PROFESSIONAL SERVICES AGREEMENT

UTILITY SYSTEM EFFICIENCIES, INC.

Strategic Planning Services - RTRP

THIS PROFESSIONAL SERVICES AGREEMENT ("Agreement") is made and entered into this _____ day of _____, 2016 ("Effective Date"), by and between the CITY OF RIVERSIDE ("City"), a California charter city and municipal corporation, and UTILITY SYSTEM EFFICIENCIES, INC., a California corporation ("Consultant").

1. **Scope of Services**. City agrees to retain and does hereby retain Consultant and Consultant agrees to provide the services more particularly described in Exhibit "A," "Scope of Services" ("Services"), attached hereto and incorporated herein by reference, in conjunction with providing strategic planning and management consulting services for the Riverside Transmission Reliability Project ("Project").

2. **Term**. This Agreement shall be effective on the date first written above and shall remain in effect until June 30, 2021, unless otherwise terminated pursuant to the provisions herein.

3. **Compensation/Payment**. Consultant shall perform the Services under this Agreement for the total sum not to exceed Sixty Five Thousand Dollars ($65,000.00) payable in accordance with the terms set forth in Exhibit "B." Said payment shall be made in accordance with City's usual accounting procedures upon receipt and approval of an itemized invoice setting forth the services performed. The invoices shall be delivered to City at the address set forth in Section 4 hereof.

4. **Notices**. Any notices required to be given, hereunder shall be in writing and shall be personally served or given by mail. Any notice given by mail shall be deemed given when deposited in the United States Mail, certified and postage prepaid, addressed to the party to be served as follows:

To City	To Consultant
City of Riverside Public Utilities Attn: Girish Balachandran 3750 University Avenue, 5th Floor Riverside, CA 92501	Utility System Efficiencies, Inc. Attn: Robert Jackson 2108 Marchita Way Carmichael, CA 95608

5. **Prevailing Wage.** If applicable, Consultant and all subcontractors are required to pay the general prevailing wage rates of per diem wages and overtime and holiday wages determined by the Director of the Department of Industrial Relations under Section 1720 et seq. of the California Labor Code and implemented by Resolution No. 13346 of the City Council of the City of Riverside. The Director's determination is available on-line at www.dir.ca.gov/dlsr/DPrcWageDetermination.htm and is referred to and made a part hereof; the wage rates therein ascertained, determined, and specified are referred to and made a part hereof as though fully set forth herein.

6. **Contract Administration.** A designee of the City will be appointed in writing by the General Manager to administer this Agreement on behalf of City and shall be referred to herein as Contract Administrator.

7. **Standard of Performance.** While performing the Services, Consultant shall exercise the reasonable professional care and skill customarily exercised by reputable members of Consultant's profession practicing in the Metropolitan Southern California Area, and shall use reasonable diligence and best judgment while exercising its professional skill and expertise.

8. **Personnel.** Consultant shall furnish all personnel necessary to perform the Services and shall be responsible for their performance and compensation. Consultant recognizes that the qualifications and experience of the personnel to be used are vital to professional and timely completion of the Services. The key personnel listed in Exhibit "C" attached hereto and incorporated herein by this reference and assigned to perform portions of the Services shall remain assigned through completion of the Services, unless otherwise mutually agreed by the parties in writing, or caused by hardship or resignation in which case substitutes shall be subject to City approval.

9. **Assignment and Subcontracting.** Consultant shall not assign any right, interest, or obligation in or under this Agreement to any other entity without prior written consent of the City. No assignment shall be made unless the assignee expressly assumes the obligations of Consultant under this Agreement, in a writing satisfactory to the City. Consultant acknowledges that any assignment may, at the City's sole discretion, require City Manager and/or City Council approval. City acknowledges that Consultant will subcontract with Energy + Environmental Economics (E3) to assist with the Services. City consents to said subcontract and the individuals from E3 that will be assigned to this Agreement are listed on Exhibit "C". E3's subcontracts shall contain a provision making them subject to all provisions stipulated in this Agreement, including without limitation, the insurance obligations set forth in Section 13. Consultant acknowledges and agrees that the City is an intended beneficiary of any work performed by E3 for purposes of establishing a duty of care between E3 and the City.

10. **Independent Contractor.** In the performance of this Agreement, Consultant, and Consultant's employees, subcontractors and agents, shall act in an independent capacity as independent contractors, and not as officers or employees of the City of Riverside. Consultant acknowledges and agrees that the City has no obligation to pay or withhold state or federal taxes or to provide workers' compensation or unemployment insurance to Consultant, or to Consultant's

employees, subcontractors and agents. Consultant, as an independent contractor, shall be responsible for any and all taxes that apply to Consultant as an employer.

11. **Duty to Defend.** Consultant agrees, at its cost and expense, to promptly defend the City, and the City's employees, officers, managers, agents and council members (collectively the "Parties to be Defended") from and against any and all claims, allegations, lawsuits, arbitration proceedings, administrative proceedings, regulatory proceedings, or other legal proceedings which arise out of, or relate to, or are in any way connected with: 1) the Services, work, activities, operations, or duties of the Consultant, or of anyone employed by or working under the Consultant, or 2) any breach of the Agreement by the Consultant. This duty to defend shall apply whether or not such claims, allegations, lawsuits or proceedings have merit or are meritless, or which involve claims or allegations that any or all of the Parties to be Defended were actively, passively, or concurrently negligent, or which otherwise assert that the Parties to be Defended are responsible, in whole or in part, for any loss, damage or injury. Consultant agrees to provide this defense immediately upon written notice from the City, and with well qualified, adequately insured and experienced legal counsel acceptable to City. This obligation to defend as set forth herein is binding on the successors, assigns and heirs of Consultant and shall survive the termination of Consultant's Services under this Agreement.

12. **Indemnification.** Except as to the negligence or willful misconduct of the City, Consultant agrees to indemnify, protect and hold harmless the City, and its employees, officers, managers, agents and council members harmless from and against any loss, damage, claim for damage, lawsuit, action, judicial, administrative, regulatory or arbitration proceeding, damage, cost, expense (including counsel and expert fees), judgment, civil fine and penalties, liabilities or losses of any kind or nature whatsoever whether actual, threatened or alleged, which arise out of, pertain to, or relate to, or are a consequence of, or are attributable to, or are in any manner connected with the performance of the Services, work, activities, operations or duties of the Consultant, or anyone employed by or working under the Consultant or for services rendered to Consultant in the performance of this Agreement, notwithstanding that the City may have benefited from its work or services. This indemnification provision shall apply to any acts, omissions, negligence, recklessness, or willful misconduct, whether active or passive, on the part of the Consultant or anyone employed or working under the Consultant.

13. **Insurance.**

13.1 **General Provisions.** Prior to the City's execution of this Agreement, Consultant shall provide satisfactory evidence of, and shall thereafter maintain during the term of this Agreement, such insurance policies and coverages in the types, limits, forms and ratings required herein. The rating and required insurance policies and coverages may be modified in writing by the City's Risk Manager or City Attorney, or a designee, unless such modification is prohibited by law.

13.1.1 **Limitations.** The amount of coverage stated herein shall constitute a limitation and cap on Consultant's indemnification obligations under Section 12 hereof.

13.1.2 **Ratings.** Any insurance policy or coverage provided by Consultant or subcontractors as required by this Agreement shall be deemed inadequate and a material breach

of this Agreement, unless such policy or coverage is issued by insurance companies authorized to transact insurance business in the State of California with a policy holder's rating of A or higher and a Financial Class of VII or higher.

13.1.3 **Cancellation**. The policies shall not be canceled unless thirty (30) days prior written notification of intended cancellation has been given to City by certified or registered mail, postage prepaid.

13.1.4 **Adequacy**. The City, its officers, employees and agents make no representation that the types or limits of insurance specified to be carried by Consultant pursuant to this Agreement are adequate to protect Consultant. If Consultant believes that any required insurance coverage is inadequate, Consultant will obtain such additional insurance coverage as Consultant deems adequate, at Consultant's sole expense.

13.2 **Workers' Compensation Insurance**. By executing this Agreement, Consultant certifies that Consultant is aware of and will comply with Section 3700 of the Labor Code of the State of California requiring every employer to be insured against liability for workers' compensation, or to undertake self-insurance before commencing any of the work. Consultant shall carry the insurance or provide for self-insurance required by California law to protect said Consultant from claims under the Workers' Compensation Act. Prior to City's execution of this Agreement, Consultant shall file with City either 1) a certificate of insurance showing that such insurance is in effect, or that Consultant is self-insured for such coverage, or 2) a certified statement that Consultant has no employees, and acknowledging that if Consultant does employ any person, the necessary certificate of insurance will immediately be filed with City. Any certificate filed with City shall provide that City will be given ten (10) days prior written notice before modification or cancellation thereof.

13.3 **Commercial General Liability and Automobile Insurance**. Prior to City's execution of this Agreement, Consultant shall obtain, and shall thereafter maintain during the term of this Agreement, commercial general liability insurance and automobile liability insurance as required to insure Consultant against damages for personal injury, including accidental death, as well as from claims for property damage, which may arise from or which may concern operations by anyone directly or indirectly employed by, connected with, or acting for or on behalf of Consultant. The City, and its officers, employees and agents, shall be named as additional insureds under the Consultant's insurance policies.

13.3.1 Consultant's commercial general liability insurance policy shall cover both bodily injury (including death) and property damage (including, but not limited to, premises operations liability, products-completed operations liability, independent contractor's liability, personal injury liability, and contractual liability) in an amount not less than $2,000,000 per occurrence and a general aggregate limit in the amount of not less than $4,000,000.

13.3.2 Consultant's automobile liability policy shall cover both bodily injury and property damage in an amount not less than $1,000,000 per occurrence and an aggregate limit of not less than $1,000,000. All of Consultant's automobile and/or commercial general liability insurance policies shall cover all vehicles used in connection with Consultant's

performance of this Agreement, which vehicles shall include, but are not limited to, Consultant owned vehicles, Consultant leased vehicles, Consultant's employee vehicles, non-Consultant owned vehicles and hired vehicles.

13.3.3 Prior to City's execution of this Agreement, copies of insurance policies or original certificates along with additional insured endorsements acceptable to the City evidencing the coverage required by this Agreement, for both commercial general and automobile liability insurance, shall be filed with City and shall include the City and its officers, employees and agents, as additional insureds. Said policies shall be in the usual form of commercial general and automobile liability insurance policies, but shall include the following provisions:

> It is agreed that the City of Riverside, and its officers, employees and agents, are added as additional insureds under this policy, solely for work done by and on behalf of the named insured for the City of Riverside.

13.3.4 The insurance policy or policies shall also comply with the following provisions:

a. The policy shall be endorsed to waive any right of subrogation against the City and its sub-consultants, employees, officers and agents for services performed under this Agreement.

b. If the policy is written on a claims made basis, the certificate should so specify and the policy must continue in force for one year after completion of the services. The retroactive date of coverage must also be listed.

c. The policy shall specify that the insurance provided by Consultant will be considered primary and not contributory to any other insurance available to the City and Endorsement No. CG 20010413 shall be provided to the City.

13.4 **Errors and Omissions Insurance.** Prior to City's execution of this Agreement, Consultant shall obtain, and shall thereafter maintain during the term of this Agreement, errors and omissions professional liability insurance in the minimum amount of $1,000,000 to protect the City from claims resulting from the Consultant's activities.

13.5 **Subcontractors' Insurance.** Consultant shall require all of its subcontractors to carry insurance, in an amount sufficient to cover the risk of injury, damage or loss that may be caused by the subcontractors' scope of work and activities provided in furtherance of this Agreement, including, but without limitation, the following coverages: Workers Compensation, Commercial General Liability, Errors and Omissions, and Automobile liability. Upon City's request, Consultant shall provide City with satisfactory evidence that Subcontractors have obtained insurance policies and coverages required by this section.

14. **Business Tax.** Consultant understands that the Services performed under this Agreement constitutes doing business in the City of Riverside, and Consultant agrees that Consultant will register for and pay a business tax pursuant to Chapter 5.04 of the Riverside Municipal Code and keep such tax certificate current during the term of this Agreement.

15. **Time of Essence.** Time is of the essence for each and every provision of this Agreement.

16. **City's Right to Employ Other Consultants.** City reserves the right to employ other Consultants in connection with the Project. If the City is required to employ another consultant to complete Consultant's work, due to the failure of the Consultant to perform, or due to the breach of any of the provisions of this Agreement, the City reserves the right to seek reimbursement from Consultant.

17. **Accounting Records.** Consultant shall maintain complete and accurate records with respect to costs incurred under this Agreement. All such records shall be clearly identifiable. Consultant shall allow a representative of City during normal business hours to examine, audit, and make transcripts or copies of such records and any other documents created pursuant to this Agreement. Consultant shall allow inspection of all work, data, documents, proceedings, and activities related to the Agreement for a period of three (3) years from the date of final payment under this Agreement.

18. **Confidentiality.** All ideas, memoranda, specifications, plans, procedures, drawings, descriptions, computer program data, input record data, written information, and other materials either created by or provided to Consultant in connection with the performance of this Agreement shall be held confidential by Consultant, except as otherwise directed by City's Contract Administrator. Nothing furnished to Consultant which is otherwise known to the Consultant or is generally known, or has become known, to the related industry shall be deemed confidential. Consultant shall not use City's name or insignia, photographs of the Project, or any publicity pertaining to the Services or the Project in any magazine, trade paper, newspaper, television or radio production, website, or other similar medium without the prior written consent of the City.

19. **Ownership of Documents.** All reports, maps, drawings and other contract deliverables prepared under this Agreement by Consultant shall be and remain the property of City. Consultant shall not release to others information furnished by City without prior express written approval of City.

20. **Copyrights.** Consultant agrees that any work prepared for City which is eligible for copyright protection in the United States or elsewhere shall be a work made for hire. If any such work is deemed for any reason not to be a work made for hire, Consultant assigns all right, title and interest in the copyright in such work, and all extensions and renewals thereof, to City, and agrees to provide all assistance reasonably requested by City in the establishment, preservation and enforcement of its copyright in such work, such assistance to be provided at City's expense but without any additional compensation to Consultant. Consultant agrees to waive all moral rights relating to the work developed or produced, including without limitation any and all rights of

identification of authorship and any and all rights of approval, restriction or limitation on use or subsequent modifications.

