

# Renewable Energy in the Electricity Sector

## Paper Session

Friday, Jan. 5, 2024 12:30 PM - 2:15 PM (CST)

Marriott Rivercenter

Hosted By: [TRANSPORTATION AND PUBLIC UTILITIES GROUP](#)

Chair: Akshaya Jha, Carnegie Mellon University

## A Bright Future for Housing Investors? Solar Panels and Bargaining Effects for Single Family Homes

Jeffrey Cohen, University of Connecticut

Xiangxin Liu, University of Connecticut

Chinmoy Ghosh, University of Connecticut

Kenneth Gillingham, Yale University

### Abstract

There has been a growing popularity of investors – both individual and institutional – purchasing single family residential properties in the U.S. in the past several years. Prior studies have shown that investors tend to bargain better than owner-occupiers – that is, on average, investors purchase for less and sell for more than owner-occupiers. At the same time as this increased investor activity in single family home markets, the growing popularity of residential solar panels in Connecticut has been accompanied by a number of new solar initiatives in the state that can be used as quasi-natural experiments. The anticipated stream of future net benefits from selling solar-generated electricity back to the grid can lead to a further incentive for investors to purchase single-family homes with solar. In homes with solar panels, do we see a larger or smaller wedge in the bargaining effect between investors and owner-occupiers? This is the primary question of interest in this paper. We use a difference-in-differences empirical approach to determine how house sales prices are impacted differently for investors versus owner-occupiers (which is how we measure bargaining power). We have data on all single-family residential home sales in Connecticut, and the exact addresses of houses with solar installations, going back to the year 2002. To our knowledge, this issue has not been explored in other research.

## Component Manufacturing, Disadvantaged Communities, and the Energy Transition

Max Fleming, Colorado School of Mines

Benjamin Gilbert, Colorado School of Mines

### Abstract

Understanding the labor market impacts of a transition to renewable energy sources, including how these impacts are distributed among historically disadvantaged communities, is crucial for stakeholders who may be guiding the location and type of renewable energy investments. In particular, the Biden administration has focused significant resources on expanding both renewable energy generation and domestic renewable energy component manufacturing. Recent studies have found local employment and earnings impacts from U.S. renewable energy generation that are too large to be explained by direct

employment at solar or wind generation facilities (Gilbert et al, 2023; Chan and Zhou 2023). Some authors point to rent and royalty payments to landowners and tax payments to local jurisdictions as possible mechanisms for an indirect economic multiplier effect (Brunner et al, 2022; Castleberry and Greene, 2017; Shoeib et al 2021). In this paper, we explore an additional mechanism: domestic manufacturing of renewable energy components. Previous research has suggested that wind component manufacturing facilities are more likely to be located in counties with greater wind resources, i.e., closer to the location of development of generation facilities (Kim, 2019). We estimate the causal effect of wind component manufacturing activity on local household income. We further evaluate whether this component manufacturing effect differs in counties that contain historically disadvantaged communities.

We combine panel data from several sources in order to quantify these effects in a difference-in-differences framework. We collect data on the presence/absence and number of wind component manufacturing facilities per county from American Clean Power (ACP), an industry association. We combine this with a state-level panel of aggregate annual revenues at wind component manufacturing facilities gathered by IBISWorld, a private industry data aggregator. We combine this data with county-level data on household earnings from the American Community Survey.

## **Pricing Synthetic Inertia: Strategies for Grid Stability in a Renewable Energy Future**

Omer Karaduman, Stanford University

Alison Ong, Stanford University

Guillaume Roger, Monash University

### **Abstract**

Inertia, essential for power system stability, is traditionally supplied by rotational power generators. Synthetic inertia becomes increasingly crucial as the energy sector shifts towards renewables, which inherently lack this attribute. Using 4-second data from Australian Electricity Market, our study first identifies events that require inertia and their impact on system frequency. We then explore synthetic inertia, particularly sourced from batteries, addressing its integration and procurement. This process involves optimizing battery operations, considering both the provision of synthetic inertia and the potential revenue generation in our renewable-dominated energy future.

