Energy, growth, and development research projects

International Growth Centre

The International Growth Centre (IGC) aims to promote sustainable growth in developing countries by providing demand-led policy advice based on frontier research. The IGC is based at the London School of Economics (LSE) in partnership with the University of Oxford. The IGC operates in 14 countries in Africa (Ethiopia, Ghana, Liberia, Mozambique, Rwanda, Sierra Leone, South Sudan, Tanzania, Uganda, and Zambia) and in Asia (Bangladesh, India, Myanmar, and Pakistan).

The large and important role that access to reliable energy will play in shaping the growth trajectories of developing countries is at the core of IGC's energy research agenda on energy and growth. Our energy research drives at answering four key questions:

- How can access to reliable electricity be improved and expanded in areas already served by the grid?
- How can rural unconnected areas be provided with energy in a sustainable manner to enable increases in productivity?
- How can investments in energy efficiency promote economic growth?
- How can the external costs associated with rising energy consumption be minimised?

The IGC has a wide network of world-class researchers who can offer assistance to policymakers and practitioners interested in designing evaluations of energy projects and policies. The IGC funds cutting-edge research on energy and development through its bi-annual calls for proposals. Anyone is welcome to apply. For more information visit: http:// www.theigc.org/research-themes/energy.

The list below highlights a selection of the IGC's research projects in the energy sector.

Energy, growth, and development

http://www.theigc.org/publication/igc-evidence-paper-energy/

Achieving reliable, widespread access to electricity will be transformative for many developing countries. However, much of the world's population remains without this reliable access and its benefits. This paper outlines many of the questions behind why this remains the case, focusing on what existing research has found and where further research is required. The paper covers four main topics: (i) improving the reliability of grid services, (ii) rural electrification, (iii) energy efficiency, and (iv) minimising the external costs of energy consumption. Each section addresses the main outstanding questions on these topics in the economics literature and also the specific questions which the IGC believes are most pressing for sustainable development. IGC encourages researchers interested in applying for IGC funding to support research projects on energy and growth in developing countries to review this background paper.

- **Michael Greenstone. 2014. "Energy, Growth, and Development." International Growth Centre Evidence Paper.**

Prepaid electricity metering in South Africa: Costs, benefits and potential for scale-up

http://www.theigc.org/project/pre-paid-electricity-better-service-delivery-for-the-poor/

High rates of customer default on utility bills present a barrier to the expansion of electricity access in the developing world. Pre-paid electricity metering offers a technological solution to ensuring timely payment. Using an eleven-year panel dataset of pre-paid electricity customers in Cape Town, South Africa, we describe patterns of purchase behaviour across property values, our measure of socioeconomic status. Poorer households

buy electricity more often, in smaller increments, and are most likely to buy on payday. These patterns suggest difficulties smoothing income, and reveal a preference for small, frequent purchases that is incompatible with a standard monthly electricity billing cycle. The next phase of this research will use a randomised phase-in of new prepaid customers to explore how the prepaid meters change the customer experience and the municipality's revenue recovery.

- **Kelsey B. Jack and Grant Smith. 2015. "Pay as You Go: Prepaid Metering and Electricity Expenditures in South Africa." American Economic Review, 105(5): 237-41.**

Does improved regulatory enforcement reduce industrial pollution? An evaluation of public and private sector approaches in India

http://www.theigc.org/project/does-improved-regulatory-enforcement-reduce-industrial-pollution-an-evaluation-of-public-and-private-sector-approaches/

In many regulated markets, private, third-party auditors are chosen and paid by the firms that they audit, potentially creating a conflict of interest. This article reports on a two-year field experiment in the Indian state of Gujarat that sought to curb such a conflict by altering the market structure for environmental audits of industrial plants to incentivise accurate reporting. Under the new scheme, instead of being hired directly by the firm, auditors were randomly assigned to firms every year and were paid using a central pool of funds. There are three main results. First, the status quo system was largely corrupted, with auditors systematically reporting plant emissions just below the regulatory limits, although true emissions were typically higher. Second, the new scheme caused auditors to report more truthfully and very significantly lowered the fraction of plants that were falsely reported as compliant with pollution standards. Third, plants in the new scheme, in turn, reduced their pollution emissions relative to plants under the old auditing scheme. The results suggest that reforms for auditor independence can improve reporting and make regulation more effective. The recommendations from this project have now been formally adopted by the Government.

