Terms of Reference
PO 7160 – Applied Research on Energy and Economic Growth

1. Introduction

The service provider will carry out a programme of research on the scope for maximising the impact of energy infrastructure on economic growth in low income countries.

The expected main beneficiaries of the project are DFID priority countries, particularly low income countries in Africa and South Asia, (see: https://www.gov.uk/government/organisations/department-for-international-development/about). To benefit those countries, the project will need to undertake research and draw on relevant case studies, other research, and lessons from other countries including (but not exclusively) those that have made the transition from Low to Middle Income Country status.

The research programme covers six complementary research areas:

1) The linkages between **electricity supply and economic growth;**

2) The **financial and policy instruments and governance structures** that encourage the development and better utilisation of appropriate large scale power infrastructure;

3) The role and potential of **electricity supply and energy efficiency measures in supporting sustainable urbanisation;**

4) The **constraints in use of large-scale renewable energy sources**, or "greener" energy sources;

5) An improved understanding of the role of **extractives in electricity/energy provision and sustainable development**;

6) The barriers and opportunities for **innovative and appropriate design** of larger-scale, centralised energy infrastructure to respond to evolving demand and support inclusive growth.

A strengthened evidence base on the enabling links between energy and economic growth could have significant implications for developing countries through assisting policy makers and investors to make better decisions about when, and how, to prioritise needed investment in high cost energy infrastructure.

2. Objective

This applied research would aim to build a body of evidence around how sector reforms, innovative technologies and practicable actions can be used to help maximise the economic impacts of larger scale energy projects in low income countries in Africa and South Asia, and also bring benefits of modern energy services to poorer people.

3. Recipient

The purpose of the work is to influence energy policy making and investments in low income countries in Africa and South Asia. The recipients of the services are relevant policy makers, energy sector investors, civil society and other relevant stakeholders in these countries.

4. Scope of work

DFID will provide funding for establishing a **research programme to undertake an applied research programme on the scope for maximising the economic development and poverty reduction impacts of large-scale energy infrastructure in** low income countries in Africa and South Asia**.** This includes the six research areas identified and address the issues set out in the DFID Business Case and summarised below. The six research areas are not intended to be all-inclusive but individually and collectively will provide important insights into optimising the role of energy in supporting development and economic growth. We are placing emphasis on larger scale energy infrastructure and electricity consumption and its contribution to economic growth to complement other on-going research which is more focussed on smaller-scale, decentralised systems.

The **research programme will be split into two parts**. Part 1 will review the literature and evidence available under the six identified research areas, and deliver a series of state of knowledge papers, as well as identify what primary future research might be undertaken in Part 2 and its scope. The state-of-knowledge papers should draw on literature and case studies and lessons learnt of good practice on energy technology, policy, and practice. Part 1 will last up to 12 months, and conclude with an overall summary of findings and recommendations for Part 2. Part 2 will last around 48 months and is subject to DFID review and approval of the Part 1 deliverables, and is covered by a break clause.

In Part 1, at least one state of knowledge paper is expected under each research theme, and these are expected to be of sufficient quality and interest for ultimate publication in the appropriate international journals. It is noted that actual acceptance for publication in journals will be impossible to organize in a timely way so the project will need to resource and arrange timely independent peer review to quality assure these outputs as having potential for publication in high quality journals. DFID reserves the right to make a final judgement on the quality of these papers, including commissioning further independent peer review of outputs as needed.

Part 1 will see the production of a research agenda under each of the six themes and also a consolidated proposal for Part 2 research. There is no *a priori* need for research in each theme to be undertaken with equal effort in Part 2. Depending on the importance of the knowledge gaps and the tractability and likely conclusiveness of research into those gaps, the programme should be prioritized. It is possible that some themes will be dropped from Part 2.

The specification of the research programme for Part 2 will be submitted for DFID's approval prior to work commencing on Part 2. Full information will be needed on the proposals for Part 2 to enable DFID staff to assess:

(i) The track record and performance in Part 1 including reference to independent reviews of key papers and an assessment of the quality of work on the research agenda for each theme;
(ii) The quality and balance of the proposed consolidated research programme for Part 2. Emphasis will be placed on ensuring that research has clear *operational relevance*, that research will be *tractable and high quality*, and finally that research will be reasonably *conclusive* (not just interesting

preliminary findings). There will be a strong practical focus on what has and has not worked and where, why and how and on the transferability of those results to low income countries in Africa and South Asia.

(iii) A credible plan to identify researchers within the existing consortium and from elsewhere.

Technical evaluation criteria for the Part 2 proposal will be shared during Part 1 inception.

The service provider's consortium will undertake all of the Part 1 research, but will shift to competitively procuring additional expertise using calls for proposals, managing, guiding and providing technical oversight of the Part 2 agreed research activities, as well as directly undertaking research (up to 50% in value of the remaining programmable research budget after Part 1). The service provider's consortium will lead on lesson learning, knowledge management and research uptake and will administer logistical and other arrangements to support the project governance arrangements.

As with all DFID projects, this project will be the subject of an **annual progress review** led by DFID staff. In the event that the project is deemed to be non-performing or under-performing against its objectives and Logical Framework, DFID will normally seek to agree a time-bound action plan for improving performance. In the event that performance does not improve, DFID reserves the right to cancel all or part of the project.

5. Outputs/Deliverables

The project is expected to deliver the following key **outputs under Part 1:**

i. By end month 10, recommendations and a proposed research agenda for Part 2 – a **framing paper** for discussion and agreement with DFID.
ii. During the initial 12 months, the service providers will conduct **seminars and conferences** relevant to the preparation of the state-of-knowledge papers and preparation of the Part 2 research programme.
iii. By end month 12, at least **6 high quality review papers and reports** which clearly set out the state of knowledge under each of the identified research areas. The exact number under each area are to be agreed with DFID. The state-of-knowledge papers are expected to be of sufficient quality and interest for ultimate publication in the appropriate international journals.
iv. By end month 12, a **final research framework report for Part 2** with research questions to be addressed under each of the themes, together with research methodologies. The report will also address the importance of the knowledge gaps, the tractability and likely conclusiveness of the research and priorities within and across themes. In addition to the detailed programme for Part 2 research, the research framework should also include: capacity building, research uptake, knowledge management and gender, poverty and vulnerable groups strategies. The report should also capture monitoring and quality assurance and risk management strategies. It is possible that some themes will be dropped from Part 2.
v. The final proposal at the end of month 12 should include a **detailed and budgeted research proposal for activities in Part 2** (years 2 to 5). In addition to providing the detail on activities for each research area (as item 5 iii), this proposal will capture the detail of approach and methodology, overall

work plan and programme, schedule of deliverables finance and management arrangements, staffing schedule, procurement plan and procurement procedures, and a detailed budget. The research plan should identify and cost in detail the research that the service provider's consortium proposes to undertake directly. It should set out indicative costs for the research being contracted in. The budgeted research proposal will be peer-reviewed and evaluated, as a normal research submission. The consolidated, costed work programme may involve some rationalisation across themes (not all themes have to be included or need to carry equal weight). The report should also include an updated theory of change and Logframe and a schedule of deliverables/milestone payments.

Subject to DFID approval of the research plan, the project is expected to deliver the following key **outputs under Part 2:**

i. High quality research reports and material leading to publication of work and findings in peer reviewed journals (number of which to be determined during Part 1 review).
ii. Operationally relevant and accessible policy material (e.g. policy briefs and other uptake products, number of which to be determined during Part 1 review).
iii. Southern research capacity building and establishment of research networks.
iv. At least 1 conference/seminar on each key theme per year, as well as wider dissemination.
v. A concluding final report assessing the take-up of the research and its impact, the status of research and policy networks established and capacity building undertaken, and recommendations for any further work.

6. Reporting

The service provider will submit formal annual progress reports against the project research areas and project outputs as specified within the Logical Framework, and shorter quarterly progress reports to be discussed with DFID. This will be supplemented by interim communications, minutes of monthly meetings with the DFID project management team during inception and minutes of meetings of the project governance bodies.

7. Budget and Timing

The research has a budget of up to £12 million, subject to DFID approval. This figure excludes the service provider's management costs.

The project will last 5 years with a break point at the end of Part 1. If necessary and justifiable DFID would consider a possible extension beyond that period or – depending on need and scale - may seek a further phase of work via a fresh tender competition at that point. If needed, DFID's decision on project extension will be informed by an independent evaluation late in the project, for which DFID will provide additional funds.

8. Background

Access to reliable energy is a critical determinant of growth. Typically, nations and regions with higher rates of GDP and urbanisation exhibit higher electrification rates. Access to reliable energy opens up opportunities for income generation through the development of economic activity, and increases in productivity. However, meeting these energy needs sustainably is a complex and expensive challenge, often with trade-offs between growth, low carbon development, energy security and poverty reduction.

While there is a strong correlation between growth and energy access, there is mixed experience of how investment in large scale energy infrastructure can maximise economic benefits, particularly in lower-income countries (LICs), despite significant past and present investments. A high energy resource endowment in a number of countries often does not translate into effective energy use, particularly in providing equitable growth and poverty reduction, while popular expectations of supply and price are often inconsistent, constraining decision making.