## **Do Red States have a Comparative Advantage in Generating Green Power?**

Robert Huang, University of Southern California

Matthew Kahn, University of Southern California

### **Abstract**

The passage of the 2022 Inflation Reduction Act will lead to a significant increase in US wind and solar power investment. Renewable power generation requires more land than fossil fuel fired power generation. The land that will be allocated to renewables depends on several demand side and supply side factors that include the land's renewable power potential, cost of acquisition, proximity to final power consumers, and local land use regulations. We find that Republican areas issue generation permits faster than progressive areas. We present evidence that rural Republican areas have a cost advantage for generating wind power; however, Democratic areas have sited more solar capacity. We use our statistical

model to identify Republican Congressional districts that have the potential to scale up green power production.

### **Discussant(s)**

Robert Harris, Georgia Institute of Technology  
Mark Curtis, Wake Forest University  
Timothy Fitzgerald, Texas Tech University  
Akshaya Jha, Carnegie Mellon University

# **Public Utilities in Developing Countries**

## **Paper Session**

Friday, Jan. 5, 2024 2:30 PM - 4:30 PM (CST)

Marriott Rivercenter

Hosted By: **TRANSPORTATION AND PUBLIC UTILITIES GROUP**

Chair: Jonathan Hughes, University of Colorado

## **The Economic and Environmental Effects of Infrastructure Improvements: Evidence from Pakistan's Electricity Sector**

Husnain F. Ahmad, Sewanee-University of the South  
Ayesha Ali, Lahore University of Management Sciences  
Robyn C. Meeks, Duke University  
Zhenxuan Wang, Duke University  
Javed Younas, American University-Sharjah

### **Abstract**

High electricity losses due to unbilled consumption are an impediment to reliable and affordable electricity provision in developing countries. We study the impacts of an infrastructure intervention that made illegal electricity connections physically more difficult in Karachi, Pakistan. The installation of aerial bundled cables (ABCs) reduced non-technical losses and increased revenue recovery, by increasing both the number of formal utility customers and the billed consumption among formal customers. Consumer surplus changes from ABCs depend on the cost of prior illegal grid connections and whether electricity quality improves. ABCs reduced the utility's annual CO2 emissions, via reductions in electricity generation.

## **Collateral Accounts: Debt Recovery through Prepaid Electricity Metering**

Jeffrey Cross, Hamilton College  
B. Kelsey Jack, University of California-Santa Barbara  
Anders Jensen, Harvard University

### **Abstract**

Challenges recovering revenue from public services such as water and electricity present a barrier to expanding access in many low and middle income countries. We study a program in Cape Town, South Africa that enrolls households with delinquent municipal tax and service accounts in an aggressive debt recovery program that leverages linkages across municipal accounts. Specifically, households in Cape

Towns receive electricity through prepaid meters, which require advance purchase of electricity, thereby eliminating arrears in electricity payments. When households reach high levels of billing debts for water use or property taxes, these debts are recovered through electricity purchases. We exploit program rules surrounding eligibility and targeting to recover program impacts on electricity purchases, water consumption and bill payment behavior, along with own- and cross-price elasticities of demand for electricity and water, respectively. A model of municipal revenue helps interpret the findings and derive the optimal revenue recovery rate. We discuss the welfare consequences of debt recovery, both for targeted households and for the population as a whole. Our findings highlight the potential for digitization and linking of government databases to lower the cost of expanding access to electricity and other services.

