**The Economics of Energy Transitions: Concepts, Methods and Research for Policymaking**

*A Hybrid Virtual and Face to Face Training Course*

**Location**

University of Cape Town; Cape Town, South Africa

**Dates**

Asynchronous (self-paced) virtual lectures and exercises: March 18-May 10, 2024

In-person intensive course: May 27-June 1, 2024

**Instructors**

Primary: Marc Jeuland; Professor of Public Policy; Duke University

Supporting: Amin Karimu, University of Cape Town; Edward Bbaale, Makerere University; Abebe Beyene, Policy Sciences Institute; Richard Mulwa, University of Nairobi; Remidius Ruhinduka, University of Dar es Salaam

Others TBD

**Course topic**

Energy consumption is strongly related to economic growth, but traditional and fossil fuel energy uses also induce substantial tradeoffs, most notably with global and local environmental quality, and also health. Accelerating climate change and associated damages are making these tradeoffs ever more apparent, as the world inexorably hurtles past temperature change thresholds and experiences disruptions that were once deemed to be far away. Today, policymakers have the opportunity to tackle these challenges by enhancing the uptake of clean energy innovations, but often lack the evidence and knowledge needed to support the design of effective policies.

This short course is aimed at mid-career civil servants and professionals (especially those based in African governmental bodies) and graduate students who are interested in acquiring both subject area and methodological expertise on the economics of energy transition as it relates to development. The particular emphasis will be on the energy transition challenges facing low- and middle-income countries today, and on co-creating an applied Global South-driven research agenda that responds to the policy needs of African decision-makers seeking to confront those challenges.

**Learning objectives**

At the end of the course, participants should:

* Understand the links between energy and development, at the micro- and macro-economic level;
* Have a deeper appreciation of the welfare tradeoffs that come with different energy technologies;
* Demonstrate functional understanding of the quantitative empirical methods that can be used to study the effectiveness of energy sector interventions; and
* Possess practical experience in framing an energy transition problem facing their specific context, and articulating how an economic research agenda could inform solutions to that problem.

**Syllabus**

The course will consist of three separate modules, the first two delivered through a series of virtual lectures and interactions with participants, and the final module being held in person during a week-long intensive capstone experience held at the University of Cape Town in South Africa.

**Course assignments**

Assignment 1 (Pre workshop, due May 21). Link [here](https://duke.box.com/s/xsgbp15tq6t7gyc0ukk0h7em2ssubd8q).

**Module 1.** The economics of energy transitions: Concepts, constraints, and opportunities.

1. What do we know about the links between energy and various outcomes related to economic and human well-being? What are some challenges that arise?

Readings / background materials:

Cleveland, Cutler (2022). “What is the relationship between energy use and economic output?” Boston University Institute for Global Sustainability Visualizing Energy Data Story. Available at: <https://visualizingenergy.org/what-is-the-relationship-between-energy-use-and-economic-output/>.

Jeuland et al. (2021). “Is energy the golden thread? A systematic review of the impacts of modern and traditional energy use in low-and middle-income countries.” *Renewable and Sustainable Energy Reviews*, 135, 110406.

IEA, IRENA, UNSD, World Bank, WHO (2023). “Tracking SDG 7: The Energy Progress Report (Executive Summary).” World Bank, Washington DC. © World Bank. License: Creative Commons Attribution—NonCommercial 3.0 IGO (CC BY-NC 3.0 IGO). Full report can also be found here: <https://trackingsdg7.esmap.org/downloads>.

Swilling, M., Nygaard, I., Kruger, W., Wlokas, H., Jhetam, T., Davies, M., ... & Cronin, T. (2022). “Linking the energy transition and economic development: a framework for analysis of energy transitions in the global South.” *Energy Research & Social Science*, 90, 102567.

**Lectures**:

Lecture 1. A Social Science Perspective on Energy Access: Current Situation and Open Questions. [Link](https://duke.zoom.us/rec/share/MKHl1gqsBJPTXmb9emo2e5ru9zE5GpftRmnnuzfnykK527D4s9y8zJ27yD_w_eIA.Jza80-NukJfRmuCm?startTime=1710774614000).

Lecture 2. What is Energy Transition? [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=3b5837d9-6b2e-46c1-bdc0-b13a00bda972).

Lecture 3. Energy Access and Energy Transitions Challenges in Developing Regions: Stylized facts and figures. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=388ba259-cb14-4b95-a4ce-b13a00ed4544).