- **Esther Duflo, Michael Greenstone, Rohini Pande, and Nick Ryan. 2013. "Truth-telling by Third-Party Auditors and the Response of Polluting Firms: Experimental Evidence from India." The Quarterly Journal of Economics, 1499(1545), 1499.**
- **Esther Duflo, Michael Greenstone, Rohini Pande, and Nick Ryan. 2013. "Inducing Indian Plants to Abate Polution." January 2013. IGC Policy Brief.**

Marketing of stoves through social networks to combat indoor air pollution in Bangladesh

http://www.theigc.org/project/marketing-of-stoves-through-social-networks-to-combat-indoor-air-pollution/

This paper examines how learning through opinion leaders and social networks influences demand for nontraditional cookstoves—a technology with important health and environmental consequences for developing country populations. We conduct marketing interventions in rural Bangladesh to assess how stove adoption decisions respond to (a) learning the adoption choices of locally identified "opinion leaders" and (b) learning about stove attributes and performance through social networks. We find that households generally draw negative inferences about stoves through social learning and that social learning is more important for stoves with less evident benefits. In an institutional environment where consumers are distrustful of new products and brands, consumers appear to rely on their networks more to learn about negative product attributes. Overall, our findings imply that external information and marketing campaigns can induce initial adoption and experiential learning about unfamiliar technologies, but sustained use ultimately requires that new technologies match local preferences.

- **Grant. Miller and Mushfiq Mobarak. 2014. "Learning about New Technologies Through Social Networks: Experimental Evidence on Non-Traditional Stoves in Rural Bangladesh," Marketing Science 34(4), 480.**
- **Grant Miller and Mushfiq Mobarak. January 2013. "Marketing of Stoves through Social Networks to Combat Indoor Air Pollution." IGC Policy Brief.**

Harnessing Natural Resources for Inclusive Growth

http://www.theigc.org/publication/igc-growth-brief-harnessing-natural-resources-for-inclusive-growth/

Natural resources can support sustainable and inclusive growth in sub-Saharan Africa if key policy areas in the natural resource management chain are tackled and strong institutions are put in place. In this brief, we present a framework for natural resource management. The brief may be useful as a starting point for those interested in understanding the challenges related to ensuring natural resources support inclusive growth, including policy-makers looking to strengthen and better diagnose the weaknesses in their national natural resource management framework.

- **Paul Collier and Caroline Laroche. March 2015. "Harnessing Natural Resources for Inclusive Growth." IGC Growth Brief.**

Natural gas and human development in Tanzania

http://www.theigc.org/wp-content/uploads/2015/02/Henstridge-2013-Working-Paper.pdf

This paper first reviews current gas production and the opportunities for increased domestic gas consumption from shallowwater or onshore gas production, before focusing on the potential from largerscale, higher cost, deep-water gas. The paper then presents a framework that explores two ways to think about the connection between natural gas and human development.

- **Mark Henstridge. September 2013. 'Natural Gas and Human Development". IGC Working Paper.**

Lighting up Bihar: Electrification to sustain economic growth

http://www.theigc.org/project/lighting-up-bihar/

The power sector is widely viewed as one of the biggest constraints on India's economic growth, the main problem being that almost half of power drawn from the grid is not paid for and in unmetered, unbilled or pilfered. In the state of Bihar, 45% of power consumed falls in this category. The Government of Bihar is trying to address this problem and expand access to electricity by implementing reforms to improve the Bihar State Electricity Board's finances and the availability of power. This project looks at incentivising consumers to pay for the electricity consumed by the area. The intervention specifically links the duration of supply to the payment performance of a group against electricity supplied in the previous month. Through a randomised controlled experiment, the researchers will measure if doing so improves payment behaviour and reduces the percentage of pilfered power consumption.

- **Researchers: Robin Burgess, Michael Greenstone, Nick Ryan, Anant Sudarshan**

Powering small business: Understanding the impact of solar energy under different pricing schemes

http://www.theigc.org/project/powering-small-business-understanding-the-impact-of-solar-energy-under-different-pricing-schemes/

This project studies the pricing schemes for a new solar technology that combines solar power, mobile repayment, and mobile enforcement in low-income peri-urban areas of Nairobi, Kenya. We are partnering with Angaza Design who will roll out 1000 units of their Solite-3 – a solar-powered device that provides light and charges phones. The devices allow payment via mobile money and monitoring of payments with enforcement upon non-payment. This enables Angaza to ask retailers for a very low and affordable down payment and allows them to gradually pay back the full amount of the device over time, based on use and at no transaction cost (PAYG using M-PESA, the current mobile money system in Kenya). Research questions include: What is the impact of electricity on small retailers? What is the impact of mobile repayments and mobile enforcement on asset purchases relating to take-up, default rates and use? What is the impact of varying the pricing structure?