21. **Conflict of Interest.** Consultant, for itself and on behalf of the individuals listed in Exhibit "C", represents and warrants that by the execution of this Agreement, they have no interest, present or contemplated, in the Project affected by the above-described Services. Consultant further warrants that neither Consultant, nor the individuals listed in Exhibit "C" have any real property, business interests or income interests that will be affected by this project or, alternatively, that Consultant will file with the City an affidavit disclosing any such interest.

22. **Solicitation.** Consultant warrants that Consultant has not employed or retained any person or agency to solicit or secure this Agreement, nor has it entered into any agreement or understanding for a commission, percentage, brokerage, or contingent fee to be paid to secure this Agreement. For breach of this warranty, City shall have the right to terminate this Agreement without liability and pay Consultant only for the value of work Consultant has actually performed, or, in its sole discretion, to deduct from the Agreement price or otherwise recover from Consultant the full amount of such commission, percentage, brokerage or commission fee. The remedies specified in this section shall be in addition to and not in lieu of those remedies otherwise specified in this Agreement.

23. **General Compliance With Laws.** Consultant shall keep fully informed of federal, state and local laws and ordinances and regulations which in any manner affect those employed by Consultant, or in any way affect the performance of services by Consultant pursuant to this Agreement. Consultant shall at all times observe and comply with all such laws, ordinances and regulations, and shall be solely responsible for any failure to comply with all applicable laws, ordinances and regulations. Consultant represents and warrants that Consultant has obtained all necessary licenses to perform the Scope of Services and that such licenses are in good standing. Consultant further represents and warrants that the services provided herein shall conform to all ordinances, policies and practices of the City of Riverside.

24. **Waiver.** No action or failure to act by the City shall constitute a waiver of any right or duty afforded City under this Agreement, nor shall any such action or failure to act constitute approval of or acquiescence in any breach thereunder, except as may be specifically, provided in this Agreement or as may be otherwise agreed in writing.

25. **Amendments.** This Agreement may be modified or amended only by a written agreement and/or change order executed by the Consultant and City.

26. **Termination.** City, by notifying Consultant in writing, shall have the right to terminate any or all of Consultant's services and work covered by this Agreement at any time. In the event of such termination, Consultant may submit Consultant's final written statement of the amount of Consultant's services as of the date of such termination based upon the ratio that the work completed bears to the total work required to make the report complete, subject to the City's rights under Sections 16 and 27 hereof. In ascertaining the work actually rendered through the termination date, City shall consider completed work, work in progress and complete and incomplete reports and other documents only after delivered to City.

26.1 Other than as stated below, City shall give Consultant thirty (30) days prior written notice prior to termination.

26.2 City may terminate this Agreement upon fifteen (15) days written notice to Consultant, in the event:

26.2.1 Consultant substantially fails to perform or materially breaches the Agreement; or

26.2.2 City decides to abandon or postpone the Project.

27. **Offsets.** Consultant acknowledges and agrees that with respect to any business tax or penalties thereon, utility charges, invoiced fee or other debt which Consultant owes or may owe to the City, City reserves the right to withhold and offset said amounts from payments or refunds or reimbursements owed by City to Consultant. Notice of such withholding and offset, shall promptly be given to Consultant by City in writing. In the event of a dispute as to the amount owed or whether such amount is owed to the City, City will hold such disputed amount until either the appropriate appeal process has been completed or until the dispute has been resolved.

28. **Successors and Assigns.** This Agreement shall be binding upon City and its successors and assigns, and upon Consultant and its permitted successors and assigns, and shall not be assigned by Consultant, either in whole or in part, except as otherwise provided in paragraph 9 of this Agreement.

29. **Venue.** Any action at law or in equity brought by either of the parties hereto for the purpose of enforcing a right or rights provided for by this Agreement shall be tried in a court of competent jurisdiction in the County of Riverside, State of California, and the parties hereby waive all provisions of law providing for a change of venue in such proceedings to any other county. In the event either party hereto shall bring suit to enforce any term of this Agreement or to recover any damages for and on account of the breach of any term or condition of this Agreement, it is mutually agreed that each party will bear their own attorney's fees and costs.

30. **Nondiscrimination.** During Consultant's performance of this Agreement, Consultant shall not discriminate on the grounds of race, religious creed, color, national origin, ancestry, age, physical disability, mental disability, medical condition, including the medical condition of Acquired Immune Deficiency Syndrome (AIDS) or any condition related thereto, marital status, sex, genetic information, gender, gender identity, gender expression or sexual orientation, in the selection and retention of employees and subcontractors and the procurement of materials and equipment, except as provided in Section 12940 of the California Government Code. Further, Consultant agrees to conform to the requirements of the Americans with Disabilities Act in the performance of this Agreement.

31. **Severability.** Each provision, term, condition, covenant and/or restriction, in whole and in part, of this Agreement shall be considered severable. In the event any provision, term, condition, covenant and/or restriction, in whole and/or in part, of this Agreement is declared invalid, unconstitutional, or void for any reason, such provision or part thereof shall be severed

from this Agreement and shall not affect any other provision, term, condition, covenant and/or restriction of this Agreement, and the remainder of the Agreement shall continue in full force and effect.

32. **Authority**. The individuals executing this Agreement and the instruments referenced herein on behalf of Consultant each represent and warrant that they have the legal power, right and actual authority to bind Consultant to the terms and conditions hereof and thereof.

33. **Entire Agreement**. This Agreement constitutes the final, complete, and exclusive statement of the terms of the agreement between the parties pertaining to the subject matter of this Agreement, and supersedes all prior and contemporaneous understandings or agreements of the parties. Neither party has been induced to enter into this Agreement by, and neither party is relying on, any representation or warranty outside those expressly set forth in this Agreement.

34. **Interpretation**. City and Consultant acknowledge and agree that this Agreement is the product of mutual arms-length negotiations and accordingly, the rule of construction, which provides that the ambiguities in a document shall be construed against the drafter of that document, shall have no application to the interpretation and enforcement of this Agreement.

34.1 Titles and captions are for convenience of reference only and do not define, describe or limit the scope or the intent of the Agreement or any of its terms. Reference to section numbers, are to sections in the Agreement unless expressly stated otherwise.

34.2 This Agreement shall be governed by and construed in accordance with the laws of the State of California in effect at the time of the execution of this Agreement.

34.3 In the event of a conflict between the body of this Agreement and Exhibit "A" - Scope of Services hereto, the terms contained in Exhibit "A" shall be controlling.

35. **Exhibits**. The following exhibits attached hereto are incorporated herein to this Agreement by this reference:

Exhibit "A" - Scope of Services
Exhibit "B" - Compensation
Exhibit "C" - Key Personnel

(Signatures on following page.)

IN WITNESS WHEREOF, City and Consultant have caused this Agreement to be duly executed the day and year first above written.

CITY OF RIVERSIDE, a California charter city and municipal corporation

By: _____
City Manager

Attest: _____
City Clerk

Approved as to Form:

By: _____
~~Chief~~ Assistant City Attorney

UTILITY SYSTEM EFFICIENCIES, INC., a California corporation

By: _____
Name Daniel Wood
Title CFO

By: _____
Name Daniel H. Wood
Title: Pres. & CEO

EXHIBIT "A"

SCOPE OF SERVICES

Scope of Work for Riverside Transmission Reliability Project Management Consulting and Strategic Planning Services

This scope of work describes the tasks E3 and USE will undertake for Riverside Public Utilities (RPU) to complete the Strategic Planning phase of the Riverside Transmission Reliability Project (RTRP) Management Consulting and Strategic Planning Services project. The Strategic Planning phase is the first phase of a multi-phase effort; we anticipate Phase 2 is a Project Alternatives analysis and Phase 3 is ongoing support through the Certificate of Public Convenience and Necessity (CPCN) process. The scopes of work, timelines, and budgets for Phases 2 and 3 will be determined after Phase 1 is complete.

Phase 1: Strategic Planning Tasks

- Summarize Riverside Public Utility's position on RTRP
  - E3 will interview the relevant RPU staff to identify the key drivers for RTRP's need
  - USE will review relevant technical analysis conducted by RPU to understand project need
- Review CAISO approval of RTRP
  - E3 and USE will review documentation of CAISO's approval of RTRP in 2006 to assess what led to project approval
  - E3 will meet with key CAISO executives and transmission planning staff to discuss RTRP and assess their understanding of project need
  - USE will review the CAISO/SCE's reliability technical analysis from 2006 and determine if the same analysis holds for today; if a new analysis needs to be conducted, USE will conduct a power flow analysis with more current assumptions to re-assess RTRP's need
- Memo on RTRP project history and need
  - E3 and USE will summarize the interviews with RPU and CAISO and technical findings from the technical analyses in a memo
- Summarize and help develop SCE's position on RTRP
  - E3 and USE will review documents from CPCN proceeding
  - E3 will meet with key SCE executives and transmission planning staff to discuss RTRP and assess their understanding of project need
  - E3 and USE will assess what benefits RTRP might provide SCE's system and customers and help-develop a position that SCE could present in the CPCN proceeding
- Determine cost recovery options for RTRP
  - E3 will prepare a memo that outlines the cost recovery mechanisms for RTRP or an RTRP alternative under the CAISO TAC, SCE's wholesale distribution tariff, or other relevant options
- Characterize positions of key intervenors in the CPCN proceeding
  - E3 and USE will review the RTRP CPCN docket and summarize the positions of key intervenors
  - E3 and USE will assess how RTRP could be designed or modified to address intervenor concerns

- Develop RTRP roadmap
    - E3 and USE will create a project roadmap, based on the findings in all of the previous tasks, which will provide a strategy to navigate RTRP's CPCN process and to identify key decision points for RPU to evaluate if and when to begin pursuing alternatives to RTRP

Budget

The consulting budget will be charged at a fixed fee of $60,000 exclusive of expenses. Travel and other expenses will be passed through at cost with a not-to-exceed budget of $5,000.

Timeline

The project will take 2-3 months to complete from when the contract is executed. The schedule variability is largely due to uncertainty in when we can schedule meetings with CAISO and SCE.

EXHIBIT "B"

COMPENSATION

Identity and Evaluate 7 Alternatives
Including RTRP and a do-nothing alternative

PRICE PROPOSAL
Cost and Staff-Hour Breakdown

Utility System Efficiencies, Inc. and EB

TASK DESCRIPTION	Consultant - USE		Consultant - EB		COMMENTS
	Man Hours	Costs	Man Hours	Costs	
Project Management					
Principal	24	$5,520	20	$8,250	
Management Consultant			120	$30,000	
Senior Consultant	42	$9,660			
Associate / Consultant	50	$11,500			
Associate / Consultant					
Administrative Support					
Analyst	20	$2,500	30	$5,850	
Office Support					
Modeling Software					
Power Flow	60	$13,800			
Transient Stability	60	$13,800			
Short Circuit	30	$6,900			
Market Modeling			186	$51,100	
Document Management and Control					
Engineering Support		$1,800			
Administrative Support					
Other Expenses					
Supplies					
Miscellaneous					
COSTS	286	$65,480	356	$95,200	TOTAL COMBINED COSTS $ 160,680

EXHIBIT "C"

KEY PERSONNEL

ROBERT W. JACKSON
Principal Power Systems Engineer

ACADEMIC BACKGROUND

B.S., Electrical Engineering with Special Honors (specializing in Power Systems Engineering), University of Colorado at Denver, 1991
Paralegal Certification, Denver Paralegal Institute, Denver, 1985
B.S., Natural Resource Management, Colorado State University, Fort Collins, 1980

PROFESSIONAL EXPERIENCE

Robert W. Jackson is an engineering professional with a strong technical background and a deep understanding of the electrical utility industry. Mr. Jackson has over 24 years of electric system utility experience, specializing in system planning (half with utilities and half as a consultant), with a focus in Transmission Planning, Distribution Planning and Protection. Mr. Jackson joined Utility System Efficiencies, Inc. (USE) in 2007 as a Senior Power System Engineer and has since been promoted to Principal Power System Engineer. Mr. Jackson has extensive knowledge and experience in electrical system modeling, planning, and the analytical tools that are used to evaluate system performance and support capital planning processes used by electric utilities and assure NERC compliance.

At the transmission level, Mr. Jackson has performed system studies including steady-state power flow, transient stability, post transient, reactive margin and short circuit analysis for Generator Interconnection Studies, the Transmission Planning Process, the WECC Path Rating Review Process, and regulatory review before the California PUC seeking Certificates of Public Convenience and Necessity (CPCN), as well as various regional studies, detailed project studies, WECC compliance, WECC exemptions, and other studies required for NERC compliance.

Mr. Jackson has used GE PSLF, PowerWorld, Aspen OneLiner, CAPE (among other programs) for this work and is proficient at power flow, transient stability, post-transient, reactive margin (QV and PV), and short circuit analyses. Mr. Jackson has also performed numerous EMF studies, and various specialty studies including Bulk Electric System (BES) Exemption and Low Voltage Load Drop studies, and reviewed and made recommendations for new breaker replacement criteria.

At the distribution level Mr. Jackson has performed numerous distribution planning studies, both short and long range, performed distributed generation studies, outage analyses, and sectionalizing studies, and performed numerous conversions of Distribution Planning models. Mr. Jackson has also designed, coordinated and troubleshot relay settings; investigated stray voltage and various harmonic inference complaints; and performed forensic analysis for insurance claims. Mr. Jackson has done this distribution analysis work for RUS cooperatives, investor owned utilities, and various municipals. Mr. Jackson has also used global positioning systems GPS technology to generate system maps and distribution analysis models.

