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Evidence: Energy, Productivity and Economic Growth

Tags: Energy, Evidence, Economic Growth, Inclusion, Climate Change

Access to affordable and reliable power is a core part of the DFID and IFI development agenda. From an economic productivity perspective, the Energy in Africa Campaign identifies that 50% of businesses in sub-Sahara Africa view a lack of reliable electricity access as a major constraint to doing business, and power outages cost countries in sub-Saharan Africa 1-2% of their GDP annually. From a household perspective, the poorest three-quarters of the global population still use only about 10% of global energy, reflecting significant levels of inequality[i]. Africa's poorest pay 80 times more for their electricity than the UK equivalent.

This paper reviews the evidence for linkages between providing improved access to reliable and affordable power and economic growth outcomes. It sets out the potential transmission mechanisms (theory of change) for these growth effects, and assesses the strength of evidence and potential constraints to this narrative. The ability for improved access to reliable and affordable power to contribute to other social and environmental development outcomes is also reviewed, alongside the implications for economic growth when activities are specially targeted to achieve such objectives. Finally, conclusions and recommendations are presented in relation to DFID programming and impact evaluation, together with potential areas for further research.

A deficit in supply side generation may be a significant factor in constraining energy access and associated economic activity.[ii] However, issues in developing countries are more often related to other regulatory and market barriers such as ineffective tariff structures, perverse subsidy policy, poor capacity utilisation and grid management, and inefficient utility operation. A key issue is technical and non-technical transmission and distribution losses, which can be significant. Examples include Botswana (39%), Cambodia (29%); Haiti (54%).[iii] Reducing technical losses can be significant cheaper than adding new capacity. Regional integration of networks may also allow capital infrastructure to be shared and demand managed more cost effectively. For this reason, CIG will take a whole systems approach to reducing the economic cost of power provision, and ensuring that electricity planning is focused on meeting productive demand.

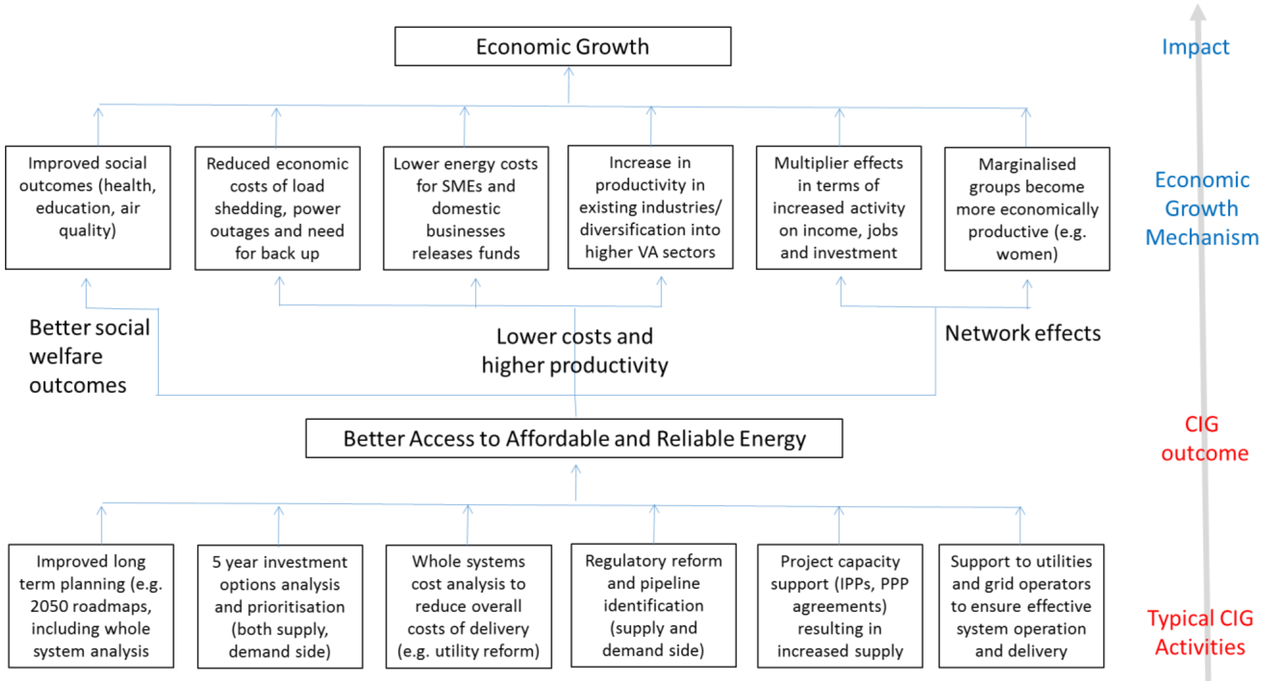
Within the Sustainable Development Goals (SDG 7), improved access to energy is framed in terms of energy services being 'affordable, reliable, sustainable and modern'. However, there is no standard definition of improved energy access, with the level of improvement being relative to the prevailing country situation (ranging from those with "full electrification" to communities primarily currently reliant on biomass). Even countries with 100% electricity access vary in their electricity consumption by more than 700% on a per capita basis. The term often includes (implicit) assumptions about increased productivity and environmental performance (e.g. low carbon).

