267.254.6107
www.AlternativeTransmission.com
2113 Middle Street Suite 205
Sullivans Island, SC 29482

Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Alternative Transmission Inc. Petition for Issuance of Declaratory Order, Docket No. EL19-__-000

Dear Secretary Bose and Deputy Secretary Davis:

Enclosed for filing please find Alternative Transmission Inc.'s Petition for Issuance of a Declaratory Order, together with a federal register notice and the supporting affidavit of Dr. Ross Baldick. Thank you for your cooperation. Should you have any questions, please contact the undersigned at (267) 254-6107 or arousselle@alternativetransmission.com.

Very truly yours,

/s/ Adam R. Rousselle Sr.

Adam R. Rousselle Sr.

President & CEO

Alternative Transmission Inc.

Enclosures:

Petition for Issuance of Declaratory Order

Federal Register Notice

Affidavit of Dr. Ross Baldick

UNITED STATES OF AMERICA
Before The
FEDERAL ENERGY REGULATORY COMMISSION

Alternative Transmission Inc.	)	Docket No. EL19-___-000

ALTERNATIVE TRANSMISSION INC.
PETITION FOR ISSUANCE OF DECLARATORY ORDER

Pursuant to 18 C.F.R. § 385.207(a)(2) (2018), Alternative Transmission Inc. (ATI) petitions the Commission for issuance of an order confirming and declaring that (1) the alternative transmission facilities and services described in this Petition provide "transmission of electric energy in interstate commerce" subject to the Commission's jurisdiction under Parts II and III of the Federal Power Act (FPA) and (2) ATI as the owner or operator of the described facilities will be a "public utility" under Parts II and III of the FPA. Accompanying this Petition is a Notice of the Petition (Attachment A) for publication in the *Federal Register* and the supporting affidavit of Dr. Ross Baldick (Attachment B). ATI has paid the $27,130 filing fee.

I. ALTERNATIVE TRANSMISSION FACILITIES & SERVICES

ATI proposes to own or operate facilities that will transmit electric energy in interstate commerce. It will do so ***without*** use of transmission wires or wire corridors. The transmission described in this Petition represents a new paradigm. For over 80 years this Commission has exercised its FPA transmission jurisdiction over transmission wires. That exercise of jurisdiction has been cabined by the state and deployment of available technology. But it is not cabined by any limitation in the controlling statute, the FPA.

Congress's assertion in 1935 of federal jurisdiction over transmission of electric energy in interstate commerce is sufficiently broad and flexible to reach beyond century-old technology. It can and should encompass innovations that in 2019 make possible and economical the flexible transmission of electric energy described in this Petition.

The alternative transmission proposed in this Petition involves construction of electric energy transfer stations—charging and discharging—at locations in the continental United States. At the charging stations electric energy generated by unaffiliated entities will be transferred to a mobile medium—*e.g.*, a shippable container of an electrically chargeable, dischargeable, and rechargeable medium. The charged mobile medium then will be transported across state lines by rail (and possibly tractor-trailer, boat or airplane, or any combination of these) to discharging stations at different locations. At the discharging station the medium in the containers will be available for instantaneous dispatch as instructed, until the charge is depleted, and the medium becomes available for recharge.

A. Example of Alternative Transmission

By way of illustration, ATI could attach 100 container cars to a locomotive engine at or near a charging station. At the charging station, electricity generated by a separate and unaffiliated generation source would be transferred to the medium in the container car. As detailed in the attached affidavit of Dr. Baldick, each car would then contain a charge of electrical energy. The locomotive would travel on existing (or enhanced as needed) rail across state lines to a discharging station. At the discharging station the container cars would be parked in a storage area capable of connecting to an electrical load in the form,

for example, of an electric distribution system or end users or both.[1]

At the discharging location the cars would be capable of delivering instantaneously, as dispatched, many megawatt hours of electricity into the distribution system or directly to end-use consumers. Once the charge of each car has been delivered to load at the discharging station, ATI would deliver new charged cars and re-attach to a locomotive the depleted cars for a return trip to the original or different stations for recharging. This sequence can be repeated. As Dr. Baldick explains, the medium in the container cars can be electrically recharged and transmitted indefinitely. *Baldick* ¶ 5.

B. Applications of Alternative Transmission

ATI's method of interstate transmission of electric energy ***without*** use of wires or wire corridors will deliver electric energy into areas accessible by surface transportation (and possibly water or air), ***but where*** (1) current or forecast demand for delivered electric energy cannot adequately be met by existing wire transmission corridors, or (2) the alternative transmission described in this Petition is the most timely or most economical solution for meeting existing or forecast demand. Further applications are conceivable and likely. For example, considerable reserves of domestic shale natural gas cannot

[1] As the courts and this Commission have determined, the jurisdictional status of the interstate transmission of electric energy does not turn on whether the transmitted electricity is delivered into the wholesale market to a distribution utility or into the retail market to end users. *New York v. FERC*, 535 U.S. 1, 20 (2002) ("FPA authorizes FERC's jurisdiction over interstate transmissions, without regard to whether the transmissions are sold to a reseller or directly to a consumer . . . ."). *See also Promoting Wholesale Competition Through Open Access Non-Discriminatory Trans. Servs. by Pub. Utils.*, Order No. 888, FERC Stats. & Regs. ¶31,048, App. G at 1 ("the Commission concludes that it has exclusive jurisdiction over the rates, terms and conditions of the unbundled transmission in interstate commerce, by a public utility, of electric energy to an end user.").
.

reach energy markets in the form of natural gas because there is not adequate pipeline capacity. By diverting this natural gas directly to combustion turbines or combined-cycle generating units constructed at or proximate to the production of those natural gas reserves, that generation could be used to electrically charge the media in container cars for transport to markets using neither pipelines nor wire corridors.