1. In depth exploration of challenges and policy solutions:
   1. High costs and investment needs (upfront and over time), and implications for utility behavior
      1. Problems of natural monopoly or imperfect competition
      2. Policy implications for governance and reform
      3. Constraints related to international finance

Readings / background materials:

Mulder, M., & Woerdman, E. (2021). “Energy networks, natural monopolies and tariff regulation.” *In Energy Law, Climate Change and the Environment* (pp. 563-572). Edward Elgar Publishing.

Gratwick, K. N., & Eberhard, A. (2008). “Demise of the standard model for power sector reform and the emergence of hybrid power markets.” *Energy Policy*, 36(10), 3948-3960.

Twesigye, P. (2022). Structural, governance, & regulatory incentives for improved utility performance: A comparative analysis of electric utilities in Tanzania, Kenya, and Uganda. Utilities Policy, 79, 101419.

Power Africa (2019). Understanding power project financing. Washington, USA. Pp. 8-18 only. Available at: <https://cldp.doc.gov/sites/default/files/UnderstandingPowerProjectFinancing.pdf>

**Lectures**:

Lecture 4. Energy systems stucture (natural monopoly). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=4f04f22c-0d2c-4390-b86d-b14600c351f3).

* 1. Issues and importance of quality of access

Readings / background materials:

Energy for Growth Hub (2019). “The Reliability-Adjusted Cost of Electricity (RACE):  A new metric for the fight against energy poverty.” *Report of the Energy Metric Working Group*. Washington, DC.

Ayaburi, J., Bazilian, M., Kincer, J., & Moss, T. (2020). “Measuring ‘Reasonably Reliable’ access to electricity services.” *The Electricity Journal*, 33(7), 106828.

Zaman, R. & M. Jeuland (2024). “How much do connected households in Sierra Leone value enhanced electricity service reliability?” *Working paper.* Duke University: Durham, USA.

Pakhtigian, E. et al. (20204). “Estimating lost dividends from incomplete energy access transitions”. *Working paper.* Penn State University: State College, USA.

**Lectures**:

Lecture 5. Quality of energy access: Measurement and implications. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=f63bb12d-082c-4c52-be5d-b147007d27b2).

* 1. Incentive problems, especially externalities (environmental, health)
     1. Problem of misaligned incentives in energy markets: Example of local pollution
     2. The role of the energy sector in climate change and climate goals

Readings / background materials:

Jeuland, M., Soo, J. S. T., & Shindell, D. (2018). The need for policies to reduce the costs of cleaner cooking in low income settings: Implications from systematic analysis of costs and benefits. Energy policy, 121, 275-285.

Fisher, S., Bellinger, D. C., Cropper, M. L., Kumar, P., Binagwaho, A., Koudenoukpo, J. B., ... & Landrigan, P. J. (2021). Air pollution and development in Africa: impacts on health, the economy, and human capital. The Lancet Planetary Health, 5(10), e681-e688.

IEA (2023). World Energy Outlook 2023. International Energy Agency; Paris, France. Pp. 17-78; 221-225.

**Lectures:**

Lecture 6. Externalities in energy (intro). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=cd897f01-91da-49dc-bf11-b15000bf55f6).

Lecture 7. Externalities in energy (cooking energy). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=bc26021d-ebb5-46d7-8555-b15000c9daf4).

Lecture 8. Externalities in energy (power generation). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=3ed64e41-44de-4d82-944f-b15000f1c47d).

* 1. Inequality and justice issues (gender, sectoral aspects, rural/urban divide, marginalized sub-populations)
     1. Concept of just or inclusive energy transition
     2. Policy acceptance

Readings / background materials:

Das, I., Klug, T., Krishnapriya, P. P., Plutshack, V., Saparapa, R., Scott, S., ... & Jeuland, M. (2023). “Frameworks, methods and evidence connecting modern domestic energy services and gender empowerment.” *Nature Energy*, 8(5), 435-449.

Sotiriou, Alexander G., Pepukaye Bardouille, Daniel Waldron, and Gianmaria Vanzulli (2018). “Strange Beasts: Making Sense of PAYGo Solar Business Models.” Forum 14. Washington, D.C.: CGAP. Available at: [https://www.cgap.org/sites/default/files/publications/Forum-Strange-Beasts-Jan-2018.pdf](https://urldefense.com/v3/__https:/www.cgap.org/sites/default/files/publications/Forum-Strange-Beasts-Jan-2018.pdf__;!!OToaGQ!rdtAqoouonOziHVsb_YbqTHPe1EoGzejW-whZDdLWefjcu7S8y2dWa2J-yKu4EZFYeDmSAUsxi3sH84qZ3SKHGHq5NsPL3iqsw$)

Phillips, J., J. Ewing, A. Rao, L. Teji, V. Plutshack, and M. Jeuland (2022). “Climate Finance for Just Transitions: Building Low-Carbon Development Pathways in an age of US-China Rivalry.” *Nicholas Institute PB 22-18*. Durham, NC: Duke University

Government of South Africa (2022). South Africa’s Just Energy Transition Investment Plan (JET IP) for the initial period 2023–2027. Pretoria, South Africa. Read Executive Summary (Pp. 5-18).