The modern energy sector appears to be highly politicised and effective plans, investments and necessary regulatory reforms difficult to implement due to factors generally described as the result of the political economy. All energy systems, whether predominantly in the public or private sector, need some form of regulation and are subject to important tax and subsidy regimes, all of which are associated with lobbying, rent seeking and winners and losers. It is therefore expected that these issues of political economy will form an important cross-cutting theme to the research areas proposed, along with financial, technical and economic issues. The research will benefit DFID priority countries, particularly low income countries in Africa and South Asia, and will look for cross- learning between these regions, as well as emerging economies and MICs.
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A strengthened evidence base on the enabling links between energy and economic growth could have significant implications for developing countries through assisting policy makers and investors to make better decisions about when, and how, to prioritise needed investment in high cost energy infrastructure.

9. Research Areas and Questions

Six research areas have been identified for Part 1, as set out in Section 1 of these ToR. Questions to be addressed under each are outlined in the attached Appendix 1. In making their proposals for conducting this research, the prospective research programme consortium should explain what sort of review and synthesis they believe is possible building on the suggestions provided under the six research themes. Adapting the research to the requirements of LICs will be one core aspect of the research programme.

10. Procurement Arrangements

All of the Part 1 scoping and research activities will be undertaken by the service provider's core team members. For Part 2, the contractor is expected to procure research expertise and policy advice from other service providers covering a minimum of 50% of the remaining research budget after Part 1 completion, undertaking the rest of the research itself. Research projects procured by the

contractor will not be subject to EU Directives on procurement, but must comply with the contract with DFID. Procurement procedures will be proposed by the service provider for DFID agreement and will be carefully monitored to ensure conflicts of interest are identified and avoided and there is full transparency and value for money in procurement.

11. Accounting & Audit

The service provider will appoint and pay an accountancy firm, acceptable to DFID, to undertake annual audits. The audits will cover the service provider and its partner organisations. The audits will include a management systems audit to ensure that procurement, fraud avoidance, human resources and other management systems by the service provider and its partner organisations are in line with DFID requirements and international best practice.

12. Funding

The service provider will need to pre-fund the research costs and claim back from DFID in arrears.

13. Open Access

DFID is committed to strengthening demand for knowledge and improving access to research information. To this end DFID launched a new Open Access policy in 2012, which this project must comply with. The service provider should maintain an updated plan for Open Access of research outputs and access to data sets by using the DFID Data Access and Management template.

With regard to author pays publishing, DFID expects the project to collaborate with researchers/authors in choosing where to place their research, and it is expected that Open Access fees will be paid for either by the project (most likely through the research uptake budget) or through arrangements that the service provider has on Open Access. It will be the project's responsibility to monitor the percentage of research outputs that are available under Open Access and to inform DFID of the details and the percentage in the programme's Annual Reports. It is expected that the vast majority of research output will be made open access. Non open access should be the exception.

DFID also encourages its research projects to archive quantitative and qualitative datasets, resulting from the research it funds, with appropriate data archiving repositories at the earliest opportunity. In any case, datasets must be retained by the research team and provided free of charge on request.

All outputs must be included on the R4D website and the service provider is responsible for arranging this.

14. DFID Branding

The public has an expectation and a right to know what is funded with public money. It is expected that all research outputs will acknowledge DFID support in a way that is

clear and explicit and which comply with DFID Branding Guidance. This will include ensuring that publications acknowledge DFID support.

If press releases on work which arises wholly or mainly from the project are planned this should be in collaboration with DFID Communications Department.

15. Duty of Care

16.1 The Service provider is responsible for the safety and well-being of their Personnel (as defined in Section 2 of the Contract) and Third Parties affected by their activities under this contract, including appropriate security arrangements. They will also be responsible for the provision of suitable security arrangements for their domestic and business property.

16.2. The Service provider is responsible for ensuring appropriate safety and security briefings for all of their Personnel working under this contract and ensuring that their Personnel register and receive briefing as outlined above. Travel advice is also available on the FCO website and the Service provider must ensure they (and their Personnel) are up to date with the latest position.

16.3. As the countries/areas of work involved in this intervention are currently undetermined, DFID is not in a position to be able to provide a Duty of Care assessment at this point. On this basis, DFID assumes that this programme will be rated as 'Medium/High' risk.

16.4. During the programme, it is DFID's expectation that any contracted service provider will provide a full Duty of Care assessment for each potential country/area of work where in-country ground work is expected to be necessary.

16.5. If the programme activities take place in medium or high risk locations, DFID will share available information with the Service provider on security status and developments in-country where appropriate. DFID will provide the following:

a. All Service provider Personnel will be offered a security briefing by the British Embassy/DFID on arrival.

b. All such Personnel must register with their respective Embassies to ensure that they are included in emergency procedures.

c. A copy of the DFID visitor notes (and a further copy each time these are updated), which the Service provider may use to brief their Personnel on arrival.

Appendix 1

APPLIED RESEARCH THEMES UNDER ENERGY AND ECONOMIC GROWTH (EEG)

Theme 1. The linkages between electricity supply and economic growth.

Problem Statement

Access to reliable energy is a critical determinant of growth[1]. Globally, regions with higher rates of GDP and urbanisation exhibit higher electrification rates. The Energy Development Index (EDI), developed by the International Energy Agency (IEA) to track the progress in a country's or region's transition to the use of modern energy services, shows that all sub-Saharan African countries (with the exception of South Africa), feature in the bottom half of the EDI ranking. Thus, a more efficient energy sector, providing more affordable and environmentally sound energy services to a greater share of the population at a more affordable cost, should make a more than proportionate contribution to accelerating economic growth and increasing living standards of the poor. While significant work has been undertaken on energy/poverty reduction linkages and impacts, the energy/growth linkages are far less well understood and much of the work available is place and context specific. At what point does lack of electricity supply create binding constraints on growth which limit economic development and hold back investment? A broader understanding needs to be developed. This theme will investigate how energy sector development, and electricity infrastructure investment in particular, can contribute to economic growth and poverty reduction.

Knowledge Gaps

Literature shows a positive elasticity of GDP with respect to energy infrastructure investment, as well as a lessening of income inequality[2] [3] [4] [5]. However, at the macro level almost every type of investment and consumption is positively correlated with GDP since GDP is income, and an increase in income boosts consumption and investment. So this relationship is two way (endogenous) and not very informative about the impact of investment on growth. It is difficult to identify the particular ways that energy investment has benefits for inclusive growth and poverty reduction. The relationship between energy sector development and economic growth may be complex, often involving prioritisation and trade-offs between electricity generation and consumption, economic growth and poverty reduction, low carbon development and possibly energy security.

In designing this research, a number of light touch research enquiries were conducted but, largely because of this endogeneity problem, they were fairly inconclusive on the central question about what level of energy supply constitutes "enabling" or a constraint on growth. An initial analysis into the relationship between

1 Energy, Growth and Development; International Growth Centre (IGC); 2013

2 Toman, M., Jemelkova, B. "Energy and Economic Development: An Assessment of the State of Knowledge," Energy Journal, 24(4), 2003, pp. 93-112.... Calderón,..

3 Barnes, D., Toman, M. "Energy, Equity and Economic Development," In: Lopez, R., Toman, M. (eds.), Economic Development and Environmental Sustainability: New Policy Options, 2006, Oxford University Press

4 Barnes, D., Khandker, S., Samad, H. "Energy Poverty in Rural Bangladesh", Energy Policy, 39(2), 2011, pp. 894-904

5 Jorgenson, D. "The Role of Energy in Productivity Growth," Energy Journal, 5(3), 1984, pp. 11-26.

electricity access/availability and economic growth was undertaken through an Evidence on Demand enquiry[6]. This included an extensive literature review. It found inconclusive evidence on the impact of higher availability of modern energy services on poverty reduction and income equality.

This finding is confirmed by a complementary literature review conducted for a more micro-level study undertaken on Utilising Electricity Access for Poverty Escape[7]. However, the case studies and country based field work provide some evidence supporting higher levels of electricity access (reflected by energy access tiers) associated with improved productive use and social outcomes, but notes that it is only relatively recently that levels of energy access availability and reliability, rather than simple binary availability measures, are being recorded. A complementary study into the relationship between electricity insecurity and businesses[8] is similarly inconclusive due to limited data availability on electricity reliability, and complexity of decision making, due to the influence of other factors.

In theory there is no reason to expect that investment in electricity generation delivers an impact on GDP with a constant elasticity. What is theoretically sound is that highly inadequate electricity supply is likely to make electricity very expensive and constrain investment in electricity using production. Inadequate electricity supply may push up the costs of other inputs including labour. High costs are likely to constrain growth, other things equal. So the central knowledge gap for Theme 1 is: how bad does power supply have to be to become the binding constraint on growth. Is this a level against which most LICs are below and against which most MICs are above?

The Intervention

It is concluded that further research to unpack these relationships, the conditions in which inadequate electricity supply really limits investment and the causal links between energy and growth and the enabling function of “modern energy services” could have important implications for developing countries through enabling policy makers and donors to make better decisions about when to prioritise and enable investment in high cost energy infrastructure.