- **William Jack and Tavneet Suri. "Powering Small Business: Understanding the Impact of Solar Energy under Different Pricing Schemes." March 2013. IGC Working Paper.**

Estimating the demand for electricity: Evidence from urban Indonesia

http://www.theigc.org/project/estimating-the-demand-for-electricity-in-urban-indonesia/

This project estimates the demand curve for electricity by experimentally varying its price, measuring the short-run changes in demand to a pricing change, as well as long-term changes in demand as a result of asset acquisition. This also tests whether poverty targeting which in part base anti-poverty programs on electricity utilisation stifle electricity demand, disincentivising investment in productive assets.

- **Researchers: Rema Hana, Benjamin Olken, Michael Greenstone**

Mapping the grid: Jumpstarting an electricity consumption GIS in Pakistan

http://www.theigc.org/project/mapping-the-grid-jumpstarting-an-electricity-consumption-gis/

Very few datasets around energy utilisation in Pakistan currently exist, and this project seeks to remedy this by creating a high-resolution dataset about electricity consumption in Lahore. This will be used as a tool by the distribution company to improve energy conservation and planning for investments. This will represent the first electricity consumption map to the awareness of

the researchers.

- **Researchers: Sohaib Ahmad Khan, Ijlal Hussain Naqvi**

Emissions trading as an environmental innovation in India: Measuring the policy impact on emissions and abatement costs

http://www.theigc.org/project/emissions-trading-as-an-environmental-innovation-in-india-measuring-the-policy-impact-on-emissions-and-abatement-costs/

This study will measure the effects of a pilot emissions trading system for particulate matter on plant emissions and abatement costs using a randomised-controlled trial design implemented jointly with environmental regulators in three Indian states. Emissions trading systems (ETS), also known as cap-and-trade, have limited emissions in developed nations at a much lower cost than command-and-control regulations. The Indian pilot will be the first ETS in a developing country and the first rigorous randomised-controlled trial of an ETS.

- **Michael Greenstone, Aparna Krishnan, Rohini Pande, Nick Ryan, and Anant Sudarshan. "Emissions Trading as an Environmental Innovation in India: Measuring the Policy Impact on Emissions and Abatement Costs." March 2012. IGC Policy Brief.**

Leakage and Livelihood Impacts of Payments for Environmental Services in Malawi

http://www.theigc.org/project/the-leakage-and-livelihood-impacts-of-payments-for-environmental-services/

Direct incentives for land use activities that create positive environmental externalities are a popular policy tool in both developed and developing countries. Most evaluations of these programs focus on the immediate environmental impacts of the incentives, and do not measure the effects on socioeconomic outcomes or on other land use activities. This study reports on a field experiment that randomly allocated afforestation contracts to smallholder farmers in Malawi. The results show evidence for within-farm leakage: contracted households are more likely to clear other parts of their land. While overall livelihood outcomes are not detectably different among the contracted treatment group, the contract does increase self-reported labour constraints and result in more off-farm labour income. Together, the results indicate broader impacts from payments for environmental services that are often overlooked in standard evaluations.

- **Kelsey Jack. "Leakage and Livelihood Impacts of Payments for Environmental Services." August 2012. IGC Policy Brief.**

Electricity and rural development: Insights from a natural experiment in Punjab, Pakistan

http://www.theigc.org/project/electricity-and-rural-development-insights-from-a-natural-experiment-in-punjab-pakistan/

Using Punjab as a case study, this project seeks to understand the implications of electricity shortages for rural economies particularly with respect to water provision for production and consumption. Based on village and household level surveys, the project will result in two papers: the first addressing electricity usage for agricultural production, the second focusing on the role of electricity for water used in household consumption.

- **Researchers: Lauge Skovgaard Poulsen, Mahvish Shami, Hadia Majid**

Power to the people: Prospects for decentralized electrification in Sierra Leone

http://www.theigc.org/project/power-to-the-people-prospects-for-decentralized-electrification-in-sierra-leone/

The aim of this project is to produce a Rapid Response Note for Sierra Leone's Minister of Energy assessing what mix of regulatory mechanisms, incentives, and public-private partnerships would be required to facilitate and accelerate rollout of decentralized clean energy (e.g. mini-grid) electrification across Sierra Leone.