**Lectures:**

Lecture 9. Energy inequality (energy poverty aspects). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=cf5d1125-9778-4cc6-8866-b15b0077bb3b).

Lecture 10. Energy inequality (gender aspects). [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=86fa2e9d-06f0-4c3a-bb8c-b15c0087398c).

Lecture 11. The Just Energy Transition concept. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=deb19b40-3a20-49bb-acae-b15c009100e2).

1. Heterogeneity arising from institutional, infrastructural, market complementarities

Readings / background materials:

Dinkelman, T. (2011). “The effects of rural electrification on employment: New evidence from South Africa.” *American Economic Review* 101(7), 3078-3108.

Bensch, G., Gotz, G., & Ankel-Peters, J. (2020). “Effects of rural electrification on employment: A comment on Dinkelman.” *USAEE Working Paper 20-436.*

Lenz, L., Munyehirwe, A., Peters, J., & Sievert, M. (2017). “Does large-scale infrastructure investment alleviate poverty? Impacts of Rwanda’s electricity access roll-out program.” *World Development* 89, 88-110.

Fetter, T. R., & Usmani, F. (2020). “Fracking, farmers, and rural electrification in India”. *Ruhr Economic Papers (No. 864)*. Essen, Germany.

Ingram, Matthew, Jonathan Phillips, Hizkyas Dufera, Liuel Hizikias, Marc Jeuland, and James Lovedale, 2022. “Improving Rural Livelihoods, Energy Access, and Resilience Where It’s Needed Most: The Case for Solar Mini-Grid Irrigation in Ethiopia.” *NI PB 22-15*. Durham, NC: Duke University. http://nicholasinstitute.duke.edu/ publications.

**Lectures:**

Lecture 12. Energy and development controversies. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=86bdfd5a-6dad-4034-b04d-b15c00a19f21).

1. Political economy
   * 1. Special interests
     2. Problems of public sector efficacy and corruption

Readings / background materials:

Baskaran, T., Min, B., & Uppal, Y. (2015). Election cycles and electricity provision: Evidence from a quasi-experiment with Indian special elections. *Journal of Public Economics*, 126, 64-73.

Steckel, J. C., & Jakob, M. (2021). “The political economy of coal: Lessons learnt from 15 country case studies.” *World Development Perspectives*, 24, 100368.

Gore, C. D., Brass, J. N., Baldwin, E., & MacLean, L. M. (2019). Political autonomy and resistance in electricity sector liberalization in Africa. *World development*, 120, 193-209.

Arndt, C., Miller, M., Tarp, F., Zinaman, O., & Arent, D. (2017). The political economy of clean energy transitions. Oxford University Press. Read Chapters 1 and 2 (Pp. 3-35).

**Lectures:**

Lecture 13. Political economy aspects. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=4bb54aa2-2d6f-4082-a68a-b16400cdff3b).

1. The know-do gap: Bridging science and policy and the role of evidence-based decision making

Readings / background materials:

Nilsen, P. (2020). Overview of theories, models and frameworks in implementation science. *In* *Handbook on implementation science* (pp. 8-31). Edward Elgar Publishing.

Turnheim, B., Asquith, M., & Geels, F. W. (2020). Making sustainability transitions research policy-relevant: Challenges at the science-policy interface. Environmental Innovation and Societal Transitions, 34, 116-120.

Elshall, A. S., Arik, A. D., El-Kadi, A. I., Pierce, S., Ye, M., Burnett, K. M., ... & Chun, G. (2020). Groundwater sustainability: A review of the interactions between science and policy. Environmental Research Letters, 15(9), 093004.

Opalo, Ken (March 22, 2024). “Policymaking for economic transformation in African states: what ought to be done.” *An Africanist Perspective* (Blog).

**Lectures:**

Lecture 14. Implementation research. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=a35965fa-c32d-47f5-9ea6-b16400d9dcf3).

1. Energy transitions opportunities as well as concerns
   1. Evolving energy sector
   2. Leap-frogging towards efficiency
   3. Building climate resilience and improving adaptation
   4. The risk of maladaptation

Readings / background materials:

Foster, V., Eberhard, A., & Dyson, G. (2021). The evolution of electricity sectors in Africa: ongoing obstacles and emerging opportunities to reach universal targets. *In Handbook on Electricity Markets* (pp. 595-628). Edward Elgar Publishing.