Alternative transmission may also have applications to address emergencies or disasters. Overhead wires can be vulnerable to extreme weather events. Recent hurricanes in Louisiana, Texas, New Jersey and New York and wildfires in Alaska, Colorado and California have driven home this grid vulnerability. Also, human-caused damage to the grid, such as inflicted through cyber-attacks or improper maintenance, can disable electric energy deliverability into areas critically important to civil society and the economy. Alternative transmission using modes other than wires and wire corridors—modes that in certain scenarios are hardened more and therefore more resilient than wires and wire corridors—can speed recovery from all forms of damage to the wires-based grid in areas proximate to discharging stations. Importantly, discharging stations can be modular and transported where needed using the same form of surface transportation used to transport the cars containing the electrically charged medium.

C. Alternative Transmission Complements Both Generation & Storage

The facilities and services that ATI proposes will provide transmission of electric energy in interstate commerce. These facilities and services will complement, but be distinct from, the generation or storage of electric energy. Neither ATI nor any

affiliate generates or will generate the electric energy that will charge the media in the container cars. That generation will come from un-affiliated entities. ATI will contract either with the generator or its purchaser to provide transmission service—***only*** transmission service. ATI will not take title to the electrical energy or store it.

While the container cars will be able to provide and likely will provide some measure of storage from time-to-time, that storage capability will only be incidental to the alternative transmission service that ATI proposes. Accordingly, ATI will submit bids to system planners that charge only for transmission, not for generation or incidental storage. The Commission recognized the distinction between transmission and storage when it eliminated the location of an electric energy resource from its originally proposed definition of storage in Order No. 841. Instead, it defined storage as "a resource capable of receiving electric energy from the grid and storing it for ***later*** injection . . . back to the grid." *Elec. Storage Participation in Markets Operated by Regional Trans. Orgs. & Indep. System Ops.*, Order No. 841, 162 FERC ¶ 61,127, at P29 (2018) (emphasis added). The Commission explained it was "removing the phrase 'regardless of where the resource is located on the electrical system' from the [notice of rulemaking] proposal" because "where an electric storage resource may be located does not change the applicability of the definition and will also provide a more adaptable definition for other Commission actions." *Id.* (footnote omitted). In other words, storage defers the timing of delivery and consumption. Only transmission changes the location. Changing location is the transmission that ATI proposes.

II. CONFIRMATION & DECLARATION OF FEDERAL POWER ACT TRANSMISSION JURISDICTION

A. Jurisdiction Over Alternative Transmission Facilities & Services

ATI seeks a declaration that the alternative transmission services and facilities described in this Petition fall within the Commission's FPA jurisdiction over the rates, terms and conditions of transmission of electric energy in interstate commerce. This declaration of jurisdiction is warranted. The Commission's transmission jurisdiction derives from Congress' power to regulate interstate commerce under the Commerce Clause (Article I, §8, cl. 3) of the United States Constitution, pursuant to which Congress enacted the FPA. By enacting Part II in 1935, Congress conferred on the Commission exclusive jurisdiction over the rates, terms, and conditions of transmission of electric energy in interstate commerce by public utilities.

As Dr. Baldick explains, what ATI proposes is to take delivery of electric energy at one location and redeliver at another location in interstate commerce. *Baldick* ¶¶ 4, 6. FPA § 201(c) explains that "electric energy shall be held to be transmitted in interstate commerce if transmitted from a State and consumed at any point outside thereof: but only insofar as such transmission takes place within the United States." The mode of transmission is not specified. It never has been. Nor is the mode of transmission delimited in any other way. In the 80-plus year history of the FPA, never have the courts or this Commission confined the scope of FPA jurisdiction over transmission of electric energy

in interstate commerce to any specific mode of transmission.[2] Rather, what triggers the Commission's FPA transmission jurisdiction is the use of any type of mode or facility for the movement of electric energy from one State into or through another State.

B. Federal Power Act Status as a Public Utility

ATI seeks a declaration that as the owner or operator of the alternative transmission services and facilities described in this Petition ATI will be a public utility for purposes of the FPA. ATI seeks this declaration so that it can invest in alternative modes of transmission with the Commission's assurance that it will be able to compete fairly with traditional wire and wire corridor modes of transmission.

