

Abstracts for EEG State-of-Knowledge Papers (October 2016)

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		1.2	Miguel, Lee, Wolfram	Electricity and Economic Development: A Microeconomic Research Agenda
		1.3	McCulloch, Zileviciute	Is Electricity Supply a Binding Constraint to Economic Growth in Developing Countries?
2	Financial and policy instruments and governance structures that encourage the development and better utilisation of appropriate large scale power infrastructure (Roy)	2.1	Eberhard, Godinho	Rethinking Power Sector Reform in Sub-Saharan Africa and South Asia
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5	An improved understanding of the role of extractives in electricity/energy provision and sustainable development (Ross)	5.1	Mahdavi, Ross	The Political Economy of Hydrocarbon Wealth and Fuel Prices
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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 (Modi)	6.1	Dubbeling, Mueller, Munuera,	Modular and Discrete: Opportunities for Alternative Power System Planning, Expansion and Operation in Developing Countries
		6.2	Modi, Rodriguez-Sanchez	Reducing Generation, Transmission and Distribution Inefficiencies and the Feasibility of Low Voltage Supply in LICs
		6.3	Modi	Low-Voltage System Designs for Energy Access
Cross-cutting	Climate Change	N/A	Frankhauser, Jotzo	Economic Growth and Development with Low-Carbon Energy
Cross-cutting	Gender	N/A	Wilhite	Gender Implications of Energy Use and Energy Access
Cross-cutting	Data	N/A	Masanet, Millard, Munuera, Quadrelli	Leveraging Smart System Technologies in National Energy Data Systems: Challenges and Opportunities

Abstracts

1.1 The Impact of Electricity on Economic Development: A Macroeconomic Perspective

Authors: Stephan B. Bruns, Paul J. Burke and David I. Stern

This paper attempts to answer the following questions: How serious do electricity supply side problems have to be in order to constitute a serious brake on economic growth and to what degree has electrification prolonged or accelerated economic growth? What can be learnt from development experience of countries that have invested successfully in electrification systems? We find that electricity use and access are strongly correlated with economic development, as theory would suggest. Despite large empirical literatures and suggestive case evidence, there are, however, few methodologically strong studies that establish causal effects on an economy-wide basis. There is evidence that reliability of electricity supply is important for economic growth. We propose that future research in this area focus on strengthening the robustness of analysis by identifying the causal effects of electricity reliability, infrastructure, and access on economic growth, testing the replicability of the literature, and deepening our theoretical understanding of how lack of availability of electricity can be a constraint to growth.

1.2 Electricity and Economic Development: A Microeconomic Research Agenda

Authors: Kenneth Lee, Edward Miguel and Catherine Wolfram

We review existing evidence on the microeconomic linkages between electricity supply and economic development. We organize our discussion around three questions. First, how should governments expand electricity supply to households and firms? Second, what are the factors that influence electricity usage, including for example, the acquisition of appliances, the electricity tariff structure, and the payment technology? Third, what are the impacts of electrification, and how do spillovers and complementarities drive these impacts? We highlight promising areas for future research.

1.3 Is Electricity Supply a Binding Constraint to Economic Growth in Developing Countries?

Authors: Neil McCulloch and Dalia Zileviciute

Is electricity supply a binding constraint to economic growth in developing countries? And to what degree is a binding constraint of inadequate electricity supply problems reflected by very high average prices for electricity? There is a large empirical literature on “binding constraints,” much of it using the Hausmann-Rodrik-Velasco (2005) framework and applying it to particular countries. There is also a large literature on the quality of the investment climate, much of which draws on the World Bank enterprise surveys. Our paper undertakes a systematic review of the published and grey literature that has applied the HRV framework at the country level in order to ascertain how frequently electricity supply is identified as a binding constraint to growth (and differentiating between access, reliability and price). It also examines the rankings of

constraints provided in the World Bank's Enterprise Surveys in order to assess the extent to which businesses regard electricity as a major constraint. We find strong evidence that electricity is a constraint to growth in several developing countries with over 40% of the studies reviewed identifying electricity as a binding constraint. But high electricity prices are not necessarily a signal of electricity being a binding constraint, although they do tend to be associated with poor quality and reliability of supply.

