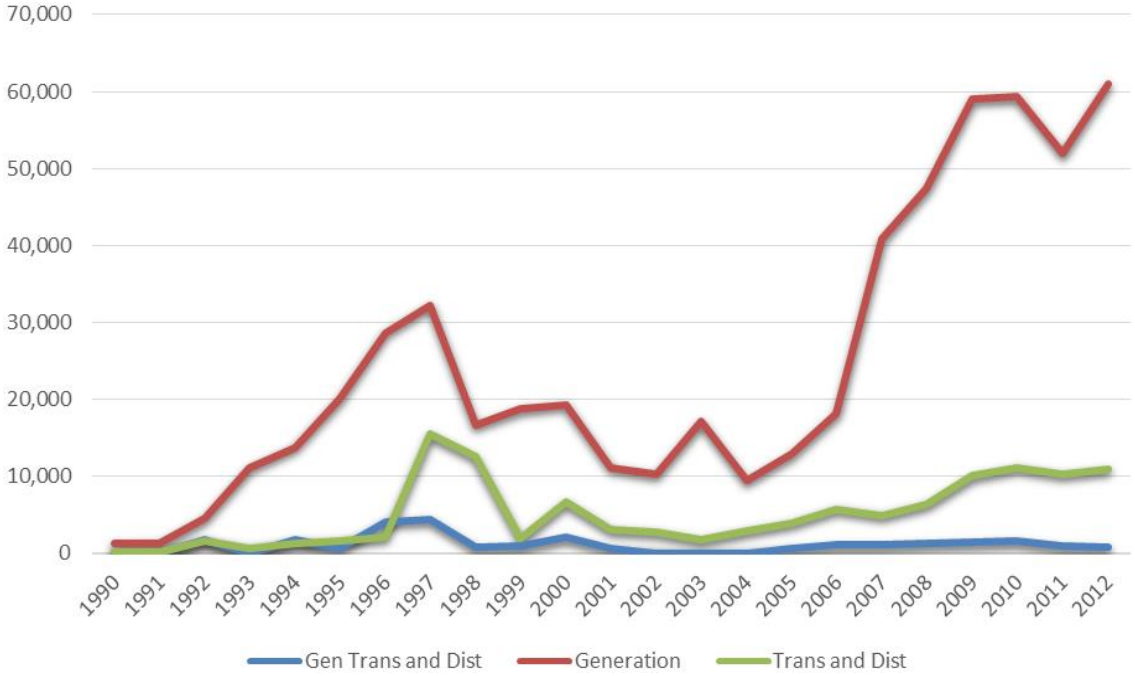
Figure 3.12 reveals the decreasing importance of generation in ODA budgets, from 1995 onwards, with an increasing share of transmission and distribution and policy and management projects. Conversely, in Figure 3.13, the private sector shows an increasing emphasis on generation projects as opposed to transmission and distribution, with the exception of the privatisation wave of the 1990s which involved the sale of public distribution companies. Generation is generally more amenable to the private sector than transmission and distribution because it provides a tradable commodity, whereas the transmission and distribution of power are natural monopolies providing network services (Besant-Jones 2006).

Figure 3.12 Electrification ODA by subtype (US$m), 1990–2010



Source: Authors' own, based on data from AidData 2.1 (2014). All figures are in millions and in constant 2009 US$.

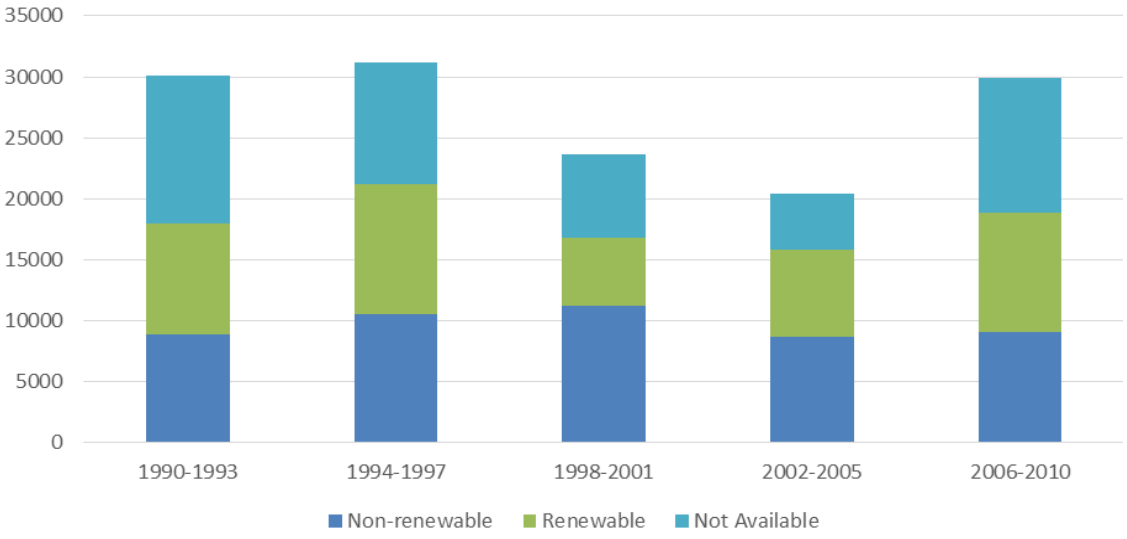
Figure 3.13 PPI electrification finance by Subtype (US$m), 1990–2012



Source: Authors' own, based on data from World Bank (2014). All figures are in millions and in constant 2009 US$.

Figure 3.14 suggests that electrification aid has not significantly increased its focus on renewable energy sources, as the shares between renewable and non-renewable sources are quite similar. The low share of renewable energy shown by the data, even in the most recent years, could be because some forms of public assistance for renewables are not classified as ODA if they are used as a part of a larger package of concessional finance. ODA may also be making an important contribution to renewable energy which is not well captured by the data – for example, if it guarantees investments in generation, as we have seen. Among renewables, hydropower technology has been the most funded by donors in the past two decades, whereas finance for non-renewable generation is concentrated in coal and gas. However, aid to coal power plants has been nearly abandoned in the past decade.