Most sections of Parts II and III of the FPA apply the Commission's Commerce Clause jurisdiction to the actions of a "public utility." Section 201(e) of Part II defines "public utility" for purposes of both Parts II and III as "any person who owns or operates facilities subject to the jurisdiction of the Commission under this Part [II]."[3] Ownership or

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[2] The inclusive scope of transmission jurisdiction under the FPA stands in contrast with the Commission's jurisdiction over natural gas transportation under the Natural Gas Act (NGA); that jurisdiction the Commission has held is confined to transportation *by pipeline*. *E.g.*, *Emera CNG, LLC*, 148 FERC ¶ 61,219 at P13 and n.15 (2014) (issuing declaratory order disclaiming jurisdiction over construction and operation of facilities to compress natural gas to be transported by truck to ships for export). The *Emera* majority cited *Exemption of Certain Transp. and/or Sales of LNG from the Reqs. of § 7(c) of the NGA*, 49 F.P.C. 1078 at 1079 (1973), as authority for confining NGA transportation jurisdiction to pipelines "because Congress enacted the NGA specifically to address *pipeline*-related abuses." *Id.* (emphasis in original). In contrast, closing the so-called *Attleboro Gap*, rather than address any specific mode of transmission, motivated Congress in 1935 to establish FPA jurisdiction over the transmission of electric energy in interstate commerce. *See New York v. FERC*, 535 U.S. 1, 6 (2002) ("When it enacted the FPA in 1935, Congress authorized federal regulation of electricity in areas beyond the reach of state power, such as the gap identified in *Attleboro* . . . .").

[3] Exempt from this definition are persons subject to Commission jurisdiction *solely* by reason of certain other sections not pertaining to the Commission's jurisdiction over the transmission of electric energy in interstate commerce. 16 U.S.C. § 824(e) (exempting

operation of charging and discharging stations, container cars and rechargeable media in those cars as described in this Petition fit squarely within this definition of a "public utility" for purposes of both Parts II and III.[4]

ATI's ability to compete with other forms of electric transmission proposed in response to Commission-mandated regional expansion plans[5] will be enhanced by its ability to attain status as a transmitting public utility. With that status, there should be no question of ATI's eligibility to participate in competitive auctions to implement transmission expansion plans and have its projects, if fairly and competitively awarded, compensated on a non-discriminatory basis. Moreover, ATI is prepared to fulfill and commits to fulfilling all of the open-access and non-discrimination responsibilities that accompany status as a transmitting public utility.

C. Public Interest in New Modes of Transmitting Electric Energy in Interstate Commerce

Public interest in robust, resilient interstate transmission of electric energy—transmission that is both available and economical—will be furthered by Commission recognition of alternative forms of transmission such as the transmission described in this Petition. Innovation in the media that can receive, transfer, and transmit electric energy is

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facilities subject to jurisdiction *solely* by reason of §§ 206(e), 206(f), 210, 211, 211A, 212, 215, 215A, 216, 217, 218, 219, 220 221, and 222).

[4] The facilities ATI proposes to own or operate would not fit within the definition of "transmitting utility" in §3(23), 16 U.S.C. § 796(23), which comprises only the governmental or certain rural cooperative utilities exempted from "public utility" status by § 201(f), 16 U.S.C. § 824(f).

[5] Originally required of regional operators by *Preventing Undue Discrimination & Preference in Trans. Serv.,* Order No. 890, FERC Stats. & Regs. ¶ 31,241 at PP 418-601 (2007), these regional transmission plans emphasize, among other principles, the need for "openness," "transparency," and "regional participation."

expanding rapidly,[6] should be acknowledged, and should be encouraged. These innovations include precision-scheduled railroading or PSR that has "reduced rail cars used, moves them faster [and] with less downtime at terminals."[7] These transmission innovations should be encouraged and allowed to compete fairly with other proposals to satisfy local and regional electric transmission expansion plans.

The Commission knows of the growing need to incentivize investment in transmission, regardless of how that transmission is provided. In Order No. 1000, the Commission opened non-discriminatory participation in the planning and implementation of transmission upgrades and expansions based on its finding that the

> record in this proceeding and the reports cited above confirm that additional, and potentially significant, investment in new transmission facilities will be required in the future to meet reliability needs and integrate new sources of generation. It is therefore critical that the Commission act now to address deficiencies to ensure that more efficient or cost-effective investments are made as the industry addresses its challenges.

Trans. Planning & Cost Alloc. by Trans. Owning and Operating Pub. Utils., 136 FERC ¶ 61,051, at P 46 (2011).[8] Facilitating participation by new forms of interstate transmission

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[6] *See, e.g.*, Mike Montgomery, *Get Ready for the Battery Revolution*, Forbes (Jan. 11, 2018); Jamie Carter, *The Future of Our Technology and Our Planet Depends on One Thing: the Battery*, Techradar (Jan. 6, 2018); Daniel Cusick, *Battery Storage Poised to Expand Rapidly*, E&E News (Jan. 1, 2017); James Conka, *Vanadium-Flow Batteries: The Energy Storage Breakthrough We've Needed*, Forbes (Dec. 13, 2016) http://www.forbes.com/vanadium-flow-batteries.

[7] Paul Ziobro, A Revolution Sweeping Railroads Upends How America Moves Its Stuff, WALL ST. J., April 3, 2019.

[8] Among several reports referenced is Department of Energy, *DOE Initiative Regarding Inter-Connection Level Transmission Analysis and Planning* (Jan. 25, 2001).

of electric energy, such as that proposed in this Petition, will help remedy existing and foreseeable deficiencies in the transmission system.

By granting this Petition and issuing the requested confirmation and declarations, the Commission will open to investment new technologies and transmission media not tethered to century-old, costly and increasingly difficult to site wires and wire corridors. That investment will speed the deployment of new and economical means of electric power transmission such as the alternative transmission described in this Petition.

III. Conclusion

For the foregoing reasons, ATI petitions the Commission to issue the requested confirmation and declaration that the transmission service described in this Petition, occurring outside of wires corridors, is jurisdictional and that ATI as its owner or operator will be a public utility under the FPA.