Part 1

This initial research (first 12 months) will build on earlier energy development and economic growth literature reviews. At issue here is not the electricity investment – growth relationship (which is highly endogenous), but the market failure mechanisms and associated costs. The review would include a synthesis or meta-analysis of what has worked in what circumstances, and an identification of any significant and relevant evidence gaps.

Part 1 questions include:

1. How serious do electricity supply side problems have to be in order to constitute a serious brake on economic growth?
2. What can be learned from analysis of energy infrastructure and supply relationships to better reflect differences in costs *and* quality of service?

6 Correlation and causation between energy development and economic growth; Economic Consulting Associates; Evidence on Demand; February 2014

7 Utilising Electricity Access for Poverty Escape; Practical Action and IDS; DFID Poverty Research Fund; December 2014

8 How does electricity insecurity affect businesses in low and middle income countries; ODI; DFID Poverty Research Fund; July 2014.

3. To what degree is a binding constraint of inadequate electricity supply problems reflected by very high average prices for electricity (including privately generated electricity), or indeed high costs of other inputs including labour?
4. To what degree is the inherent flexibility in the type and timing of electricity infrastructure exploited to support economic activities?
5. What can be learnt from additional econometric work with more disaggregated data? Does it provide further insights into how electricity investments affect economic development? Does the quality of such data support such analysis? For example, triangulation of sector investment, electricity prices and other prices and outputs.
6. What can be learnt from historically successful countries, including in Asia and Latin America, which have invested successfully in energy systems, and the degree to which this has prolonged economic growth and maintained competitive average electricity prices?

This synthesis into the relationships and the causal links between energy and growth and the enabling function of "modern energy services" captured in a State-of-Knowledge paper may provide a sufficient framework to inform the Part 2 research under the other EEG research themes, and Theme 1 research can be concluded after the initial Part 1 review.

If the Part 1 review identifies that further primary research is required, this should be clearly justified, including how it will be undertaken to address remaining questions and knowledge gaps. This might include sector based or economy-wide simulation modeling and econometric work to build better empirical understanding of benefits as well as costs, and insights into sector investment priorities and options for electricity development, both conceptually and quantitatively.

Other actors and opportunities for partnership
In undertaking this initial (Part 1) review full account should be taken of the Evidence on Demand enquiries undertaken to provide the background to this research proposal.

Additionally, the **International Growth Centre (IGC)** has a research theme on energy. During its phase 1 (2009-12) only limited research on energy was undertaken, but this, (both broader sector based and country based) is now scaling up. This and the IGC network of individual researchers and its country offices offer an important resource that should be drawn on. Similarly, the World Bank research group, DECEE, has an active interest in this area and there is potential to collaborate either through the on-going **World Bank/DFID Strategic Research Partnership** or in an advisory capacity under the EEG research governance framework.

THEME 2: The financial and policy instruments and governance structures that encourage the development and better utilisation of appropriate large scale power infrastructure

Problem Statement

In many LICs, the national energy systems that could convert available energy resources into modern energy services are in a mess. Many LICs have energy sectors characterised by near monopoly public sector utilities, often with severe problems with uneconomic pricing, solvency, backlogs of detrimental commitments and poor investments, inadequate maintenance, corruption in procurement and low levels of investment[9]. Our hypothesis is that these problems are not intrinsic to the business of supplying electricity in LICs but are the outcome of common governance problems.

If governance problems are common, not enough progress is being made in removing those problems – finding the feasible steps to take is the topic of this theme. Analysis by Pueyo and Orraca Romano[10] tracks the flows of both aid and private investment to electrification in developing countries between 1900 and 2010. They found that aid flows correlate strongly negatively with governance – donors favour countries with better governance – and correlate negatively with private sector investment.[11] The poor governance, and weak financial and policy instruments send negative signals to the private sector, which could otherwise be key to mobilising the needed finance to develop energy infrastructure, hampering countries in their choice of energy resource development[12]. Progress in regulatory reform has been modest, with widespread knock on effects.

Knowledge gaps

A significant contributory factor to the lack of reform in many countries derives from the fact that those donors catalysing the reforms have done so without a deep understanding of political realities.[13] This neglect of considerations of power and politics is a major oversight when considering large energy infrastructure. Large oil, gas and electricity systems are characterised by huge financial flows and the concentration of decision making in relatively few hands; and they are sub-sectors that have long histories opacity and dirty dealing[14]. Furthermore all energy systems, whether predominantly in the public or private sector, need some form of regulation and are subject to important tax and subsidy regimes, all of which are associated with lobbying, rent seeking and winners and losers. The Energy Governance Initiative (EGI)[15]. at the World Resources Institute notes that "*Decisions made in the electricity*

9 PEAKS Report: Political considerations relevant to Energy and Economic Growth; November 2014

10 Anna Puyo

11 Pueyo, A, and Orraca Romano, PP., Finance for electrification 1990-2010. DRAFT WORKING PAPER 2014

12 PEAKS Report: Factors at Country Level Influencing Choice in Utilisation of Energy Resource Potential, January 2014

13 Democratization, Energy Poverty, and the Pursuit of Symmetry, Global Policy, Volume 5. Issue 1 . February 2014, by Griffin Thompson, Georgetown University, Morgan Bazilian, Columbia University.

14 PEAKS Report: Political considerations relevant to Energy and Economic Growth; November 2014

15 The Electricity Governance Initiative (EGI) is a global network of civil society organizations dedicated to promoting transparent, inclusive, and accountable decision-making in the electricity sector. EGI facilitates collaboration of civil society, policymakers, regulators, and other electricity sector actors to ensure that sector decisions reflect public interest. http://www.wri.org/our-work/project/electricity-governance-initiative. The Electricity Governance Initiative (EGI) has been supported by the C. S. Mott Foundation, the Netherlands, Ministry of Foreign Affairs, the Renewable Energy and Energy Efficiency Partnership and the U. K. Foreign and Commonwealth Office, the U.S. Agency for International Development, and the Wallace Global Fund... The Electricity Governance Initiative (EGI) is a

sector have repercussions with fundamental impacts on the public and their interests. Closed political processes and politically powerful groups often give limited attention to sustainable development objectives and public interest in decision making, particularly during sector reform processes"[16] In South Africa, Eberhard remarks *"The process of reform of the distribution sector has been slow and frustrated by the complex web of political interests at the local level and the fear of loss of control of an important infrastructure service and large income streams."*[17].

The academic study of these political realities is referred to as 'political economy analysis'[18]. It has risen in profile as tool to understand why 'obviously' sensible plans and programmes associated with international development fail to be implemented. It is a multi-disciplinary field of enquiry which comprises two strands:

- Analysis of the incentives and interests, both formal and informal, that influence the decisions of governing elites, other powerful interest groups and change agents in civil society, the private sector and the government bureaucracy.
- Beyond this, political economy analysis should also focus on politics: power, interests, agency, ideas, the subtleties of building and sustaining coalitions, and the role of contingency. A recent influential critique of political economy analysis methods[19] notes that focusing on incentives evades issues of power, which is central to understanding how change happens.

Using political economy approaches can have dramatic results. For example, a World Bank review of the Zambian power sector experience[20] concluded that the insights gained from the application of a political economy perspective *"enabled the government to obtain the political support needed for increasing tariffs significantly: a series of major tariff increases were implemented in 2009 and 2010... These tariff increases have allowed Zesco to improve its financial performance, put the company on the path to financial sustainability, while at the same time increasing the number of people connected to the electricity grid"* but in addition *"During the past three years, the energy sector has attracted upwards of US$2 billion in foreign direct investment and electricity generated in the country is projected to double over the next five years, as a result"*.

The intervention

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global network of civil society organizations dedicated to promoting transparent, inclusive, and accountable decision-making in the electricity sector. EGI facilitates collaboration of civil society, policymakers, regulators, and other electricity sector actors to ensure that sector decisions reflect public interest. http://www.wri.org/our-work/project/electricity-governance-initiative. The Electricity Governance Initiative (EGI) has been supported by the C. S. Mott Foundation, the Netherlands, Ministry of Foreign Affairs, the Renewable Energy and Energy Efficiency Partnership and the U. K. Foreign and Commonwealth Office, the U.S. Agency for International Development, and the Wallace Global Fund.

16 EGI Assessment Toolkit, Benchmarking Best Practice & Promoting Accountability in the Electricity Sector, Shantanu Dixit, Navroz K. Dubash, Crescencia Maurer, Smita Nakhooda, WRI June 2007

17 Anton Eberhard , chapter 6: The political economy of power sector reform in South Africa, in The Experiences of Five Major Developing Countries, Edited by David G. Victor, Stanford University, California, and Thomas C. Heller, Stanford University, California, January 2009 Cambridge University Press, ISBN 9780521100700

18 Or 'New political economy analysis', or 'Problem Driven Political Economy Analysis'

19 David Hudson and Adrian Leftwich, From Political Economy to Political Analysis, Developmental Leadership Program, Research Paper 25, June 2014, School of Government and Society, University of Birmingham, www.dlprog.org

20 Monica Beuran, Gaël Raballand, and Kapil Kapoor " Political Economy Studies: Are they Actionable, Lessons from Zambia", World Bank WPS 5656 May 2011.

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The main objective of this research theme is to **apply political economy approaches** to understand how **financial and policy instruments, and governance structures can be reformed** to encourage the **improvement and better utilisation of appropriate large scale power infrastructure** to deliver development outcomes. The intervention shall be carried out in two parts.