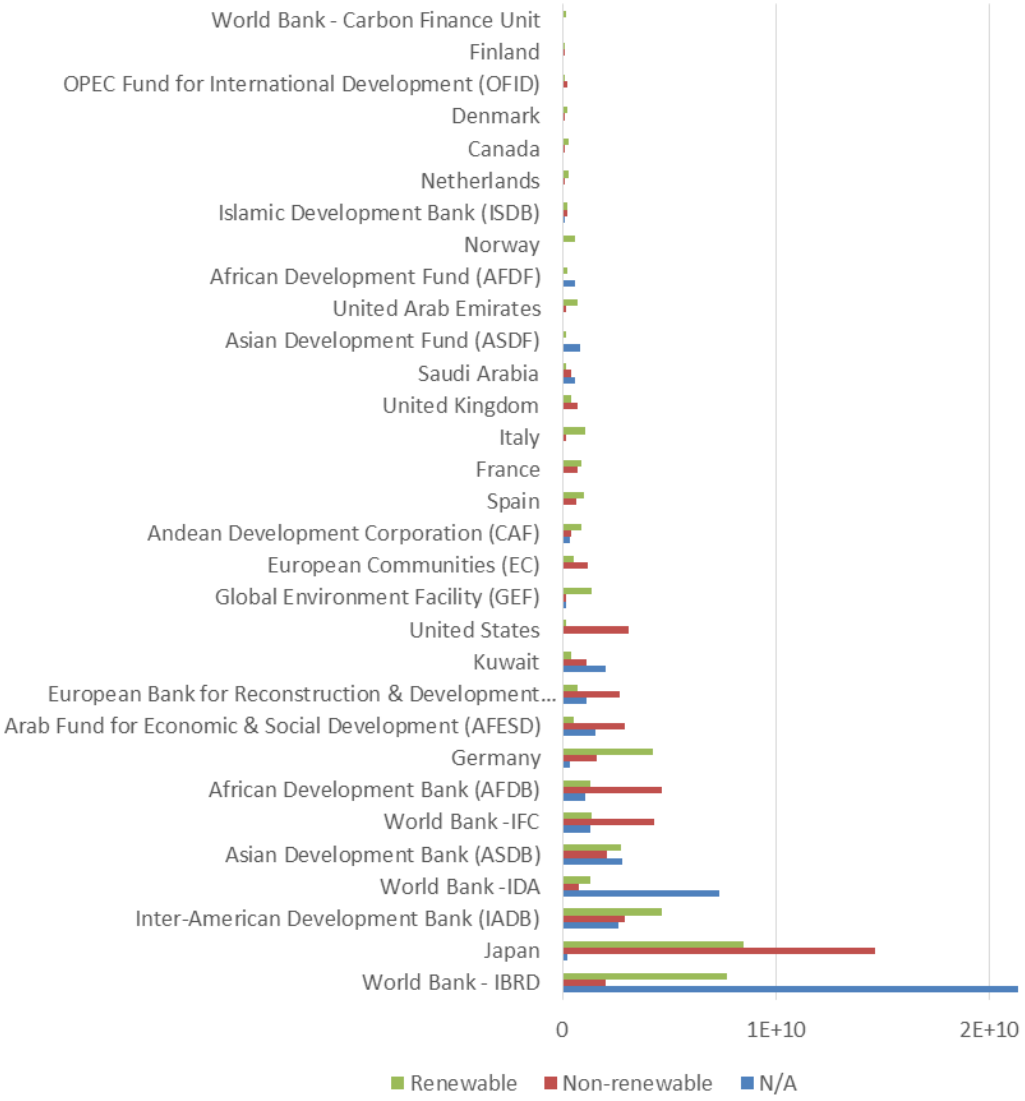
Figure 3.14 Electrification aid by type of generation (US$m), 1990–2010



Source: Authors' own, based on data from AidData 2.1 (2014). All figures are in millions and in constant 2009 US$. Only projects classified in subtype as 'generation' are included.

Figure 3.15, meanwhile, presents the share between renewable and non-renewable per donor. Some institutions, such as the International Finance Corporation (IFC), have explicitly moved towards renewables as a focus of financing[14] but the aggregated data for the past two decades still do not show a clear shift. The large amount of World Bank projects for which data about energy source are not available is also preventing us from drawing clear conclusions.

Figure 3.15 Electrification aid for generation per donor and energy source 1990–2010 (US$bn)



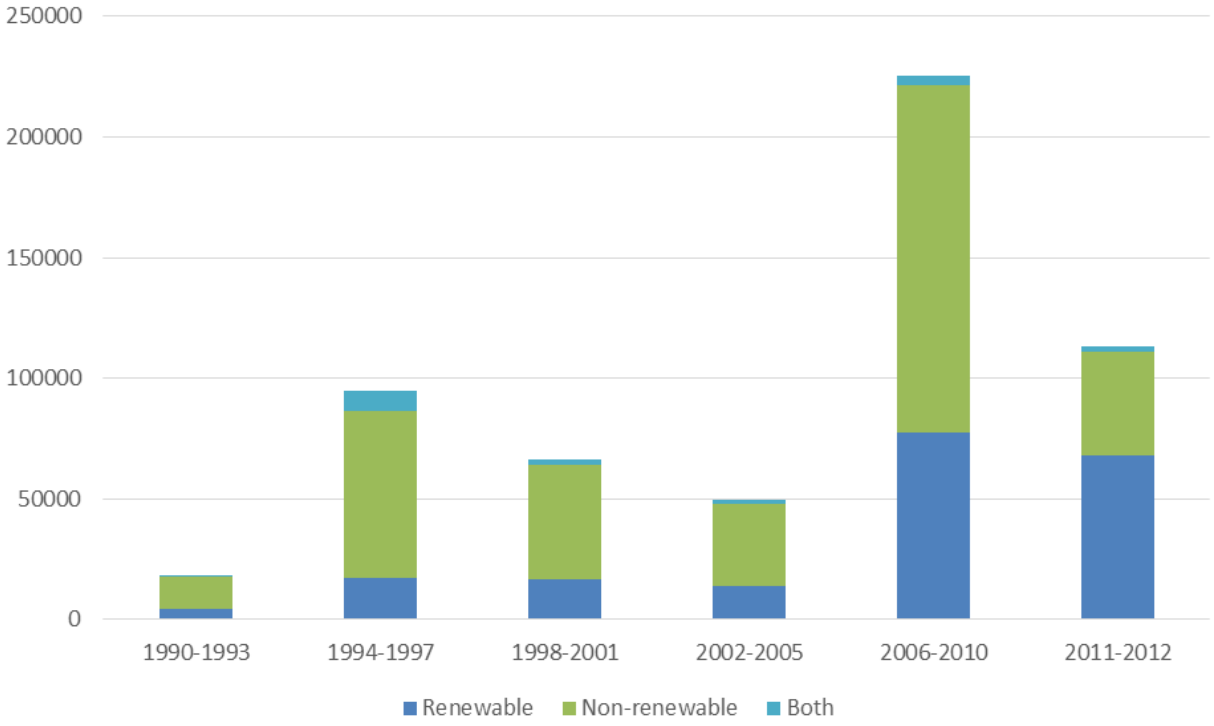
Source: Authors' own, based on data from AidData 2.1 (2014). All figures are in billions and in constant 2009 US$. Only projects classified in subtype as 'generation' are included.