Respectfully,

/s/ *Adam R. Rousselle Sr.*
Adam R. Rousselle Sr.
President & CEO
Alternative Transmission Inc.

April 17, 2019

Attachments: Federal Register Notice
Affidavit of Dr. Ross Baldick

ATTACHMENT A:

Federal Register Notice

Federal Register
A Daily Journal of the United States of America

Alternative Transmission Inc.; Notice of Petition for Declaratory Order

Take notice that on May 3, 2019, pursuant to Rule 207(a)(2) of the Federal Energy Regulatory Commission's (Commission) Rules of Practice and Procedure, 18 CFR 385.207(a)(2)(2017), Alternative Transmission Inc. filed a petition for a declaratory order seeking confirmation that (1) the facilities and services described in the petition provide transmission of electric energy in interstate commerce subject to the Commission's jurisdiction under Parts II and III of the Federal Power Act (FPA) and (2) Alternative Transmission Inc. as the owner or operator of the described facilities that provide transmission of electric energy in interstate commerce will be a public utility under Parts II and III of the FPA, all as more fully explained in the petition.

Any person desiring to intervene in or to protest this filing must file in accordance with Rules 211 and 214 of the Commission's Rules of Practice and Procedure (18 CFR 385.211, 385.214). Protests will be considered by the Commission in determining the appropriate action to be taken, but will not serve to make protestants parties to the proceeding. Any person wishing to become a party must file a notice of intervention or motion to intervene, as appropriate. Such notices, motions, or protests must be filed on or before the comment date. Anyone filing a motion to intervene or protest must serve a copy of that document on the Petitioner.

The Commission encourages electronic submission of protests and interventions in lieu of paper using the eFiling link at *http://www.ferc.gov*. Persons unable to file electronically should submit an original and 5 copies of the protest or intervention to the Federal Energy Regulatory Commission, 888 First Street NE, Washington, DC 20426.

This filing is accessible on-line at *http://www.ferc.gov*, using the eLibrary link and is available for review in the Commission's Public Reference Room in Washington, DC. There is an eSubscription link on the website that enables subscribers to receive email notification when a document is added to a subscribed docket(s). For assistance with any FERC Online service, please email *FERCOnlineSupport@ferc.gov*, or call (866) 208-3676 (toll free). For TTY, call (202) 502-8659.

ATTACHMENT B:

Affidavit of Dr. Ross Baldick
In Support of Petition

UNITED STATES OF AMERICA
Before The
FEDERAL ENERGY REGULATORY COMMISSION

Alternative Transmission Inc.	)	Docket No. EL19-___-000

Affidavit of Dr. Ross Baldick
in Support of Petition for Issuance of
Declaratory Order

STATE OF TEXAS)
) ss.
County of Travis)

Comes now Dr. Ross Baldick, being first duly sworn, under oath, and states that the following is within his personal knowledge, expertise and belief:

1. My name is Ross Baldick and my business address is Department of Electrical and Computer Engineering, University of Texas, 2501 Speedway, Austin, TX 78712.

2. I have been asked by the principals of Alternative Transmission Inc. (ATI) to make this affidavit in support of the proposition in its Petition for Issuance of Declaratory Order that the service ATI proposes in the Petition contemplates the transmission of electric energy in interstate commerce. In particular, I affirm that what ATI proposes to transmit is electric energy.

3. I am Professor and Leland Barclay Fellow in the Department of Electrical and Computer Engineering at The University of Texas at Austin. I received my B.Sc. and B.E. degrees from the University of Sydney, Australia and M.S. and Ph.D. from the University of California, Berkeley. In 1991 and 1992, I was a post-doctoral fellow at the Lawrence Berkeley Laboratory. I am a Fellow of the IEEE and the recipient of the 2015 IEEE PES Outstanding Power Engineering Educator Award. I have published over 100 refereed journal articles and have research interests in a number of areas in electric power. My resume, including a list of my journal articles and seminars is attached to this affidavit.

4. The service ATI proposes in the Petition involves taking electric energy at one location and delivering electric energy at another location. As with high-voltage direct-current (HVDC) transmission, the energy is converted from conventional alternating current (AC) power at one location in the electric grid into another type of energy and then converted back to AC power at another location. In the case of HVDC transmission, the

energy is converted into DC power, whereas in the case of ATI's proposed service it is converted into the chemical bonds in an "electrolyte" solution. Both cases involve transmitting electric energy from one location to another.

5. The service ATI proposes uses a "flow battery." All chemical batteries, including flow batteries, allow conversion between electric energy and the energy in chemical bonds in the component of the battery called its electrolyte. In most familiar batteries, the electrolyte is permanently located inside a package that also includes the electrical connections. A flow battery, in contrast, allows the electrolyte to be removed and, as in the ATI proposal, transferred from one battery to another.

6. In its Petition, ATI proposes to locate its flow battery infrastructure adjacent to railway lines. Electrical energy would be taken from the conventional AC system and converted into chemical energy in the electrolyte. The electrolyte can be pumped into rail container cars, which can then be moved on the railway network. Later, the electrolyte can be pumped from the rail cars into a flow battery at another location, and the energy in the chemical bonds in the electrolyte can be converted into electrical energy again.