Utility System Efficiencies, Inc. **2007-Present**

- **Developer Representative.** Have assisted several developers, primarily in Western Electricity Coordinating Council (WECC) including California (***CAISO***), Arizona, Nevada, New Mexico, Colorado and Texas. Limited experience in NYISO, MISO and SPP. Such assistance includes site evaluation, development of Interconnection Requests for filing under GIDAP, Large Generator Interconnection Procedures (LGIP), SGIP and WDAT Interconnection Application Procedures, calculation of wind, solar and battery energy storage systems (BESS) collector system modeling equivalence pursuant to ***WECC Power Flow and Dynamic Modeling Guidelines***, preparation and testing of transient stability dynamic data, and review of evaluation study results. This assistance further included determining possible points of interconnection, with mapping, interconnection queue analysis, LGIP Tariff comparisons and screening studies. Then, following Feasibility Studies, System Impact Studies or Facility Studies have performed Trigger Point Analyses and Short Circuit Incremental Contribution Studies. Assisted in verifying and vetting Affected System studies. Have also developed a procedure for an Economic Conductor Analysis and Transformer Loss Evaluation for use in wind and solar plants.
- **Interconnection Studies.** Have performed and/or contributed to numerous Interconnection Studies (Feasibility, System Impact and Facility Studies), and Power Factor Requirement studies in Colorado, Arizona and New Mexico.
- **Specialty Studies - BES Exemption, Load Shedding, Stuck Breaker Analysis and Import Studies.** Have performed numerous specialty studies including: ***Import Studies*** to determine system limits and verify nonograms; ***Stuck Breaker Analysis*** which included evaluation of substation single line diagrams to define stuck breaker contingencies, and the performance of transient stability and post transient VAR margin analyses on breaker failures; ***Load Shedding Study*** in response to a WECC Disturbance Report; and a ***BES Exemption Study*** which included the usual power flow, transient stability, post transient as well as Line Outage Distribution Factors (***LODF***) and Outage Transfer Distribution Factors (***OTDF***).
- **Path Rating and other Regional Planning Studies.** Have run and/or contributed to several path rating or regional planning studies including the SDG&E ***Sunrise Powerlink*** Phase 2 Study, LS Power Southwest Intertie Project – South (***SWIP-S***), Southern Nevada Intertie Project (***SNIP***) and Xcel Energies, ***High Plains Express*** Transmission Project.
- **Annual Transmission Assessment.** Conducted/Supervised the 2008 PacifiCorp West Annual Transmission Assessment.
- **GPS Map Making and System Inventory.** Used GPS receivers to inventory, map and create a power model for analysis of the electrical system of City of Blanding, Utah.

San Diego Gas and Electric Company **2001-2007**

- **Sunrise Powerlink.** Was technical lead on the Sunrise Powerlink, including the initial Alternative Evaluation, Transmission Comparison, Plan of Service, Import Capability, and Path Rating Studies as well as its regulatory review at CPUC and prosecution of its CPCN (including its thousands of data requests).

- **Imperial Valley Study Group, Valley Rainbow and other Regional Planning Studies.** Contributed to the Imperial Valley Study Group analysis of delivery of renewable generation in the Imperial Valley, near the Salton Sea, including geothermal and solar resources. Contributed to the CPUC Prosecution Studies including its hundreds of data requests for Valley Rainbow and was an active member of several Peer Review Groups.
- **Annual Transmission Assessments.** Was a senior member of the SDG&E Grid Assessment team for four years, including analysis, review, cost estimates and stakeholder meetings. This transmission assessment was the precursor of the current Transmission Planning Process.
- **CPCU Regulatory Review.** Led the transmission planning study effort associated with the Sunrise Powerlink's regulatory review before the CPUC for its CPCN, including thousands of data requests. Prior to that, assisted with the transmission planning effort associated with the CPUC regulatory review of Miguel-Mission #2 and Valley-Rainbow.
- **EMF Management.** Performed numerous EMF Transmission management studies, supervised and trained others in same. Also performed a few EMF management studies at the distribution level.
- **Breaker Replacement Criteria.** Evaluated SDG&E's Breaker Replacement Criteria
- **Generator Interconnection Studies.** Performed and/or assisted in interconnection studies.
- **Various Special Project Studies.** Included the Otay Mesa 230 kV loop and its CPUC prosecution and an Orange County Long Range Planning Study.

Peak Power Engineering, Inc. **1998-2001**

- **Generator Interconnection Studies.** Began the transition from distribution planning to transmission planning while performing several Generation Interconnection studies in the Southern California-Arizona area.
- **Distribution Planning.** Performed several RUS Construction Work Plans, Long Range Planning Studies and other distribution plans for various RUS distribution cooperatives (coops) and municipals. Built distribution analysis models for coops and municipals and helped link billing data (load data) to distribution models.
- **Distributed Generator Interconnection Studies.** Performed several distributed generator studies which tied biomass, methane gas and other co-generation facilities into distribution systems. Later represented an Australian distributed generator developer in their pursuit of interconnection into distribution systems across the US, including concerns about insulation coordination, parallel operation of dispersed generation and utility electrical systems, over voltage conditions during faults, desensitizing of utility ground fault protection, utility equipment ratings and reclosing out of sync.
- **GPS Mapping.** Mapped, inventoried and built distribution analysis models for a municipal distribution systems, using GPS.
- **Forensic Analysis.** Conducted several forensic analyses of end-use customer's damaged equipment, their electrical systems for insurance claims against distribution utility

companies. As part of this work conducted National Electric Code audits and offered possible solutions to prevent future damage.

- **System Protection.** Prepared Time Current Curves, digital relay settings, recloser settings, fuse sizing for transformers, generators, motors, substations, and distribution systems. Reviewed proposed interconnected generator protection schemes.
- **Steel Pole Evaluations.** Per the RUS rules performed several steel pole evaluations to determine the economics of using steel poles versus wood poles for sub-transmission and distribution lines.

United Power, Inc. **1991-1998**

- **Distribution Planning.** Prepared six or seven RUS Construction Work Plans, Borrower's Environmental Reports (BER) and numerous amendments. Pioneered new BER formats. Completed two distribution planning model/software conversions, from DVDCal to Envison to MilSoft. Have also prepared Comprehensive Long Range Planning Studies, Sectionalizing Studies and Economic Conductor Analysis. Also, performed conductor impedance and ampacity calculations, capacitor placement studies, power factor corrections, and calculation of regulator settings. Also have contributed to and coordinated Power Requirements Studies, and Cost of Service Studies.
- **Project Management.** Several years of experience in project management of utility distribution construction projects including overhead and underground distribution lines and distribution substations. Project management included planning, design, budgeting, scheduling, preparing bid proposals, supervising contractors, overseeing construction, inspecting and closing. Some design experience, including overhead and underground distribution line and raptor protection. Contributed to and expedited substation design and construction, including grounding, cable and conduit schedules, and interconnect wiring diagrams.
- **Assisted Operations.** Performed emergency outage switching through SCADA systems and coordinated field switching through radio communications. In addition, prepared switching orders and reports. Troubleshot and handled customer complaints including power quality, harmonics, outages, PCBs and stray voltage concerns. Conducted 60 Hz EMF studies and measurements.
- **Outage Analysis.** Maintained outage history by customer, cause and indices. Summarized outage history, generated raw outage data, wrote dBase program to calculate outage indices by substation, area, franchise and cause.
- **Mapping.** Supervised and assisted in the performance of two mapping conversions from hand drafted maps to AutoCad and then from AutoCad to ArcInfo GIS.
- **Supervised Planning Group.** Supervised planning team which included the distribution planning discussed above and a small team in charge of right-of-way, joint-use, rates (and cost-of-service) and GIS Mapping.

Power Systems Analysis Tools

- GE Positive Sequence Load Flow (PSLF)
- PowerWorld
- Aspen OneLiner
- CAPE
- Perl Script
- Milsoft WindMil
- Envision Distribution Analysis (RDAP)
- Southern Engineering *DVDCAL*
- As well as Word, Excel, dBase, MathCad, PowerPoint, and Visual Basic
- Limited exposure to PTI PSS, Project, Access, AutoCad, ArcInfo, VSAT and GridView
- Programming experience in Perl, epcl, GE Macro Language, Visual Basic, dBase, Fortran, Pascal, and Basic

Professional Associations and Committee Memberships

- Registered Professional Electrical Engineer, Colorado
- Registered Agent (RA) (inactive) United States Patent and Trademark Office
- Institute of Electrical and Electronics Engineers
- Western Electricity Coordinating Council, Technical Study Subcommittee Member
- Western Electricity Coordinating Council, System Review Work Group, Former Member
- Conférence Internationale des Grands Réseaux Électriques (CIGRÉ), a Haute Tension (International Conference on Large High Voltage Electric Systems)
- Sigma Nu, College Social Fraternity, Delta Rho Chapter, Colo St U, Ft Collins

Relevant Course Work & Training

- Engineering Analysis for Dynamic Stability, General Electric, John Undrill, 2004
- Mechanics of Running PSLF Dynamics, General Electric, 2004
- Mechanics of Running EPCL, General Electric, 2002
- Steady State Analysis & Applications, General Electric, 2002
- PSLF Fundamentals, General Electric, 2002
- Distributed Generation, University of Wisconsin-Madison, 2001
- Protection, Graduate course, University of Colorado, Denver,1997
- Understanding Powerline Electromagnetic Fields, University of Colorado, 1996
- Distribution System Overcurrent Protection, Cooper Power Systems, 1996
- Stray Voltage Investigations Training Course, 1996
- Distribution Planning, ABB, 1995
- National Electric Safety Code, 1994

Awards

- **Eta Kappa Nu,** National Electrical Engineering Honor Society
- **Tau Beta Pi,** National Engineering Honor Society

- **Golden Key** National Academic Honor Society
- **National Deans List** 1987-1991
- **Eagle Scout,** with Bronze and Gold Palms (plus Boy Scout Camp Counselor – 3 summers)
- **Order of the Arrow,** Boy Scout Honorary Society

Presentations

- *Renewable Energy Technologies,* a presentation to the Senior Class of the Delphian Private School
- *Electric Transmission Planning,* a presentation to the Renewable Resources Engineering Department at the University of North Texas
- *Post Transient Stability,* a presentation to the Transmission Planning Department, SDG&E
- *The Transmission System and What Causes Blackouts,* a presentation to various SDG&E regional distribution operation centers
- *Electromagnetic Field Management,* a presentation to the Transmission and Distribution Departments, SDG&E
- *Distributed Generation,* a presentation before the Denver Section of PES, IEEE, 2001
- *Power System Fundamentals,* a half day class, taught several times (each week) to Distribution Lineman at the annual, week-long Kansas "Overhead/Underground Metering" School for three years (1999, 2000, and 2001).

BEN MORRIS, P.E.
Electrical Engineering Consultant

ACADEMIC BACKGROUND

Bachelors, Business Management, Saint Mary's College of California, 1995
Courses in Electrical Engineering
Management Training Classes

PROFESSIONAL EXPERIENCE

Ben Morris has about 40 years of experience in electric transmission planning.

Mr. Morris was with PG&E from 1972-2008. While employed by PG&E, he led or participated in the analysis of several large scale transmission projects to increase the transfer capability of major transmission paths in California to access resources both internal and external to the State. These projects included the California-Oregon Transmission Project (COTP), the Path 15 Upgrade, 500 kV Series Capacitor Project and the 500 kV Remedial Action Scheme Project.

He has served as an expert witness before the California Public Utilities Commission and the California Energy Commission to support the need for proposed, major PG&E electric transmission projects, including the COTP, Path 15 Upgrade and the interconnection of geothermal units at the Geysers (1985-2001). He is familiar with cost recovery principles and between 2001 and 2008 submitted written testimony to and testified before the Federal Energy Regulatory Commission on the recovery of capital costs of electric transmission facilities in PG&E's Transmission Owner filings.

Mr. Morris began consulting in 2008. Since then he has led the WECC rating studies for a 500 kV AC/DC transmission line from British Columbia to northern California with termination in the Pacific Northwest, and has led the study effort to analyze potential transmission upgrades in central California.

Mr. Morris has conducted analyses and participated in workshops sponsored by State and Federal regulatory authorities on the impacts and mitigation associated with the siting of potential transmission facilities in California to access renewable resources.

Consulting (Various Companies) **2008-Present**

- **Canada-Northern California Transmission Study:** Direct and guide the initial feasibility study and WECC Rating Studies for the Canada-Northern California Transmission Project and the Central Valley study in Northern California. Present study results to Project Committees and Stakeholder Groups.

- **Central California Transmission Study:** Direct studies to upgrade the Central California transmission system to provide greater access to renewable generation and improve reliability in the Fresno area.
- **California Transmission Planning Group:** As technical study team lead for the California

Transmission Planning Group, analyzed transmission impacts of various renewable resource portfolios and identified potential mitigation for these impacts.

- **Generation Interconnection:** Perform technical reviews and analysis of generation interconnection proposals, including interconnection alternatives, power system analysis studies, estimated costs and implementation schedules.

- **Jordanian Electrical System Project:** Audit of the Jordanian utility's transmission planning practice and the development of an approach for evaluating the interconnection of renewable generation to their transmission system.

- **Determination of System Operating Limits:** For entities in Northern California, performed power flow and dynamic stability analysis to support SOLs.

- **Planning Audits:** Provide analysis of utility compliance with NERC Reliability Standards. Such analysis includes assembly of evidence, documentation assessment and identification of any gaps in documentation.

Pacific Gas and Electric Company **1972-2008**

- **Manager, Strategic and Technical Services (2001-2008)**

- **Supervisor, Transmission Planning (1988-2001)**
  - Supervised up to a 13-member staff of electrical engineers, an engineering assistant, and an administrative assistant
  - Directed power system studies of the 500 kV transmission system to provide for increased access to generating resources in the West. Major projects included the California – Oregon Transmission Project and the Path 15 Upgrade. Led the WECC Rating Process for the Path 15 Upgrade.
  - Served as PG&E's witness for transmission capital in PG&E's Transmission Owner (TO) Tariff annual filings between 2002 and 2008 before the Federal Energy Regulatory Commission.
  - Served as PG&E's expert witness for transmission planning before the California Public Utilities Commission for the California-Oregon Transmission Project and Path 15 upgrade project. Served as PG&E's expert witness before the California Energy Commission for the interconnection of geothermal units at The Geysers. This assignment required developing written testimony, responding to data requests and providing oral testimony at regulatory hearings.
  - Directed studies to (1) reduce reliance on local area generating capacity and (2) establish interconnections for large independent generating projects
  - Represented PG&E on the Western Electricity Coordinating Council (WECC)

Reliability Subcommittee, the WECC Planning Coordination Committee and the WECC Compliance Process Task Force. Participated in the development of WECC Planning standards and the review/comment on the North American Electric Reliability Council (NERC) reliability standards.