Figure 3.16 shows that private finance has tended to favour non-renewable generation technologies, particularly coal in the second half of the 2000s. However, the most recent period (2011–12) shows a growth in private sector finance for renewable generation which is also supported by alternative sources of data such as those provided by Bloomberg New Energy Finance (Frankfurt School-UNEP Centre/Bloomberg New Energy Finance 2014). Globally, private investment in renewable energy has grown at an annual average of 21 per cent since 2007, nearly doubling between 2011 and 2012 (World Bank 2013). This was partly

[14] Interview with Stephen Spratt, Research Fellow at IDS, 18 and 25 November 2014.

caused by the cutting back of policies in support of renewable energy in Europe following the crash, which led companies to search for new investment opportunities in developing countries.[15]

Figure 3.16 PPI electrification finance by type of generation (US$m), 1990–2012



Source: Authors' own, based on data from World Bank (2014). All figures are in millions and in constant 2009 US$. Figure 3.12 only includes projects classified in subtype as 'generation'.

The relatively even spread of both aid and private investment across power generation technologies in developing countries reflects their use of most available options to satisfy surging electricity demand (IEA 2014).

3.5 Impact on electrification rates

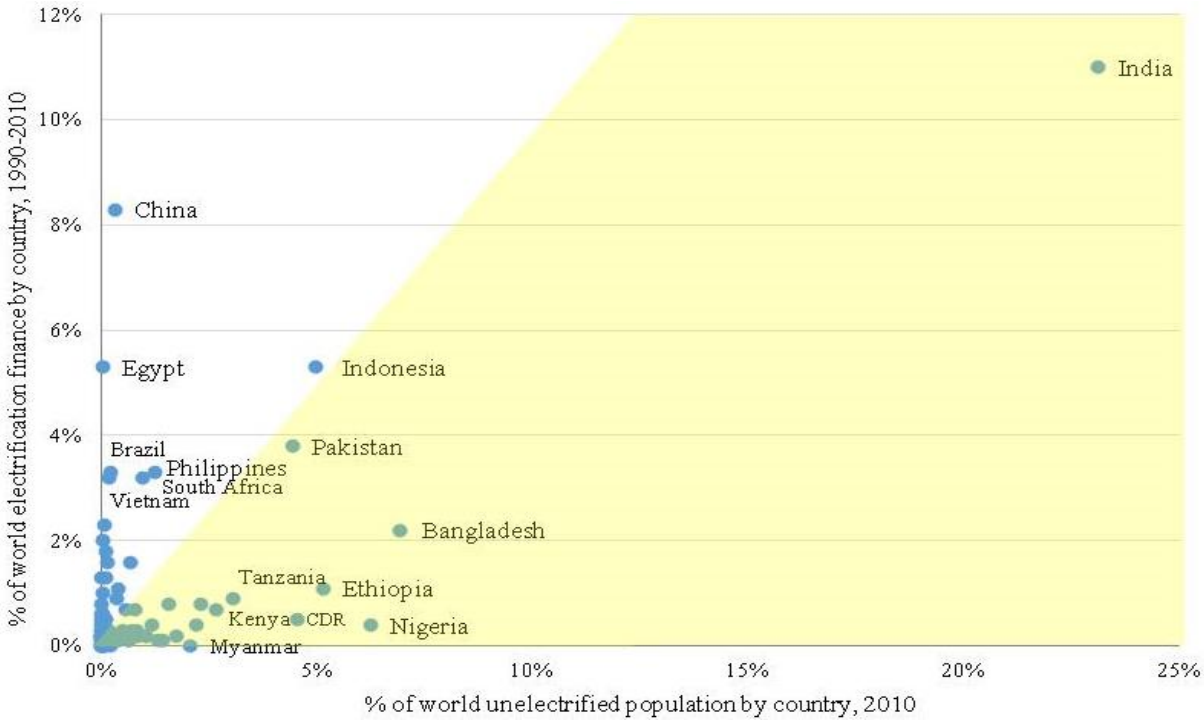
Our analysis does not show a clear relationship between the levels of ODA and private investment received and its progress towards increasing electrification rates. There is a high correlation between total aid and private investment received and the reduction in total unelectrified population. However, it disappears when we correct for the scale effect and look at correlations between electrification rates and finance flows per capita. This could be due to the different shares of both aid and private investments in electricity that different countries direct towards energy access, understood as an increase in the number of connections and the use of a sufficient amount of electricity. For example, the International Energy Agency (IEA) estimates that between 5 per cent and 20 per cent of the total investment recorded in the PPI database goes towards energy access (IEA 2011). It is likely that a large share goes towards improving infrastructure for those already connected or to support economic growth through commercial uses.

Figures 3.17 and 3.18 map countries according to the percentage of total ODA or private investments for electrification they have received in the past two decades and the percentage of global population without access to electricity that live in these countries. India

[15] Interview with Dana Rysankova, World Bank Senior Energy Specialist, 4 December 2014.