7. The transmission of electric energy that ATI proposes solves a number of challenges to the economical delivery of electric energy in various locations. In many areas of the nation, building conventional electric transmission lines is increasingly difficult because of the lack of availability of suitable "corridors" and because of local opposition to the construction of new lines. This issue can be particularly limiting for new lines that cross state lines, since the benefits of such lines can often be perceived to accrue to people and organizations that are far from those directly affected by the line corridors. The implication is that transmission lines can take long lead times before they are constructed, if at all.

8. Because of the mobility of the infrastructure at the heart of ATI's proposal, that infrastructure can also complement conventional transmission by providing timely deliveries of electric energy while more conventional electric transmission solutions are being planned and installed. If a conventional line is subsequently energized, the ATI infrastructure could be readily moved to another location with minimal stranded costs.

9. Further, the ability to move the ATI infrastructure has advantages even if conventional electric transmission is never developed in the area. For example, consider regions of the nation where oil and gas developments result in temporary, but significant, electrical loads. Instead of building a conventional transmission line, a temporary supply could be established. Conversely, in some regions there is excess natural gas that cannot otherwise be transported to market. Generating electricity at the site of natural gas production and moving that electricity by alternative transmission would facilitate utilization of that energy source. Since conventional transmission is not re-locatable, conventional investment can become stranded once the electrical requirements for the oil and gas development subside or once the available gas is depleted. Alternative transmission allows for relatively temporary construction of transmission facilities, therefore enhancing the integration of the nation's energy resources.

R. Baldick

SUBSCRIBED AND SWORN to before me this 9th day of April, 2019, by Ross Baldick.

NOTARY PUBLIC FOR TEXAS. My Commission Expires: 02/16/2023

Chris Johnston

CHRIS JOHNSTON
Notary Public, State of Texas
Expires 02/16/2023
I.D.#130117951

RESUME

ROSS BALDICK
PO BOX 4216
AUSTIN, TX 78765-4216
EMAIL: ROSS@BALDICK.COM
512 371-3516

AREAS OF QUALIFICATION

Electric generation, transmission, and distribution: technical analysis, economics, and policy.

Wholesale electricity market analysis: interaction of economics, public policy, and technical issues in electricity restructuring, particularly involving transmission.

Merger and competition analysis: FERC merger guidelines, market power.

Electric vehicle—grid interactions.

PROFESSIONAL EXPERIENCE

Dr. Baldick has been involved in the electric utility industry since 1985 as a professional engineer, teacher, researcher, and consultant. During this time he has been involved in a number of projects, including:

- incentive properties of electricity tariffs;
- policy and economic analysis of case histories of transmission expansion;
- analysis of the effect of phase-shifting transformers on regional trade;
- theoretical analysis and development of a prototype distributed model of multi-region economic dispatch and electricity trading;
- development of a unit commitment model to minimize the cost of operation of a portfolio of generation;
- co-development of an electricity trading model of ERCOT and adjacent regions;
- development of prototype distributed optimal power flow and state-estimation software;
- development of models of exercise of market power;
- analysis of the variation of power transfer distribution factors used in flowgate transmission rights,
- development of theory on the interaction between transmission constraints and market power in electricity markets,
- development of systematic transmission expansion planning models,
- development of policies for charging of electric vehicles to provide grid benefits,

- review of charging methodologies and technical arrangements in several electricity markets,
- statistical analysis of demand forecasts in the context of transmission expansion planning.

He has assisted several interveners in legal cases and has prepared presentations, testimony, and affidavits for federal and state bodies. Dr. Baldick has been a Visiting Researcher at the University of California Energy Institute and a Research Fellow at the Harvard Electricity Policy Group. Dr. Baldick is a Fellow of the IEEE and the author of *Applied Optimization: Formulation and Algorithms for Engineering Systems,* Cambridge University Press, 2006.

EMPLOYMENT HISTORY

- Department of Electrical and Computer Engineering, The University of Texas at Austin, Professor, 2003-present; Associate Professor, 1998-2003; Assistant Professor, 1994-1998. Taught classes and supervised PhD and Masters research in analysis of electricity markets.
- Utility Planning and Policy Group, Energy and Environment Division, Lawrence Berkeley Laboratory, Staff Scientist, 1993. Analyzed the competitive effect of phase-shifting transformers in restructured wholesale electricity markets.
- Department of Electrical and Computer Engineering, Worcester Polytechnic Institute, Assistant Professor, 1992-1993. Taught classes and supervised Masters research.
- Utility Planning and Policy Group, Energy and Environment Division, Lawrence Berkeley Laboratory, Post-Doctoral Fellow, 1991-1992. Analyzed electric transmission policy.
- System Planning and Control Divisions, Electricity Commission of New South Wales, Australia, Professional Engineer, Grade 1, 1985-1986. Developed software for electricity system planning and control; performed transmission planning studies.

COURSES AND SEMINARS

Dr. Baldick teaches a number of courses within the Cockrell School of Engineering at the University of Texas at Austin, including courses on: power systems, including locational marginal pricing and market power in electricity markets, and optimization.

In addition to courses for engineering students, he teaches a short course called “Introduction to Electric Power for Legal, Accounting, and Regulatory Professionals” that explains technical issues in the electric utility industry to professionals having a non-technical background. This course has been presented at a number of organizations, including:

- The Federal Energy Regulatory Commission (FERC),
- Direct Energy,
- Hunt Power, LP,
- Koch Energy,
- Weil, Gotshal and Manges, LLP,
- Bracewell and Giuliani,
- Alston & Bird,
- Dynegy.