- **Electrical Engineer/Transmission Planning Analyst, Transmission Planning 1972-1988**
  - Performed power system analyses of the 230 kV, 115 kV and 60 kV network for various Divisions throughout the PG&E service area. Such analyses involve identifying system performance that does not comply with reliability standards, investigating solutions to mitigate those violations, and preparing economic analyses to identify those solutions that would have the least financial impact to PG&E customers.

  - Prepared study reports and memoranda to management recommending the installation of additional facilities.

Professional Associations

- Registered Professional Engineer in Electrical Engineering, State of California, 1987

JENNIFER GEER
Principal Power Systems Engineer

ACADEMIC BACKGROUND

B.S., Electrical Engineering, University of New Mexico, 1985

PROFESSIONAL EXPERIENCE

Jennifer Geer is an engineering professional with a strong technical background and a deep understanding of the electric utility industry. She has over 28 years of electric utility industry experience and has extensive background in the transmission and distribution areas with experience including transmission planning and generation interconnection studies, distribution planning, outage analysis, reliability analysis, project development, and project management. Ms. Geer has also provided training in many of these areas. Ms. Geer joined Utility System Efficiencies, Inc. (USE) in 2009. At USE, Ms. Geer's focus has been on generation interconnection studies, transmission planning and project development, and developer feasibility studies.

Prior to joining USE, Ms. Geer was a member of San Diego Gas and Electric's Transmission Planning Department. Though part of their generation interconnection team, she was also involved in studies to determine the need and benefit of new transmission projects on the existing system, examining different route and voltage options.

While running Geer and Geer Engineering, Ms. Geer developed a procedure to determine if a new substation was needed. She also led teams to optimize substation site selection based on both engineering and non-engineering issues, and provided project management for a long term transmission study that was used to determine client company strategy. In addition, Ms. Geer developed or reviewed many distribution projects, trained engineers and leads on distribution planning, developed a training manual, provided process mapping of distribution functions, and analyzed visibility and accuracy of distribution accounting.

While employed by Hewlett Packard (HP), Ms. Geer was the electrical manufacturing engineer on two projects. She debugged and resolved an "unknown" printer shut-down problem, developed a training manual, went on a training tour of warranty repair centers, and with her team reduced warranty expenses by 50%. For a developing project, Ms. Geer coordinated with the R&D team to design the product for manufacturability and testability, set up much of the equipment on the production line, identified testing strategy and supported getting the product into production.

Utility System Efficiencies, Inc. **2009-Present**

- **Generation Interconnection. 2009-Present.** Performed numerous studies for individual generation projects (Feasibility and System Impact Studies), which typically required: scoping the study, building and verifying generator models, performing power flow analysis, transient stability analysis, post-transient analysis, testing the system under multiple conditions for reliability, and preparing reports. Interconnection projects included both

individual generator projects as well as generator cluster studies.

- **Transmission Studies for Utilities and Developers. 2010-Present.** Performed multiple studies in California, New Mexico, and Arizona, identifying issues and developing new transmission projects or validating and/or refining projects already under study. Studies frequently included tuning the cases for multiple scenarios, with sensitivities to examine additional generation or transmission project variations. One series of studies required Ms. Geer to develop analytical techniques (equations) to predict the flow on the most limiting facility in the study area, which included identifying the key variables and conducting regression analysis.
- **Generation Feasibility Studies for Developers. 2010-Present.** Performed feasibility analyses of various generation location options, investigating opportunities and issues in order to provide clients preliminary information on their potential projects or ventures.
- **Distribution Interconnection Procedures. 2011-2012.** Provided technical assistance to the California PUC Energy Division's Distribution Interconnection Settlement process (formerly the Rule 21 Working Group), a consensus-based settlement process to update and reform the existing distribution system interconnection procedures. Activities included participating in engineering discussions and fostering consensus, reviewing and proposing changes to the interconnection procedures, assisting staff in preparing for settlement meetings, and reviewing and proposing changes to the revised tariff language and form agreements. Ms. Geer also developed a document providing background material for CPUC Staff to use in scoping the Phase 2 technical standards discussion.
- **Substation Saturation Studies.** Conducted study to verify need and determine approximate timing and location for new distribution substations.

San Diego Gas and Electric Company (SDG&E) **2007-2009**

- **Generation Interconnection. Various.** Performed studies for individual generation projects (Feasibility, System Impact and/or Facility Studies), which typically required: scoping the study, building and checking a model for the system, performing power flow analysis, transient stability analysis, post-transient analysis, testing the system under multiple conditions for reliability, and preparing reports. Interconnection studies included both individual generator projects as well as generator cluster studies.
- **Infrastructure Studies. Various.** Performed studies to determine the need and benefit of new transmission projects on the existing system, analyzing alternate route and voltage options. Presented results to management. Provided language for formal project documentation and submittal.

Geer and Geer Engineering **1997-2007**

- **Substation Saturation Studies (Area Studies).** Developed a streamlined procedure for substation area studies, to verify need and determine approximate timing and location of new distribution substations. Developed forecasts, reviewed existing distribution system expansion capabilities, and identified areas that needed new substations. Where applicable,

led multi-discipline project team to evaluate site options, make recommendation, and initiate budget process. Forms and checklists were developed to assist in the evaluation.

- **Distribution Planning.** Forecasted distribution loads, developed circuit and substation projects, identified cost savings alternatives, and prioritized capital projects. On several occasions, reviewed the client company's entire set of capital distribution projects and suggested changes as needed. Evaluated and developed targeted procedures to streamline specific areas within distribution planning. Piloted a reliability analysis procedure, and worked out a process to reduce the analysis time down to 1/3rd the original time required, then wrote up the revised procedure and trained other engineers on it. Addressed several project management concerns on capital projects by participating in a work flow team, developing reporting expectations/requirements and devising database macros to extract relevant data from multiple spreadsheets providing a quick, concise status report which brought visibility to specific problem areas.
- **Training.** Developed checklists, forms and procedures to assist in forecasting and project development, and trained engineering personnel on distribution planning procedures. Developed distribution planning process maps for client company in merger discussions, to allow comparison of the two entities' processes. Trained engineers and leads on elements of distribution planning. Developed a training manual.

Hewlett Packard (HP) **1994-1997**

- **Existing Product.** Resolved manufacturing issues, developed repair manual, debugged printer shut-down problem. Went on training tour of warranty repair centers as part of 3-person team resulting in 50% decrease in product warranty costs.
- **Product under Development.** Manufacturing test lead. Developed testing strategy for the manufacturing and repair of the all-in-one product, including sub-assembly level testing. With team, identified specific tests and command capabilities needed. Directly coordinated with applicable R&D engineers to drive means and access for needed testing. Also worked with R&D team to design for manufacturability and repair. Selected computer equipment for manufacturing line. Supported getting product into production.

San Diego Gas and Electric Company (SDG&E) **1986-1994**

- **Distribution Planning.** Forecasted distribution loads, identified issues and alternatives, and developed circuit and substation projects. Utilized re-phasing of loads and capacitor installation/repair to improve power factor, reduce peak loading and defer projects when applicable. Examined heating effects from getaway duct packages and re-introduced that examination into the planning procedure. Determined 12 kV fusing requirements and cable and conduit package requirements for new business projects. Ms. Geer also conducted distribution reliability studies to improve performance indices and developed training documents on multiple topics. She reviewed the entire set of distribution circuit forecasts and proposed distribution capital projects for San Diego Gas & Electric in later years, and provided feedback and/or modification as needed. Also developed checklists and forms to assist in forecasting, project development and new business engineering review, and trained engineering personnel on distribution planning procedures.

- **Special Studies.** New substation studies, manpower studies, accounting studies.
- **Voltage Complaints/Outages.** Troubleshooting of customer end-use complaints, outage analysis, reliability analysis, fusing selection.

Power Systems Analysis Tools

- General Electric PSLF/PSDS
- DSATools VSAT

Professional Associations and Committee Memberships

- IEEE Power Engineering Society, Member
- Project Management Institute (PMI), Member

R. PETER MACKIN, P.E.
Senior Vice President, Analytical Services

ACADEMIC BACKGROUND
M.S., Electrical Engineering, Montana State University, 1982
B.S., Civil Engineering, Montana State University, 1981

PROFESSIONAL EXPERIENCE
Peter Mackin is an engineering professional with a strong technical background and a deep understanding of the electrical utility industry. Mr. Mackin has over 33 years of power system planning and computer application development experience and has been involved in WSCC/WECC planning and operating activities since 1985. Mr. Mackin joined Utility System Efficiencies, Inc. (USE) in April 2006. At USE, among other duties, Mr. Mackin has directed and performed system studies to meet the requirements of the WECC Project Rating Review Process, assisted developer clients with interconnection applications, and supervised a wind integration study for FERC.

While employed at Navigant Consulting, Inc., Mr. Mackin performed several transmission and resource integration studies for the Alberta Electric System Operator (AESO) as well as generation interconnection studies and transmission feasibility analyses for other clients. In 2005, Mr. Mackin was vice chairman of the NERC Phase III/IV Standards Drafting Team which was responsible for revising the NERC Phase III/IV Standards to be clear and enforceable while incorporating the concerns of the industry as reflected in comments that were received. In 2004, Mr. Mackin was a member of the NERC Version 0 Standards Drafting Team that revised the NERC Planning Standards and Operating Practices to create the Version 0 set of NERC Reliability Standards.

While employed by the California Independent System Operator (CAISO), Mr. Mackin performed or reviewed system planning studies for Reliability Must Run generation requirements, new generator interconnection studies, as well as Participating Transmission Owner annual Transmission Assessments. In addition, Mr. Mackin helped develop the CAISO's New Facility Interconnection Policy and Long-Term Grid Planning Policy. Mr. Mackin has provided expert witness testimony regarding six new generation projects before the California Energy Commission.

While employed by Pacific Gas and Electric Company (PG&E), Mr. Mackin was the lead transmission planning engineer performing transient stability simulations for the 500 kV California - Oregon Transmission Project. In addition, Mr. Mackin performed, supervised or reviewed studies to determine simultaneous import capabilities into California from the Pacific Northwest and the Desert Southwest. For two years, he served as chairman of the work group that undertook these studies comprised of utilities from California, the Northwest, and the Southwest.

Utility System Efficiencies, Inc. **2006-Present**

- **Interconnection Application Assistance. 2007 - Present.** Provide assistance developing data for and completing interconnection applications for various generator developers (solar, wind and conventional thermal) throughout the WECC. The data developed includes models for both steady state and dynamic simulations.
- **NCPA WECC Base Case Model Development. 2013 - Present.** Prepared steady state and dynamic model data for NCPA facilities as part of the WECC base case development process. Typically, 11 WECC base cases are prepared annually.
- **City of Bellevue Independent Technical Analysis. 2014 - 2015.** Performed an independent analysis to evaluate the need for the PSE sponsored Energize Eastside transmission project for the City of Bellevue. This analysis evaluated the load forecast assumptions and performed additional transmission studies to independently determine if there was in fact a need for this project.
- **MATL Operating and Curtailment Studies. 2013 - 2015.** Led the system studies to determine seasonal System Operating Limits (SOLs) for the MATL project. Also led the effort to perform curtailment analyses for the fall/winter and summer operating seasons.
- **MATL Transmission Assessment. 2014.** Led the system studies to perform the NERC required 10 year transmission assessment for the MATL system.
- **Confidential Client Model Development. 2014.** Helped develop steady state models of a new electrical device created by the confidential client. The models of this device that were developed can be used with the GE PSLF and Siemens PTI PSS/E simulation software to model the operation of this new electrical device.
- **Various Clients - Affected System Studies. 2014.** Supervised affected system studies for various utility clients. These studies were performed to determine if the utility client was impacted by proposed new generation additions on the CAISO grid.
- **Confidential Client BES Exemption Request. 2014.** Supervised studies to determine whether or not a utility's system could adversely impact the BES as defined by NERC. Used the results of these studies to help prepare a BES Exemption Request for this client.
- **Modesto Irrigation District. 2013 - 2014.** Provided assistance with operating studies (System Operating Limits (SOL)), compliance with NERC Transmission Operator (TOP) Reliability Standards, and the CAISO interconnection process.
- **J.P. Morgan Ventures Energy Corp. 2012 - 2013.** Prepared affidavits in ER13-21-000.
- **Southline Project. 2011 - 2014.** Provided process support and advice to the Southline project. Assisted with the Project Coordination Review, Comprehensive Progress Report, and Phase 2 studies.
- **Local Capacity Requirement (LCR) Studies. 2011.** Reviewed available study reports and performed additional analysis to assist a confidential client determine the future LCR

requirements for the LCR area where some of their older generating resources are located. The client used this information to help decide whether or not to propose future upgrades to their generating resources in this LCR area.

- **Lamar - Front Range Project. 2010 - 2012.** Provided coordination and leadership for planning studies that were performed to assess multiple transmission alternatives to provide transmission access to renewable generation development areas in eastern Colorado.
- **BES Definition Task Force. 2010 - 2011.** Participated in the WECC Bulk Electric System (BES) Definition Task Force to develop a BES definition, exemption criteria and study methodology, ADR process, and points of demarcation between the BES and other facilities. In addition, performed one assessment using preliminary exemption criteria to test a client's system to determine if it would be in or out of the BES.
- **MATL Wind Addition WECC Studies. 2009 - 2012.** Led the effort to complete a revision to the MATL WECC Phase 2 studies to assess the impact of the addition of 300 MW of wind generation on the MATL project's approved Path Rating.
- **NCPA and Glendale Water and Power (GWP). 2009 - 2011.** Led studies for NCPA and GWP to determine if either utility had any Critical Assets (CAs). These studies were used as a basis for determining if either utility had any Critical Cyber Assets (CCAs) under NERC Reliability Standard CIP-002 Version 1 and 3.
- **Wind Integration Studies. 2009 - 2010.** Led a study for FERC to analyze the frequency response and the impacts on reserve requirements of large amounts of new wind generation on the WECC, ERCOT, and Eastern interconnections.
- **SWIP North Phase 2 Studies. 2009 - 2013.** Led the study effort to establish an Accepted Rating for the SWIP North project, a 500 kV transmission line between Twin Falls, Idaho and Robinson Summit, Nevada (near Ely).
- **Economic Transmission Proposals. 2009.** Led an effort to provide a confidential client with screening analyses for multiple transmission projects that the client was considering proposing to the CAISO. The results of these analyses as well as production cost modeling analyses were used to select the projects that were ultimately submitted to the CAISO as part of the CAISO's Transmission Planning Process.
- **Merced ID Transmission Assessment. 2008 - 2014.** Led the study efforts to perform annual transmission assessments for Merced ID. Each annual assessment was performed to demonstrate compliance with NERC Reliability Standards TPL-001 through TPL-004.
- **Eastshore Energy Center. 2007.** Assisted Tierra Energy, the project developer, in the subject areas of transmission system engineering and local system effects (a.k.a., system benefits) for the Eastshore Energy Center license application before the California Energy Commission.
- **NorthWestern Energy (NWE) MSTI Project. 2007 - 2011.** Assisted NWE with the WECC Regional Planning Process and the WECC Project Rating Review Process for the Mountain States Transmission Intertie (MSTI). MSTI is a proposed 500 kV line from

western Montana to south central Idaho that is being proposed to provide an outlet for new generation proposed in Montana.