Part 1

Part 1 will synthesise the financial, policy and governance arrangements that support pro-development change in access to large scale power infrastructure. This should draw together what is known into a 'state of the knowledge paper'. There is a relative dearth of "academic literature" on some issues within the political economy of energy and international development. But this is amply made up with the literature from "practitioners" such as The World Bank (especially from ESMAP and DECEE) and consultants' reports. The research should target low income countries, particularly in sub-Saharan Africa and South and South-East Asia, and will look for cross- learning between these regions, and well as emerging economies and MICs.Research into financial and policy instruments and governance structures (political economy) can inform the development and the successful deployment of appropriate large scale energy infrastructure. Barnett (2014)[21] suggests Knowledge gaps could include power sector reform, and the political economy of donor behaviour.

Part 1 questions include:

1. Where power sector reforms have been undertaken, what has worked and why?
2. What does political economy research tell us about driving pro-development changes in access to energy by sub-sector (including gas, coal, oil, renewables etc.), and by context (national, regional)?
3. Using political economy analysis, what can we say in terms of progress on power sector reform (structural issues, unbundling etc.); tackling subsidies; promoting inclusive electricity access, donor behaviour etc?
4. What are the transitional possibilities for improving the supply of electricity, possibly without solving the deeper problems of the main service provider, allowing for assessment against classic (capital and capacity) constraints?
5. What has been the experience in successful transition countries – full reform of the central system or more piecemeal decentralised solutions, and the possibility of "n^{th}-best" solutions and "working with the grain" in the power sector and managing expectations.
6. How can research be designed to support findings or principles that are transferrable from one context to another?
7. How do external actors (like DFID) balance the desire to 'work with the grain' without supporting the interests of individuals or groups that are, at best, apathetic, about development outcomes?

The prospective research provider should explain what sort synthesis and review they think is possible.
In Part 1, the research provider should review the governance structures, power sector reform experience, political decision making, and financial and policy instruments that encourage development of the electricity sector, both nationally and regionally, with lessons and examples, and identify what future primary research, if any, is necessary in Part 2 to explain constraints and develop effective markets and governance structures.

21 PEAKS Report: Political considerations relevant to Energy and Economic Growth; November 2014

The final outputs of Part 1 would be:

a. Relevant, high-quality and robust evidence synthesis products that meet the research objectives (State of Knowledge papers).
b. Presentation of research findings to a series of policy fora with discussions of policy implications linking into relevant ongoing activities (e.g. World Bank or ESMAP activities) where possible.
c. Recommendations and proposed research questions for Part 2, identifying what future primary research, if any, is necessary.

Possible Part 2

Part 1 may highlight specific gaps where new knowledge is needed. Depending on the scale and nature of these gaps, it may be most practical to address these within the other EEG research themes of the programme (*The constraints in use of large-scale renewable energy sources, or "greener" energy sources; An improved understanding of the role of extractives and electricity/energy provision and sustainable development; The barriers and opportunities for innovative and appropriate design of larger-scale, centralised energy infrastructure to respond to evolving demand and support inclusive growth*). In this case. this formal research strand on political economy might therefore be closed at the conclusion of Part 1, with follow-on research embedded where appropriate in the other research themes. Alternatively, it might be justified for a Part 2 research programme to focus on the wider constraints to promoting conducive financial and policy instruments and governance structures by governments, donors and other actors.

Other actors and opportunities for partnership

Potential key actors in this area are the World Bank Group, with whom DFID has an on-going Strategic Research Partnership, the International Growth Centre and a number of university groups as well as relevant programmes that consider the enabling environment (such as ESMAP Readiness for Investment in Sustainable Energy (RISE), and Climatescope (Bloomberg New Energy).

THEME 3: Electricity supply and energy efficiency measures in supporting sustainable urbanisation

Problem Statement

We look to cities to be the centres of productivity gains in low income countries in coming years. But even more than elsewhere, productivity gains in cities might be conditional on adequate access to electricity, for firms and workers. What can we say about the point at which electricity supply becomes a binding constraint on productivity gains and on growth in urban areas. To the extent that institutional or governance problems are at the heart of inadequate electricity supply, is there any experience with or conclusive evidence about urban level solutions to governance constraints, or any way of incorporating urban development interests into power supply governance arrangements?

Webs of interactions exist in developing cities linking economic activity, electricity access, energy efficiency, and the growing numbers of urban poor. 54% of the world's population live in cities in 2014, a proportion that is expected to increase to 66% by 2050. According to UN-Habitat, a quarter of all urban people live in slums, around 863 million people[22]. Cities are engines of economic growth and are critical to future economies: they account for 80% economic growth globally, and 70% of energy use. The main energy uses in cities are transport (energy used for transport accounts for 65% of global CO_2 emissions), buildings and people. With more people, more energy is needed for the services these people use, the buildings they live and work in, and the transport that gets them around. In general, people are normally more likely to be productive in cities than elsewhere, and it is vital such productivity gains are not impeded. Also, private enterprise in low income countries identified inadequate electricity supply as a key constraint time and again.

Rapid expansion of urban populations, including slum dwellers often lacking tenure, pose severe challenges in terms of access to electricity, fast growing demand, affordability, and reliability. If the supply of electricity is inadequate or subject to frequent and lasting connectivity issues, it will limit productivity and the ability of people to prosper. Electrical distribution and access should be simpler to establish in a city context due to concentration in demand but urban areas pose problems due to peaks in demand, loses, and disparities in serving both formal and informal settlements.

Additionally, energy efficiency interventions can help close this access gap, through reducing transmission and distribution losses, and reduce costs due to lowering reducing overall demand. Nationally, there can be large benefits in terms of balance of payments (from avoided fossil fuel imports), growth potential, improved levels of energy services and lower carbon emissions. Buildings are consumers of energy, dependent on how they are built and also in how they operate ('built-in energy use', and 'plug-in energy use'). Energy efficiency improvements in buildings in hotter drier areas have not progressed significantly in recent years. The IPCC have highlighted that energy efficient buildings have the greatest potential for cost-effective CO_2 emission reductions by 2020 of all energy consumer sectors[23]. Municipal buildings

22 UNHABITAT (2014) Background Paper for World Habitat Day http://unhabitat.org/wp-content/uploads/2014/07/WHD-2014-Background-Paper.pdf

23 Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino, 2007: Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

such as schools and hospitals are large consumers of energy with potential to implement measures at scale. How can such energy efficiency measures be best promoted in developing city contexts?

The time to act on energy efficiency is now. It is vital that cities develop in as an efficient and sustainable way as possible, as developments now can lock-in inefficiencies and energy use patterns for years to come. Furthermore, a strategy based on 'grow first, tackle environmental risks later' will be ineffective given the risks to economic growth and urban poor from depletion of natural resources, climate change and global population pressures. The New Climate Economy report[24] estimates that compact connected urban development can save up to $3 trillion infrastructure capital over 15 years. But, many developing country municipalities and utilities, often lack capacity for sound electricity sector planning and long-term strategic decision making.

Knowledge gaps

There is a limited evidence base on how best to serve effectively fast growing urban demand and manage supply and demand to deliver best development outcomes. The barriers are likely to be related to issues around political economy, governance and perceived market weakness, as well as technologies.

The core knowledge areas to be addressed and extended by this Theme are around the particular nature of power supply as a constraint on growth in cities, whether there are particular governance features of national power suppliers which tend to produce adverse outcomes for cities, also whether there are particular energy efficient or innovative technologies which should be applied much more widely in low income/ascendant urban envirnoments.

Building on the theoretical framework of theme 1 this theme should explore whether there are particular features of national level power sector governance which have an insidious effect on power supply in cities, and whether there are incentive compatible solutions which can make urban power supply governance much more amenable to the needs of economic development in cities.

The theme can also cover access issues in cities. A DFID systematic review[25] highlighted the lack of solid evidence on key barriers to access to energy, notably political and cultural aspects. There is a clear gap in knowledge in what are the barriers preventing energy access to the urban poor, and what are best methods to ensure energy access for disadvantaged groups, including women and girls. There is a vital need strengthen the evidence base in regards of community and private sector-led models to tackle the market failures and deliver sustainable access for households and communities. This relates both to barriers within both informal and formal settlements and workplaces, although the solutions could be different for the differing circumstances.

Finally there might be particular energy efficiency issues in cities. Energy efficiency improvements can be difficult to achieve as they require a combination of technical developments, market mechanisms and government policies that can influence the actions of millions of consumers from large companies to individual consumers[26]. The

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http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter6.pdf

24 New Climate Economy (2014) http://newclimateeconomy.report/

25 Watson, J., Byrne, R., Opazo, J., Tsang, F., Morgan-Jones, M. & Diepeveen, S. 2011. What are the major barriers to increased use of modern energy services among the world" s poorest people and are interventions to overcome these effective? CEE protocol 11-004. Collaboration for Environmental Evidence: www.environmentalevidence.org/ SR11004.html

26 IEA (2010) Energy Efficiency Governance

NCE report[27] highlighted a number of barriers that are holding back energy efficiency gains including energy pricing, policy distortions, lack of awareness and low priority of energy efficiencies.