Dr. Baldick also teaches a one-day class on locational marginal pricing that has been presented to several organizations, including:

- Austin Energy,
- Lower Colorado River Authority,
- Dynegy,
- ERCOT stakeholders.

Dr. Baldick is a regular participant at IEEE Power Engineering Society meetings and has given a number of presentations on his research at these meetings. He is a former Editor of *IEEE Transactions on Power Systems,* and the former Chairman of the IEEE Power Engineering Society System Economics Sub-Committee. He has also presented seminars to:

- the Harvard Electricity Policy Group,
- the University of California Energy Institute,
- at an Infocast conference, and
- to several other university research groups in Australia, Brazil, Chile, China, Colombia, England, Germany, Hong Kong, South Korea, and Spain.

SAMPLE EXPERIENCE

- Developed an approach to coordinating trade between regions while respecting transmission constraints. Demonstrated the first analytically rigorous decomposition of AC power flow equations into regions. Supervised the implementation of prototype software. Supervised the analysis of several case studies that demonstrated the effectiveness of the coordination. Reported in Balho Kim and Ross Baldick, "Coarse-grained Distributed Optimal Power Flow," *IEEE Transactions on Power Systems,* 12(2):932-939, May 1997, and Balho Kim and Ross Baldick, "Coarse-grained Distributed Optimal Power Flow," *IEEE Transactions on Power Systems,* 12(2):932-939, May 1997. On behalf of the Midwest ISO, simplified and updated this approach for application in the United States Eastern Interconnection.

- Supervised the development of a market analysis tool tailored to bilateral energy markets. Supervised its use in analyzing the economics of AC interconnection between ERCOT and the Eastern Interconnection. Modeled in software the market rules in place in these markets in the late 1990s and analyzed the gains from trade that would be possible with various levels of interconnection capacity, considering sensitivities to various parameters. Reported in Chapter 6, "Energy Trade Analysis," of *Report to the 76th Texas Legislature: Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC*, January 1999.

- On behalf of interveners in a utility merger case, critiqued the merger applicants' merger analysis and provided expert testimony. Found and exemplified various shortcomings in the applicants' analysis and in the merger guidelines themselves.

- On behalf of a coalition of generation owners, presented on the topic of capacity benefit margin at a technical conference held by the Federal Energy Regulatory Commission.

- In a lawsuit between an electric utility and cities and municipalities, provided expert testimony on the nature of electric power flow.

- On behalf of interveners, critiqued the technical basis underlying the zonal transmission congestion management scheme in the ERCOT interconnection, showing the economic inefficiencies of the scheme and suggesting alternatives. Reported in "Shift factors in ERCOT congestion pricing," Ross Baldick, March 2003, http://www.ece.utexas.edu/~baldick/papers/shiftfactors.pdf

- On behalf of the Federal Energy Regulatory Commission, investigated technical issues in the implementation of regional transmission organizations and standard market design. Developed a definition of rights to transmission that is consistent with Standard Market Design and provides "network service" to transmission customers. Reported in Richard O'Neill, Udi Helman, Ross Baldick, William Stewart, Michael Rothkopf, "Contingent Transmission Rights in the Standard Market Design," *IEEE Transactions on Power Systems,* 18(4):1331-1337, November 2003.

- On behalf of a wind asset owner, provided expert testimony on transmission and transmission rights in the context of a lawsuit between the asset owner and the purchaser of the wind power regarding responsibility for provision of transmission services.

- On behalf of a generation asset owner, supervised the development of a comparison between locational marginal pricing forecast tools. Provided a recommendation regarding acquisition of a tool.

- Provided advice on transmission issues to SPP market monitor.

- On behalf of an industry group, developed a national perspective on transmission cost allocation.

- On behalf of ERCOT, developed and taught a class on the economics of locational marginal pricing tailored to the ERCOT market Protocols.

- On behalf of a wind asset owner, provided expert testimony on the operation and economics of electricity markets.

- On behalf of a large electricity consumer, provided expert testimony on the operation of the ERCOT electricity market.

- On behalf of Ofgem in the United Kingdom, reviewed and critiqued the transmission charging methodology in the United Kingdom and proposed alternatives.

- On behalf of market operators, reviewed unit commitment and spinning reserve arrangements.

- On behalf of generation owners, reviewed needs for transmission expansion in terms of forecast peak demand requirements in regions of the ERCOT market.

- On behalf of generation owners, critiqued and advised on issues related to ERCOT nodal market.

- On behalf of generation owners, critiqued the ERCOT zonal congestion management protocol.

EDUCATION

- University of California, Berkeley, PhD, Electrical Engineering and Computer Sciences, 1990;
- University of California, Berkeley, M.S., Electrical Engineering and Computer Sciences, 1988;
- University of Sydney, Australia, B.E., Electrical Engineering, first-class honors, medal (pr. acc) 1985;
- University of Sydney, Australia, B.Sc., Physics and Pure Mathematics, 1983.

PROFESSIONAL AFFILIATIONS

- Fellow of the Institute of Electrical and Electronics Engineers (IEEE), 2007.

- Member of the IEEE Power Engineering Society, Chair of System Economics Subcommittee of the Power Systems Analysis, Computing and Economics Committee.

- Member of the Society for Industrial and Applied Mathematics.

