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Who should pay for transmission?

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Electricity 3 Concurrent Session

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Improving cost allocation is key to transmission buildout, which in turn is necessary for grid decarbonization

KEY TOPICS

Transmission and decarbonization

Building out the transmission grid is essential to integrating greater shares of renewable energy, and thus meeting US and international decarbonization goals

- Princeton's Net-Zero America report estimates that 2 to 5 times as much transmission is needed to achieve net-zero greenhouse gas emissions in the US by 2050, compared to 2020 levels (Larson et al.)
- Cost allocation = determining transmission rates (and who to charge) for service – it is often a significant hurdle to both merchant and regulated projects

Transmission cost allocation

Why is cost allocation controversial?

- Transmission rates are typically related to costs rather than the benefits that customers receive
- Costs for transmission are typically fixed in the short-term and indifferent to how much transmission service customers take
- Measuring overall benefits is not simple, but is possible nonetheless
- Social benefits of a project often exceed private benefits (externalities)
- Some customers may benefit more than others

OBJECTIVES OF THE PAPER

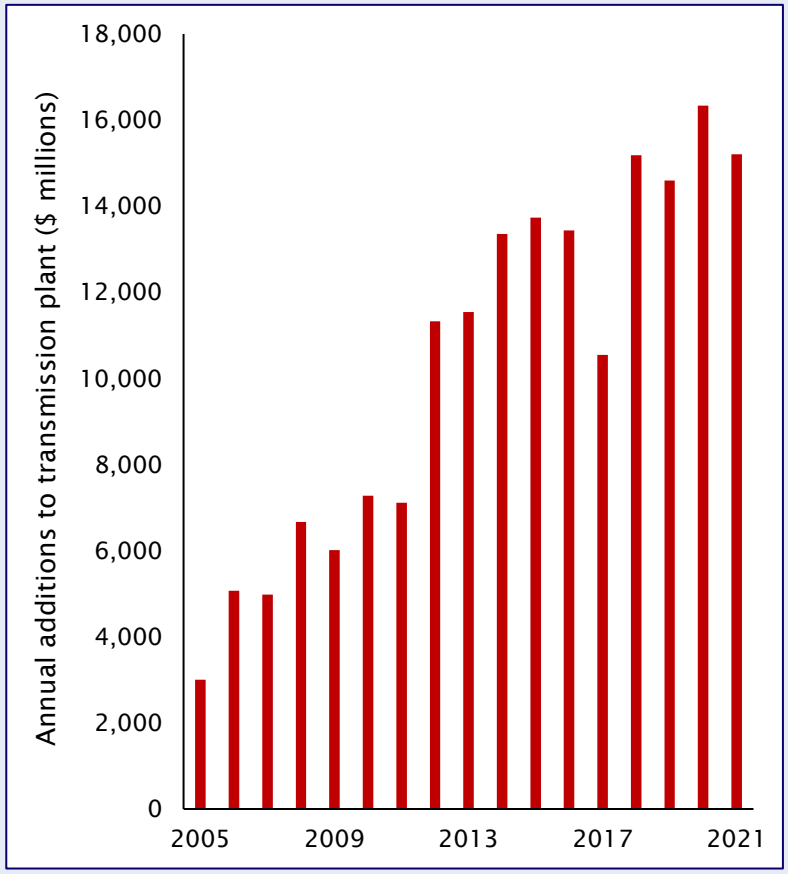
- **The purpose of the paper is to discuss how insights from microeconomic theory that focuses on externalities can improve transmission rate design and cost allocation practices**
  - Coase theorem in particular offers practical guidance on structuring negotiation processes to reach a welfare-maximizing outcome for customers that anticipate different benefit (cost) outcomes from transmission system expansion
- **By applying principles and extensions of the Coase theorem, transmission stakeholders may be able to overcome "holdout" problems among some affected parties and move transmission plans forward**