The IEA Energy Efficient Market report highlighted the need for improved data collection and analysis which will help track energy efficiency developments, and in turn support stronger policy design and better identification of market opportunities**.** IEA projections to 2035 show that as much as 2/3 of energy efficiency potential will remain untapped unless policies change. ESMAP has suggested that the single biggest obstacle to uptake of cost effective measures is 'underdeveloped state of energy efficiency investment delivery mechanisms…adapted to local and national economic environments'.[28] Other gaps could relate to what degree does inadequate technical knowledge and technological transfer lock municipalities and urban populations into negative development? How best to ensure developing economies, especially in the urban context, are not locked into resource intensive development?

Another issue around access and energy efficiency is the rebound effect, where reduced costs and more efficient energy provisioning, increase the demand for energy, and users increase their use. It has been said that this increasing use can reduce any gains from efficiency. However there are questions in this regards in a developing country context, and where this is applicable to the 1.2 billion without access to electricity does this indeed matter. Could this rebound actually aid economic development? Or will increased energy use within the affluent and middle classes further reduce access for the poor and disadvantaged.

The intervention

The main objective of this research theme is to explore the role of electricity supply and energy efficiency in the urban context and its role in boosting or constraining the potential productivity of cities, resident firms and workers who live there. The intervention shall be carried out in two parts.

Part 1

This Part 1 state-of-knowledge paper should look at similar questions as under research areas 1 and 2, but as applied to cities. Are electricity supply problems a major constraint to the productivity and growth of cities? Are there special n^{th} –best market and governance solutions which can work (like separate municipal power authorities or companies)? What have been the historical experiences in successful cities/ cities in successful LIC-MIC transition counties? Is there a menu or mix of options for cities with constrained supplies? What are the political, technical and financial barriers to promoting energy efficiency in these contexts? Part 1 will also identify what future primary research, if any, is necessary under Part 2. Transport is beyond the scope of this research – there are other DFID research programmes focusing on it - but interactions with urban planning will need to be considered.

Part 1 questions to be considered include:

1. Are electricity supply problems a major constraint to the productivity and growth of cities? What have been the historical experiences in successful cities/ in LIC-MIC transition counties? Do electricity supply, access and

http://www.iea.org/publications/freepublications/publication/gov_handbook-1.pdf

27 New Climate Economy (2014) http://newclimateeconomy.report/

28 Taylor R.P, Govindarajalu C., Levin J., Meyer A.S., Ward W. A., (2008) 'Financing Energy Efficiency: Lessons from Brazil, India and China'. ESMAP, World Bank

costs improve as cities transition from LIC to MIC status and does this lead or lag development? Do any cities manage to industrialize and become prosperous without addressing electricity supply problems?

2. Are there special problems for cities caused by typical national-level power sector governance measures? Can a more city-oriented governance structure be devised? Are there special nth –best market and governance solutions which can work (like separate mini-municipal power authorities or companies)?
3. What method is best used to ensure energy efficiency in an urban context, both point of generation, distribution and end use? Which sectors are best targeted for efficiency gains (excluding transport) building stock, end user etc? Where are the trade-offs? Which sector is best for delivering benefits to the urban poor and disadvantaged?
4. What are the main barriers to achieve access and efficiency in urban areas, pricing regulation, consumer behaviour, access to goods etc? Subsidies generally act as a significant disincentive for energy efficiency investments and limit the scope and profitability of energy services companies. What effective measure/successful examples have there been to address these issues which can be replicated in the developing world.
5. Is there an Energy Efficiency Gap in developing countries, Gillingham and Palmer[29], suggest that the size of the gap is overestimated for failing to account for all costs and neglecting particular types of economic behaviour, is this the same for the urban context and in developing countries?
6. Does a rebound affect happen in the context of the urban poor, and does it contribute to economic growth?
7. What is the role of municipality reforms, decentralisation on ensuring energy efficiency and energy access? City planning could also play an important role; are there case study examples that are replicable in the Sub-Saharan context e.g. Curitiba in Brazil[30]?

Possible Part 2 research

Part 2 will build on Part 1, which will have highlighted significant gaps and sought to produce a synthesis of current knowledge. Using this as a basis the researchers will identify areas for further in-depth research, which could lead to substantial benefit on the ground, in the urban context for the poor and disadvantaged and also lead to carbon reductions.

Other actors and opportunities for partnership

The World Bank ESMAP programme has a specific topic area on “Energy Efficient Cities” (http://www.esmap.org/Energy_Efficient_Cities).This is looking at supporting cities to quickly identify improvements and prioritise sectors and actions for energy efficiency intervention. Through supporting cities to develop an energy efficiency

29 Gillingham K & Palmer K (2014) Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence

30 Good practice in city energy efficiency: Eco2 Cities Land use and public transportation planning in Curibita https://www.esmap.org/node/1232

framework, and a pipeline of investment-ready energy efficiency projects, ESMAP are helping them move to a low carbon growth pathway.

The IEA is also engaged on energy efficiency (http://www.iea.org/topics/energyefficiency/) and in a recent report called it an "invisible powerhouse". Although concentrated in the developed world they are increasingly interested in developing countries.

Enerdata (http://www.enerdata.net/.) in France are collecting energy efficiency indicators in countries around the world and conducting surveys of energy efficiency policies and measures. The EU Energy Initiative Partnership Dialogue Facility (EUEI PDF http://www.euei-pdf.org/) is an instrument of the EU Energy Initiative supporting the creation of an enabling environment for investments through a number of mechanisms. These include knowledge sharing and capacity development and policy, regulation and strategy development

The Sustainable Energy for All Energy Efficiency Knowledge Hub (http://www.unepdtu.org/What-We-Do/Thematic-Programmes/SE4All-Energy-Efficiency-Hub), with support from the Danish government, has been in operation since 2011 and is a programme of the UNEP Riso Centre seeking to become an international knowledge centre for collaboration and exchange on energy efficiency.

The World Business Council for Sustainable Development (WBCSD) has a number of programmes under their 'Action 2020' approach which are bringing together a variety of stakeholders across civil society and the private sector to address challenges that are relevant to this project including Energy Efficiency in Buildings (http://www.wbcsd.org/buildings.aspx) and Electrical Utilities (http://www.wbcsd.org/work-program/sector-projects/electricity-utilities.aspx) and Urban Infrastructure (http://www.wbcsd.org/urban-infrastructure.aspx).

THEME 4: Constraints in the Use of Large-Scale Renewable Energy Sources or Greener Energy Sources

Problem Statement

Large scale renewable energy sources can contribute to the global shift to a low carbon economy. In many Sub-Saharan African (SSA) and South Asian (SA) countries, large scale renewable resources such as hydro and geothermal have the potential to significantly augment national electricity supply, and capacity surplus can contribute to meeting deficits in neighbouring countries through inter-connection and power pooling, with the opportunity to generate revenues for exporting countries. However, countries particularly in SSA and SA, appear reluctant to trade in electricity across borders, even where transmission lines exist. Globally exports of electricity are around 3%.

Promoting opportunities for renewables can be problematic against a backdrop of lack of familiarity and experience, as well as new finds and improving access to fossil fuel reserves, with perceived lower investment costs and shorter development times. Country and regional energy policies, strategies and infrastructure development plans can also lock-in a dependency on high carbon generation of electricity.

The fact that current capacity is a long way behind current and predicted future needs provides an opportunity as SSA and SA can benefit from recent global knowledge, experience and cost reductions in renewable power generation technologies, to leapfrog the development path taken by industrialised countries and plan around a renewable energy-based system[31].

For renewables to compete at a large scale in the energy mix requires a policy and planning environment that motivates governments, suppliers and distributors to collaborate. Models include the introduction of generation or purchase quotas, power purchasing agreements, use of tax incentives, investment subsidies, agreeing feed-in tariffs and tradable green certificates and adequate renewable energy funding opportunities. In reality, different countries and donors are often using different master planning and modelling techniques (as well as different pricing policies) and have different security concerns and energy/commodity trading priorities[32]. More evidence is needed on economic and financial challenges facing large scale renewable options and the success or otherwise of different instruments and models, and how these can be successfully adapted to LICs.

Knowledge gaps

This research theme will focus on four groupings of knowledge gaps:

- Non-economic barriers to the uptake of renewables
- Economic barriers including technical challenges in bringing renewable costs down
- Power pool operation and energy trading
- Integration of renewables into grid systems

Barriers and challenges will, of course, vary with scale, context, region and market. The specific context of LICs and poverty reduction will add a further dimension of complexity.

31 Prospects for the African Power Sector Scenarios and Strategies for Africa Project. IRENA. 2012. www.irena.org/.../Prospects_for_the_African_PowerSector.pdf

32 Perceptions provided by the DFID Afghanistan programme, January 2015

Analysis suggests that there are significant non-economic barriers that limit the opportunity to scale-up and increase the renewable mix[33],[34],[35],[36]. These include regulatory and policy uncertainty (e.g. poor policy design, ineffective sector governance, insufficient transparency); institutional and administrative challenges (e.g. lack of strong, dedicated and mandated institutions); infrastructure capability to absorb or integrate renewable energy; and insufficient knowledge about the availability or potential for renewables and public/environmental challenges to planning, particularly on hydropower development.