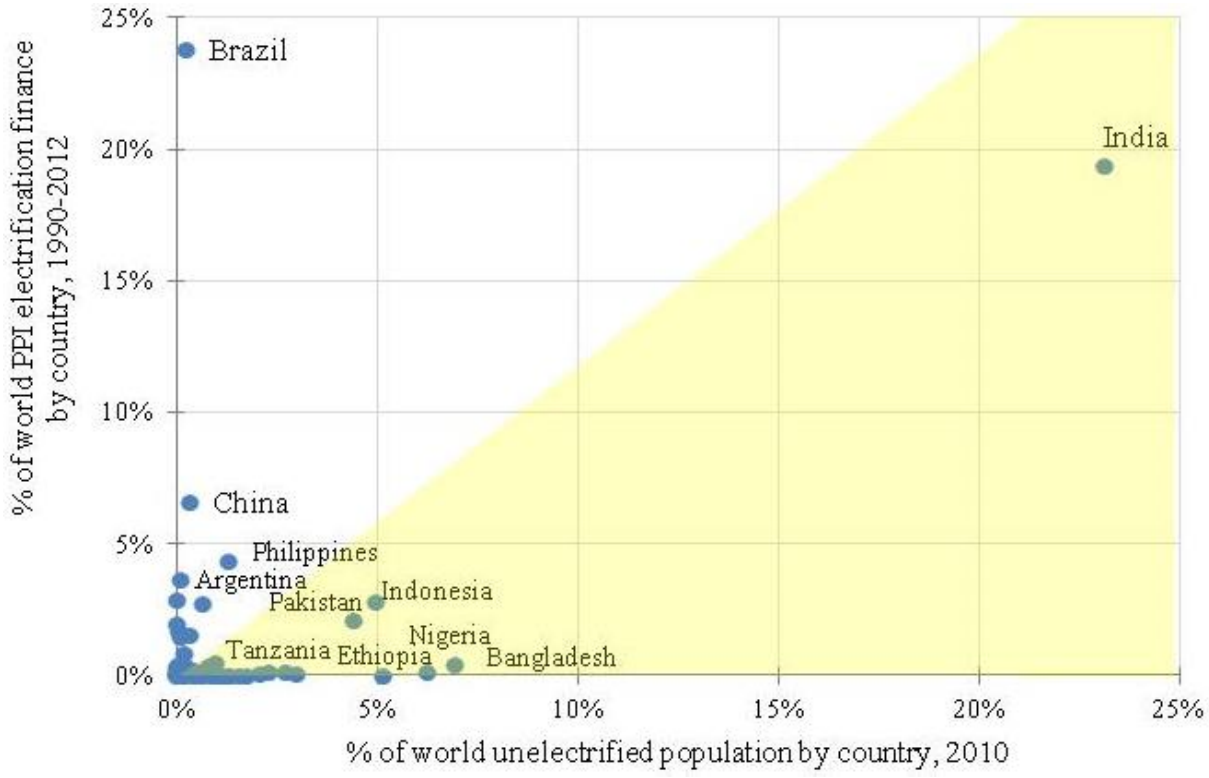
has received the largest share of aid and the second largest share of private investment for electrification, but still hosts the largest number of people without access to electricity in the world. As we will see, however, India has nevertheless made a significant effort to reduce the number of unelectrified people since 1990. China is the second country in terms of aid received for electrification since 1990, but now claims a 100 per cent electrification rate. However, most progress towards this goal was made before 1990. Brazil has received the largest share of private investment for electrification and a significant share of aid and has also nearly eradicated lack of access to electricity. Other countries showing relatively large shares of aid for electrification and small access gaps include Egypt, Vietnam, South Africa, the Philippines, Morocco and Argentina. On the other side, countries that show large access gaps but had received relatively low levels of aid for electrification until 2010 include Nigeria, Ethiopia, Tanzania, DRC and Bangladesh. Figure 3.18 reveals that private investment has not reached countries with very low levels of access such as Bangladesh, Nigeria and Ethiopia, but has flown widely to countries like Brazil, China and Argentina, which had already provided near-universal access by the year 2000.

Figure 3.17 Percentage of world electrification aid received per country 1990–2010 and percentage of world unelectrified population in 2010



Source: Authors' own, based on data from WDI (2014), AidData 2.1 (2014) and IEA (2012).

Figure 3.18 Percentage of private investments received per country 1990–2010 and percentage of world unelectrified population in 2010



Source: Authors' own, based on data from WDI (2014), World Bank (2014) and IEA (2012).

Table 3.1 lists the countries that have shown the largest increase in electrification rates since 2000. For example, Nepal had an electrification rate of 15.6 per cent in 2000 and had reached 76 per cent in 2011. Myanmar's electrification rate was 5 per cent in 2000 and is now 49 per cent. Bangladesh's rate was 20.4 per cent in 2000 and is now 60 per cent. Cameroon and India follow suit. In absolute numbers, South and East Asian countries have made the largest effort to provide electricity to an increasing number of their populations since 2000 and are to be praised for most of the global progress during the past two decades. India stands out with an additional 273 million people electrified since 2000, followed by Bangladesh, with 44 million, and Indonesia, with 32 million. However, these figures need to be looked at with caution. For example, the definition of rural 'access' in India has changed through the years, often involving just the availability of distribution lines passing by a village, even if few households are connected or if electricity is available for as little as one hour per day.[16] The large inflow of private investment received in India since the early 2000s is not thought to have had a significant impact on access, as it was mainly directed to increasing generation capacity to improve the supply in large and some second tier cities.[17]

[16] Interview with Hari Natarajan, Senior Technical Advisor for the Indo-German Energy Programme, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. 20 December 2014.
[17] *ibid.*

Table 3.1 Top 20 countries increasing electrification rates 2000–2011

Country	Electrification rate % 2000	Electrification rate % 2011	Incremental number of people with electricity 2000–2011 (million)
Nepal	15.4	76	12
Myanmar	5	49	21
Bangladesh	20.4	60	44
Cameroon	20	54	3
India	43	75	273
Nicaragua	48	78	1
Dominican Republic	66.8	96	2
Gabon	31	60	0.2
Honduras	54.5	83	2
Morocco	71.1	99	8
Ghana	45	72	4
Bolivia	60.4	87	2
Senegal	30.1	57	1
Namibia	34	60	0.3
Angola	12	38	1
Botswana	22	46	0.1
Paraguay	74.7	98	1
Sri Lanka	62	85	4
El Salvador	70.8	92	1
Vietnam	75.8	96	16

Source: Authors' own, based on data from WDI (2014), IEA (2002) and IEA (2013).

The scale of the progress in increasing electrification rates, in terms of number of people with a connection, does not always reflect the depth or quality of this access, which is generally measured in terms of actual consumption. As shown in Table 3.2, many of the countries previously described as high achievers actually show very low consumption levels per capita, particularly Nepal and Myanmar, but also India. There could be several causes for this in addition to low household consumption, such as low industrial and commercial uses,[18] or the prevalence of self-generation, which may not appear in official energy statistics.