## **Donor Contracting Conditions and Public Procurement: Causal Evidence from Kenyan Electrification**

Catherine Wolfram, University of California-Berkeley  
Edward Miguel, University of California-Berkeley  
Eric Hsu, Yale University  
Susanna Berkouwer, University of Pennsylvania

### **Abstract**

There is limited causal evidence on the effects of different public procurement regulations on project quality and value-for-money for projects funded by national governments or foreign aid donors. This paper uses both policy and experimental variation to study how two key contracting features—namely, the bundling of contract components, and enhanced ex post monitoring—affect outcomes of a large economic development project. To implement Kenya’s nationwide electrification program, the electric utility Kenya Power awarded and administered dozens of contracts with private contractors. We exploit an unusual program feature: different contracting procedures were often used across nearby villages, with Kenya Power awarding bundled contracts at African Development Bank (AfDB)-funded villages but unbundled contracts together with strengthened monitoring at World Bank (WB)-funded villages. To measure impacts, we collect on-the-ground engineering assessments, voltage and reliability data, household survey data on connection quality and usage, and analyze original contracts. The analysis suggests a stark trade-off: construction completion was delayed by 16 months on average at WB-funded sites relative to AfDB-funded sites but WB-funded sites saw a sizeable 0.6 standard deviation increase in construction quality. To disentangle the effects of contract bundling versus monitoring, we implement a randomized audits scheme. The audits improve household connectivity, network size, and voltage at AfDB-funded sites, but have no impact at WB-funded sites, suggesting monitoring and unbundling contracts may be substitutes. Given the apparent trade-off, we investigate how net benefits depend on policymaker time preferences and infrastructure longevity due to improved quality. Under plausible assumptions, WB processes could generate a net benefit ranging anywhere from +4% to -7% of total project value, indicating that neither procurement approach clearly dominates the other in this context.

## **Do Contests Deliver Cost-Effective Energy Conservation?**

Teevrat Garg, University of California-San Diego  
Jorge Lemus, University of Illinois  
Guillermo Marshall, University of British Columbia

Chi Ta, Virginia Tech  
Biz Yoder, Duke University

### **Abstract**

The energy sector in low- and middle-income countries (LMICs) is characterized by two stylized facts: high rates of particulate and carbon emissions per unit of electricity generated, as well as low reliability of electricity. To reduce air pollution levels and increase reliability, utilities have been encouraging urban households to conserve energy and reduce electricity use through various programs. Unlike utilities in other countries, Vietnamese utilities have been employing contests among households to encourage energy conservation, rather than using one-on-one contracts. Contests, which employ relative rather than absolute standards, have the potential to achieve larger aggregate energy conservation. In this paper, we explore the cost-effectiveness of contests versus contracts, particularly when contracts are incomplete due to households' abatement effort and costs being unobservable to the utility. Additionally, we examine how these programs can be scaled in a cost-effective and fiscally feasible manner in LMICs. To answer these questions, we have partnered with a state-owned electric utility company in Hanoi, Vietnam, to conduct a field experiment using their newly launched app. The experiment is conducted on a subset of 12,000 EVN Hanoi customers who have installed the utility's app. We assign households to one of four groups: a control group, a contest group, and two one-on-one contract groups with different terms.

The paper makes significant contributions to the empirical literature on tournaments. First, we provide new evidence on a classic question in the tournaments literature, which is whether tournaments are superior to contracts (Lazear and Rosen, 1981; Green and Stokey, 1983). Our analysis is strengthened by the fact that the tournament and contract designs faced by participants are randomly assigned, and we are able to observe high-frequency performance measures (i.e., energy use) before, during, and after the competitions.

### **Discussant(s)**

Edson Severnini, Carnegie Mellon University  
Steven Puller, Texas A&M University  
Jesse Buchsbaum, University of Chicago  
Frank Wolak, Stanford University

## **Impact of Transportation Infrastructure**

### **Paper Session**

Sunday, Jan. 7, 2024 8:00 AM - 10:00 AM (CST)

Marriott Rivercenter

Hosted By: [TRANSPORTATION AND PUBLIC UTILITIES GROUP](#)

## **Eliminating Fares to Expand Opportunities: Experimental Evidence on the Impacts of Free Public Transportation on Economic Disparities**

Rebecca Brough, University of California-Davis  
Matthew Freedman, University of California-Irvine  
David Phillips, University of Notre Dame

### **Abstract**

We conduct a randomized controlled trial to study the direct and downstream effects of providing free public transit to individuals with low income. While a subsidy that reduces the price of transit to zero nearly doubles transit use, it does not have economically or statistically meaningful effects on paid hours worked or earnings. However, rich administrative data on a wide range of other outcomes indicate that free transit improves individuals' well-being, and in particular health. Complementary survey data reveal that participants use free transit to access a variety of services and amenities, implying that the benefits of lower transit costs primarily accrue from sources other than employment. Our results have implications for estimating the welfare benefits of public transportation and can help to inform policy aimed at expanding opportunities for individuals with low income.