Agenda

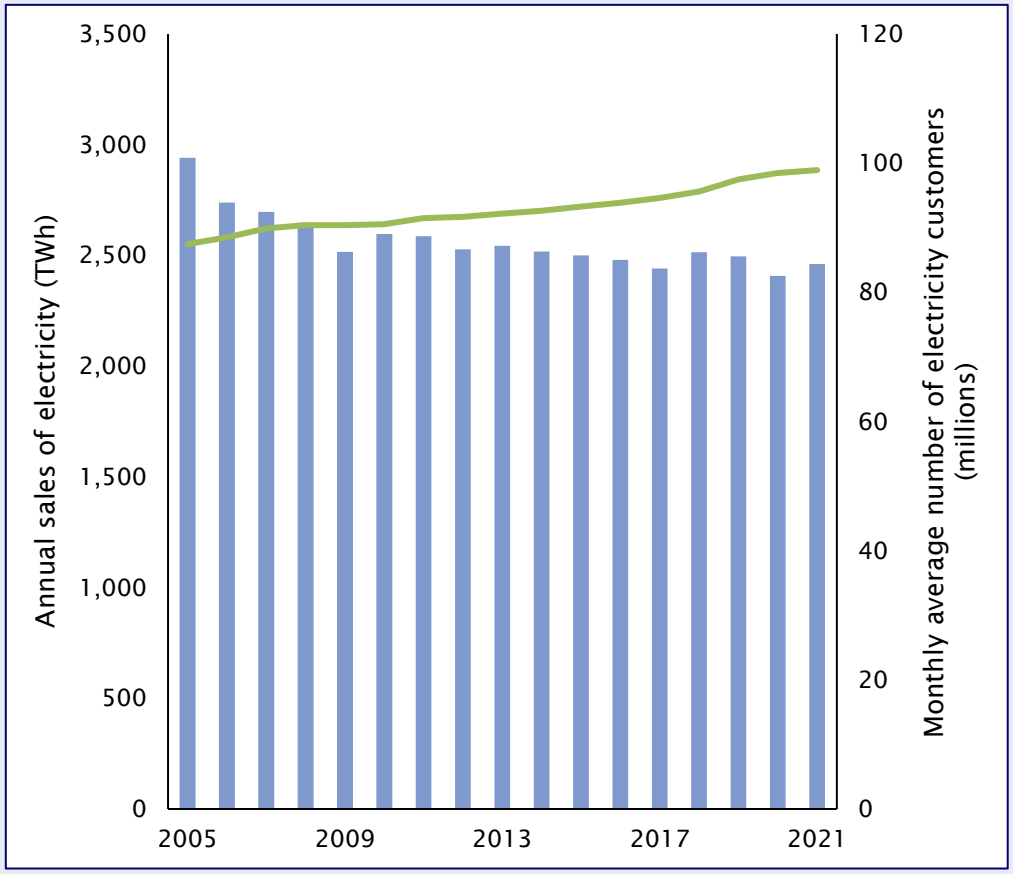
1	Transmission investment today
2	Approaches to transmission cost allocation
3	Applying Coasean insights
4	Conclusion

Trends in the US show a divergence between regulated transmission investment and electricity consumption

Annual additions to transmission plant by end of year, 2005-2021



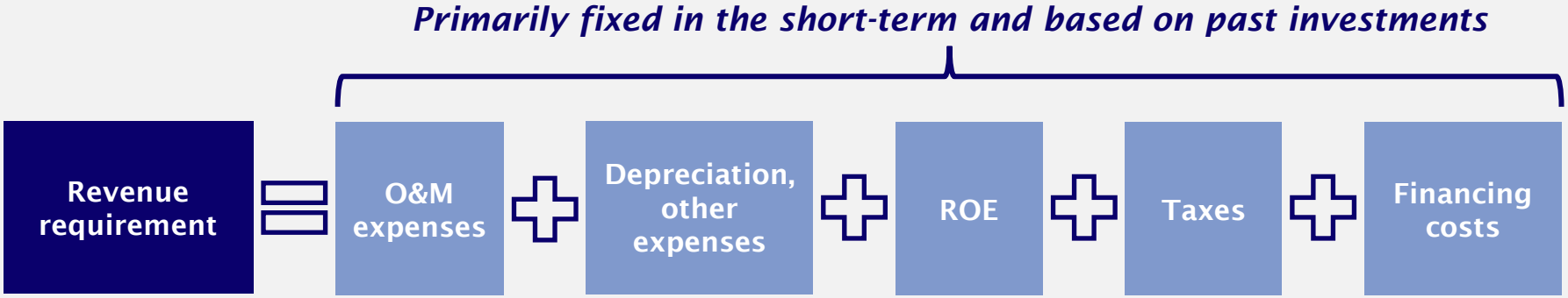
Annual sales of electricity (left axis, bars) and average number of customers (right axis, line), 2005-2021



Note:

*Based on FERC Form 1 data filed by regulated entities and compiled by S&P. Not all utilities report data in all years and across all fields. Therefore, only **100** regulated companies have been analyzed and included in our sample – this includes all entities that reported data for each year from 1992-2021 for the following fields: value of transmission plant, total sales of electricity (MWh sold), and monthly average number of electricity customers.*

Regulated transmission rates are primarily driven by fixed costs and are not tied to the value of benefits customers may receive from transmission service



- **Revenue requirements for transmission utilities are calculated using a set of basic elements**
  - Operations and maintenance ("O&M") expenses – costs of labor, materials, etc.
  - Depreciation expenses – the cost of an asset divided over its useful life; represents an asset's loss in value over time
  - Return on equity ("ROE") – set by the regulator and typically static during rate-setting periods; represents compensation to a utility's shareholders and debtors for investment risk
  - Taxes – income taxes and other taxes paid by the transmission utility; varies by jurisdiction
  - Financing costs – related to the cost to service debt, which is often used to finance investment
- **These costs are fixed in the short-term, and do not vary with use of the transmission system**
  - Across the US, transmission costs are typically recovered through rates that are primarily allocated based on coincident peak demand ($/kW) or a load ratio/energy rate ($/MWh)
- **Resulting rates – based on embedded (or historical) revenue requirement – may not be reflective of future costs of investment to serve load**

Sources: LEI, FERC

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Transmission rate design shows a preference towards traditional approaches, but dimensionality is emerging

- **Bonbright's seminal principles (1961) emphasize cost causation – allocating costs among customers based on their role in driving costs of service**
  - Accordingly, rate design approaches for public utilities have not changed significantly for many years – it remains primarily based on COS
- **Nonetheless, transmission rates do have some dimensionality:**
  - **Locational differences:** transmission tariffs account for system use differences at various points in the grid and charge users accordingly (ENTSO-E)
  - **Time of use:** e.g., peak vs off-peak, where electricity use is priced higher during periods of high system demand, in order to discourage consumption during peak periods (Environmental Defense Fund)
  - **Firm vs non-firm:** firm service is scheduled in advance with the transmission provider, and is less liable to curtailment; non-firm service is based on availability, and has a lower priority than firm service in case of interruption/ curtailment (Cecil)

Bonbright principles

Bonbright's three fundamental ratemaking criteria are:

1. **Recovery of the revenue requirement**
2. **Fair or equitable apportionment of costs among customers:** "the burden of meeting total revenue requirements must be distributed fairly among the beneficiaries of the service"
3. **Optimal efficiency:** rates should "discourage the wasteful use of public utility services while promoting all use that is economically justified"

Source: Bonbright, James C. Principles of Public Utility Rates. 1961 (Reprinted in 2005). P. 291-292 (PDF P. 155-156).

- **Discussions of highly granular locational pricing have largely been confined to commodity pricing, not transmission rates**
  - The UK is one exception: locational elements are present in network charging arrangements
- **Rates that discriminate between similarly – situated customers are generally not allowed**
  - Except for certain preferential rates that address extenuating circumstances and policy goals (e.g., economic development, customer retention)

Sources: ENTSO-E, EDF, Cecil, Energy Systems Catapult

Drivers of transmission investment have become more diverse as environmental policy and other priorities grow in prominence

- One transmission project may respond to multiple drivers
- Importantly, beneficiaries may differ and the quantum of benefits they see may differ

Reliability & resiliency	Climate change	Renewable integration	Aging infrastructure	Increased electrification
• Consistently meeting needs of both present and future customers, while acknowledging that customers may seek different levels of reliability (which may be managed through smart meters and load shed) • Ability to endure and survive disruptive events	• Increased air temperatures and extreme weather events can impact transmission infrastructure, requiring grid hardening and weatherization investments	• Areas of greatest wind/solar abundance are usually not located near load centers • Need additional transmission infrastructure to better connect generation to load and reduce system congestion	• Aging transmission assets are not located in the same places • A 2015 study from the Department of Energy found that 70% of US transmission lines are more than 25 years old • Newer transmission technology can also address other drivers	• A 2018 NREL study found that US electricity consumption could grow by 0.65% to 1.6% per year (2016-2050) • More transmission is needed to meet this growing demand, which will be locationally specific and stem primarily from a specific customer segment (e.g., EV users)

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Sources: LEI for WIRES, DOE, NREL

Even for merchant transmission that may use negotiated rates, the societal benefits of transmission investment are generally greater than the private benefits that can be monetized