ESMAP (2019). Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers (Executive Summary). World Bank. Washington, DC. Read the “By the Numbers” and “Main Findings,” pages 1-12.

Phillips, J.; B. Attia, B.; and V. Plutshack (2020). “Lessons from the proliferating mini-grid incentive programs in Africa”. Brookings. Available at: <https://www.brookings.edu/articles/lessons-from-the-proliferating-mini-grid-incentive-programs-in-africa/>

Peters, J., Sievert, M., & Toman, M. A. (2019). “Rural electrification through mini-grids: Challenges ahead.” *Energy Policy*, 132, 27-31.

Fetter, T. R. (2022). “Energy transitions and technology change: ‘Leapfrogging’ reconsidered.” *Resource and Energy Economics*, 70, 101327.

**Lectures:**

Lecture 15. Emerging issues. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=effb4084-f4d6-49c2-b11a-b16400fe966b).

**Module 2.** Empirical methods applied to understand energy sector intervention targeting and evaluation. Building appreciation and basic skills.

1. Evaluation of programs – framework

Readings / background materials:

Jeuland, M. & R. Ruhinduka (2024). “Research Designs for Impact Evaluation of Agricultural Technology Adaptation Interventions”. *White Paper Discussion Draft.* Durham, USA.

**Lectures:**

Lecture 16. Impact evaluation framework. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=7fc312b0-19c2-42c6-9739-b16a0083ce87).

1. Primer on evaluation methods
   1. Experimental
   2. Quasi-experimental
   3. Observational

Readings / background materials:

General

Jeuland, M. & R. Ruhinduka (2024). “Research Designs for Impact Evaluation of Agricultural Technology Adaptation Interventions”. *White Paper Discussion Draft.* Durham, USA.

Randomized trials

Duflo, E., Glennerster, R., & Kremer, M. (2007). “Using randomization in development economics research: A toolkit.” *Handbook of development economics*, 4, 3895-3962.

Lee, K., Miguel, E., & Wolfram, C. (2020). “Experimental evidence on the economics of rural electrification.” *Journal of Political Economy*, 128(4), 1523-1565.

Regression discontinuity

Burlig, F., & Preonas, L. (2022). “Out of the darkness and into the light? development effects of rural electrification.” *Journal of Political Economy (Forthcoming).*

Jones, M., F. Kondylis, J. Loeser and J. Magruder (2022). "Factor market failures and the adoption of irrigation in rwanda." American Economic Review 112(7): 2316-2352.

Panel difference-in-differences

Roth, J., Sant’Anna, P. H., Bilinski, A., & Poe, J. (2023). What’s trending in difference-in-differences? A synthesis of the recent econometrics literature. Journal of Econometrics, 235(2), 2218-2244.

Gupta, E. (2019). The impact of solar water pumps on energy-water-food nexus: Evidence from Rajasthan, India. Energy Policy, 129, 598-609.

Natural experiment

Cerdá, M., Morenoff, J. D., Hansen, B. B., Tessari Hicks, K. J., Duque, L. F., Restrepo, A., & Diez-Roux, A. V. (2012). Reducing violence by transforming neighborhoods: a natural experiment in Medellín, Colombia. American journal of epidemiology, 175(10), 1045-1053.

Matching and synthetic control

Rosenbaum, P. R., & Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. The American Statistician, 39(1), 33-38.

Putra, R. A. R. S., Liu, Z., & Lund, M. (2017). The impact of biogas technology adoption for farm households–Empirical evidence from mixed crop and livestock farming systems in Indonesia. Renewable and Sustainable Energy Reviews, 74, 1371-1378.

West, T. A., Wunder, S., Sills, E. O., Börner, J., Rifai, S. W., Neidermeier, A. N., ... & Kontoleon, A. (2023). Action needed to make carbon offsets from forest conservation work for climate change mitigation. Science, 381(6660), 873-877.

Instrumental variables

Dinkelman, T. (2011). “The effects of rural electrification on employment: New evidence from South Africa.” *American Economic Review* 101(7), 3078-3108.

Lipscomb, M., Mobarak, A. M., & Barham, T. (2013). Development effects of electrification: Evidence from the topographic placement of hydropower plants in Brazil. American Economic Journal: Applied Economics, 5(2), 200-231.

Bensch, G., Ankel-Peters, J., & Vance, C. (2021). Development effects of electrification in Brazil–a comment on Lipscomb et al. (2013).