2.1 Rethinking Power Sector Reform in Sub-Saharan Africa and South Asia

Authors: Anton Eberhard and Catrina Godinho

This paper provides an overview of market-oriented power sector reforms in Sub-Saharan Africa, South Asia, and Latin America over the past twenty-five years. The role of political economy contextualities in driving, constraining or otherwise influencing power sector reform is explored through a review of the essential literature. Though this literature is found to have considerably expanded the scope of understanding around power sector reform and development, political economy research in the area is found to be lacking in methodological coherence and theoretical substance. Future efforts are needed to systematically bring together the array of insights, methodological approaches and recommendations in this literature, as well as better bound, differentiate and systemise political economy research in the area going forward. Two initial frameworks are advanced through this paper in relation to this dual research imperative.

2.2 The Political Economy of Aid for Power Sector Reform

Authors: Neil McCulloch, John Ward and Esme Sindou

Recent literature on the effectiveness of donor programmes points to the importance of understanding the political context within which reforms are taking place. A body of evidence is now emerging suggesting that programmes that are more flexible and iterative are often more successful in achieving their objectives than programmes that adopt a more rigid, linear approach to reform. Moreover, recent experiments with projects that "think and work politically" appear to show promising results. Power sector reform is intensely political in almost all countries and donor projects have sometimes failed because of an inability to navigate the local politics of reform. This paper reviews what is known about how donors have taken politics into account in designing and implementing power sector reform programmes in Sub-Saharan Africa and South Asia. It illustrates the challenges which donors have faced with reference to case studies of donor attempts to support power sector reform in Tanzania and in the Indian state of Orissa. The paper draws on documentary evidence from the major donors to the sector in each country as well as a set of qualitative interviews with experienced project supervisors. It concludes with a set of recommendations for further research designed to provide insights on how best to design and implement power sector reform programmes given the political context in which they are working.

3.1 Energy Efficiency in the Developing World

Authors: Meredith Fowlie and Amol Phadke

The burgeoning literature assessing demand-side energy efficiency potential, and the policies that can be deployed to tap this potential, has traditionally focused on developed and emerging economies. We review the state of knowledge on demand-side energy efficiency investments, and reframe the discussion in terms that are better suited to a low income country setting. This reframing opens up new lines of inquiry which have been under-emphasized to date. We provide a conceptual framework for exploring questions concerning the returns on investment in energy efficiency, market failures and barriers that can lead to under-investment, and policy design considerations. A case study of a large scale efficiency program in India underscores both the challenges and the potential for welfare improving energy efficiency programs in the developing world.

3.2 Electricity Supply and Urbanization: A Microeconomic Research Agenda

Authors: Paul J. Gertler, Kenneth Lee and A. Mushfiq Mobarak

We review existing evidence on the relationship between the quality of electricity supply and urbanization in the developing world. We highlight three patterns that emerge from existing data. First, based on household survey data, the main issue in cities is not the lack of access to electricity but the reliability of supply. Second, based on administrative data from Dhaka, Bangladesh, load shedding outages appear to follow predictable patterns across time and space, and are correlated with the local temperature. Third, based on enterprise survey data, firms find ways to adapt to shortages given the role of electricity in urban production. We then discuss the importance of reliability to urban productivity and growth, and the way in which the quality of supply varies across different groups of urban users. We highlight promising areas for future research.

3.3 Urban Governance, Urban Development, Land Use and Energy Access

Authors: Harry Smith (with research assistance from Marco Lorusso)

This paper addresses the role of governance of urban areas in shaping energy use in LICs and MICs, from the perspective of the poorest and disadvantaged. Urban dwellers in LICs and MICs often access electricity through irregular, patchy and informal connections which are frequently considered illegal. This situation is closely linked to how urban areas develop in LICs and MICs, often with weak urban governance and little control, resulting in what is termed 'informal settlements' and slums. Studies of urban infrastructure in LICs and MICs have tended to concentrate on water and sanitation networks, with comparatively very limited attention being paid to access to electricity. The paper reviews the literature that exists on access to electricity in urban areas in the Global South, and draws on experiences in other urban infrastructures that may provide lessons towards improving such access for the poorest and disadvantaged.