- **Researchers: Chukwu-Emeka Chikezie, Ronke Luke, Sahr Aruna**

Contract and market design for land-based carbon offsets in Zambia

http://www.theigc.org/project/contract-and-market-design-for-land-based-carbon-offsets/

We implement a field experiment in Eastern Zambia, in collaboration with local partners, including a large contract farming company (Dunavant Cotton). The project focuses on the adoption of fertiliser trees (faidherbia albida) by small holder farmers engaged in contract farming arrangements with a large cotton company. In addition to sequestering carbon, faidherbia albida drops its leaves at the time of the first rains and fixes nitrogen in its roots, providing farmers with substantial private benefits over the long term, including better soil fertility and higher maize yields. These private benefits are slow to accumulate and with high discount rates may be insufficient to justify the up-front investment costs in the absence of more short-run incentives. The project provides training and inputs – and incentive payments for some treatment groups – through

Dunavant's farmer infrastructure.

- **Researchers: Kelsey Jack, Olueyede Ajayi, Samuel Bell, Raymond Guiteras, Paulina Oliva**

The benefits of solar technology adoption for street vendors in Bihar, India

http://www.theigc.org/project/the-benefits-of-solar-technology-adoption-for-street-vendors-in-bihar/

We evaluate the socio-economic impact of distributing solar lighting to street vendors in urban Bihar. The project will be implemented in collaboration with a local civil society organisation, NIDAN.

- **Researchers: David Szakonyi, Johannes Urpelainen**

Rural electrification with off-grid community microgrids: An impact evaluation in Uttar Pradesh, India

http://www.theigc.org/blog/how-solar-power-could-transform-rural-india/

This research will examine the impact of solar microgrids on growth-enhancing outcomes and activities in rural India through a randomised control trial in Uttar Pradesh.

- **Researchers: Johannes Urpelainen, S.P. Harish, Patrick Bayer, Michaël Aklin**

Local level estimates of corruption and theft in the energy sector in Uttar Pradesh, India

http://www.theigc.org/project/local-level-estimates-of-corruption-and-theft-in-the-energy-sector-in-uttar-pradesh-india/

A third of electricity in India is lost each year, where losses refer to power that is supplied but not billed. Utilizing data from the power corporation of Uttar Pradesh, India's most populous state, we study the politics of electricity losses. Examining annual data over four decades, we document that UP's electricity losses tend to increase in periods immediately prior to state assembly elections. Drawing upon geographically disaggregated data for the period 2000–09, we observe higher line losses just prior to the 2002 and 2007 state elections. Our analysis shows that the incumbent party was more likely to retain the assembly seat as line losses in the locality increased. We interpret these results as corroboration that political parties deliberately redirect electricity to flat rate and unbilled users in a context of chronically inadequate supply. Political factors appear to affect line losses in ways that technical and economic factors alone cannot explain.

- **Miriam Golden and Brian Min. 2014. "Electoral cycles in electricity losses in India," Energy Policy 65, 619.**

A global database of rural electrification

http://www.theigc.org/project/a-global-database-of-rural-electrification/

The primary goal of this research project is to describe and explain variation in the success of rural electrification across developing countries. Researches will collect, validate, and analyse crossnational, time-series data on progress in rural electrification for developing countries between the years 1980 and 2012.

- **Researchers: Johannes Urpelainen, Michaël Aklin, S.P. Harish**

Impact of direct benefit transfer on leakage in cooking fuel subsidy in India

http://www.theigc.org/project/impact-of-direct-benefit-transfer-on-leakage-in-cooking-fuel-subsidy/

The project aims to evaluate the impact of India's direct benefit transfer of cooking gas subsidy on leakage. How can direct benefit transfers help in curbing leakages in the delivery of LPG subsidy? Given the high current deficit and large fiscal burden of the petroleum subsidy, this is a relevant question for policy makers.

- **Researchers: Prabhat Barnwal**

Rural electrification: The Potential and Limitations of Solar Power

http://www.theigc.org/project/rural-electrification-the-potential-and-limitations-of-solar-power/

The aim of this project is to examine how liquidity constraints and information influence the decision to adopt a decentralised and renewable energy source such as solar power at the household level. In addition, it will examine how access to this source of energy influences household outcomes.