**Lectures:**

Lecture 17. Experimental method. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=973c40ac-a495-44e0-90ea-b16a00904d6a).

Lecture 18. RDD and natural experiments. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=346ae70e-28c4-4629-b52e-b16a00965486).

Lecture 19. Difference-in-differences. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=3cd9f069-b58b-4552-8cb5-b16b00c7a429).

Lecture 20. Matching methods. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=cf78076e-ccb1-4ef9-b139-b16b00cdd235).

Lecture 21. Instrumental variables. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=dce58806-efc7-4999-a36c-b16b00d2359e).

1. Understanding how to target interventions
   1. Cost-benefit analysis w/distributional analysis
   2. Non-market valuation and understanding of preferences

Readings / background materials:

Alem, Y., Hassen, S., & Köhlin, G. (2023). Decision-making within the household: The role of division of labor and differences in preferences. Journal of Economic Behavior & Organization, 207, 511-528.

Baker, R., & Ruting, B. (2014). Environmental policy analysis: A guide to non‑market valuation. *Australian Government Productivity Commission.* Melbourne, Australia. Read Pp. 2-75.

Khavari, B., Ramirez, C., Jeuland, M., & Fuso Nerini, F. (2023). A geospatial approach to understanding clean cooking challenges in sub-Saharan Africa. Nature Sustainability, 6(4), 447-457.

Jeuland, M., Pattanayak, S. K., Tan Soo, J. S., & Usmani, F. (2020). Preferences and the effectiveness of behavior-change interventions: Evidence from adoption of improved cookstoves in India. Journal of the Association of Environmental and Resource Economists, 7(2), 305-343.

Loomis, J. B. (2011). Incorporating distributional issues into benefit cost analysis: why, how, and two empirical examples using non-market valuation. Journal of Benefit-Cost Analysis, 2(1), 1-24.

**Lectures:**

Lecture 22. Cost-benefit analysis. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=22436bc7-6955-4c1f-a7dd-b16d00c23a47).

Lecture 23. Nonmarket valuation. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=2e03a059-af96-4c84-b0f3-b16d00cd1c13).

1. Collaborating with energy modelers, engineers, and natural scientists: Integrated models

Readings / background materials:

Pfenninger, S., Hawkes, A., & Keirstead, J. (2014). Energy systems modeling for twenty-first century energy challenges. Renewable and Sustainable Energy Reviews, 33, 74-86.

Musonye, X. S., Davíðsdóttir, B., Kristjánsson, R., Ásgeirsson, E. I., & Stefánsson, H. (2020). Integrated energy systems’ modeling studies for sub-Saharan Africa: A scoping review. Renewable and Sustainable Energy Reviews, 128, 109915.

**Lectures:**

Lecture 24. Integrated modeling. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=61313002-b2a2-49d9-9e49-b16d00d61212).

1. Reading the scientific literature

Readings / background materials:

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. Health information & libraries journal, 26(2), 91-108.

Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. Energy Policy, 61, 729-739.

**Lectures:**

Lecture 25. Reviewing the literature. [Link](https://duke.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=0eebe5fb-f1da-4164-b0ad-b16d00da911e).

**Module 3.** In-person capstone: Describing an energy transition problem and proposing a research agenda that would inform policymaking to tackle that problem.

In this module, participants will apply what they have learned in modules 1 and 2 to a problem of their choosing, that is apparent in their country (or in a sub-region in their country). Prior to attending, all participants will be asked to prepare a short individual concept note. In this note, each participant will identify a problem with energy that is currently facing their country, and to brainstorm on potential solutions to that problem (and what might go wrong), based on their own knowledge and also what they will have learned in module 1. They will also do a mini-literature review related to that problem.

Then, during in-person lectures and work sessions, participants will learn to put structure around a research agenda to support policymaking to tackle that problem. Specifically, they will need to create and defend a plan to build an evidence-based case for the scale up of interventions to solve their problem. In that plan, they will need to emphasize how monitoring and evaluation research fits into achieving their impact goal.

During this module, participants will have in depth interactions with select course instructors and other cohort members. Joint sessions will be held during the mornings, with time granted for preparing written and presentation materials, and interacting with others, in the afternoons. We will cover the following major topics and discuss examples that help demonstrate:

* How to write a compelling policy-focused research proposal
* How to choose an appropriate research method for supporting evaluation and sound policymaking
* How to strategize around data scarcity or data collection challenges
* How to identify potential funding sources for applied research
* How to present your ideas clearly and increase the chances your proposal will be supported (by funders and administrators)

Readings / background materials:

TBD