- **High Plains Express. 2007 and 2010.** Led the Stage 1 feasibility study effort and the Stage 2 system study effort for the High Plains Express (HPX) project. The HPX project is a proposed 345 kV or 500 kV transmission project extending from Wyoming to Arizona. HPX is being designed to enable the delivery of renewable resources in Wyoming, Colorado, and New Mexico to load centers in Colorado, New Mexico and Arizona.

- **Islanding Studies. 2007.** Performed studies to determine appropriate operating limits for either the Burbank system or the combined Burbank and Glendale systems to minimize loss of load and to speed load restoration under various scenarios in which the Burbank or Burbank and Glendale systems become islanded from the rest of the WECC. As part of this analysis, developed a detailed dynamic load model representation for the Burbank and Glendale power systems. Also, developed a reduced equivalent of the WECC system to reduce the time needed to perform the dynamic simulations for this study.

- **MATL WECC Three Phase Rating Process. 2006 - 2007.** Led the WECC Project Review Group and performed and supervised the WECC Phase 2 rating studies for the Montana Alberta Tie Ltd. (MATL) project. The MATL project is a proposed 230 kV tie line between Lethbridge, Alberta and Great Falls, Montana. The MATL project achieved WECC Phase 3 status in August, 2007.

- **APS SIL Study. 2006 - 2007.** Supervised studies performed for APS to establish the Simultaneous Import Limits for APS. These studies were performed in accordance with established FERC guidelines as part of a FERC market power filing.

- **Eastern Plains Transmission Project (EPTP). 2006.** Supervised system studies for Tri-State Generation and Transmission Association for their proposed EPTP and its associated new generation resources. These studies were performed to determine the appropriate project line configuration and series compensation levels for EPTP.

- **WECC System Model Validation. 2006 to 2009.** Led the development of epcl and C++ programs to convert transient stability simulation data into PMU data file format. Used this converted data to compare the frequency response of model simulations to actual system disturbances (e.g., August 10, 1996) using SCE's PSO program. Models were refined where necessary to more closely match model simulations to actual system performance.

- **CAISO CSRTP Studies. 2006.** Assisted the CAISO with the CAISO South Regional Transmission Planning (CSRTP) studies. These studies were performed to determine the reliability benefits of three major proposed transmission and generation projects in southern California. The projects assessed were the SDG&E Sunrise Powerlink 500 kV transmission line, the LEAPS pumped storage and 500 kV transmission project, and the Tehachapi wind resource area 230 and 500 kV transmission reinforcements.

Navigant Consulting, Inc. **2001-2006**

- **Montana Alberta Tie Ltd (MATL). 2005 - 2006.** Led the first phase of the WECC Project Rating Review process as well as the WECC Regional Planning Project Review process for

the MATL project. Successfully obtained WECC Phase 2 status for this project. The MATL project is a proposed 230 kV tie line between Lethbridge Alberta and Great Falls Montana.

- **Reliability Must Run (RMR) Generation Expert Witness Testimony. 2004 - 2005.** Provided expert witness testimony for the Western Area Power Administration (WAPA) in FERC Docket ER01-1639-006. Supervised a series of RMR studies that demonstrated the reliability benefits provided to the system by generation units controlled by WAPA. Quantified these RMR benefits using a methodology similar to that used by the ISO to determine the RMR contract payments for RMR generation. All parties to this case agreed to a settlement after the hearing but prior to the issuance of the ALJ's decision.

- **Edmonton - Calgary Transmission Needs Assessment. 2003 - 2004.** Supervised and performed system planning studies in support of the Alberta Electric System Operator's (AESO) Edmonton-Calgary 500 kV Transmission Development Need Application to the Alberta Energy and Utilities Board. These studies involved power flow and dynamic simulations of the Alberta electric system to help determine the short-term and long-term reinforcements needed to reliably and economically serve Alberta load while simultaneously minimizing the amount of congestion on the transmission system.

- **Alberta Transmission Development - Strategy and Conceptual Studies. 2003.** Was the project manager on a project to evaluate various transmission and generation development scenarios for the Alberta Electric System Operator (AESO). This project determined the transmission reinforcements needed to reliably serve Alberta load under various generation development and power export scenarios. The capital and O&M costs of the needed transmission reinforcements and the market price of the generation were combined in a financial model to determine the NPV for each scenario. These scenarios were then used to show the benefits to Alberta ratepayers of having adequate transmission available to accommodate a generation development near the low cost fuel supply sources.

- **NERC Facility Ratings Standard Authorization Request Drafting Team. 2003.** Was a member of the team that drafted the Standard Authorization Request (SAR) for NERC Reliability Standards FAC-008 to FAC-013 (Determine Facility Ratings, System Operating Limits, and Transfer Capability). This SAR was used as the basis for the new NERC Reliability Standards that were recently approved.

- **Silicon Valley Power Pico Project. 2002.** Was the project manager for the system studies being performed on behalf of Silicon Valley Power to determine the impacts of the Pico Project on the transmission systems of PG&E and Silicon Valley Power. The Pico Project is a 150 MW combined cycle power plant that is located in the City of Santa Clara, California.

- **Transmission Project Feasibility Analysis. 2001 - 2002.** Performed a feasibility analysis for a confidential client to determine the viability of a potential merchant transmission project. Reviewed the transmission studies and supervised the production simulation studies that were used to evaluate the economic potential of the project.

- **Other Generation Projects (NCI). 2001 - 2002.** Reviewed studies and other information to provide clients with feasibility analysis regarding transmission interconnection for various potential generation projects. Also developed dynamic models for some projects to be able

to model transient behavior of the new generation project. These potential generation projects ranged in size from 35 MW to over 600 MW.

- **Independent Consultant's Report for the California Department of Water Resources. 2001 - 2002.** Revised all major WECC transmission path limitations for input into the production simulation models used to by NCI help evaluate the power purchase contracts signed by CDWR on behalf of the people of the State of California.

- **Alberta 500 kV System Studies. 2001 - 2002.** Was the lead technical manager on a project to evaluate 500 kV transmission alternatives for the Alberta Transmission Administrator. This project included steady state, post-transient, and transient simulations to determine power system performance under various scenarios. The objective of this project was to develop preferred alternatives for three different generation development scenarios in the Province of Alberta. Additional analysis performed for these studies included EMF and SSR calculations and EMTP simulations.

- **Open Access Tariff Review. 2001.** Reviewed the Open Access Tariff (OAT) of SaskPower to determine compliance with FERC Order 888 and the NERC Available Transmission Capacity (ATC) calculation methodology.

- **California Power Authority. 2001.** Reviewed or supervised the review of the transmission system impact of 60 proposed projects submitted to the California Power Authority. This review was designed to discover any potential fatal flaws in the transmission interconnection for each project. This information along with input from other critical subject areas was used to rank the viability of each project.

California Independent System Operator Grid Planning **1997-2001**

- **August 10 Validation Study and System Model Development. 2000 - 2001.** Was one of six task force members that developed "interim" modeling recommendations for WSCC operating transfer capability studies. The task force investigated various model parameters (e.g., induction motor models, motor inertia, multi-terminal DC, gas turbine, steam and hydro governors among others) before developing a recommendation that all operating study cases should model induction motors for approximately 20% of the system load. This recommendation was then benchmarked against a well-documented system disturbance, the August 10, 1996 collapse of the WSCC system. The task force is currently investigating additional load modeling parameters, and is working on developing a long-term load modeling recommendation for the WSCC system.

- **Other Generation Projects. 2000 - 2001.** While at the CAISO, was responsible for reviewing all studies for each individual generation project to ensure that the project was in compliance with local and regional reliability criteria. During 2000 and 2001, was responsible for 36 different generation projects (six of these are listed above). In addition to reviewing studies, was also responsible for tracking internal CAISO processes to make sure that when each of these generators was ready to synchronize to the CAISO controlled grid, all internal ISO requirements had been met.

- **El Segundo Modernization Project. 2000 - 2001.** The El Segundo Modernization Project is a 280 MW (net increase) combined cycle generator project planned for the site of the existing El Segundo Generating Station located in the city of El Segundo, California. Was responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject area of Transmission System Engineering.

- **Policy Development. 1999 - 2001.** One of the primary developers of the California ISO's New Generation Interconnection Policy and the CAISO's Long-Term Grid Planning Policy. In addition to developing the policies, had significant input in to the development of the Tariff language implementing both policies. Both policies were developed through a comprehensive stakeholder process involving representatives from generators, transmission owners, loads, and regulators.

- **Metcalf Energy Center. 1999 - 2001.** The Metcalf Energy Center is a 600 MW combined cycle generator project in southern San Jose, California. Responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject areas of Alternatives, Transmission System Engineering and Local System Effects. The Local System Effects testimony was based on studies performed by Mr. Mackin (with assistance from CEC Staff) to determine the local and regional electrical benefits that would result from the construction and operation of the Metcalf Energy Center.

- **Moss Landing Power Plant Project. 1999 - 2000.** The Moss Landing Power Plant Project is a 1060 MW combined cycle generator project currently operating east of Moss Landing, California. Was responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject area of Transmission System Engineering.

- **Computer Model Development. 1999.** Developed an "EPCL" model for the GE PSDS program to simulate the fast governor response of the Humboldt Bay Power Plant to system line faults or system under-frequency events. This model was required to correctly model the power system in PG&E's Humboldt Division, and use of this model allows for more accurate unit commitment in the area.

- **Three Mountain Power Project. 1998 - 2001.** The Three Mountain Power Project was a proposed 500 MW combined cycle generator project located in Burney, California. Was responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject area of Transmission System Engineering. Also assisted in negotiations between TANC, PG&E, and TMPP, regarding the issues of congestion management, curtailment priorities, and Existing Transmission Contracts.

- **Delta Energy Center. 1998 - 2001.** The Delta Energy Center is an 880 MW combined cycle generator project located in Pittsburg, California. Was responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject area of Transmission System Engineering. Also worked with PG&E and Calpine to develop additional mitigation plans to allow the full output of the plant to be available to serve load following system condition changes that were not studied in the system impact and facility studies.

- **Los Medanos Energy Center (a. k. a., Pittsburg District Energy Facility). 1998 - 2001.** The Los Medanos Energy Center is a 555 MW combined cycle generator project currently operating in Pittsburg, California. Was responsible for reviewing all system impact and facility studies associated with this project to make sure that the project would meet all applicable local and regional reliability criteria. In addition, provided expert witness testimony before the California Energy Commission in the subject area of Transmission System Engineering. Also worked with PG&E and Calpine to develop operating procedures to allow the full output of the plant to be available to serve load following system condition changes that were not studied in the system impact and facility studies.

- **Transmission Expansion Plans. 1998 - 2000.** Responsible for reviewing transmission studies and recommended transmission expansion plans for various areas of the ISO controlled grid. For the 1999 Transmission Expansion Plan, reviewed studies and recommended transmission expansion plans for PG&E's North Valley, Sacramento, Sierra, Stockton, Stanislaus, Yosemite, Fresno, and Kern divisions. For the 2000 Transmission Expansion Plan, reviewed studies and recommended transmission expansion plans for PG&E's Humboldt, North Valley, Sacramento, Sierra, Stockton, and Stanislaus divisions.

- **1998 Reliability Must Run Study. 1997 - 1998.** Performed all analyses to determine the minimum generation requirements for the Humboldt, North Valley, Sacramento, Sierra, North Bay and North Coast divisions of Pacific Gas and Electric Co. This work involved steady state power flow, voltage stability and transient stability analyses. The results of these studies were used by the California ISO Board of Governors to determine the RMR requirements for the ISO control area and to designate generators that would become RMR units for each year. In addition, evaluated proposals for Local Area Reliability Services (LARS) that could serve as alternatives to RMR contracts for maintaining system reliability. These alternatives were evaluated based on, among other criteria, effectiveness, cost, environmental impact, safety, and impact on markets.

- **Alturas Project. 1997 - 1998.** Represented the ISO on the WSCC review group reviewing the system studies for the Alturas Transmission Project. The Alturas Transmission Project is a 345-kV transmission line that runs from Hilltop substation in northern California to Valley Road Substation west of Reno, NV. As the ISO representative, had significant input into ISO policy regarding the Alturas Transmission Project and its effects on other transfer paths in the WSCC.

Pacific Gas and Electric Company **1983-1997**

- **Simultaneous Transfer Limit Studies. 1997.** Served as a PG&E representative on Operating Capability Study Group (OCSG), a work group of utility engineers that was formed following the major WSCC system disturbances on July 2, July 3, and August 10, 1996. The OCSG developed modeling and study methodologies to ensure that simultaneous transfer limits determined from the studies would be conservative and not result in system collapse if a major disturbance were to occur while operating at the determined limits.

- **Area Planning. 1995 - 1997.** Responsible for all Area Transmission planning activities for PG&E's North Valley Division. This work included forecasting division transmission loads, base case development, contingency analysis, problem identification, solution development, and recommendation to Management on the appropriate projects to maintain system reliability.

- **Transmission Oriented Production Simulation. 1993 - 1994.** Lead PG&E representative on the WSCC Transmission Oriented Production Simulation Program Development Task Force. This task force developed a recommendation to WSCC management regarding program requirement to accurately model transmission system constraints in a production simulation program. In addition, this task force evaluated products on the market or under development to develop a recommendation to WSCC management regarding program packages that could potentially meet the requirements developed in the first recommendation.