SELECTED REFEREED PUBLICATIONS

- J. Zarnikau, C. K. Woo and R. Baldick, "Did the introduction of a nodal market structure impact wholesale electricity prices in the Texas (ERCOT) market?" *Journal of Regulatory Economics*, 45(2):194-208, April 2014. This paper makes a statistical analysis of the effect on prices of the change of market arrangements in ERCOT from zonal to nodal.

- Ross Baldick, "Wind and Energy Markets: A Case Study of Texas," *IEEE Systems Journal*, 6(1):27-34, March 2012. This paper discusses issues related to wind power in Texas, including negative wholesale prices and the underlying costs of using wind power.

- Yen-Yu Lee, Ross Baldick, and Jin Hur, "Firm-based Measurements of Market Power in Transmission-Constrained Electricity Markets," *IEEE Transactions on Power Systems*, 26(4):1962-1970, November 2011. This paper discusses indices of market power that are derived from fundamental economic principles in a transmission-constrained electricity market context.

- Ross Baldick and Richard P. O'Neill, "Estimates of comparative costs for uprating transmission capacity," *IEEE Transactions on Power Delivery*, 24(2):961-969, April 2009. This paper provides a uniform framework for estimating the cost per unit capacity of various technologies for transmission upgrades.

- Manho Joung, Ross Baldick, and You Seok Son, "The Competitive Effects of Ownership of Financial Transmission Rights in a Deregulated Electricity Industry," *The Energy Journal,* 29(2):165-184, 2007. This paper discusses how the ownership of financial transmission rights can affect the competitive interaction between market participants in an electricity market.

- Lin Xu and Ross Baldick, "Transmission-constrained Residual Demand Derivative in Electricity Markets," *IEEE Transactions on Power Systems*, 22(4):1563-1573, November 2007. This paper demonstrates the calculation of the derivative of residual demand in a tranmission-constrained context. This parameter is a fundamental determinant of market power in a transmission-constrained electricity market.

- Ross Baldick, "Border flow rights and Contracts for differences of differences: Models for electric transmission property rights," *IEEE Transactions on Power Systems*, 22(4):1495-1506, November 2007. This paper defines a new property right for electric transmission.

- Ross Baldick and William Hogan, "Stability of Supply Function Equilibrium: Implications for daily versus hourly bids in a poolco market, *Journal of Regulatory Economics,* 30(2):119-139, August 2006. This paper shows that electricity market rules concerning bidding can greatly affect equilibrium outcome.

- Ross Baldick, Sergey Kolos, and Stathis Tompaidis, "Interruptible Electricity Contracts from an Electricity Retailer's Point of View: Valuation and Optimal Interruption," *Operations Research,* 54(4):627-642, July-August 2006. This paper presents a structural model of wholesale spot electricity market prices and values interruptible contracts to an electricity retailer that purchases some of its obligations from the wholesale spot market.

- Ross Baldick, Udi Helman, Benjamin F. Hobbs, and Richard P. O'Neill, "Design of Efficient Generation Markets," *Proceedings of the IEEE,* 93(11):1998-2012, November 2005. This paper describes principles and practice in the design of efficient electric generation markets.

- John Ning Jiang and Ross Baldick, "Distinguishing Design Flaws From Misconduct: A New Approach to Electricity Market Analysis," *IEEE Transactions on Power Systems,* 20(3):1257-1265, August 2005. This paper describes a statistical analysis technique that enables flaws in market design to be distinguished from the exercise of market power.

- Richard P. O'Neill, Ross Baldick, Udi Helman, Michael H. Rothkopf, and William Stewart, Jr., "Dispatchable Transmission in RTO Markets," *IEEE Transactions on Power Systems,* 20(1):171-179, February 2005. This paper considers active transmission owners who offer capacity into forward and spot markets.

- You Seok Son, Ross Baldick, Kwang-Ho Lee, and Shams Siddiqi, "Short-term Electricity Market Auction Game Analysis: Uniform and Pays-as-Bid Pricing," *IEEE Transactions on*

Power Systems, 19(4):1990-1998, November 2004. This paper shows that the revenue equivalence theorem does not apply in a simple model of electricity markets.

- You Seok Son and Ross Baldick, "Hybrid Co-evolutionary Programming for Nash Equilibrium Search in Games with Local Optima," *IEEE Transactions on Evolutionary Computation,* 8(4):305-315, August 2004. This paper introduces the notion of "false equilibria" in the search for Nash equilibria and describes algorithms to avoid the false equilibria.

- You Seok Son, Ross Baldick, and Shams Siddiqi, "Reanalysis of 'Nash Equilibrium Bidding Strategies in a Bilateral Electricity Market'," *IEEE Transactions on Power Systems,* 19(2):1243-1244, May 2004. This paper critiques a previous analysis of an electricity market model.

- Javier Salmeron, Kevin Wood, and Ross Baldick, "Analysis of Electric Grid Security Under Terrorist Threat," *IEEE Transactions on Power Systems,* 19(2):905-912, May 2004. This paper introduces a model of optimal interdiction, that is, attack, of electric power networks and develops an algorithm to identify critical components in the system.

- Ross Baldick, Ryan Grant, and Edward Kahn, "Theory and Application of Linear Supply Function Equilibrium in Electricity Markets," *Journal of Regulatory Economics*, 25(2):143-167, March 2004. This paper extends the application of supply function equilibrium theory in electricity markets and applies the analysis to divestitures in the England and Wales electricity market between 1996 and 2000.