- **Researchers: Tessa Bold, Anna Aevarsdottir**

The impact of electric stoves and electricity subsidy on charcoal consumption in urban Africa: Evidence from a randomised controlled experiment in Tanzania

http://www.theigc.org/project/the-impact-of-clean-stoves-on-charcoal-consumption-in-urban-africa-evidence-from-a-randomised-controlled-trial-in-tanzania/

A large proportion of households in urban areas of Africa use charcoal as a main source of energy for cooking. The use of biomass fuel like charcoal has been documented to be one of the prime drivers of deforestation and forest degradation the countries. Between 2001 and 2007 - a period during which Tanzania (TZ) experienced rapid economic growth - the proportion of households using charcoal as a main source of cooking energy in the capital Dar es Salaam increased from 47 percent to over 70 percent (World Bank, 2009). This phenomenon is contrary to the predictions of the energy ladder hypothesis, which postulates a decline in reliance on biomass fuel sources as income rises. In this project, we undertake a randomised controlled experiment to explain why households in urban Africa still continue to use charcoal as a main source of cooking energy even when income increases.

- **Researchers: Yonas Alem, Peter Berck, Martin Chegere**

Let them buy light: The welfare benefits of electricity for rural households and enterprises in India

This project measures the welfare effects of increased access to electricity for rural households and micro-enterprises in rural areas of Bihar, India by letting them buy light. The research design will experimentally offer off-grid, solar connections and measure both the willingness to pay for connections and the welfare benefits of a connection once adopted, with special focus on the productivity and education effects that bear on economic growth.

- **Researchers: Michael Greenstone, Robin Burgess, Nicholas Ryan, Anant Sudarshan**

Adoption and revenue models for clean off-grid energy in Rwanda

The goal of the research is to (1) understand the main drivers of sustainably scaling up an innovative revenue model for off-grid renewable energy, (2) identify how different pricing strategies affect consumer behaviour in the adoption and usage of clean energy, and (3) assess the resulting impact on local communities.

- **Researchers: Ioana Popescu, Serguei Netessine, Bhavani Uppari Shanker, Rowan Clarke**

Smart meters for promoting energy efficiency in rural India

This project brings experimental and quasi-experimental research methods to bear on important issues confronting rural electrification initiatives. The overarching objective is to investigate how modular smart grid technology can be used to improve both supply and demand-side efficiency in rural settings.

- **Researchers: Meredith Fowlie, Catherine Wolfram**

Understanding Blackouts: Analysing detailed blackouts information of Dhaka, Bangladesh

The aim of this research is to fill this gap by collecting extensive data on blackouts of Dhaka city to understand seasonal, spatial, time-of-the-day and neighbourhood variations of load shedding to better our understanding on how local authorities are managing this limited resource. This research also aims to establish a system to get continued collection of data which would be used to delve into interesting public policy and political economy questions. The extent and the distributive implications of the capture of public good allocation process to further individual interests by political elite, for example, are policy-relevant issues that can be also be looked at using this data.

- **Researcher: Abu Shonchoy**

Fuel subsidy: Evasion under changes in point of provision in India

This project exploits a quasi-experimental set up based on a recently introduced fuel subsidy policy in India. Does leakage in the fuel subsidy (equivalent to fuel tax evasion) depend on the point of provision of the subsidy? Particularly, is lowering down the point of subsidy provision downstream effective in containing the leakage? How much subsidy leakage can be avoided by providing the subsidy benefit directly to households? Do upstream agents respond to the lost evasion opportunities by affecting the quality of fuel service delivery? How do fuel prices in an unregulated market respond to controls on evasion?

- **Researchers: Prabhat Barnwal**

Building environmental regulation that enables growth

This project will test how technology and market mechanisms can support environmental regulation that minimises the social costs of energy consumption.

- **Researchers: Michael Greenstone, Rohini Pande, Mohammed Kamal, Nicholas Ryan, Anant Sudarshan**

Asymmetric information and the energy-efficiency of durable goods: Evidence from cooking stoves in India

The project will test whether energy labels on cooking stoves sold in India change consumer preferences and willingness to pay. It will also measure the actual efficiency savings of cleaner cookstoves against their claimed savings.

- **Researchers: Anant Sudarshan, Nicholas Ryan, Prabhat Barnwal.**