4.1 Power Markets and Renewables Deployment in Developing Countries

Authors: Goran Strbac and Frank A. Wolak

This paper identifies the key features of successful electricity market designs that are particularly relevant to the experience of low-income countries. Important features include: (1) the match between the short-term market used to dispatch generation units and the physical operation of electricity network, (2) effective regulatory and market mechanisms to ensure long-term generation and transmission resource adequacy, (3) appropriate mechanisms to mitigate local market power, and (4) mechanisms to allow active involvement of final demand in short-term market. Regulatory and market mechanisms to foster the cost-effective deployment of intermittent renewable resources will also be discussed. The paper concludes with a recommended baseline market design that reflects the experience of the past 25 years with electricity restructuring processes.

4.2 Economic and Non-Economic Barriers and Drivers for the Uptake of Renewables

Authors: Bridget Woodman, Catherine Mitchell, and Mario Ragwitz

Large scale renewables raise new challenges and provide new opportunities across electricity systems. This paper considers the barriers faced by large scale renewables in electricity systems in Sub-Saharan Africa and South Asia. We review the current state of knowledge in relation to grid-connected renewables. This paper then explores key issues in electricity system structure, the main challenges to the uptake of renewables, and the various existing fiscal and policy approaches to encouraging renewables. We also highlight possible ways moving forward to ensure more widespread renewables deployment.

5.1 The Political Economy of Hydrocarbon Wealth and Fuel Prices

Authors: Paasha Mahdavi and Michael Ross

All governments either tax or subsidize the consumption of fossil fuels. These pricing policies have far-reaching consequences not only for the environment, but also for governance and economic development. In this state-of-knowledge paper, we examine previous research on fossil fuel subsidies, noting areas that are understudied in the context of determinants of price policies and causes for policy reform. We then introduce new data on implicit gasoline taxes and subsidies, describe global trends, and explore the relationship between oil wealth and government policies. We conclude with actionable ideas for future research projects.

5.2 What Do We Know About Economic Diversification in Resource Rich Countries?

Author: Michael L. Ross

Diversification is portrayed as an important policy goal for petroleum-rich nations, yet surprisingly little is known about how to achieve it. In this paper I review the recent literature on diversification in oil-exporting states and suggest it has been limited by missing and inconsistent data, a reliance on uninformative measures, and the challenges of causal

identification. I also document unconditional diversification trends in the 35 largest net oil and gas exporters from 1995 to 2014, using four indicators. Over these two decades, the oil producers became significantly more concentrated: about two-thirds became more dependent on fuel exports, and three-quarters saw their exports become more concentrated. Most countries that became less concentrated did so because their oil production fell – often due to war, economic sanctions, or reserve depletion. A handful of states combined modest diversification gains with subsidized fossil fuels, although it is unclear whether cheap energy played a role. I conclude with an agenda for research addressing the potential gaps in the literature.

6.1 Modular and Discrete: Opportunities for Alternative Power System Planning, Expansion and Operation in Developing Countries

Authors: Timon Dubbeling, Simon Mueller and Luis Munuera

When developing electricity systems, generation and grid have been separately planned and demand has generally been assumed passive, estimated using aggregated approaches. However a variety of design, technology and regulatory solutions are available in modern power systems for a more tailored approach to power system development, which may hold great promise for low income countries to leapfrog towards sustainable and decentralised energy delivery. Monitoring of power systems from generation to load, PMUs, on-site storage, DLR, OLTC, direct load control or innovative network topologies including micro- and mini-grids can reduce total costs, increase asset utilisation and modify the optimal phase-in of investments along a planning horizon. These allow for new planning approaches and more holistic phase-in of generation and networks. This paper reviews the scientific literature and best practice databases, providing a state-of-the-art perspective on the technical options, costs, benefits and barriers to deployment of a progressive build-up of power infrastructure.