- **In the US, negotiated rates do not have to reflect the underlying costs of service; negotiated rates are deemed just and reasonable so long as there is no undue discrimination in the allocation of transmission rights or other market power abuses**
- **From the perspective of economic theory (particularly the theory of positive externalities which applies to public goods), the difference between private and social benefits can lead to an under-investment in transmission**

Private benefits of transmission

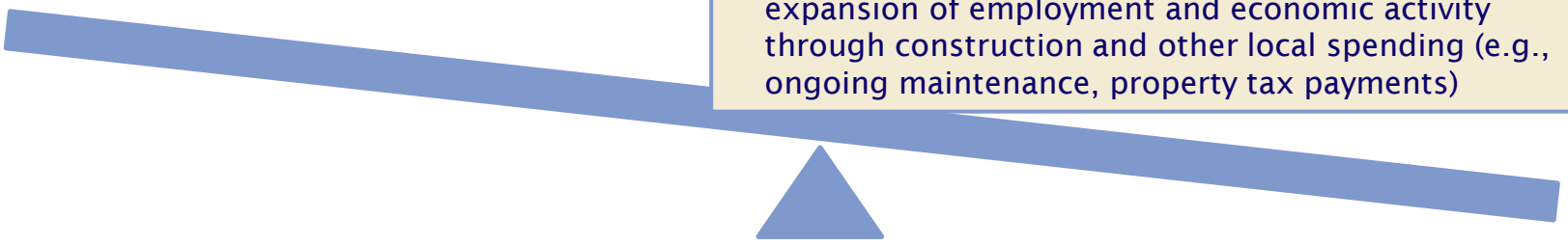
The benefits that are typically captured in negotiated rates relate to market price differences between the source and sink, or **congestion rents**.

Congestion rents are a function of market price disparities and energy flows on a project (so the size of the project limits the scope of congestion rents)

Social benefits of transmission

Social benefits are wide-ranging:

- **Production cost savings** – economic efficiency gains to the market through dispatch of lower marginal cost suppliers accommodated by more transmission capacity
- **Cost to load savings** – reduction in the market clearing price across all load, effectuated from greater trading opportunities and more competitive resources setting price at the margin
- **Environmental benefits** – lower emissions of greenhouse gases and other pollutants
- **Employment and economic development benefits** – expansion of employment and economic activity through construction and other local spending (e.g., ongoing maintenance, property tax payments)



Cost allocation/rate design has been identified as a challenge to new investment – but it does not have to be a barrier

What FERC has said about transmission cost allocation challenges

"We agree with many commenters that the lack of clear *ex ante* cost allocation methods that identify beneficiaries … may be impairing the ability of public utility transmission providers to implement more efficient or cost-effective transmission solutions … **Failing to address the allocation of costs** for these transmission facilities in a way that aligns with the evaluation of benefits through the transmission planning process **could lead to needed transmission facilities not being built, adversely impacting ratepayers**." (FERC, Order 1000, 2011)

"Identifying a cost allocation method that is perceived as fair … remains challenging. … Moreover, even where the cost allocation method is reasonably settled, **regional transmission facilities face significant uncertainty and risk of not reaching construction if certain stakeholders … do not perceive the regional transmission facilities' value as commensurate with their costs**." (FERC, 179 FERC ¶ 61,028, 2022)

Merchant projects have unique challenges…

- **Costs might be greater than congestion rents (i.e., private benefits), which may make the project appear commercially unviable**
- **Congestion rents may also be reduced or dissipate once a project is built, if the additional transmission capacity is sufficient in size to eliminate locational price differences**
  - This can reduce opportunities for arbitrage and thus the market value of the transmission rights going forward by the transmission customer or shipper

…as do regulated projects

- **A project would cause prices in the exporting zone to rise and prices in the importing zone to decrease**
  - This may benefit customers in the importing zone and generators in the exporting zone
  - The flip side is that customers in the exporting zone and generators in the importing zone are worse off
- **Customers in the exporting zone may object to a project (a hold-out problem), even if the gains for other customers outweigh the losses to exporting zone customers (net social benefit)**

Sources: FERC, LEI, Hogan

Measuring benefits and identifying beneficiaries of transmission is not simple, but doable – and essential

Categories of benefits

- Generation capacity cost savings
- Public policy benefits
- Employment and economic development benefits
- Production cost savings
- Insurance value benefits
- Environmental benefits
- Reliability and resource adequacy benefits
- Competitive market benefits