A range of indicators can be found which target different aspects of measuring access to electricity. These include indicators such as DFID International Climate Fund (Number of people with improved access to clean energy as a result of ICF programmes). IFIs such as the World Bank measure higher level macro indicators (e.g. energy use in urban areas, electric power consumption per capita, time to get access to electricity connection). Often, progress in measuring energy access is captured in terms of new capacity installed (including renewable share) and number of new connections for households or SMEs. However, the effectiveness of the system is less well captured in terms of costs and benefits.

From improved energy outcomes to economic growth

There are several potential linkages between increasing access to reliable and affordable power and economic growth (Figure 1).

Figure 1: Theory of Change - Access to Affordable and Reliable Power - Economic Growth Linkages



These economic benefits flow differently to different stakeholders, and generate economic benefits for these groups both directly and indirectly, alongside longer term transformational effects. The overall description of linkages between improved access to energy and economic growth is set out below.

- *Improved social welfare outcomes:* There is strong evidence that improved access to reliable and affordable power can deliver significant social welfare benefits that underpin long-term economic growth, including improved education, health and income generation outcomes.[iv] For example, education levels of children are improved by allowing additional study and access to information.[v] Earnings are also likely to be higher in electrified households.[vi] Improved electrification can also improve awareness of gender issues (e.g. safety and uptake of family planning services). There is strong evidence that improved access to power reduces the socio-economic costs of environmental pollution from energy-related pollution such as particulates and to reduce the economic burden of disease, particularly for women.[vii] More reliable and affordable power can support better provision of public services (such as vaccine refrigeration, sterilisation, operating theatre support, and extend opening hours.[viii]

- *Reduction in power outages and lost productivity:* Better management of power systems and utilities can reduce the incidence of power supply disruption, whether planned (e.g. load-shedding) or unplanned. In addition to a lack of capacity, outages can also be caused by fuel shortages, poor grid management and shutdowns for repairs due to poor maintenance. Power disruption can shutdown critical infrastructure such as water supply, financial services and telecommunication networks as well as disrupt wider economic activity. This creates significant economic costs. in sub-Saharan Africa, an average of 4.9% of annual sales are estimated to be lost due to electrical outages, with very high losses reported in the Central African Republic and Nigeria.[ix] The use of back-up power generation to mitigate poor grid-based supply increases costs for businesses. In 2012, the cost of fuel for back-up generation (across businesses and households in Africa) is estimated to have been at least $5 billion, significantly more expensive than the equivalent grid price.[x] Improving energy planning, grid operation and making investments in the most cost effective way can reduce the incidence of power supply disruption, increasing sales and reducing expenditure on backup generation. The outage costs for African firms are estimated to be in the range USD 0.60 – 3.32 per kWh.[xi] It is estimated that the elimination of outages in Uganda would increase GDP by 2.6%.[xii]

- *Lower energy costs:* There is strong evidence that reducing the costs of electricity consumption for SMEs and households allows financial resources to be put to other economically and socially productive uses. This is particularly true where the use of diesel generators for electricity or kerosene for lighting are prevalent, and where these can be displaced by more reliable and lower cost grid electricity. Alternatively, it allows for an increase the amount of power consumed where this is a binding constraint.[xiii] Better grid management and lower overall system costs can also result in lower electricity prices, as can improvements to the efficiency of generation and transmission & distribution infrastructure. Where costs of electricity fall, but prices remain the same, economic gains flow to the utilities themselves which may allow for balance sheet improvement and greater capacity to invest in the network. Reduction in power prices may also be feed through into lower inflation rates and support macro-economic sustainability;