- **California Simultaneous Import Studies. 1991 - 1994.** Performed, supervised or reviewed operating studies to determine simultaneous import capabilities into California from the Pacific Northwest and the Desert Southwest. For two years, served as chairman of the work group that undertook these studies. The study work group was comprised engineers from utilities in California, the Northwest, the Rocky Mountain region, and the Southwest.

- **California - Oregon Transmission Project. 1985 - 1993.** Was the lead transmission planning engineer for PG&E performing transient stability simulations for the 500-kV California - Oregon Transmission Project. The California - Oregon Transmission Project is a 340-mile, 500-kV transmission line between Oregon and California. This project was placed in service in March of 1993.

- **Computer Model Development. 1985 - 1995.** Helped develop a revised Static VAr Compensator model for the WSCC transient stability program. This revised model incorporated a non-windup limiter on the firing angle control of the SVC. Also helped develop the "MaxFlow" program. This program is a DC power flow model that uses linear programming techniques to determine the maximum flow on any particular system element for any possible combination of a defined list of system inputs. This model is especially useful in determining the system impact of transmission contracts that allow any load to be served from any generation source.

Power Systems Analysis Tools

- General Electric PSLF/PSDS - 12 *Years*
- WSCC Interactive Power Flow System (IPS) and WSCC Stability - *12 Years*

- Power Technologies, Inc. PSS/E - *2 Years*

Professional Associations and Committee Memberships

- Registered Professional Electrical Engineer, California, 1985 - Present
- WECC Transmission Expansion Planning Policy Committee, 2014 - Present
- WECC Planning Coordination Committee, Member, 2004 - 2014
- WECC Joint Synchronized Information Subcommittee, 2009 - Present
- WECC Disturbance Monitoring Work Group, Chair, 2004 - 2007
- WECC Disturbance Monitoring Work Group, Member, 2004 - 2009
- WECC/WSCC Technical Studies Subcommittee, Member, 2001 - 2005
- WSCC Modeling and Validation Work Group, Member, 1997 - 2001
- Sacramento Area Transmission Planning Group, Member, 1998 - 2001
- Sacramento Valley Study Group, Member, January 1999 - 2001
- Operating Capability Study Group (OCSG), Member, 1997
- Operating Studies Subcommittee (OSS), Member, 1994 -1997, 2001 - 2006
- WSCC Transmission Oriented Production Simulation Program T.F., Member, 1993-1994
- WSCC PAST Technical Studies Work Group, Chairman, 1991-1992
- WSCC PAST Subcommittee, Member, 1991-1992
- WSCC PAST Study Methodology Review Work Group, Member, 1991-1994
- WSCC Program Work Group, Member, 1985-1990
- IEEE Power Engineering Society, Member and Senior Member, 1983 - Present

Publications and Presentations

"Dynamic Simulations Studies of the Frequency Response of the Three U.S. Interconnections with Increased Wind Generation," P. Mackin, R. Daschmans, B. Williams, B. Haney, R. Hunt, and J. Ellis, Lawrence Berkeley National Laboratory, Berkeley, CA, LBNL-4146E, 2010.

"An Interim Dynamic Induction Motor Model For Stability Studies in the WECC" L. Pereira, D. Kosterev, P. Mackin, D. Davies, J. Undrill, and W. Zhu, IEEE Transactions on Power Systems, pgs 1108-1115, November 2002

"Grid Planning and Generator Interconnection in California", P. Mackin, EUCI Congestion Management Conference, Denver, CO; June 22-23, 2000

"Power System Stability Controls in a Restructured Industry - The California ISO Perspective", P. Mackin, IEEE/PES 1998 Summer Power Meeting, San Diego, CA; July 13-17, 1998

"Subtransmission Reduction For Voltage Instability Analysis"; J. McCalley, J. Dorsey, J. Luini, P. Mackin, G. Molina; IEEE/PES 1992 Winter Power Meeting; New York, NY; January 26-30, 1992

Lakshmi Alagappan

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Managing Consultant

Ms. Alagappan joined E3 in 2008 and her work has focused on the Transmission Planning and Pricing, Renewables and Emerging Technologies, and Emerging Technology Strategy practice areas. She works extensively with transmission developers and guides them through the transmission planning process in California. In addition to her transmission planning work, she provides market valuation and strategy analysis for developers, utilities, and government agencies. Her recent clients include TransCanyon Pacific Gas & Electric Company, Northern Tier Transmission Group, Sempra Energy, AltaLink, Hydro-Quebec TransEnergie, and the World Bank. Among the many projects worked on, Ms. Alagappan has:

- Led the benefits analyses for two transmission projects, including the first economically driven transmission project in California, that were recently approved by the CAISO .
  - Gates-Gregg 230kV transmission project in CAISO's 2012-2013 TPP
  - Delaney-Colorado River 500kV transmission project in CAISO's 2013-2014 TPP
- Assisted California IOUs in a joint Long Term Procurement Planning (LTPP) filing to determine system need for capacity.
- Conducted a multi-jurisdiction survey to understand the transmission barriers to renewable energy development in industrialized countries, focusing on cost allocation procedures in transmission interconnection policies.
- Performed market valuation for energy storage technologies and analyzed the regulatory framework under which they could participate in wholesale energy markets in the U.S.

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Intern Summer 2007

- Researched transmission interconnection and service policies for wind generators in North America.
- Research required extensive reading of government orders (particularly from the Federal Energy Regulatory Commission)

NATURAL RESOURCES DEFENSE COUNCIL (NRDC)
AIR AND ENERGY DIVISION Washington, D. C.
MAP Sustainable Energy Fellow Summer 2006

- Helped create a campaign to endorse oil savings policy in a road tour through the Midwest.
- Wrote a report on U.S. state oil intensities as a measure of economic vulnerability.

CONSUMER ENERGY COUNCIL OF AMERICA (CECA) Washington, D. C.
Energy Research and Policy Intern Summer 2005

- Helped with writing and researching white papers for CECA's Fuels and Technologies Forum.

Education

Stanford University Palo Alto, CA
M. S. Civil and Environmental Engineering June 2008
Atmosphere/Energy Program

Stanford University Palo Alto, CA
B. A. Economics/Minor in Human Biology June 2007
Honors in Environmental Science, Technology and Policy

Citizenship

United States

Refereed Papers

1. Alagappan, L., C.K. Woo, R. Orans (2011) "What Drives Renewable Energy Development?" Energy Policy, 39:9, 5099-5104.

Jack Moore

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Director, Transmission Analysis

Mr. Moore joined E3 in 2006 and his work focuses on the practice areas of Transmission Planning and Pricing, Renewables and Emerging Technology, and Energy and Climate Policy. He has worked extensively on projects to analyze the impact of transmission development and policy on energy planning decisions related to reliability, economics, and renewable resource development throughout the Western United States and Canada. His clients include the California ISO, the California Public Utilities Commission, the Western Electric Coordinating Council (WECC), Bonneville Power Administration, BrightSource Energy, British Columbia Hydro and Power Authority, Electric Power Research Institute, and the State Of Idaho. Mr. Moore holds both a B.A. degree in Economics and a M.S. degree in Management Science Engineering from Stanford University. At E3, Mr. Moore has:

- Managed a two phase assessment of the potential benefits of implementing 5-minute energy imbalance market (EIM) across the Western Interconnection (excluding CAISO and AESO) for the WECC. Created multiple production simulation cases and sensitivity analyses based on stakeholder input and used cases to analyze potential savings in generator production costs for 2020 as a result of potential energy imbalance market.
- Led a screening-level non-wires alternatives analysis of the potential for economic energy efficiency, demand response and distributed generation to defer the need for a 500-kV transmission project in the Pacific Northwest.
- Provided strategic transmission advice regarding siting and timing of upgrades for developer projects, including assessing curtailment risks and the cost of wheeling power.
- Assessed the potential savings for renewable energy procurement that could be enabled by long-distance multi-jurisdictional transmission lines for *Load-Resource Balance in the Western Interconnection: Towards 2020*, a study of west-wide infrastructure needs for achieving aggressive RPS and greenhouse gas reduction goals in 2020 for the Western Electric Industry Leaders (WEIL) Group, comprised of CEOs and executives from a number of utilities in the West
- Conducted screening studies of long-distance transmission lines to connect to remote renewable energy zones for PG&E, BPA, and British Columbia Hydro and Power Authority
- Created renewable resource supply curves based on a standardized set of costing assumptions and public data and integrated supply curve modeling results into E3's Greenhouse Gas Calculator for the California PUC and California Energy Commission to assess the cost to comply with AB32, California's greenhouse gas compliance law.
- Assisted in California ISO evaluation of economic and reliability benefits provided by SDG&E's proposed Sunrise 500 kV Transmission line. Calculated value of the renewable resources that the project enables for development based on their contribution towards state RPS requirements, and assessed their renewable procurement benefits relative to other resource options.

- Provided research and visual presentations of energy information to assist the Idaho Legislative Council Interim Committee on Energy, Technology and the Environment in developing the 2007 Idaho Energy Plan.
- Designed optimized sensitivity analysis and user interface, and authored comprehensive user guide for EPRI-sponsored Energy Storage Valuation Tool (ESVT) software, which uses a multiple stakeholder perspective to assess the energy economics and system avoided costs enabled by the use of energy storage devices. Led case studies with multiple utilities to use the Tool to evaluate storage demonstration projects.

ELECTRIC POWER RESEARCH INSTITUTE — Palo Alto, CA
Graduate Student Researcher, Climate Team — Summer 2009

- Modeled the impact and value that improved low-carbon generation technologies would create for U.S. and other regions to meet deep greenhouse gas mitigation targets using EPRI's MERGE (Model for Estimating the Regional and Global Effects of Greenhouse Gas Reductions) Model.
- Analyzed long-term economic effect and mitigation costs dynamics that would result from China, India, and other developing nations joining a regime to mitigate climate change on an accelerated or delayed timetable.

CORNERSTONE RESEARCH — Menlo Park, CA
Senior Analyst — 2003-2006

- Played key role on case teams which provided economic and financial analysis of liability and damage issues arising in commercial litigation to support experts, attorneys and their client companies. Tasks included: generation of ideas for conceptualization of research agenda, creation of trial presentations and expert report exhibits, and management of junior analysts.
- Provided thorough analysis of anti-trust and accounting-related commercial issues for industries including healthcare, real-estate, alternative fuels, software, and consumer products.
- Developed and executed activity-based costing model of consolidated real estate organization's profitability if it had been operating as multiple regional separate entities; model used to assess claims that firm overcharged customers for services provided.

DYNEGY, INC. — Houston, TX
Summer Intern — 2001

Supported natural gas trading desk traders by implementing Excel macro-based tool to verify and track natural gas futures and options trades, and provided natural gas market data research.

Education

Stanford University — Palo Alto, CA
M.S. Management Science and Engineering — 2009

Stanford University — Palo Alto, CA
B. A. Economics with Departmental Honors — 2003
Anna Laura Myers Award for Outstanding Honors Thesis, "Long-Term Consequences of Youth Unemployment"

Citizenship

United States

Refereed Papers

1. *Williams, J.H., A. DeBenedictis, R. Ghanadan, A. Mahone, J. Moore, W. Morrow, S. Price, and M.S. Torn (2012). The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity, Science, 335, 53-59.*

2. *Woo, C.K., I. Horowitz, J. Zarnikau, J. Moore, B. Schneiderman, T. Ho, and E. Leung (2015). What Moves the Ex Post Variable Profit of Natural-Gas-Fired Generation in California?, The Energy Journal, Forthcoming.*

3. *Orans, R., A. Olson, J. Moore, J. Hargreaves, R. Jones, G. Kwok, F. Kahrl and C.K. Woo (2013) "Energy Imbalance Market Benefits in the West: A Case Study of PacifiCorp and CAISO," The Electricity Journal, 26(5), 26-36.*

4. *Woo, C.K., H. Liu, F. Kahrl, N. Schlag, J. Moore, and A. Olson (2012) "Assessing the Economic Value of Transmission in Alberta's Restructured Electricity Market," The Electricity Journal, 25:3, 68-80.*

5. *Woo, C.K., I. Horowitz, J. Moore, and A. Pacheco (2011) "The impact of wind generation on the electricity spot-market price level and variance: The Texas experience," Energy Policy, 39:7, 3939-3944.*

6. *Woo, C.K., J. Zarnikau, J. Moore, and I. Horowitz (2011) "Wind generation and zonal-market price divergence: Evidence from Texas," Energy Policy, 39:7, 3928-3938.*

7. *DeBenedictis A., D. Miller, J. Moore, A. Olson, and C.K. Woo (2011) "How Big Is the Risk Premium in an Electricity Forward Price? Evidence from the Pacific Northwest," Electricity Journal, 24:3, 72-76.*

8. *Woo C.K., I. Horowitz, A. DeBenedictis, D. Miller, and J. Moore (2011) "Cross-Hedging and Forward-Pricing of Electricity in the Pacific Northwest," Managerial and Decision Economics, 32, 265-279.*

9. *Moore, J., C.K. Woo, B. Horii, S. Price, A. Olson (2010) "Estimating the Option Value of a Non-firm Electricity Tariff," Energy, 35, 1609-1614.*

10. *Olson A., R. Orans, D. Allen, J. Moore, and C.K. Woo (2009) "Renewable Portfolio Standards, Greenhouse Gas Reduction, and Long-line Transmission Investments in the WECC," Electricity Journal, 22:9, 38-46.*

11. *Orans, R., S. Price, J. Williams, C.K. Woo, and J. Moore (2007) "A Northern California-British Columbia partnership for renewable energy", Energy Policy, 35, 3979-3983.*

Arne Olson

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Partner

Since joining E3 in 2002, Mr. Olson has been a lead in the practice areas of Resource Planning; Renewables and Emerging Technology; Transmission Planning and Pricing; and Energy and Climate Policy. He is an expert in evaluating the impacts of aggressive state and federal policies to promote clean and renewable energy production. He led the technical analysis and drafting of the recent report *Investigating a Higher Renewable Portfolio Standard for California*, prepared for the five largest utilities in California. He led a multi-company team that developed the Renewable Energy Flexibility (REFLEX) Model, a new stochastic production simulation model that calculates the need for power system flexibility under high renewable penetration, which was used for the California utility report as well as for separate renewable integration analysis performed on behalf of the California ISO. He has led numerous other resource planning studies on behalf of utilities, government agencies and electricity consumers, including studies of a 33% RPS for the California Public Utilities Commission and multiple studies of the economic benefits of long-line transmission projects. In 2007, he served as advisor, facilitator and drafter to the Idaho Legislature in developing the 2007 Idaho Energy Plan, the state of Idaho's first comprehensive, state-wide energy plan in 25 years. His clients include the California Independent System Operator, California Public Utilities Commission, Colorado Public Utilities Commission, the Western Electric Coordinating Council, the Western Electric Industry Leaders' Group, the Western Interstate Energy Board, the City of Seattle, Pacific Northwest Generating Cooperative, Mid-American, AltaLink, Pacific Gas & Electric Company, Southern California Edison Company, the Sacramento Municipal Utilities District, the Bonneville Power Administration, TransElect, BC Hydro, and Hydro-Quebec TransEnergie.