Challenges

- **Quantifying indirect benefits, such as reduced greenhouse gas emissions**
- **Determining basis for sharing system-wide or society-wide benefits**
- **Modeling network effects, such as impacts on future generation capacity, and agreeing on assumptions**
- **In situations where actual data is used, isolating the contributions of a transmission project in a network**

The beneficiary pays approach

- The beneficiary-pays approach provides a way to allocate transmission costs based on project benefits – the approach aims to allocate costs such that the amortized costs of the project will be incurred by customers in proportion to the benefits they receive
- In Order 1000, FERC required that cost allocation for regional and interregional transmission projects be based on a beneficiary pays approach – but to date, it has been implemented "roughly" based on rules and snapshots
- Currently available ex-ante investment assessment models, as well as transmission planning and dispatch models, produce the outputs necessary to help estimate beneficiary-pays cost allocations in many scenarios (Hogan)

Agenda

Coase theorem identifies the conditions necessary for productive private negotiations

- **Coase theorem assumes that transaction costs are (virtually) zero – in the real world, transactions costs can be large**
- **However, that does not mean that Coase theorem has nothing to teach us**
  - It can help focus policymaking on ways to promote effective negotiation, as with transmission projects

Coase theorem

In the absence of transaction costs, resources will always flow towards their highest-value use, regardless of the initial arrangement of property rights.

Source: Coase, Ronald. H. "The Problem of Social Cost." The Journal of Law & Economics 3 (October 1960): 1-44.

Institutional design

- In the presence of transaction costs, legal frameworks often determine economic outcomes
- Thus, many factors must be considered when codifying a particular arrangement:
  - Costs to operate it, costs to transition to it, gain from a particular use of resources, loss from foregoing an alternative use
- Institutions should also be focused on facilitating Coasean exchange through defining and protecting property rights

Negotiation incentives

- Critiques of the theorem suggest that if more than two externalities exist, there may not be a stable, welfare-maximizing arrangement
- But negotiation mechanisms can facilitate reaching an optimal arrangement:
  - Penalties for breaking contracts
  - Time-limited negotiations
  - Lump-sum penalties
  - Sequential, rather than simultaneous, negotiations

Information dissemination

- Critics of Coase theorem argue that it requires complete information to work
  - More restrictive than "perfect knowledge," which economists assume when studying markets
- Thus, the theorem may fail in the presence of information asymmetry
- Negotiation policy, particularly in regulated industries, can adopt requirements to encourage transparency and information sharing

Sources: Coase, Libecap, Aivazian and Callen, Hahnel and Sheeran

Real-world observations and Coasean insights can help strengthen information dissemination in transmission planning and cost allocation

Real-world lessons

- Improving stakeholder participation (e.g., by allowing interested parties to offer robust input earlier in the project timeline) could help reduce project delays, legal disputes and opposition
  - *Analysis by Späth and Scolobig of innovative public participation practices in French and Norwegian transmission projects (2017)*
- In addition to early involvement of communities (or community reps), projects should adopt a formal structure for such involvement with clear roles for parties – potentially helping to increase trust and improve information dissemination
  - *Tobiasson, Beestermöller and Jamasb's analysis of the Beauly-Denny line in Scotland (2016)*

Coasean insights

- The presence of information asymmetry increases transaction costs
  - This impedes optimal Coasean negotiation
- The challenge is that information dissemination is both a source of transaction costs and a key to reducing costs
  - The requirement to prepare and disclose information makes negotiations more costly (in terms of time, effort, etc.) – but is unavoidable
- Structuring information disclosure in such a way that parties communicate their preferences, and align costs and benefits, should move negotiated outcomes closer to the Coasean ideal