- *Increased productivity and diversification:* Improvements in the quality and cost of electricity access allows for greater commercial productivity (both for SMEs and household businesses). Improved lighting allows for extension of operating hours, and goods and services can be delivered to a higher quality and potentially with lower energy cost per unit. Greater access to electricity can increase the productivity of existing economic activities (e.g. supporting textile workers by enabling the use of electric sewing machines). New economic activities with greater load demands (e.g. welding) also become accessible. There may be a level of diversification of economic activity (e.g. into light manufacturing industries and services), creating jobs and additional economic opportunity. Within the household, women and children may benefit from using for more productive economic income generating purposes.[xiv] Energy service and product markets may also expand (e.g. energy efficient equipment);
- *Wider economic transformation effects:* Income generation effects from improved access and quality of electricity supply can be re-invested in further productive activity or feed through into consumption, both of which can deliver an economic multiplier effect; Diversification of economic activity can reduce income volatility for businesses and households, which in turn increases capacity to take on economic risks and make new investments. There are also short run Keynesian effects (increased economic activity from infrastructure investment and construction processes) associated with investment in energy sector improvement (e.g. new capacity, better transmission);
- *Inclusive growth pathways:* Improved access to affordable and reliable power can, if properly targeted, provide opportunities for women and marginalised groups to become involved in enterprises in the energy value chain thus widening the potential reach and therefore the basis for longer term economic growth. This enables them to contribute to the city economy, often as part of the informal economy serving the formal economy, or to transition to the formal economy over time.[xv] There is strong evidence that power sector investment delivers strong economic growth returns.[xvi] One estimate suggests that, in the context of sub-Saharan Africa, every additional $1 of power sector investment could boost GDP by around $15.[xvii] Large capital investments in energy infrastructure would have immediate Keynesian effects in terms of stimulus, as well as a range of potential longer term economic benefits.

Constraints on growth narrative

While there is strong evidence that improved access to power can support economic growth outcomes, there are several potential constraints to this growth narrative as set out below:[xviii]

- *Affordability:* Access to power must be affordable for intended beneficiaries. Affordability should be assessed in the context of potential alternatives, and include willingness and ability to pay;
- *Accessibility:* Improved energy services must be accessible to a broad range of economic actors to facilitate inclusive growth, rather than captured by existing users or higher income groups;
- *Reliability:* Power networks should deliver reliable supply to support productivity and reduce the need for expensive back up or alternative fuels which erode the economic benefits;
- *Suitability:* Improved supply should be aligned with potential demand, with a focus on providing connections of a quality that can support economic activity (e.g. for energy intensive SMEs);
- *Policy risk:* Activities should be sensitive to regulatory and market trends (e.g. grid extension, subsidy policy) to ensure that infrastructure does not become obsolete or stranded;

Implications for achieving other development goals

Social Inclusion

- Increasing electricity capacity or the number of connections does not necessarily deliver economic benefits for low-income and other marginalised groups. Often, new capacity is consumed primarily by industry and middle to high-income households – particularly as many low-income households are not connected to the grid.[xix] New investments tend to gravitate towards serving these higher income segments which can provide economies of scale (e.g. revenue per connection), offer stronger ability to pay and may subsequently engage in higher value-added income generating activities;
- Ensuring that low-income and other marginalised groups enjoy the benefits of new installed capacity is likely to require additional interventions, for example in extending the electricity grid to informal settlements or establishing tiered tariff structures so that low-income households are cross-subsidised both connection and usage. This can result in overall economic growth rates being lower, although growth effects are almost certain to be more evenly spread;
- There is the potential for increased job creation in labour intensive sectors supported by better electricity supply, particularly where there are spill-over effects (e.g. construction, food processing, textile manufacturing). However, these benefits may only be realised where accompanied by enabling government policies or complementary investment in extending the grid;
- There is strong evidence that women are disproportionately impacted by a lack of access to electricity, and that the distributional effects of improved access may favour women's economic and social empowerment.[xx] Research suggests that female politicians are more likely than men to push for increased access to cleaner and affordable energy options that would benefit women. This may in turn have strong economic multiplier effects as evidence shows that women reinvest income towards family welfare expenditures such as education.[xxi]
- Socially inclusive energy interventions have the potential to benefit lower income and marginalised groups (e.g. developing women-owned small scale enterprises), but this may result in lower rates of economic growth in the short run.[xxii] However, in the long run, more socially inclusive programmes can offer a stronger basis for more sustainable and broader-based economic development, helping to reduce spending on welfare budgets and bringing new groups into the formal economy.