Resource Planning and Valuation:

- Currently leading a team that is evaluating the need for flexible generation capacity on behalf of Portland General Electric.
- Led a team that assessed electricity-natural gas infrastructure issues on behalf of the Western Interstate Energy Board.
- Led a team that investigated the capacity contribution of new wind, solar and demand response (DR) resources on behalf of the Sacramento Municipal Utilities District.
- Assisted the Colorado Public Utilities Commission in developing long-term scenarios to use across a range of energy infrastructure planning dockets.
- Assisted BC Hydro in evaluating the impact of BC's provincial greenhouse gas reduction policies on future electric load as part of BC Hydro's 2011 Integrated Resource Plan.
- Provided expert testimony in front of the California Public Utilities Commission on rates and revenue requirements associated with several alternative portfolios of demand-side and supply-side resources, on behalf of Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas & Electric.

- Served as lead investigator in assisting the California Public Utilities Commission (CPUC) in its efforts to reform the long-term procurement planning process in order to allow California to meet its aggressive renewable energy and greenhouse gas reduction policy goals.
- Prepared an integrated resource plan (IRP) on behalf of Umatilla Electric Cooperative, a 200-MW electric cooperative based in Hermiston, Oregon. The IRP considered a number of different resource and rate product options, and addressed ways in which demand-side measures such as energy efficiency, distributed generation and demand response can help UEC reduce its wholesale energy and bulk transmission costs.
- Served as lead investigator in developing integrated resource plans for numerous publicly-owned utilities including PNGC Power, Lower Valley Energy, and Platte River Power Authority.
- Provided generation and transmission asset valuation services to a number of utility and independent developer clients.

Renewables and Emerging Technology:

- Currently leading a team that is advising Portland General Electric Company on potential strategies for cost-effective procurement of distributed or utility scale solar generation.
- Currently leading a team that is evaluating flexible capacity needs under high renewable penetration across the Western Interconnection on behalf of the Western Electric Coordinating Council and the Western Interstate Energy Board. The team includes technical contributions from E3, NREL and Energy Exemplar.
- Led the technical analysis and drafting of the influential report *Investigating a Higher Renewable Portfolio Standard for California*. The report evaluated the operational challenges, costs and solutions for integrating a 40% or 50% Renewable Portfolio Standard on behalf of the five largest utilities in California.
- Led the team that developed the Renewable Energy Flexibility (REFLEX) model, commercial software that assesses power system flexibility needs under high renewable penetration.
- Led the team that developed the Renewable Energy Capacity Planning (RECAP) model, commercial software that calculates reliability metrics such as Loss of Load Probability (LOLP), Loss of Load Expectation (LOLE) and Planning Reserve Margin (PRM), along with Effective Load-Carrying Capability (ELCC) of wind and solar resource, demand response programs, and other dispatch-limited resources.
- Currently advising the CPUC on renewable energy resource policy and procurement.
- Currently leading the California Independent System Operator's (CAISO) renewable integration needs studies. The studies are evaluating the need for firming capacity and flexible resources to accommodate the variable and unpredictable nature of wind and solar generation. Results of the studies will be used to determine the need to procure new, flexible resources.
- Led the team that developed renewable and conventional resource cost and performance characteristics for use in the WECC's Regional Transmission Expansion Planning process.
- On behalf of the Wyoming Governor's Office, developed a model of the cost of developing wind resources in Wyoming relative to neighboring states to inform policy debate regarding taxation. The model included detailed representations of state-specific taxes and capacity factors.
- On behalf of the CPUC, investigated a number of strategies for achieving a 33% Renewables Portfolio Standard in California by 2020, and estimated their likely cost and rate impacts using the 33% RPS Calculator, a publicly-available spreadsheet model developed for this project.
- Evaluated market opportunities and provided strategic advice for renewable energy developers in California and the Southwest.

- Investigated for Bonneville Power Administration (BPA) the economics and feasibility of investing in new, long-line transmission facilities connecting load centers in the Pacific Northwest with remote areas that contain large concentrations of high-quality renewable energy resources. The study informed BPA about cost-effective strategies for procuring renewable energy supplies in order to meet current and potential future renewable renewables portfolio standards and greenhouse gas reduction targets.
- Co-authored *Load-Resource Balance in the Western Interconnection: Towards 2020*, a study of west-wide infrastructure needs for achieving aggressive RPS and greenhouse gas reduction goals in 2020 for the Western Electric Industry Leaders (WEIL) Group, comprised of CEOs and executives from a number of utilities through the West, and presented results indicating that developing new transmission infrastructure to integrate remote renewable resources can result in cost savings for consumers under aggressive policy assumptions.

Transmission Planning and Pricing:

- Currently serving as technical support to the Western Electric Coordinating Council's Scenario Planning Steering Group (SPSG). The SPSG is developing scenarios for long-term transmission planning in the Western Interconnection.
- Currently advising several transmission developers seeking approval for projects through the CAISO's Transmission Planning Process.
- Led a team that investigated the use of Production Cost Modeling for the purpose of allocating costs of new transmission facilities on behalf of the Northern Tier Transmission Group, and contributed to NTTG's Order 1000 compliance filing.
- Served as an expert witness in front of the Alberta Utilities Commission in a case regarding the Alberta Electric System Operator's proposed methodology for allocating Available Transmission Capacity among interties during times of congestion.
- Led studies in 2009, 2011 and 2012 to develop generation and transmission capital cost assumptions for use in WECC's Transmission Expansion Planning and Policy Committee (TEPPC) studies.
- Contributed to a study of the benefits of North-South transmission expansion in Alberta on behalf of AltaLink.
- Led a study for WECC to estimate the benefits of developing a centralized Energy Imbalance Market (EIM) across the Western Interconnection. The study estimated benefits due to increased generation dispatch efficiency resulting from reduced market barriers and increased load and resource diversity among western Balancing Authorities. Led several follow-up studies of alternative Western EIM footprints for potential EIM participants.
- Retained by a consortium of southwestern utilities and state agencies including the Wyoming Infrastructure Authority, Xcel Colorado, Public Service Company of New Mexico, and the Salt River Project to perform an economic feasibility study of the proposed High Plains Express (HPX) transmission project, a roadmap for transmission development in the Desert Southwest and Rocky Mountain regions.
- Provided assistance to the Seattle City Council to develop guidelines for the evaluation of large electric distribution and transmission projects by Seattle City Light (SCL). Guidelines specified the types of evaluations SCL should perform and the information the utility should present to the City Council when it seeks approval for large distribution or transmission projects.
- Conducted screening studies of long-distance transmission lines connecting to remote renewable energy zones for multiple western utilities.

- Assisted in the development of a methodology for evaluating the renewable energy benefits of the Sunrise Powerlink transmission project in support of expert testimony on behalf of the California ISO.
- Assisted British Columbia Transmission Corporation and Hydro-Quebec TransEnergie with open access transmission tariff design.
- Represented BC Hydro in RTO West market design process in areas of congestion management, ancillary services, and transmission pricing.

Energy and Climate Policy:

- Developed policy themes and integrated them into the four long-term planning scenarios under consideration by WECC's Scenario Planning Steering Group.
- Led a team that developed a model of deep carbon dioxide emissions reductions scenarios in the western United States and Canada on behalf of the State-Provincial Steering Committee, a body of western state and provincial officials that provides oversight for WECC.
- Led a study of likely changes to power flows and market prices at western electricity trading hubs following California's adoption of a cap-and-trade system for regulating greenhouse gas emissions in 2013.
- Served as advisor, facilitator and drafter to the Interim Committee in developing Idaho's first comprehensive, statewide energy plan in 25 years. The Interim Committee and subcommittees held 18 days of public meetings and received input from dozens of members of the public in developing state-level energy policy recommendations. This process culminated in Mr. Olson drafting the 2007 Idaho Energy Plan, which was approved by the Legislature and adopted as the official state energy plan in March 2007.
- Developed a model that forecasted renewable and conventional generating resources in the WECC region in 2020 as part of an E3 project to advise the California Public Utilities Commission, California Energy Commission and California Air Resources Board about the cost and feasibility of reducing greenhouse gas emissions in the electricity and natural gas sectors.

WASHINGTON OFFICE OF TRADE AND ECONOMIC DEVELOPMENT Olympia, WA
Senior Energy Policy Specialist 1996-2002

- **Electricity Transmission**: Lead responsibility for developing and representing agency policy interests in a variety of regional forums, with a primary focus on pricing and congestion management issues. Lead negotiator on behalf of agency in IndeGO and RTO West negotiations in areas of Congestion Management, Ancillary Services, and Transmission Planning. Participated in numerous subgroups developing issues including congestion zone definition, nature of long-term transmission rights, and RTO role in transmission grid expansion.
- **Western Regional Transmission Association, 1996-2001:** Member, WRTA Board of Directors. Participated in WRTA Tariff, Access and Pricing Committee. Participated in sub-groups examining "seams" issues among multiple independent system operators in the West and developing a proposal for tradable firm transmission rights in the Western Interconnection.
- **Wholesale Energy Markets:** Monitored and analyzed trends in electricity, natural gas and petroleum markets. Editor and principal author of Convergence: Natural Gas and Electricity in Washington, a survey of the Northwest's natural gas industry in the wake of the extreme price events of winter 2000-2001, and on the eve of a significant increase in demand due to gas-fired power plants. Authored legislative testimony on the ability of the Northwest's natural gas industry to meet the demand from new, gas-fired power plants.

- **Electricity Restructuring:** Co-authored Washington Electricity System Study, legislatively-mandated study of Washington's electricity system in the context of ongoing trends and potential methods of electric industry restructuring. Authored legislative testimony on the impact of restructuring on retail electricity prices in Washington, electric industry restructuring and Washington's tax system, and the interactions between restructured electricity and natural gas markets.
- **Energy Data:** Managed three-person energy data team that collected and maintained a repository of state energy data. Developed Washington's Energy Indicators, a series of policy benchmarks and key trends for Washington's energy system; second edition published in January 2001.

DECISION ANALYSIS CORPORATION OF VIRGINIA — Vienna, VA
Associate — 1993-1996

- **Energy Modeling and Analysis:** Developed energy demand forecasting models for Energy Information Administration's National Energy Modeling System. Results are published each year in EIA's Annual Energy Outlook.

Education

University of Pennsylvania — Philadelphia, PA
Institut de Francais du Petrole — Rueil-Malmaison, France
M.S., International Energy Management & Policy

University of Washington — Seattle, WA
B.S., Mathematical Sciences, B.S. Statistics

Citizenship

United States

Expert Witness Testimony

1. *Province of Ontario, Commercial Arbitration, 2015, testified regarding policies related to renewable energy procurement and determination of available transmission capacity.*

2. *California Energy Commission, 2014, testified on behalf of Abengoa and BrightSource Energy regarding the cost and feasibility of distributed generation and energy storage alternatives to a large, concentrating solar power plant project in the context of a power plant siting case.*

3. *California Energy Commission, 2013, testified on behalf of BrightSource Energy regarding the cost and feasibility of distributed generation alternatives to a large, concentrating solar power plant project in the context of a power plant siting case.*

4. *Alberta Electric Utilities Commission, 2012, testified on behalf of Powerex Corporation reviewing industry practices regarding treatment of existing transmission capacity, in the case when new transmission lines are interconnected.*

5. *California Public Utilities Commission, 2011, provided testimony on behalf of Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company regarding cost, revenue requirement, average retail rates, and cost of carbon reductions from alternative resource portfolios in the Long-Term Procurement Planning Proceeding.*

6. *California Energy Commission, 2010, testified on behalf of BrightSource Energy regarding the cost and feasibility of distributed generation alternatives to a large, concentrating solar power plant project in the context of a power plant siting case.*

Refereed Papers

1. *C.K. Woo, J. Moore, B. Schneiderman; A. Olson; R. Jones; T. Ho; N. Toyama; J. Wang; and J. Zarnikau, "Merit-order Effects of Day-ahead Wind Generation Forecast in the Hydro-rich Pacific Northwest", The Electricity Journal, forthcoming*

2. *Olson, A., R. Jones, E. Hart and J. Hargreaves, "Renewable Curtailment as a Power System Flexibility Resource," The Electricity Journal, Volume 27, Issue 9, November 2014, pages 49-61*

3. *Hargreaves, J., E. Hart, R. Jones and A. Olson, "REFLEX: An Adapted Production Simulation Methodology for Flexible Capacity Planning," IEEE Transactions on Power Systems, Volume:30, Issue: 3, September 2014, pages 1306 - 1315*

4. *C.K. Woo, T. Hob, J. Zarnikau, A. Olson, R. Jones, M. Chait, I. Horowitz, J. Wang, "Electricity-market price and nuclear power plant shutdown: Evidence from California", Energy Policy,* 2014, vol. 73, issue C, pages 234-244

5. *Woo, C.K., Zarnikau J, Kadish J, Horowitz I, Wang J, Olson A. (2013) "The Impact of Wind Generation on Wholesale Electricity Prices in the Hydro-Rich Pacific Northwest," IEEE Transactions on Power Systems, 28(4), 4245-4253.*

6. *Olson A., R. Jones (2012) "Chasing Grid Parity: Understanding the Dynamic Value of Renewable Energy," Electricity Journal, 25:3, 17-27.*