Table 3.2 Countries with high percentages of access to electricity but low electricity consumption per capita, 2010

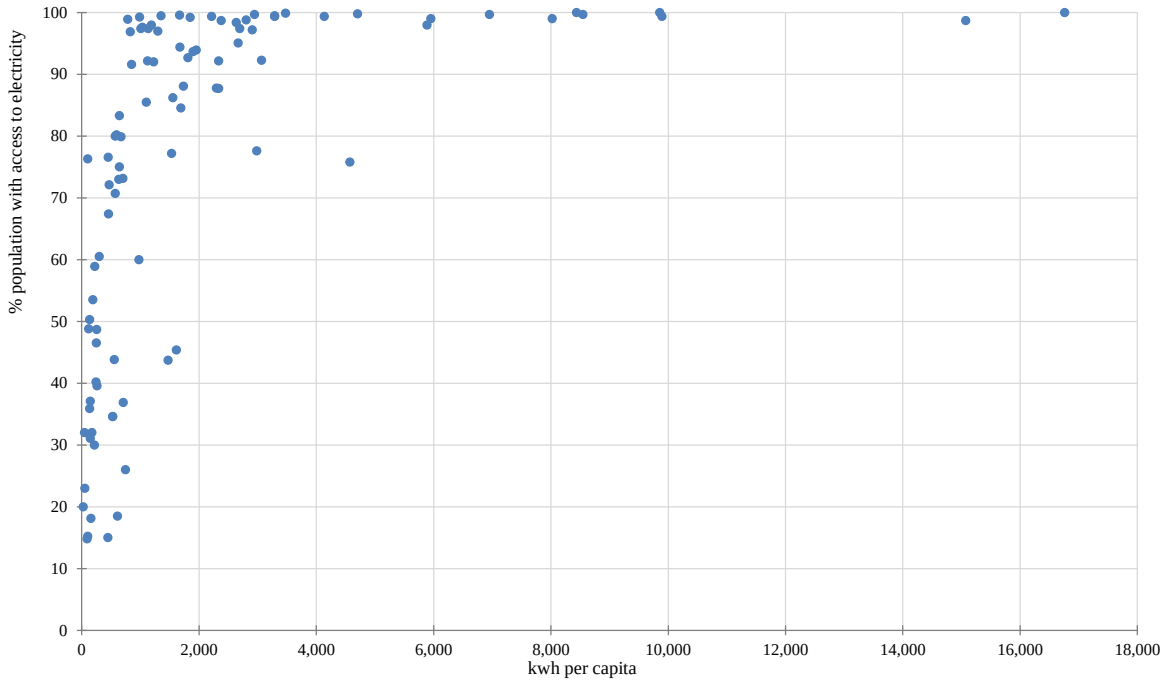
Year	Yearly electricity consumption per capita kWh	Percentage of population with access to electricity
Nepal	103.4	76.3
Myanmar	121.1	48.8
Nigeria	135.4	50.3
Senegal	187.7	53.5
Cote d'Ivoire	224.7	58.9
Ghana	299.1	60.5
Sri Lanka	449.2	76.6
Pakistan	457.8	67.4
Nicaragua	470.4	72.1
Guatemala	569.2	80.0
Bolivia	592.5	80.2
Indonesia	634.5	73.0
India	641.3	75.0
Philippines	641.5	83.3
Honduras	668.9	79.9
Morocco	783.3	98.9
Dominican Republic	830.5	96.9
El Salvador	852.5	91.6
Gabon	974.2	60.0
Algeria	986.9	99.3

Source: Authors' own, based on data from WDI (2014) and IEA (2012)

Figure 3.19 illustrates that there is a wide range of consumption levels per capita among countries with near-universal access to electricity. Electricity can only convey its potential to reduce poverty and promote economic growth when it is used at a sufficient level. Therefore, high access rates with low electricity consumption levels still reflect pervasive energy poverty.

[18] *ibid.*

Figure 3.19 kWh per capita and population with access to electricity at country level, 2010



Source: Authors' own, based on data from WDI (2014) and IEA (2012).

4 Econometric model

This section provides an econometric analysis of the determinants of electrification finance flows in developing countries. The objective is to understand why some developing countries receive more finance for electrification than others in per capita terms, as has been observed in Section 3, and to derive policy recommendations on how to improve the attractiveness of countries receiving insufficient flows.

The period of examination covers the years ranging from 1991 to 2010. A potentially problematic characteristic of electrification aid and private electrification investments is that these flows are often lumpy. This arises because there are certain years when large investments occur (e.g. when a major hydroelectric project is constructed) that are subsequently followed by years in which very little or no finance is received at all, even though the project is still in progress (Hausman *et al*. 2014: 59). To minimise this issue, both the dependent and independent variables used in the econometric analysis were smoothed and thus constructed as the means of either ten- or five-year periods. Specifically, ten-year panels for 1991–2000 and 2001–10 were created, and were subsequently estimated as pooled cross-sections for the whole 20-year period. In addition, five-year panels for 1991–95, 1996–2000, 2001–05 and 2006–10 were also constructed, and were once again estimated as a pooled cross-section for the entire period. The use of both ten- and five-year panels allows us to examine the sensitivity of the results to the level of year aggregation. Aggregating the data into ten-year panels compared to five-year panels has the advantage of minimising the issue of missing values, which is a common problem when working with data from developing countries. Nonetheless, the use of more aggregated data has its drawbacks since it captures to a lesser degree yearly variations in the explanatory variables. Five-year panels increase our sample size and capture more of the variation of the covariates through the two decades.

To determine the patterns of electrification finance flows in developing countries, regressions are estimated through ordinary least squares (OLS) and, due to the truncation of the dependent variable, as a left-censored Tobit. The advantage of a left-censored Tobit technique is that it includes all countries that received aid or private investment in any time period, even if they show zero values in other time periods, as long as data for the control variables are available. Because finance for electricity is very lumpy, this technique is particularly appropriate for our data set.

The estimated models are specified as follows:

$$ln(y_{it}) = \alpha + X_{it}\beta + \mu_c + \delta_t + \epsilon_{it} \qquad (1)$$

where y_{it} denotes either electrification aid received per capita or private electrification finance received per capita for country $\boldsymbol{i}$ in period $\boldsymbol{t}$; X_{it} denotes a matrix of country-level characteristics that may affect electrification finance; μ_c represents continent-level dummies that capture time-invariant characteristics which may affect electrification finance flows; δ_t represents time dummy variables that help control for trends in electrification finance flows; and ϵ_{it} is an error term.