## Land Development along National Highway Networks

Dustin Frye, University of Wisconsin-Madison

### Abstract

This paper examines the impact of interstate highways on land development across the United States. First, by considering the intensity of building construction from 1955 to 2015 measured at the 1 km x 1 km grid cell level. Next, it considers the share of developed land using land cover data from 1974 to 2015. For identification, the paper uses proposed but never built highway segments from a 1920s interstate plan as counterfactual interstate locations. Results indicate that interstates significantly increased land development. These gains are strongest among commercial and industrial land and are concentrated within 5 kilometers of interstates.

## Urban Rail Transit and Endogenous Worker Choices

Justin Tyndall, University of Hawai'i-Mānoa

### Abstract

The provision of public transportation can improve the accessibility of work opportunities, particularly for low-income residents. However, predicting the labor market effects of new transit infrastructure is difficult because workers may endogenously adjust location, commute mode, and work decisions based on the existence of the infrastructure. I examine a large public transit rail project on the island of O'ahu, Hawai'i. Using a matrix of census block level travel times, I propose and estimate a structural model of location and mode choice for workers on O'ahu. I use estimated parameters to predict the effects of the rail project. I find the new rail system substantially increases the use of public transit and increases the employment rate, particularly among low-income workers. Accounting for endogenous household decisions through structural modeling is key to the findings. High-income workers have a strong preference for driving and a low preference for the neighborhoods in which rail was constructed, this allows low-income workers to capture a high share of transit's direct benefits.

## Airport Business Practices and Capacity Utilization

Fecri Karanki, Purdue University  
Volodymyr Bilotkach, Purdue University

### Abstract

Lumpy capacity is a chronic problem for airports as they hold excess capacity in the short run, considering long-run needs. Besides economic factors like demand uncertainty, competition at the airport, or market concentration, business practices can also account for excess capacity. Therefore, we examine the impact of use agreement types and governance forms on airport capacity utilization rates. In addition, hub size is added to the model to control the size effect on capacity utilization. Our data includes 59 U.S. large and medium hub airports in the years between 2009 and 2019. A two-stage semi-parametric model is employed. In the first stage, we conduct two DEA models: a modified DEA based on Johansen (1968)'s capacity definition and a standard DEA. Thereby, we obtain information on capacity utilization rates, optimal capacity, variable input utilization rates, and technical efficiency scores. The second stage incorporating a truncated regression with a bootstrap process enables us to assess the impact of use agreements, governance forms, and hub size on capacity utilization. The results suggest that compensatory airports have lower capacity utilization rates than residual airports. This can be explained by the control of signatory airlines over the airport investment decisions and the lack of retained earnings under the residual agreement. We did not detect a significant difference between hybrid and residual methods. State-governed airports have higher unused capacity than the airports governed by port/airport authority. This implies that the inability of port/airport authorities for issuing enough bonds curbs new capital investments. Finally, large hub airports have higher capacity utilization rates than medium hubs.