6.2 Reducing Generation, Transmission and Distribution Inefficiencies

Authors: Vijay Modi and Sebastian Rodriguez-Sanchez

The paper addresses the issue of reducing generation, transmission and distribution inefficiencies in the context of low-income countries that are addressing issues of electricity access, consumption growth, and reliability of supply at the same time. The paper addresses both reductions in technical and non-technical losses. We suggest that creating an enabling environment for attracting investment for electric utilities might require ensuring tighter technical auditing and payment systems. Can a bottom-up approach using smart prepaid metering, or at least remote meter reading allow a utility to both better manage quality of supply, identify losses, create accountability metrics and support tighter revenue collection?

In the spirit of identifying impactful research areas, two larger questions are also raised within this theme. One pertains to the specific mix of generation technologies that a country would be prudent to pursue given the uncertainties in supply and implied carbon costs and the uncertainties around costs of deeper penetrations of renewables. The second pertains to the prioritization of energy investments that would remove impediments to specific sectoral growth as part of a broader country development program.

6.3 Low-Voltage System Designs for Energy Access

Author: Vijay Modi

While low-voltage DC systems are not new, they are new to the provision of basic residential electricity services and to the provision of lighting for vendors and shops. Being stand-alone individual systems, they have the advantage of being sold as a product bypassing complex design, financing, and installation steps associated with large infrastructure grids, that have to also ensure generation and transmission investments.

The paper examines the potential questions policy makers need to know as they plan investments with the expectation of those investments being more efficient in delivering not just access but also economic growth. What role would off-grid systems, such as solar home systems and mini-grids play in bringing first access to electricity and possibly providing a pathway to economic growth? What role do sectoral policies have on the prioritization of grid and mini-grid roll-out?

The paper describes lessons learnt from several mini-grids deployed in Africa and from an example of agriculture-sector specific provision of electricity for irrigation, to demonstrate that the nature of electricity service needed for different sectors may be different. This approach has implications to national policies for growth and renewable integration.

Cross-cutting paper: Economic Growth and Development with Low-Carbon Energy

Authors: Sam Fankhauser and Frank Jotzo

Transition to low-carbon energy systems will be necessary if global climate change objectives are to be met. The transition will need to take place in all countries, and at rapid pace if ambitious global carbon budgets are to be met. The process of development has traditionally relied on fossil fuel based energy. The transition to zero-carbon energy poses challenges and opportunities for developing countries that are not yet fully understood. In this paper we review the literature on how the need to reduce emissions in the energy sector affects economic growth and development; set out empirical findings about trajectories for energy intensity and emissions intensity in the development process; and analyse options for and barriers to effective policy for decarbonisation in the development process. We conclude by identifying research gaps.

Cross-cutting paper: Gender Implications of Energy Use and Energy Access

Author: Harold Wilhite

The scoping paper reviews and consolidates both theory and findings on the gender consequences of energy access in the Global South. Women across the Global South have far greater responsibility than men for the work involved in producing essential home energy services such as light and heat, cooking, and cleaning. The most significant impact of electrification is that it enables better time management and the reduction of women's physical work (drudgery), as well as enabling health improvements by reducing the need to burn biomass

and kerosene for cooking and lighting. There is evidence from many local contexts that the time saved can be used by women to study, take on salaried work and start new small businesses, and that these empowering activities can be facilitated by the inclusion of women in energy governance and planning. There remain gaps in knowledge on the longer-term empowerment and health benefits of energy access, and work needed to refine claims of causality between energy access and increased salaried work and better education for women.

Cross-cutting paper: Leveraging Smart System Technologies in National Energy Data Systems: Challenges and Opportunities

Authors: Eric Masanet, Luis Munuera, Roberta Quadrelli and Duncan Millard

Effective energy policies rely on credible and comprehensive national energy data systems, in developed and developing economies alike. Smart system technologies will play a central role in the clean energy transition—including applications in smart homes, factories, transport systems, and renewable electricity grids—and their ability to compile and communicate point-of-use energy data presents new opportunities for improving national energy data systems. This paper reviews the growing importance of energy data systems for multiple aspects of energy policy in the developing country context, identifies the key characteristics a national data system needs to have in order to be robust and viable, discusses the potential role of smart system technologies in national energy data systems moving forward, and recommends several future research projects to better understand and seize their potential, and in developing countries in particular.