The covariates included in the matrix X_{it} can be grouped into five general categories:

1. Size, structure and prospects of the economy, including GDP per capita, GDP per capita squared, annual GDP growth rate, and population size[19]
2. Poverty, including the infant mortality rate
3. Energy poverty, including lagged values of electric power consumption per capita[20]
4. Governance, including the Freedom House political rating and dummy variables for the country's power supply structure
5. Energy resources, including the gross theoretical capability of hydropower and the pump price of diesel fuel.[21]

The linear and quadratic terms of the GDP per capita variable allow us to see not only if finance flows are directed towards high- or low-income economies, but also if this relationship is non-linear. The Freedom House rating for political rights variable (Freedom House 2014) provides a yearly assessment of the state of global freedom as experienced by individuals. The rating ranges from one to seven, taking the value of one for countries with the best assessment of global political rights and civil liberties and the value of seven for the worst. We would therefore expect the rating to be inversely related to aid and private investment in electricity. The power supply structure variables capture the sensitivity of electrification finance flows to the country's stage of power sector reform as defined in Besant-Jones (2006). The reference category is constituted by countries that have retained the traditional structure of a vertically integrated monopoly. The middle category (VIP[22] + IPPs,[23] Comb. gen. and trans. entity) includes countries with a national generation, transmission or distribution entity, a combined national generation and transmission entity, or a combined transmission and distribution entity acting as the single buyer with IPPs that sell power to it and regional distribution entities unbundled from the monopolist that buy power from it. The final, most advanced category (Many dist., gen., and trans. entities) includes countries with many distribution and generation entities and a transmission entity formed from unbundling the monopolist, in which the transmission entity acts as a single buyer of power from the generators and IPPs and sells power to the distribution entities and large users of power. We acknowledge that this is a rough measurement of power sector reform, which is more a process than a static event and has several dimensions in addition to privatisation. However, the complexity of power reform processes as well as time constraints as part of this study have precluded a more detailed and updated measurement of the stage of power sector reform.

On the other hand, μ_c includes dummies for the continents of America, Asia and Europe, where Africa represents the reference category. Finally, in the models constructed based on the ten-year panels, δ_t includes a time dummy for 2001–10, where the 1991–2000 period is taken as the reference category. The estimations performed on the five-year panels include

[19] Previous specifications also included the square of the logarithm of the population but this variable was dropped from the final model since it was generally not statistically significant. A variable denoting crude oil reserves was also included in previous specifications but was subsequently not incorporated. This was because the variable was somewhat correlated with the variable pump price of diesel fuel and because it was generally not significant. Finally, other covariates such as the country's installed electricity capacity or the pump price of gasoline were not included since they are highly correlated with other variables such as electric power consumption or the pump price of diesel, respectively.

[20] Although potentially important to the analysis, a variable indicating the country's electrification rate or access to electricity was not included in the final specification for a variety of reasons. First, among the 134 countries examined, information on electrification rates was only available for 75 of them. In addition, over the 20-year period of analysis, data on country-level electrification rates could only be obtained from 2009 onwards. Finally, for the years in which the information was indeed available, changes in the data collection method imply that these annual figures are not directly comparable to one another.

[21] In results not shown, the investment share of GDP was also included as a regressor. The variable was subsequently not included since it was generally not significant. As argued by Hausman *et al*. (2014: 59), this covariate is thought to capture the prospective rewards of a growing capital stock for either electrification aid or privately financed electrification projects. Furthermore, it can be interpreted as testing whether these financial flows followed previous investments.

[22] Vertically integrated monopolist.

[23] Independent power producers.

time dummies for 1996–2000, 2001–05, and 2006–10, where the 1991–95 period is taken as the reference category.[24]

Since the dependent variable is in logarithms, the OLS estimations only include country-level observations that received a positive amount of electrification finance flows in the period of reference. Limiting the analysis to countries that receive a positive amount of electrification finance is likely to affect the econometric results. Therefore, the Tobit estimations include all countries irrespective of whether or not they received zero electrification finance.[25]

[24] Data on GDP per capita, GDP growth rate, population size, infant mortality rate, electric power consumption and pump price of diesel fuel were taken from WDI (2014). Information on the country's hydropower gross theoretical capability was obtained from WEC (2001, 2004, 2010). Information on the country's political rating was taken from the Freedom in the World Country Ratings database collected by Freedom House. See www.freedomhouse.org. Information on the country's power supply structure was obtained from Besant-Jones (2006).

[25] Given that the dependent variable is in logarithms, the Tobit model was estimated with the dependent variable defined as $ln(y_{it} + 1)$.

5 Results

As previously stated, estimations of Eq. (1) which help explain the allocation of electrification finance based on recipients' characteristics were performed for the data aggregated into both ten- and five-year panels. When applicable, the regressions were corrected for heteroskedasticity using robust standard errors based on the method outlined in White (1980).

Table 5.1 shows results of OLS estimations including both dependent variables on aid and private investment (PPI) and both ten- and five-year panels covering the period from 1991 to 2010. Electrification aid flows grouped in ten-year panels are positively associated with a country's annual GDP growth rate and negatively related with its population size and Freedom House rating, where these last two coefficients are statistically significant at the 1 per cent level. The positive relationship with GDP growth indicates that electricity aid is specifically allocated to places that are growing more quickly. The negative relationship with population size indicates that smaller countries receive more aid per capita. The Freedom House rating variable sheds light on whether the quality of the recipient's country governance is important for donors. Consequently, the negative sign suggests that donors indeed favour countries with higher quality governance. The infant mortality rate, which is a measure of poverty, is negatively related with total electrification aid, where this variable is statistically significant at the 10 per cent level. This could indicate a shift in donor priorities towards covering basic needs such as health and nutrition in the poorest countries, instead of access to electricity, whose link to poverty reduction was questioned by the World Bank in the 1990s. Compared to 1991–2010, aid flows appear to be lower during 2001–10 since the time dummy for this period is statistically significant at the 10 per cent level. Energy poverty, measured as electricity consumption per capita, is not significant enough to explain aid flows. Regressions using five-year panels provide very similar results but show a higher size of the coefficients of GDP growth and infant mortality rate. A lower year disaggregation can also capture the impact of power sector reform, showing that countries at the early stages of power sector reform appear positively and significantly correlated with total flows of electrification aid. Compared to 1991–95, the two five-year periods after 2000 appear to receive lower aid flows.

We now shift our attention to private electrification finance flows, where OLS results are also presented in Table 5.2. It can be seen that total flows are highly responsive to GDP per capita, where this covariate has a positive but decreasing effect on the dependent variable. Moreover, the country's hydro resources, its power supply structure compared to countries with a vertically integrated monopoly, and being located in Asia also influence total private electrification flows in a positive manner. On the contrary, population size and the lagged values of electric power consumption per capita produce a negative effect on total private flows. Results with five-year panels are broadly similar but are able to capture the impact of the variability of fossil fuel prices, with countries with higher prices attracting more private investment for electrification. Electric power consumption per capita is not significant when using five-year periods. The period 1996–2000 saw the highest level of private investment as compared with the reference period 1991–95, with lower investment after 2000.