In terms of the second knowledge gap, economic challenges, there are market barriers to large scale renewables (e.g. fossil fuel subsidies, inconsistent pricing, failure of social or environmental costing methods etc). In addition, more evidence is needed on the policy measures to reduce the renewables investor's perceived or real risks and challenges around scaling up, such as legal security, financial and administrative arrangements, political unpredictability and access to grids. What are the premiums on these risks, how are they handled and transferred?

Technological factors play a role in reducing costs. Renewables are likely to attract higher upfront costs than fossil fuel-based energy production. More than 150 years of research and learning has driven down the cost of conventional energy sources; 70 years in the case of nuclear[37]. What can we learn from the past to help unlock the cost reduction potential of large scale renewables?

How can the collective evidence on handling the technical challenges, including complementarity to regional mix, be utilised to benefit renewable scale up in SSA and SA?

The third knowledge gap concerns power pools. The lack of well-functioning power pools is a major barrier to large scale renewable energy resource use in LICs. There is a significant knowledge gap around how LICs can best participate, negotiate and share winning benefits; gain fair prices; deal with monopolies and big players, avoid import dependence and handle national demand, gain energy security and protect sovereignty, handle regulation and market monitoring, extend market opportunities nationally and deal with potentially disparate utility companies, tariffs setting and subsidies.

Across the power pools in Africa, coal and other hydrocarbons dominate the energy mix with 80% based on coal in SAPP[38]; 82% on oil and gas in EAPP; and, 67% on oil and gas in WAPP. Renewables in the mix are 15% (hydro) SAPP[39]; 18% (hydro and geothermal) EAPP; and 33% (hydro) WAPP [40],[41],[42]. These proportions do not reflect

33 Muller, S; Brown, A and Olz, S. Renewable Energy: Policy Considerations for Deploying Renewables. International energy Agency. November 2011.

34 Shaw, D and Perera, N. Factors at country level influencing choice in utilisation of energy resource potential. Evidence on Demand. February 2014.

35 Scaling up Renewable Energy in Africa. 12th Ordinary Session of Heads of State and Governments of the AFRICAN UNION. Addis Ababa, Ethiopia. Available at: http://www.unido.org/fileadmin/user_media/Services/Energy_and_Climate_Change/Renewable_Energy/Publications/Scaling%20Up%20web.pdf.

36 SREP Sub-Committee reviewed document SREP/SC.12/3, SREP Semi-Annual Operational Report, October, 2014. Available at: https://www.climateinvestmentfunds.org/cif/content/srep-semiannual-reports

37 Muth, J. Hat-trick 2030: An integrated climate and energy framework. EREC. European Renewable Energy Council. April 2013. Available at: http://www.erec.org/toolbox/search.html

38 SAPP Southern African Power Pool; EAPP East African Power Pool; WAPP West African Power Pool

39 Balances in SAPP are nuclear

40 Africa Clean Energy Corridor: Concept Overview. Singh, G. Division Of Country Support and Partnerships, International Renewable Energy Agency www.irena.org/.../Africa%20CEC%20session%202_IRENA_Singh_2206

the availability of renewables in Africa, so there is a significant opportunity to build more renewable energy into better power pools.

By adding large scale renewables into the mix, does this change any of the basic operating principles for the power pool or trading? What actions can governments and international community take to facilitate increases for large scale renewables? Can power pools withstand supply shocks and stress, if, for example, hydro capacity is temporarily reduced? What support can governments give to reduce risk and cost to the private sector?

Outside of power pools, LICs with renewable energy resources gain, especially when energy can be traded[43]. What data and information exists on successful trading and trading experience and how can this be used to facilitate energy trade benefits for LICs. What are the implications and risks for LICs in power purchase agreements? How can smaller schemes complement, enter and support trading?

Lastly, there is a knowledge gap around integration of renewables into national grids. As the share of variable renewables connected to the grid rises, it also becomes important to consider the impact on grid stability and reliability. Much depends on the network and the power generation system, but local stability issues can arise when renewables account for as little as 10% of total generation. What does the evidence tell us about how the trans-boundary spatial distribution of renewables can be coordinated and optimised, to minimise intermittency of supply?

The intervention

The main objective of work in this area is to understand what constrains the use of large renewable energy technologies, particularly hydro, geothermal and greener energy sources in competing with fossil fuels, and increasing their share in the energy mix to deliver better green growth outcomes, nationally and regionally.

The intervention shall be carried out in two parts.

Part 1:

Part 1 will review knowledge, experience and lessons in the use of large-scale renewables, in LICs and MICs. It should build on the earlier rapid desk based study on Factors at Country Level Influencing Choices in Utilisation of Energy Resources Potential. Part 1 research will comprise of **one overarching synthesis** study – the state of the knowledge paper - and be supported by **selected case studies,** targeting LICs, particularly in Sub-Saharan Africa and South Asia, and will look for cross-learning between these and other developing/developed regions and international experience.

Part 1 research questions may include:

1. What are the main causal factors behind real or perceived (economic and non-economic) barriers and challenges to successful deployment of large scale renewable energy? What measures have been taken to address these and what is the evidence for success?
2. What policy mechanisms and planning tools are needed, or are available, to encourage use of renewables, including 'green growth policies', such as

41 West African Power Pool: Planning and Prospects for Renewable Prospects for the African Power Sector. IRENA. 2013. www.irena.org/DocumentDownloads/Publications/WAPP.pdf

42 WAPP shortfall of 1GW also supplemented with diesel generators

43 Kambanda,C. Power Trade in Africa and the Role of Power Pools. Jul 10 2013. Available at: http://www.afdb.org/en/blogs/integrating-africa/post/power-trade-in-africa-and-the-role-of-power-pools-12101/

pricing and regulation to internalise environmental capital costs (Dercon, 2011) and why they have had limited application?
3. How can the disparate performance of international/regional power pools be explained and what lessons can be drawn out for LICs entering such agreements?
4. What are the opportunities to learn from and transfer knowledge from successful pools to poorer performing pools in SSA and SA. Building on the experience of international power pools, what are the opportunities for large scale renewable energy development and how can these be applied in the context of LICs?
5. What approach is needed and what are the requirements for building greater familiarity and access to knowledge on large-scale renewable energy development in SSA and SA?
6. What tools and technologies are available for renewables to challenge coal and other hydrocarbon based energy sources in energy mix and how would these be applied in LICs?
7. How can large-scale renewable energy development increase energy access for the poorest and maximise the economic benefits for equitable growth?

It is envisaged the key gaps and recommendations from Part 1 will be prioritised and form a basis for the Part 2 of this research. Part 2 shall only commence pending approval of the outputs from Part 1.

Part 1 will provide a high-quality and robust evidence synthesis of the state of knowledge on large scale renewables as relevant to LICs. The synthesis from Part 1 may show that there are significant knowledge gaps that require additional research. These will be proposed as research questions that could form a coherent programme on large scale renewables for Part 2.

Possible Part 2 activities:
Part 2 may focus research on further exploration of one or more of the knowledge gaps, themes or sub-themes covered in Part 1 or it may follow a new, unexplored, stream related to large scale renewables that has been identified. It may also consider rolling out findings from Part 1 directly into donor, government and private sector practice to adapt policies, strategies or plans through dissemination and high-level advocacy and awareness raising events. Should Part 2 be approved, there would also be an intention to deepen existing and develop new and wider partnerships

Other actors and opportunities for partnership?

There are a number of international organisations representing various groups with interest in promoting renewables (e.g. Energy Sector Management Assistance Program (ESMAP); International Renewable Energy Agency (IRENA); - European Renewable Energy Council; International Renewable Energy Alliance (REN Alliance); and, the Renewable Energy Policy Network for the 21st Century (REN21)). Potential key actors in this area include the MDBs and RDBs providing lending for large scale renewable energy projects and programmes WBG and AsDB notably, as well as the EIB and EUEI PDF). Some of the MDBs will have energy sector technical groups with specialist interest in renewable research (WB DEC). Other partners include the Power Pool boards or secretariats, and sector technical committees of the main Regional Economic Communities (RECs) in SSA and SA. Some DFID regional and country programmes also have a direct interest in large scale renewable energy

development and energy security, often working closely with MDBs. These include the Pakistan and Afghanistan programmes, Ethiopia and the Africa Regional Department, as well as the DFID East Africa Research Hub. These offices should be consulted during the scoping phase and framing of the primary research questions.

THEME 5: An improved understanding of the role of extractives in electricity/energy provision and sustainable development

Problem Statement

Persistently high poverty levels present a delicate balance of challenges and competing objectives for regions rich in fossil fuels[44]. Nigeria and Angola are two well-known examples of countries with high energy resource endowments and high levels of inequality and poverty[45]. However, after many years of political instability and economic stagnation, the narrative on sub-Saharan Africa is changing. The continent now hosts some of the world's fastest-growing economies[46] and accounts for almost 30% of global oil and gas discoveries in the last five years[47]. An unprecedented increase in commodity prices driven by the demand from emerging economies such as China and India,[48] (nothing is permanent with commodity prices!) coupled with the diminishing supply from other areas has sparked the global appetite for investment in exploration of the resource potential in sub-Saharan Africa[49].