Climate and Environment

- More efficient electricity systems can lead to overall lower fossil fuel use due to better planning, capital investment and grid balancing. Improved reliability can also avoid the need for inefficient back up. Both factors result in lower GHG emissions. A switch to cleaner fuels (both on- and off-grid) can also reduce GHG emissions.[xxiii] Doubling the share of renewables in Africa for example, could potentially increase socio-economic welfare by 2.7-3.7% beyond GDP growth.[xxiv]
- Improved access to affordable and reliable power can also provide environmental (and health) benefits where this access displaces end-user consumption of polluting diesel, kerosene, other fossil fuels. Poor air quality creates significant health and mortality impacts for poor and vulnerable populations which carry significant economic costs.[xxv] Air pollution related mortality and morbidity are estimated to have annual economic costs of 1% of global GDP by 2060.[xxvi] Improving air quality avoids the cost of medical care and lost labour.
- Reducing the share of dirty fossil fuel use in power generation (e.g. coal) as part of system optimisation can also provide strong environmental benefits with significant equity implications.[xxvii] Air quality impacts are often borne by those who live close to large emitting generation facilities, but who do not enjoy the benefits of electricity consumption.[xxviii] Waste products (solid waste, sludge and cooling water discharge, and environmental contaminants such as toxic heavy metals, radioactive material, hydrocarbons and sediment) may also be avoided.[xxix]
- Improving the affordability and reliability of electricity provision may moderate the unsustainable consumption of biofuels, including wood, charcoal, dung and agricultural residues, which can in turn

support more sustainable eco-systems, avoid deforestation and improve biodiversity. All of these may have significant non-market socio-economic benefits.[xxx]

- Cleaner energy systems typically carry higher capital costs than their fossil fuel based alternatives.[xxxi] Even though renewable energy systems are expected to be competitive over the medium term, this still creates short term opportunity costs (e.g. potentially reducing funds for investment in improved access which may have higher socio-economic returns).[xxxii] However, as renewable energy costs fall, and carbon regimes become more restrictive, power systems can capitalise on increasing their share of clean energy, potentially saving money, reducing price and currency risk for imported fossil fuels and supporting balance of payments.[xxxiii] IRENA estimates that the costs of renewable system development in Africa might be approximately US$1 trillion lower than for an equivalent fossil fuel scenario.[xxxiv]

Conclusions and Recommendations for further research

There is strong evidence that improved access to reliable and affordable power can have significant economic growth benefits. Reducing the overall economic costs of provision, and addressing access for underserved communities can result in a range of benefits, including improved welfare (improved health and education outcomes), lower economic costs associated with reduced outages, lower electricity prices, greater productivity and diversification of economic activity into higher value added sectors, multiplier effects from increased provision and consumption of energy services and the empowerment of currently excluded and marginalised groups to enter economic and labour markets.

There is strong alignment between improved access to power and social inclusion with few identified trade-offs. However, improvements in system efficiency and cost may not automatically result in strong social distributional benefits, particularly where poor communities do not have access to grid electricity, and economic benefits may therefore be captured by higher income groups. They face other barriers (e.g. informality) that prevent access. Improved access for the lowest income groups and most marginalised communities (households and non-formal sector businesses) may need to be supported through cross subsidy, as market-based solutions will orientate towards those with greater ability to pay. Nonetheless, many low-income households are willing and able to pay tariffs reflecting the levelised costs of electricity as these are lower than current alternatives. Where cross subsidy exists, the overall economic benefits may be lower for socially-oriented programmes.

Where improved access is combined with clean energy provision or energy efficiency, then the co-benefits for between economic growth and sustainability are strong. Renewable energy solutions can deliver lower operating costs than fossil fuel alternatives, with declining costs and increasing efficiencies forecast over time. Energy efficiency improvements may have short paybacks and strong cost saving benefits. However, the higher capital costs of low carbon energy can reduce returns in the short term and create opportunity costs for investing in other priorities (e.g. extending energy access). They may also require subsidy or other financing support. In the longer term, more environmentally sustainable energy systems are also likely to help reduce the economic impacts of climate change impacts, and lower fossil fuel related economic risks (e.g. to volatile fossil fuel prices or the potential for stranded high carbon assets).

Care should be taken when developing CIG programme indicators to ensure that energy access is measured in terms of its reliability, affordability or other similar parameters depending on the potential use and beneficiary. Measuring installed capacity and the number of new connections does not properly capture the potential benefits in electricity system optimisation or access. The productive uses of improved electricity supply need to be captured. Where environmental sustainability is a key objective, indicators should seek to capture low carbon and resilience where possible.

In terms of further research, there is a comprehensive body of work on the potential benefits of energy access, but additional work is needed to assess the economic growth impacts of access-related initiatives. Potential areas for further research include:

- How can of access and affordability definitions be better defined, depending on context, level of service and the productive purposes to which improved access might be put?
- What are the economic impacts of improved electricity access, including the potential effects on SME growth, job creation and social mobility, and how can these be best valued?

- How does improved access relate to economic growth for different sectors of the economy (manufacturing, services) and to different population segments?

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