The Tobit estimations on the determinants of electrification aid and private investment flows are presented in Table 5.2. In the case of total electrification aid, the sign and significance of the coefficients are similar to those obtained in the OLS model, showing that countries with growing economies, low infant mortality rates, a good governance rating and which are at the early stages of power sector reform are likely to receive more aid for electrification. Besides, smaller countries receive more electrification aid per capita.

Tobit estimations on the determinants of private electrification finance flows show, like OLS estimations, that these are positively associated with GDP per capita but with a decreasing

rate, and with high fossil fuel prices. Unlike the OLS results, Tobit estimations show a stronger influence of power sector reform, with countries at the most advanced stages of reform likely to receive more investment, but countries at early stages also receiving significantly more investment than those keeping a monopolistic power sector. Besides, a better governance rating has a positive influence that is not captured by OLS estimations. European countries are negatively associated with private investment in electrification.

Some interesting differences between drivers of aid and private finance for electrification are that recipient countries' income levels do not seem to influence aid, but they have a strong influence on private finance. Poverty rates which are proxied with infant mortality rates do not have an influence on private finance, but limit aid for electrification, probably as donors' priorities shift towards covering basic needs. Countries with growing economies are favoured by aid flows, but not by private investors. Private investment is much more responsive than aid to market forces such as power sector reform, the high price of fossil fuels (which could also proxy for cost recovery pricing in the power sector) and the cost and availability of hydro resources (measured as gross theoretical capability of hydropower). Private finance also shows a positive geographic bias towards Asian countries and a negative bias towards European countries and this is not observed in aid flows. The energy poverty of the recipient country does not show a significant influence on either aid or private investment. Our model can explain much more of the variation of private investment than that of aid, as shown by the R-square. This is probably because the model does not include covariates related to the political and historical links between donors and recipients, which play a strong influence on allocation of aid. Previous research has shown, for example, that countries' colonial histories and voting patterns in the UN explain more of the variation in aid allocated than economic and governance variables (Alesina and Dollar 2000).

Table 5.1 OLS dependent variables: log of electrification aid and log of electrification PPI (pooled ten- and five-year averages), 1991–2010

	Aid: 10 year	Aid: 5 year	PPI: 10 year	PPI: 5 year
Log (GDP per capita)	0.828 (1.764)	–0.428 (1.318)	6.933*** (2.280)	6.060*** (2.074)
[Log (GDP per capita)]2	–0.083 (0.122)	–0.014 (0.092)	–0.410*** (0.155)	–0.349** (0.141)
Annual GDP growth rate	0.099** (0.044)	0.160*** (0.046)	–0.007 (0.057)	0.051 (0.049)
Log (population)	–0.290*** (0.110)	–0.271*** (0.096)	–0.305** (0.118)	–0.251*** (0.091)
Infant mortality rate (per 1,000 live births)	–0.142* (0.078)	–0.217*** (0.064)	0.039 (0.073)	0.039 (0.069)
Electric power consumption (kWh) (t-1)	0.148 (0.177)	0.198 (0.172)	–0.462* (0.245)	–0.252 (0.154)
Freedom House rating	–0.240*** (0.088)	–0.227*** (0.063)	–0.044 (0.105)	–0.042 (0.081)
Hydropower: Gross theoretical capability (MWh/year)	–0.007 (0.011)	–0.007 (0.009)	0.015** (0.006)	0.014** (0.006)
Pump price per diesel fuel (US$ per litre)	0.801 (0.860)	0.870 (0.623)	1.304 (0.805)	1.353** (0.569)
PSS: VIP + IPPs, Comb. gen. and trans. entity	0.464 (0.328)	0.651** (0.262)	1.063** (0.487)	0.968*** (0.362)
PSS: Many dist., gen., and trans. entities	0.236 (0.390)	0.369 (0.368)	0.956 (0.643)	0.820* (0.448)
America	0.373 (0.506)	0.235 (0.397)	0.726 (0.509)	0.533 (0.454)
Asia	0.463 (0.435)	0.162 (0.334)	1.743*** (0.352)	1.265*** (0.344)
Europe	–0.282 (0.612)	–0.123 (0.539)	1.272 (0.835)	0.884 (0.629)
t = 2001–10	–0.846* (0.455)		–0.669 (0.437)	
t = 1996–2000		–0.234 (0.267)		0.895** (0.383)
t = 2001–05		–1.156*** (0.351)		–0.438 (0.390)
t = 2006–10		–1.438*** (0.536)		–0.373 (0.487)
R2	0.318	0.325	0.507	0.441
Observations	150	271	107	173

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is in per capita terms. PPI refers to private participation in infrastructure. Monetary figures are in constant 2009 US$. PSS refers to power supply structure. VIP refers to vertically integrated monopolist. IPP refers to independent power producer. A constant was included in all regressions. Standard errors are in parentheses.

Table 5.2 Tobit, dependent variables: log of electrification aid and log of electrification PPI (pooled ten- and five-year averages), 1991–2010

	Aid: 10 year	Aid: 5 year	PPI: 10 year	PPI: 5 year
Log (GDP per capita)	0.348 (0.902)	0.376 (0.713)	3.139* (1.868)	4.265** (1.741)
[Log (GDP per capita)]2	–0.030 (0.062)	–0.038 (0.049)	–0.190 (0.127)	–0.268** (0.118)
Annual GDP growth rate	0.046*** (0.016)	0.069*** (0.015)	0.048 (0.032)	0.047 (0.033)
Log (population)	–0.198*** (0.050)	–0.173*** (0.041)	0.012 (0.095)	0.046 (0.085)
Infant mortality rate (per 1,000 live births)	–0.074** (0.035)	–0.082*** (0.029)	–0.036 (0.068)	0.016 (0.062)
Electric power consumption (kWh) (t-1)	0.056 (0.069)	0.105 (0.064)	–0.108 (0.132)	0.040 (0.135)
Freedom House rating	–0.105** (0.041)	–0.111*** (0.033)	–0.163** (0.080)	–0.169** (0.070)
Hydropower: Gross theoretical capability (MWh/year)	–0.001 (0.002)	0.000 (0.002)	0.009* (0.005)	0.009* (0.005)
Pump price of diesel fuel (US$ per litre)	0.264 (0.309)	0.164 (0.238)	1.267** (0.588)	1.102** (0.512)
PSS: VIP + IPPs, Comb. gen. and trans. entity	0.205 (0.156)	0.363*** (0.129)	1.263*** (0.306)	1.697*** (0.291)
PSS: Many dist., gen., and trans. entities	–0.000 (0.212)	0.078 (0.174)	1.607*** (0.405)	1.922*** (0.377)
America	0.062 (0.239)	–0.011 (0.188)	0.079 (0.452)	0.446 (0.399)
Asia	0.262 (0.169)	0.052 (0.142)	0.264 (0.324)	0.563* (0.302)
Europe	–0.107 (0.281)	–0.142 (0.233)	–1.607*** (0.553)	–1.376*** (0.510)
t = 2001–10	–0.423** (0.165)		–0.328 (0.311)	
t = 1996–2000		0.022 (0.138)		1.229*** (0.312)
t = 2001-05		–0.362** (0.147)		0.641* (0.328)
t = 2006–10		–0.428** (0.194)		0.707* (0.422)
Pseudo-R2	0.160	0.134	0.184	0.162
Observations	150	278	150	278