The questions of interest here are about the interplay of major hydrocarbon discoveries and electricity/energy supply and policy (primarily oil and gas, but with reference to the lessons derived from coal based energy sectors in countries such as South Africa and India). Does a major discovery alter comparative advantage and improve competitiveness, and is this conditional on an altered energy policy? Does it permit a lower cost of electricity than otherwise and hence new levels of competitiveness, new investment and potentially much greater demand, with more energy-using industries than otherwise? Are there risks of resources being squandered to the ultimate disadvantage of a country and a resulting unsustainable power sector? What is the historical experience? How can the benefits be fairly shared between local communities and national interests such that the resulting energy mix meets all energy consumption needs? How can a political dialogue around extractives and development also inform energy sector strategies and mitigate risks?

Knowledge gaps

This research theme should focus on two broad knowledge gaps. First, whether the discovery of significant hydrocarbon resources has the potential to improve competitiveness in energy-using industries and stimulate non-extractive, job creating economic development, and whether this has been the experience in any countries (eg Malaysia, Indonesia?). Second, whether this is likely to occur only in very particular political-economic settings given the known risks that hydrocarbon discoveries may allow accountability and governance to deteriorate, including, if not especially, in the energy sector itself. And whether steps can or have in the past

44 Africa Progress Panel (ARR, 2013). Equity in Extractives - Stewarding Africa's natural resources for all, Africa Progress Report 2013

45 Nigeria – see Washington Post, 27 September 2013; Angola – see Energy Economist, 10 February 2011.

46 Kawa, L. (2013). The 20 Fastest-Growing Countries in the World. Available at: http://www.businessinsider.com/fastest-growing-economies-through-2015-2013-1?op=1 (Accessed 28th August 2014).

47 The Plundered Planet, Paul Collier, Oxford, 2010. The Oil Curse, Michael Ross, Princeton, 2012See also Towards A Framework for Extractive Industries Governance Assessment (FEIGA), Report to the World Bank Institute, William Kingsmill and Gareth Williams, April 2013, http://thepolicypractice.com/papers/21.pdf.

48 World Bank, (2014). Breaking out of Enclaves: Leveraging Opportunities from Regional Integration in Africa to Promote Economic Diversification and Mitigate Resource Curse, Draft Concept Note.

49 International Energy Agency (IEA, 2014). Africa Energy Outlook – Focus on Energy Prospects in sub-Saharan Africa, World Energy Outlook Special Report

been taken to guard against these risks in order to exploit the best potential offered by the natural resource discovery.

As global energy demand continues to grow with an additional 3 billion middle-class consumers expected by 2030[50], emerging oil and gas resources, particularly in sub-Saharan Africa, can be a driver of growth just from the proceeds of exploiting the natural resources. But at least hypothetically, these resources could boost competitiveness and create many more jobs if they were coupled with enhanced energy infrastructure and accelerating productivity and human development. The problem is that very little is known about the interplay between major extractives discoveries and energy infrastructure supply. So it is not clear when and how energy policy should alter in the face of hydrocarbon discoveries. The aim should be to exploit big reductions in energy costs if they are available, and to increase access for the poorest in the most effective ways and maximise the economic benefits for equitable growth. Yet hydrocarbon discoveries are certainly not always associated with cheaper electricity and enhanced competitiveness – the downside risks affecting accountability and institutions and conflict are better understood.

Optimising investment in energy infrastructure is critical for growth[51], and it is a critical question for policy because both the level of investment and the whole market for energy tends to be so politicized, and is no less likely to be if there have been major hydrocarbon discoveries. Generating investments on the scale needed for power generation very often requires public sector involvement or control in poor countries. To provide an effective modern energy service to poor people it is likely cross subsidies within power utilities will be required. But public control of huge investments and intervention in large markets can create huge rents and attract private and political actors who try and capture those rents, to the detriment of the sector and the public interest. The distortions resulting from the large subsidies are well documented and widely known[52]. Where tariffs have risen to levels that cover costs (for example Kenya), this may have the effect of passing the cost of inefficiency and rent seeking to consumers. This in turn choked off demand, and reduced the impact that electricity could have on development[53].

Against this general background in the power sector (theme 2), the introduction of huge rents associated with a hydrocarbon discovery may worsen accountability and governance in general, and even more so in the energy sector. This would seem to create bleak conditions for an enlightened public policy for energy investments aimed at exploiting the potential for cheap and plentiful electricity. Yet whilst the capture of hydrocarbon rents by elites is very widespread, so are populist policies such as the subsidy of fuels and/or electricity for all or some consumers. In many African countries, the combination of fuel subsidies and poor energy sector investment means that small-scale diesel generation is financially cost effective , which is a very distorted situation. Conversely, perhaps a combination of moderate rent capture and populism can allow reasonable levels of investment in energy, low costs and substantial benefits.

50 Energy, Growth and Development; International Growth Centre (IGC); 2013

51 Africa's Infrastructure, A Time for Transformation, http://www.infrastructureafrica.org/flagship-report

52 See The Ministry of Finance Green Paper, and reports by IISD, BPPT, EIU, World Bank briefs.

53 There are many possible sources for these statements, but see for instance: Africa Infrastructure Country Diagnostic: Background Paper 6 Africa Infrastructure, Country Diagnostic Underpowered: The State of the Power Sector in Sub-Saharan Africa, Anton Eberhard, Vivien Foster, Cecilia Briceño Garmendia, Fatimata Ouedraogo, Daniel Camos, and Maria Shkaratan, May 2008.

Terms of Reference
PO 7160 – Applied Research on Energy and Economic Growth

The accessibility of high-quality research unpacking the interplay between major extractives discoveries in developing countries; large scale energy infrastructure investments and the underlying, context-specific political economy, is low. There has been little attempt to synthesize the existing literature or expand the research to a global spectrum exploring opportunities on how investments from extractives, particularly oil and gas discoveries, may increase modern energy services for the poor and maximise economic benefits. Clear evidence gaps remain in understanding the context-specific political economy and the manifestation of incentives and disincentives behind large-scale investments in energy, making it difficult for policy makers to develop effective strategies and processes.

The intervention

The main objective of this research theme is to understand how the interplay between major extractives[54] discoveries, large scale modern energy infrastructure, the impact of this on **competitiveness of energy using industries beyond extraction** and the **prospects of exploiting this potential competitiveness in any particular political-economic setting.** How soft are the institutional barriers to realizing these benefits for the poor?

The intervention shall be carried out in two parts. Part 1 scope will review experience of the best ways of managing and using extractives to maximise economic and human development, explore opportunities for investing revenues from extractives in the energy sector and investigating how real and significant the competitiveness implications of this can be, draw on relevant examples to understand how these might contribute to economic growth and also how extractive industries can serve as an enabling environment to provide modern energy services to the poor. It will also assess the state of knowledge on just how different are the political-economic conditions and institutional environments in countries which seem to be able to exploit cheap fossil fuels to create competitiveness versus those which only distribute rents to a few.

Part 1

Part 1 research will comprise of **one overarching synthesis** study aimed at the two target "knowledge gaps". It could involve widespread literature review and may have to break down questions further, and could even involve some serious quantitative work. As usual the countries of interest are low income countries especially in Africa but the literature reviews and any quantitative work should look at relevant countries which are no longer LICs – countries which have had significant hydrocarbon discoveries, exploited them, and which may or may not have exploited attendant potential for cheap electricity.

Potential Part 1 overarching and case study questions include, but are not limited to the following:

1. Is there any general relationship between the discovery and exploitation of hydrocarbon fuels and cheaper fuels and/or electricity in the local market?
2. Where hydrocarbon endowments seem to allow cheaper fuel and/or electricity in the local market, how significant are the benefits? Do large hydrocarbon always cause "Dutch Disease" and reduce the competitiveness of other industries or can cheaper energy stimulate competitiveness and growth?;
3. Can we identify historical experiences of countries which have capitalized on cheaper energy?

54 Oil and gas

4. Are there critical institutional differences which seem to help explain why some countries convert natural resource discoveries into economic diversity and competitiveness and some move in the opposite direction? Are initial institutional differences, large or small, and is there any institutional "taxonomy" which can be offered and evidenced?

Researchers should look at these and related problems and questions. A starting point should be a literature review. If these or the addition of any quantitative work allows researchers to be reasonably conclusive this will be very welcome but we would prefer the outputs of Part 1 to tour the evidence and identify useful and tractable questions for Part 2 research rather than arrive at false or premature conclusions in Part 1.

Possible Part 2 research

The final outputs of Part 1 will be relevant, high-quality robust evidence products that meet the research objectives, which will also be presented in a series of policy fora, with discussions of policy implications; along with recommendations for research questions for Part 2. In this theme, as mentioned, it is quite likely that Part 1 evidence products will leave major questions unanswered. To take research further in Part 2 there will clearly need to be a scientific strategy that can be more conclusive – this may not be possible.

Other actors and opportunities for partnership

Potential key partners for this research theme are the World Bank Group, including ESMAP with its programmes on fossil fuel subsidies etc; the International Energy Agency (IEA); and the Extractive Industries Transparency Initiative (EITI), as well as the International Growth Centre (IGC). Consideration will be given to incorporating certain relevant on-going activities and current proposals into the scoping stage (Part 1) work. For example, Chatham House is considering exploring the synergies and risks between extractive-led and low-carbon development models, through a series of workshops and briefings, and this could compliment and be integrated this research theme.