#### **Discussant(s)**

Alexander Rothenberg, Syracuse University  
Tanner Regan, George Washington University  
Alex Anas, State University of New York at Buffalo  
Kerry Tan, Loyola University Maryland

## **Transportation Externalities**

### **Paper Session**

Sunday, Jan. 7, 2024 10:15 AM - 12:15 PM (CST)

Marriott Rivercenter

Hosted By: **TRANSPORTATION AND PUBLIC UTILITIES GROUP**

Chair: Jonathan Hall, University of Alabama

## **Heterogeneous Speed, Reliability, and Traffic Externalities**

Ian Herzog, Huron University College

### **Abstract**

This paper estimates traffic's effect on travel times and congestion externalities on a broad sample of London roads which enables detailed heterogeneity analysis. A fixed effects approach that compares across times of day finds that 10% more traffic increases travel time by 4%, erodes reliability, and marginal effects are smallest on high-capacity roads. Quantifying a traffic externality model gives substantial congestion costs and I explore how magnitudes depend on modelling assumptions. Computing trip-level

externalities suggests that public transit creates substantial congestion relief benefits and that Central London's Congestion Charge is too high to reflect time savings alone

## **Subways or Minibuses? Privatized Provision of Public Transit**

Lucas Conwell, University College London

### **Abstract**

Workers in developing countries waste significant time commuting, and gaps in public transit constrain access to productive jobs. In many cities, privately-operated minibuses provide 50–100% of urban transit, at the cost of long wait times and poor personal safety for riders. Should developing-country cities follow the typical recommendation of bus rapid transit or subway investments or rather optimize this existing, home-grown network? I build a micro-founded model of privatized shared transit subject to externalities in matching between buses and passengers. I then estimate the model with newly collected data on minibus and passenger queues in Cape Town and stated user preferences for exogenously-varied commute attributes. I find that Cape Town's existing bus rapid transit decreased welfare, net of costs, but socially-optimal minibus fares and commuter taxes correct matching externalities, particularly benefit low-skill workers, and reduce spatial misallocation. Government actions to improve security bring even more substantial welfare gains.

## **Hear Ye, Bear Ye: Housing Prices, Noise Levels, and Noise Inequality**

Jeffrey Cohen, University of Connecticut  
Cletus Coughlin, Federal Reserve Bank of St. Louis  
Felix Friedt, Macalester College

### **Abstract**

The relationship between house prices and transportation noise has been studied for many locations, but the underlying factors and issues of heterogeneity have not been as extensively explored. Transportation noise – both air and road – can be pervasive in major metropolitan areas, and there is much heterogeneity in the noise exposure faced by many residents across geographic space. High housing prices in urban centers can impede some residents in moving from louder to less noisy areas. This paper relies on a Census tract-level dataset on road and aviation noise covering the contiguous U.S. for 2016 and 2018, along with American Community Survey data, to address the question of how house prices can be a barrier to avoiding noise for some residents. In the first known comprehensive analysis of this type combining these datasets for multiple years, we first explore which tracts, states and demographic groups experience disproportionate amounts of noise. Then, we use quantile regressions to demonstrate the inter-relationships between house prices and demographics, and how these interactions are correlated with noise. We find evidence for some tracts that when house prices are relatively high, higher Black population tracts are associated with additional noise exposure.

## **(How Much) Do Airlines Self-Internalize and Cross-Internalize Congestion?**

Christy Zhou, Clemson University  
Chungsang Tom Lam, Clemson University

### **Abstract**

"Air traffic congestion literature has debated whether and to what extent airlines self-internalize congestion they impose on their own flights, and provided mixed empirical evidence and theoretical implications. In this paper, we aim to quantify the self-imposed congestion using counterfactuals produced from (i) quasi-random variation from unscheduled flights from Lam and Zhou (2023) and (ii) projected propagated delay over time within an airport using artificial neural networks. We find sizable heterogeneity in both (a) marginal congestion an airline generates from placing a flight at a particular time, and (b) the proportion of which is imposed on its own flights versus rivals' flights. The distribution of the above effects helps reconcile the self-internalization debate by highlighting the conditions under which the self-internalization is realized in the equilibrium that we observe. In addition, we unpack the conventional external congestion (the congestion an airline imposes on its rivals) into a part that is internalized by the airline and a truly external part. We refer to the former as cross-internalized congestion. We also find substantial heterogeneity in this measure.

**Discussant(s)**

Andrew Waxman, University of Texas  
Ian Savage, Northwestern University  
Xi Yang, University of North Texas  
Anming Zhang, University of British Columbia