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is in per capita terms. PPI refers to private participation in infrastructure. Monetary figures are in constant 2009 US$. PSS refers to power supply structure. VIP refers to vertically integrated monopolist. IPP refers to independent power producer. A constant was included in all regressions. Standard errors are in parentheses.

6 Conclusions

The aim of this paper is to inform policy looking to step up investment in the electricity sector of developing countries and align it to other development goals such as universal access to energy or sustainability. The three main questions guiding our analysis were:

1. How and why has the contribution to the electricity sector of private investors and donors changed across time?
2. What are the different motivations of private investors and donors as regards who gets finance and what is financed (hardware or software elements of the electricity system, renewable or non-renewable generation)?
3. Are sustainability and equitable access to electricity priorities for private and donor investment?

These questions have been addressed by describing flows of aid and private investment for electrification in developing countries during the period 1990–2010 and showing their size, recipients, providers, what has been financed (in particular, what is the amount and destination of finance for renewable energy), and how funds are related to energy poverty. The data analysis has been complemented with interviews with experts to check its reliability and interpret the patterns observed. Subsequently, we have specified an econometric model to explain inter-country allocation of aid and private investment in the electricity sector aggregated per ten- and five-year periods over 1990–2010.

Firstly, we have observed an increasing participation of the private sector since 1990, driven initially by the World Bank's shift towards attracting private investment instead of directly providing capital investments in the electricity sector. The private sector showed a strong responsiveness to the World Bank's approach, rapidly increasing its investment in some specific countries. However, the boom was relatively short-lived, ending with the 1997 Asian financial crisis. As explained in Barnett (2014), the World Bank's approach had tragic consequences for Africa. The emphasis on a model of power sector reform based on unbundling the system to promote competition between generators was inappropriate for the very small systems of the region, which resisted reform or implemented it badly and insufficiently. This led to massive underinvestment, in the so-called 'lost decades', which is reflected in the large electrification deficits we observe today (Barnett 2014).

Both ODA and private finance for electrification have seen a revitalisation since 2004. Some of the factors contributing to this are a renewed emphasis within donor circles on the importance of energy for sustainable development, the increased use of blended finance type models in multilateral agencies to leverage private investment, and the large stimulus packages with a strong component in electricity infrastructure enacted in China, India and Brazil during the 2008 financial crisis.

Addressing the second question, our data show that donors and the private sector display different roles and motivations. There is a clear role for the public sector in the provision of universal access, in spite of the decreasing importance of aid relative to private investment since the 1990s.

Private sector investment in the electricity sector is strongly concentrated in a few countries, particularly middle-income, emerging economies such as Brazil, India and China, which capture half of it. It flows to countries with high income per capita but with a non-linear, decreasing relationship, strong governance, with large and low-cost renewable energy resources, preferably with unsubsidised energy markets and which have progressed in reforming their power sector through unbundling and privatisation. The private sector also shows a positive geographic bias towards Asia. As we have seen, sub-Saharan African countries with low electrification rates have been mainly left behind.

The international public sector, represented by bilateral and multilateral donors, shows a higher distribution of funds among countries, with 11 countries capturing 50 per cent of these flows. Donors favour countries whose economies are growing quickly, have strong governance, and which have started a process of power sector reform. In addition, smaller countries tend to receive higher sums of aid per capita. Somewhat surprisingly, electrification aid does not favour countries with high levels of poverty, which could indicate a shift in donor priorities towards covering basic needs such as health and nutrition in the poorest countries. Our analysis shows, backing previous research, that the higher levels of aid per capita in the past decades have not actually been channelled to those countries with the highest electrification deficits.

Private sector finance has consistently focused on generation, which as we have suggested is more amenable to private participation than other areas of electrification. By contrast, ODA's contribution to generation has gradually fallen over time, while its contribution to transmission and distribution, policy, education and research has increased. These trends reflect the shift towards the use of ODA as a catalyst for private investment and for areas which are unattractive for private investors.

All this suggests that ODA continues to have a strong role to play financing investment in those countries, and those areas (for example, off-grid and mini-grid systems, grid connections to the poorest people and transmission and distribution infrastructure) that private finance is unlikely to find attractive.

As regards the third question, neither private investors nor donors show a clear preference for renewable generation over fossil fuel-based technologies. Instead, there is a relatively even spread of investments across generation technologies, which suggests that the priority is to meet a surging electricity demand using whatever source is available.

The relationship between private investment and aid flows and the provision of universal access to electricity is uncertain. Our descriptive data reveal how private investment does not necessarily translate into new electricity infrastructure, as it can relate to purely financial transactions such as mergers and acquisitions, which were very common during the privatisation wave of the 1990s. This was clearly exemplified by Brazil, which experienced record figures of private investment during the 1990s followed by a severe crisis in electricity supply at the start of the following decade. In any case, the participation of private capital was expected to raise the performance of the electricity sector, and that was the rationale of power sector reform. Moreover, neither aid nor private investment has been channelled towards those countries with the highest access gaps. Often, aid and private investment in electrification are used to improve the supply for those already connected or to serve the industrial and commercial sector of growing economies. Economic growth can, of course, benefit the poor when appropriate redistribution channels are in place, but this would happen indirectly. Further analysis would be required to identify those countries that have more efficiently used private investment and aid in the electricity sector towards the goal of universal access and to understand the policies they put in place to succeed. Further understanding of the role of domestic public finance for the provision of universal access is also required. We expect to analyse these issues as part of our ongoing research programme on pro-poor access to electricity.

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