THEME 6: The barriers and opportunities for innovative and appropriate design of larger-scale centralised energy infrastructure to respond to evolving demand and support inclusive growth

Problem statement

Sub-Saharan Africa is rich in energy resources, yet, two-thirds of the population live without access to electricity supply. On-grid power generation capacity was only 90 GW in 2012, with around half of this being in South Africa[55]. The World Energy Outlook, forecasts rapid expansion of the SSA energy system by 2040 as the economy quadruples and the population nearly doubles (to almost 1.8 billion).

Meeting latent and growing demands for energy is a huge challenge, which requires expansion of large scale power systems as well as off-grid and mini-grid electricity provision solutions. Experience to date of fully utilising the capacity of existing large scale energy infrastructure to support economic growth, as well as meeting the energy needs of local populations, especially marginalised groups, has been extremely poor. Challenges include:

- Generation and transmission line capacity being underutilised;
- Regional energy market trading being slow to grow,
- Connected demand and purchasing arrangements not matching investment and revenue profiles,
- Lock-in to inefficient plant,
- Generation and transmission losses, and
- Inadequate and poorly funded operations and maintenance.

At the same time, despite massive past investment in major power infrastructure, the electricity generated has often not benefited or served the poor, and this has rightly been criticised[56]. Research in western Kenya[57] found that even in seemingly ideal settings, where there is high population density and extensive grid coverage, within just 200 meters of a low-voltage power line, electrification rates remain very low, averaging 5% for rural households and 22% for rural businesses. Implementation of energy access for the poor faces a number barriers and challenges, many of which are of a political economy nature, and these include:

- lack of capacity by the poor to pay for the services;
- lack of pro-poor policies on subsidies means difficulties in applying effective subsidies for the poor;
- lack of appropriate financial mechanisms to enable people's access to credits to cover costs of implementation, connection, spare parts, repairs and services;
- high connection costs;
- inappropriate or difficult regulatory and legal frameworks to promote community management models.

Given the large energy demands, limited resources to invest, extensive and challenging geographies, and sparse populations to serve, as well as the poor

55 International Energy Agency. World Energy Outlook Factsheet Africa Energy Outlook: Energy in sub-Saharan Africa today -. October 2014. Available at: www.worldenergyoutlook.org

56 Report on EU Development Cooperation in support of the objective of Universal Energy access by 2030. 2011/2112(INI). Committee on Development. Rapporteur: Norbert Neuser

57 Lee,K et.al. Barriers to Electrification for "Under Grid" Households In Rural Kenya. Working Paper 20327. National Bureau of Economic Research, Cambridge, USA. July 2014. http://www.nber.org/papers/w20327

current performance of existing infrastructure, genuinely innovative approaches are required. DFID with its priorities in economic development and poverty reduction, and promoting good governance, is in a good position to collaborate with the principle funders to large scale energy infrastructure to pursue better outcomes. This theme sets out to determine whether better and more flexible design, innovation and incentives can offer better outcomes.

Knowledge gaps
Many developing countries require large scale infrastructure and high investment to tap available energy resources to meet the electricity needs of their population and businesses, and to be sustainable, this requires efficient capacity utilisation and revenue generation. Innovative and appropriate design may provide opportunities for matching investment and capacity more closely to take-up and revenue generation, whilst at the same time improving access to electricity for the poor and, with appropriate incentives, removing some of the barriers to improved energy access.

There are also a number of emerging technologies that could improve existing network efficiency and the manner in which networks are operated and managed. Smart communication technologies are increasingly being used to monitor and manage both traditional network infrastructure and decentralised mini-grid supply systems. Smart technologies are also available to improve electricity grid and network efficiencies by, for example, enabling load levelling of the electrical grid (allowing a power company to run cleaner sources such as hydroelectric, wind, or solar); using smart meters and other smart (ICT) devices to manage demand side response, monitor non-technical losses and manage the grid[58]. Smart technologies can potentially be deployed alongside high-voltage transmission lines, low-voltage distribution lines, transformers or direct current connections and convertor stations for better grid management. These technologies have potential in LICs as well developed country networks.

To understand how alternative design features or technologies used for large-scale energy infrastructure might be adapted to make designs and investments more appropriate, efficient and cost-effective for lower-income countries, three knowledge areas are of interest:

1. The technical and financial feasibility of utilising modular or phased approaches for scaling up generation, transmission and distribution infrastructure in meeting demand build up.
This type of approach might be feasible in large electrification projects where there is a likelihood of initial excess capacity and where utilisation is uncertain or likely to grow slowly. An understanding is needed of the options, opportunities, and experiences through case studies of adopting this type of modular or phased approach.

2. Technical options and approaches that can reduce generation, transmission and distribution inefficiencies need to be captured and understood.
Plant and transmission losses place a significant burden on generation infrastructure, particularly with older plant. Losses (including non-technical losses) among the developing countries of SSA are estimated to have averaged 11 per cent

58 Vivid Economics and ARUP; Electricity network efficiencies: report prepared for the International Climate Fund; DFID; January 2015

in 2011, compared to six per cent in the EU. Replacing older plant or sections of plant can be cost effective in reducing losses and increasing output.

3. Design options that can provide low voltage supplies to local populations and SMEs that are both technically attractive and affordable.
Construction of large scale generation and transmission facilities can also be designed include electrification sub-projects. Design options can consider optimising the siting of transmission lines, transformers and additional sub-stations to benefit remote communities and local SMEs, or using shield wires for low voltage connections. Innovative planning, design, financing, implementation and maintenance methodologies that have been successfully used on projects need to be captured and assessed through case studies and best practice analysis.

The intervention
The intervention shall be carried out in two parts.

Part 1

Part 1 shall review the literature and sector experience, and deliver a synthesis of the evidence through state-of-knowledge papers in the three knowledge areas. Part 1 research questions include:

1. Utilising modular or phased approaches for scaling up infrastructure.

- Can a modular approach, where capacity is added in a phased manner, provide a workable option for poor countries and regions? Based on case studies, what are the options, opportunities, experiences and issues of adopting this type of approach?
- What innovative features can be included in large energy and electrification projects to provide solutions for utilising excess capacity in the system, whilst providing better connection for poor and marginalised communities?
- What innovative planning, design, financing, implementation and maintenance methodologies are available and what are the best practices that could be adopted in LIC contexts?
- Are there political economy considerations that are causing good engineering options and innovative approaches to be rejected in an inefficient way, given the interests and incentives of many state monopoly electricity organisations?

2. Reducing generation, transmission and distribution inefficiencies.

- Which smart technologies can potentially be deployed in power systems and in what situations for better grid management and which of these technologies are adaptable to low income country situations?
- How are choices made in technology selection and what are the common challenges or issues that prevent such technology being used in low income countries to increase system efficiencies?
- Are new or innovative technologies being overlooked because of institutional problems and political decision-making or as a result of lack of technical awareness or capacity?
- How can smart technologies and innovative approaches promote the integration of renewables?
- What has been the experience of more successful LIC-MIC transition countries to date and are there lessons from the successful adoption of certain new and innovative technologies?

3. Design options for lower voltage supplies.

- Can large scale energy projects integrate effectively electrification sub-projects and what features are most promising? Can such approaches be used as part of social acceptance and mitigation for larger projects?
- How can planning and design optimise siting and location of transformers and sub-station infrastructure to better benefit poorer groups, local communities and SMEs?
- Can smart devices support pre-paid metering to manage access to electricity services, support revenue collection and encourage private developers, such that the poor benefit from electricity access?

Three areas of review are proposed but these maybe adapted during the scoping work to focus on where most potential exists. The Part 1 state-of-knowledge paper will review knowledge, experience and lessons and this will be supported, where possible, by selected case studies targeting low to middle income countries, particularly in SSA and SA; and will look for cross-learning between these and other developing/developed regions and international experience. Where published literature is limited, it is expected that extensive use will be made of grey literature and project reports. Part 1 will identify the primary future research, if any, to be undertaken in Part 2, and the areas for this additional research. .

Other actors and opportunities for partnerships
A wide range of research and development organisations should be consulted to gather evidence and operational experience.

Multilateral Development Banks (WBG, AsDB and EIB etc) and bilateral donors (such as JICA, USAID and GIZ) have relevant project experience and expertise in these research areas. The experience of developed economies should be accessed such as through the European Union, Directorate-General for Research, Directorate J – Energy (research@cec.eu.int) and Horizon 2020 (http://ec.europa.eu/research/energy), and national and international energy and renewable energy associations such as the National Renewable Energy Centre – Narec, (www.narec.co.uk); International Hydropower Association – IHA, (www.hydropower.org); Renewable Energy Association-REA (http://www.r-e-a.net); Energy Networks Association – ENA, (http://www.energynetworks.org) and International Energy Agency – IEA, (iea.org);. The relevant national research centres and innovation centres should be consulted, as well as professional institutions, and utilities. There is also a wide range of pprivate sector organisations with R&D expertise and experience in implementing new technologies.

A stakeholder mapping and resource summary should be included in the Part 1 scoping work. Joining various energy and innovation portals, discussion groups and webinars should also be considered.