- Kwang-Ho Lee and Ross Baldick, "Solving three-player games by the matrix approach with application to an electric power market," *IEEE Transactions on Power Systems,* 18(4):1573-1580, November 2003. This paper develops algorithms to solve for equilibria in three and more player games and applies the analysis to electricity markets.

- Ross Baldick, "Variation of Distribution Factors with Loading," *IEEE Transactions on Power Systems*, 18(4):1316-1323, November 2003. This paper analyzes theoretically the reasons why the "DC power flow" approximation holds so well in practice.

- Richard O'Neill, Udi Helman, Ross Baldick, William Stewart, Michael Rothkopf, "Contingent Transmission Rights in the Standard Market Design," *IEEE Transactions on Power Systems,* 18(4):1331-1337, November 2003. This paper proposes and analyzes rights to transmission that are consistent with Standard Market Design and provide "network service" to transmission customers.

- Kwang-Ho Lee and Ross Baldick, "Tuning of Discretization in Bimatrix Game Approach to Power System Market Analysis," *IEEE Transactions on Power Systems*, 18(2):830-836, May 2003. This paper develops an algorithm for solving for certain mixed strategy equilibria in electric power system markets.

- Lance B. Cunningham, Ross Baldick, and Martin L. Baughman, "An Oligopoly Simulation of a Restructured ERCOT: Will Future Prices be Competitive?" *The Electricity Journal,*

16(3):59-71, April 2003. This paper describes an economic model of the ERCOT electricity system including transmission constraints.

- Ross Baldick, "Electricity market equilibrium models: The effect of parameterization," *IEEE Transactions on Power Systems,* 17(4):1170-1176, November 2002. This paper critically analyzes various supply function equilibrium models and argues that some published results are the artifacts of modeling assumptions that are unrealistic.

- Lance B. Cunningham, Ross Baldick, and Martin L. Baughman, "An Empirical Study of Applied Game Theory: Transmission Constrained Cournot Behavior," *IEEE Transactions on Power Systems,* 17(1):166-172, February 2002. This paper describes an economic model of an electricity market where there are significant transmission constraints.

- R. Baldick, A. B. Kahng, A. A. Kennings, and I. L. Markov, "Efficient Optimization by Modifying the Objective Function," *IEEE Transactions on Circuits and Systems,* 48(8), August 2001. This paper describes an approach to approximating objective functions that arise in the optimization of integrated circuit layout with a view to utilizing standard optimization techniques to optimize layouts.

- Reza Ebrahimian and Ross Baldick, "State Estimation Condition Number Analysis," *IEEE Transactions on Power Systems*, 16(2):273-279, May 2001. This paper describes an analysis of the effect of type and placement of measurements in an electric utility state-estimation system.

- Reza Ebrahimian and Ross Baldick, "State Estimation Distributed Processing," *IEEE Transactions on Power Systems,* 15(4):1240-1246, November 2000. This paper describes the development of prototype distributed state-estimation software.

- Balho H. Kim and Ross Baldick, "A Comparison of Distributed Optimal Power Flow Algorithms," *IEEE Transactions on Power Systems,* 15(2):599-604, May 2000. This paper develops and compares several algorithms for multi-region economic dispatch.

- Ross Baldick, Balho H. Kim, Craig Chase, and Yufeng Luo, "A Fast Distributed Implementation of Optimal Power Flow," *IEEE Transactions on Power Systems,* 14(3):858-864, August 1999. This paper describes the development of a prototype distributed model of multi-region economic dispatch and electricity trading.

- Shih-Yih Lai and Ross Baldick, "Unit Commitment with Ramp Multipliers," *IEEE Transactions on Power Systems,* 14(1):58-64, February 1999. This paper describes a unit commitment model to minimize the cost of operation of a portfolio of generation while respecting ramping constraints.

- Gustavo de Veciana and Ross Baldick, "Resource Allocation in Multi-service Networks via Pricing: Statistical Multiplexing," *Computer Networks and ISDN Systems,* 30(9-10):951-962, May 1998. This paper presents an approach to pricing services in a network that enables multiple services to be accommodated within a single pricing framework.

- N. Menezes, R. Baldick, and L.T. Pileggi, "A Sequential Quadratic Programming Approach to Concurrent Gate and Wire Sizing," *IEEE Transactions on Computer-Aided Design,* 16(8):867-881, August 1997. This paper presents an approach to design of interconnect and gates in integrated circuits that minimizes area while respecting delay constraints.

- Balho Kim and Ross Baldick, "Coarse-grained Distributed Optimal Power Flow," *IEEE Transactions on Power Systems,* 12(2):932-939, May 1997. This paper describes theoretical analysis for a distributed model of multi-region economic dispatch and electricity trading.

- Ross Baldick and Edward Kahn, "Contract Paths, Phase-Shifters, and Efficient Electricity Trade," *IEEE Transactions on Power Systems,* 12(2):749-755, May 1997. This paper analyzes the effect of phase-shifting transformers on regional trade.

- Ross Baldick and Edward Kahn, "A Linear Model of Voltage Limited Transmission Interface Constraints," *IEEE Transactions on Power Systems*, 10(1):476-482, February 1995. This paper develops a model of voltage constrained transmission corridors.

- Edward Kahn and Ross Baldick, "Reactive Power is a Cheap Constraint," *The Energy Journal*, 15(4):191-201, December 1994. This paper compares the economic value of relieving voltage constraints to the cost of reactive elements such as capacitors.