TRANSMISSION INVESTMENT

Sources: Späth and Scolobig, Tobiasson et al., LEI, Hahnel and Sheeran

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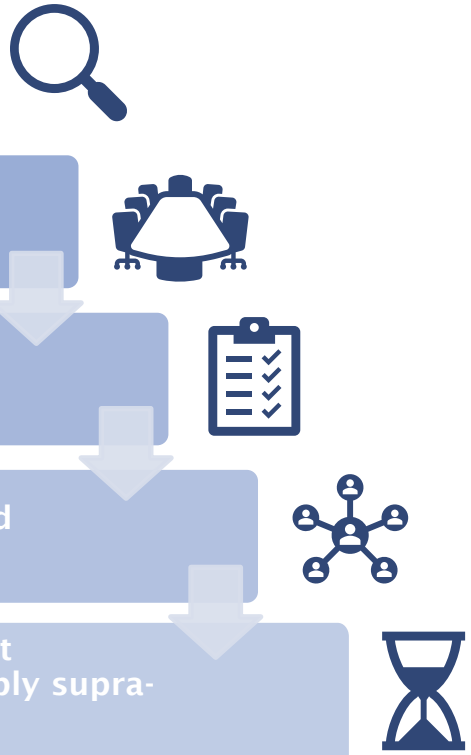
Guided by Coase theorem, transmission cost allocation can take practical steps to improve infrastructure outcomes

Establish a regulatory process for cost allocation that is tied to the transmission system planning process and contains the following elements:

- Identify/screen for socially net beneficial projects, while acknowledging that benefits to customers may vary (and some parties may be worse off)
- Set up a negotiation space/structure where all affected parties are invited
- Provide information about benefits and positive and negative externalities to all affected parties
- Identify negotiating hierarchy (nested classes of affected parties)
- Set time limits (as with efficient arbitration), permit compensatory cost allocation mechanisms, and apply supra-majority voting metrics for designating successful outcomes (to stop individual hold outs)



A paper exploring this topic in more detail is forthcoming, to be posted on LEI's website: www.londoneconomics.com

Bibliography

Aivazian, Varouj A. and Jeffrey L. Callen. "The Coase Theorem and the Empty Core." *The Journal of Law and Economics* 24.1 (April 1981): 175-181.

Aivazian, Varouj A. and Jeffrey L. Callen. "The Core, Transaction Costs, and the Coase Theorem." *Constitutional Political Economy* 14 (2003): 287-299.

Cecil, Walt. "Transmission Service Types." *NARUC and USAID*. November 5, 2012.

Coase, Ronald. H. "The Problem of Social Cost." *The Journal of Law & Economics* 3 (October 1960): 1-44.

Energy Systems Catapult. *Introducing nodal pricing to the GB power market to drive innovation for consumers' benefit. Why now and how?.* 2021.

Environmental Defense Fund. *Time-variant electricity pricing can save money and cut pollution.*

European Network of Transmission System Operators for Electricity. *Overview of Transmission Tariffs in Europe: Synthesis 2019.*

Federal Energy Regulatory Commission. *179 FERC ¶ 61,028.* April 21, 2022.

Federal Energy Regulatory Commission. *Formula Rates in Electric Transmission Proceedings: Key Concepts and How to Participate.* July 5, 2022.

Federal Energy Regulatory Commission. *Order No. 1000.* July 21, 2011.

FERC Form No. 1. Compiled by S&P.

Bibliography

Hahnel, Robin and Kristen A. Sheeran. "Misinterpreting the Coase Theorem." *Journal of Economic Issues* 43.1 (2009).

Hogan, William W. "A Primer on Transmission Benefits and Cost Allocation." *Economics of Energy & Environmental Policy* 7.1 (March 2018): 25-46.

Larson, Eric et al. "Net-Zero America: Potential Pathways, Infrastructure and Impacts." *Princeton University.* October 29, 2021.

Libecap, Gary D. "Coasean bargaining to address environmental externalities." *NBER Working Paper 21903.* January 2016.

London Economics International, LLC. "Repowering America: Transmission investment for economic stimulus and climate change." *WIRES*. May 2021.

London Economics International LLC. "Market resource alternatives: An examination of new technologies in the electric transmission planning process." *WIRES.* Prepared by Julia Frayer and Eva Wang. September 2014.

Mai, Trieu et al. "Electrification futures study: Scenarios of Electric Technology Adoption and Power Consumption for the United States." *National Renewable Energy Laboratory.* 2018.

Ronald H. Coase - Econlib

Späth, Leonhard and Anna Scolobig. "Stakeholder empowerment through participatory planning practices: The case of electricity transmission lines in France in Norway." *Energy Research and Social Science* 23 (2017): 189-198.

Bibliography

Tobiasson, Wenche, Christina Beestermöller and Tooraj Jamasb. "Public engagement in electricity network development: the case of the Beauly-Denny project in Scotland." *Economia e Politica Industriale* 43 (2016): 105-126.

US Department of Energy. *Quadrennial Technology Review 2015: Enabling Modernization of the Electric Power System.* 2015.