7. *Woo, C.K., H. Liu, F. Kahrl, N. Schlag, J. Moore and A. Olson (2012) "Assessing the economic value of transmission in Alberta's restructured electricity market," Electricity Journal, 25(3): 68-80.*

8. *DeBenedictis, A., D. Miller, J. Moore, A. Olson, C.K. Woo (2011) "How Big is the Risk Premium in an Electricity Forward Price? Evidence from the Pacific Northwest," Electricity Journal, 24:3, 72-76.*

9. *Woo, C.K., I. Horowitz, A. Olson, A. DeBenedictis, D. Miller and J. Moore (2011) "Cross-Hedging and Forward-Contract Pricing of Electricity in the Pacific Northwest," Managerial and Decision Economics, 32, 265-279.*

10. *Moore, J., C.K. Woo, B. Horii, S. Price and A. Olson (2010) "Estimating the Option Value of a Non-firm Electricity Tariff," Energy, 35, 1609-1614.*

11. *Olson A., R. Orans, D. Allen, J. Moore, and C.K. Woo (2009) "Renewable Portfolio Standards, Greenhouse Gas Reduction, and Long-line Transmission Investments in the WECC," Electricity Journal, 22:9, 38-46.*

12. *Moore, J., C.K. Woo, B. Horii, S. Price, A. Olson (2009) "Estimating the Option Value of a Non-firm Electricity Tariff," Energy, 35, 1609-1614.*

13. *Woo, C.K., I. Horowitz, N. Toyama, A. Olson, A. Lai, and R. Wan (2007) "Fundamental Drivers of Electricity Prices in the Pacific Northwest," Advances in Quantitative Analysis of Finance and Accounting, 5, 299-323.*

14. *Lusztig, C., P. Feldberg, R. Orans, and A. Olson (2006) "A survey of transmission tariffs in North America," Energy-The International Journal 31, 1017-1039.*

15. *Woo, C.K., A. Olson, I. Horowitz and S. Luk (2006) "Bi-directional Causality in California's Electricity and Natural-Gas Markets," Energy Policy, 34, 2060-2070.*

16. *Woo, C.K., I. Horowitz, A. Olson, B. Horii and C. Baskette (2006) "Efficient Frontiers for Electricity Procurement by an LDC with Multiple Purchase Options," OMEGA, 34:1, 70-80.*

17. *Woo, C.K., A. Olson and I. Horowitz (2006) "Market Efficiency, Cross Hedging and Price Forecasts: California's Natural-Gas Markets," Energy, 31, 1290-1304.*

18. *Woo, C.K., A. Olson and R. Orans (2004) "Benchmarking the Price Reasonableness of an Electricity Tolling Agreement," Electricity Journal, 17:5, 65-75.*

19. *Orans, R., A. Olson, C. Opatrny, Market Power Mitigation and Energy Limited Resources, Electricity Journal, March, 2003.*

Selected Public Presentations

1. *"Planning for Variable Generation Integration Needs", invited panelist, Utility Variable-generation Integration Group, Operating Impact And Integration Studies Users Group Meeting, San Diego, California, October 13, 2015*

2. *"The Role of Renewables in a Post-Coal World", invited panelist, Energy Foundation, Beyond Coal to Clean Energy Conference, San Francisco, California, October 9, 2015,*

3. *"Implications of a 50% RPS for California", invited panelist, Argus Carbon Summit, Napa, California, October 6, 2015*

4. *"Western EIM: Status Report and Implications for Public Power", Keynote speaker, Large Public Power Council meeting, Seattle, Washington, September 16, 2015*

5. *"California's 50% RPS Goal: Opportunities for Western Wind Developers", Keynote speaker at a meeting of the Wyoming Infrastructure Authority, Berkeley, California, July 28, 2015*

6. *"Western Interconnection Flexibility Assessment", Western Electric Coordinating Council Board of Directors, Salt Lake City, Utah, June 24, 2015*

7. *"California's New GHG Goals: Implications for the Western Electricity Grid", invited panelist, National Association of State Energy Officials, Western Regional State and Territory Energy Office Meeting, Portland, Oregon, May 14, 2015*

8. *"Replacing Aging Fossil Generation," invited panelist, Northwest Energy Coalition NW Clean & Affordable Energy Conference, Portland, Oregon, November 7, 2014*

9. *"Investing in Power System Flexibility," invited panelist, State/Provincial Steering Committee & Committee on Regional Electric Power Cooperation System Flexibility Forum, San Diego, California, October 20, 2014*

10. *"Opportunities and Challenges for Higher Renewable Penetration in California", invited panelist, Beyond 33%: University of California at Davis Policy Forum Series, Sacramento, California, October 17, 2014*

11. *"Renewable Curtailment as a Power System Flexibility Resource," Boise State University Energy Policy Research Conference, San Francisco, California, September 4, 2014*

12. *"Natural Gas Infrastructure Adequacy: An Electric System Perspective", Pacific Northwest Utilities Conference Committee Board of Directors, Portland, Oregon, August 8, 2014*

13. *"The Future of Renewables in the American West," invited panelist, Geothermal Energy Association Annual Meeting, Reno, Nevada, August 6, 2014*

14. *"Long-Term Natural Gas Infrastructure Needs", invited panelist, U.S. Department of Energy Quadrennial Energy Review, Public Meeting #7, Denver, Colorado, July 28, 2014*

15. *"Meeting the Demands of Renewables Integration—New Needs, New Technologies, Emerging Opportunities", invited panelist, InfoCast 2nd Annual California Energy Summit, San Francisco, California, May 28, 2014*

16. *"Power System Flexibility Needs under High Renewables", EUCI Utility Resource Planning Conference, Chicago, Illinois, May 14, 2014*

17. *"Natural Gas Infrastructure Adequacy: An Electric System Perspective", Western Interstate Energy Board Annual Meeting, Denver, Colorado, April 24, 2014*

18. *"Power System Flexibility Needs under High RPS", invited panelist, joint meeting of the Committee on Regional Electric Power Cooperation, State-Provincial Steering Committee and Western Interconnection Regional Advisory Body, Tempe, Arizona, March 26, 2014*

19. *"Natural Gas Infrastructure Adequacy: An Electric System Perspective", joint meeting of the Committee on Regional Electric Power Cooperation, State-Provincial Steering Committee and Western Interconnection Regional Advisory Body, Tempe, Arizona, March 25, 2014*

20. *"Investigating a Higher Renewables Portfolio Standard for California", 19th Annual Power Conference on Energy Research and Policy, University of California Energy Institute, Berkeley, California, March 17, 2014*

21. *"Investigating a 50 Percent Renewables Portfolio Standard in California", invited panelist, Northwest Power and Conservation Council, Portland, Oregon, March 12, 2014*

22. *"Investigating a 50 Percent Renewables Portfolio Standard in California", invited panelist, Western Systems Power Pool, Spring Operating Committee Meeting, Whistler, B.C., March 5, 2014*

23. *"Investigating a Higher Renewables Portfolio Standard for California", invited speaker, Western Electric Coordinating Council, Transmission Expansion Planning and Policy Committee, Salt Lake City, Utah, February 25, 2014*

24. *"Investigating a 50 Percent Renewables Portfolio Standard in California", invited speaker, Committee on Regional Electric Power Cooperation, State-Provincial Steering Committee and Western Interconnection Regional Advisory Body, Webinar, February 12, 2014*

25. *"Flexibility Planning: Lessons From E3's REFLEX Model", EUCI Conference on Fast Ramp and Intra-Hour Market Incentives, San Francisco, California, January 29-30, 2014*

26. *"The Effect of High Renewable Penetration on California Markets and Carbon Balance", EUCI Conference on California Carbon Policy Impacts on Western Power Markets, January 27-28, San Francisco, California, 2014*

27. *"Reliance on Renewables: A California Perspective", invited panelist at Harvard Electricity Policy Group, Seventy-Third Plenary Session, Tucson, Arizona, December 13, 2013*

28. *"The Role of Renewables in Meeting Long-Term Greenhouse Gas Reduction Goals", State Bar Of California, Energy And Climate Change Conference, Berkeley, California, November 14, 2013*

29. *"Benefits, Costs and Cost Shifts from Net Energy Metering", invited expert panelist at Washington Utilities and Transportation Commission Workshop on Distributed Generation, Olympia, Washington, November 13, 2013*

30. *Pacific Northwest Utilities Conference Committee (PNUCC) California Power Industry Roundtable, invited panelist, Portland, Oregon, September 6, 2013*

31. *"After 2020: Prospects for Higher RPS Levels in California", invited speaker at Northwest Power and Conservation Council's California Power Markets Symposium, Portland, Oregon, September 5, 2013*

32. *"Determining Flexible Capacity Needs for the CAISO Area", invited speaker at Northwest Power and Conservation Council's California Power Markets Symposium, Portland, Oregon, September 5, 2013*

33. *"California Climate Policy and the Western Energy System", invited speaker at the Western Interstate Energy Board annual meeting, Reno, Nevada, June 13, 2013*

34. *"Determining Power System Flexibility Need", EUCI Conference on Resource Planning and Asset Valuation, Westminster, Colorado, May 21, 2013*

35. *"California Policy Landscape and Impact on Electricity Markets", EUCI Conference on Resource Planning and Asset Valuation, Westminster, Colorado, May 21, 2013*

36. *"Determining Power System Flexibility Need", EUCI Conference on Fast and Flexi-ramp Resources, Chicago, Illinois, April 23, 2013*

37. *"State-Provincial Steering Committee WECC Low Carbon Scenarios Tool", 3 Interconnections Meeting, Washington, DC, February 6, 2013*

38. *"Distributed Generation Benefits and Planning Challenges", Committee on Regional Electric Power Cooperation/State-Provincial Steering Committee, Resource Planners' Forum, San Diego, California, October 3, 2012*

39. *"Thoughts on the Flexibility Procurement Modeling Challenge", invited speaker at the California Public Utilities Commission, Long-Term Procurement Planning Workshop, San Francisco, California, September 19, 2012*

40. *"Generation Capital Cost Recommendations for WECC 10- and 20-Year Studies", Western Electric Coordinating Council, Transmission Expansion Planning and Policy Committee, Technical Advisory Subcommittee, Webinar, August 15, 2012*

41. *"Renewable Energy Benefits", California Energy Commission, Integrated Energy Policy Report Workshop, Sacramento, California, April 12, 2012*

42. *"The Role of Policy in WECC Scenario Planning", Western Electric Coordinating Council, Scenario Planning Steering Group, San Diego, CA, November 1, 2011*

43. *"WECC Energy Imbalance Market Benefit Study", Western Electric Coordinating Council, Board of Directors, Scottsdale, Arizona, June 22, 2011*

44. *"Renewable Portfolio Standard Model Methodology and Draft Results", California Public Utilities Commission Workshop, San Francisco, California, June 17, 2010*

45. *"Draft Results from 33% Renewable Energy Standard Economic Modeling", California Air Resources Board Workshop, Sacramento, California, May 20, 2010*

46. *"Market Opportunities for IPPs in the WECC", invited speaker at the Independent Power Producers of British Columbia Annual Meeting, Vancouver, British Columbia, November 2, 2009*

47. *"A Low-Transmission Alternative for Meeting California's 33% RPS Target", EUCI Webinar, July 31, 2009*

48. *"Remote Renewable and Low-Carbon Resource Options for the Pacific Northwest", Center for Research on Regulated Industries Conference, Monterey, California, June 19, 2009*

49. *"Engineers are from Mars, Policy-Makers are from Venus: The Effect of Policy on Long-Term Transmission Planning", invited speaker at the Western Electric Coordinating Council Long Term Transmission Planning Seminar, Phoenix, Arizona, February 2, 2009*

50. *"The Long-Term Path to a Stable Climate, and its Implications for BPA", invited speaker at the Bonneville Power Administration Managers' Retreat, Portland, Oregon, April 29, 2008*

51. *"Load-Resource Balance in the Western Interconnection: Towards 2020", Western Electric Industry Leaders Group, Las Vegas, Nevada, January 18, 2008*

52. *"Integrated Resource Planning for BPA Customers", invited speaker at the Bonneville Power Administration Allocation Conference, Portland, Oregon, September 19, 2006*

53. *"Idaho's Current Energy Picture", Energy, Environment and Technology Interim Committee, Boise, Idaho, July 11, 2006*

54. *"Locational Marginal Pricing – The Very Basics", Committee on Regional Electric Power Cooperation, San Diego, California, April 30, 2002*

55. *"Effect of 2000-2001 Energy Crisis on Washington's Economy", Conference on Business Economics, Seattle, Washington, July 19, 2001*

Research Reports

1. *Natural Gas Infrastructure Adequacy in the Western Interconnection: An Electric Sector Perspective, Phase 2, July 2014, project lead and contributing author, https://ethree.com/public_projects/wieb.php*

2. *Natural Gas Infrastructure Adequacy in the Western Interconnection: An Electric Sector Perspective, Phase 1, March 2014, project lead and contributing author, https://ethree.com/public_projects/wieb.php*

3. *Investigating a Higher Renewables Portfolio Standard for California, January 2014, technical lead and lead author, http://www.ethree.com/public_projects/renewables_portfolio_standard.php*

4. *Optimal Investment in Power System Flexibility, E3 White Paper, December 2013, https://ethree.com/documents/Olson_Flexibility_Investment_2013-12-23.pdf*

5. *Cost and Performance Review of Generation Technologies: Recommendations for WECC 10- and 20-Year Study Process, October 2012, editor and contributor,*

http://www.wecc.biz/committees/BOD/TEPPC/TAS/121012/Lists/Minutes/1/121005_GenCapCostReport_finaldraft.pdf.

6. *Economic Assessment of North/South Transmission Capacity Expansion in Alberta, January 2012, contributor.*

7. *WECC EDT, Phase 2 EIM Benefits, Analysis & Results, October 2011, contributor, http://www.wecc.biz/committees/EDT/EDT%20Results/EDT%20Cost%20Benefit%20Analysis%20Report%20-%20REVISED.pdf*

8. *High Plains Express Initiative, Stage 2 Feasibility Report, April 2011, contributor, http://www.highplainsexpress.com/site/stakeholderMeetingDocuments/HPX_Stage-2_Feasibility-report.pdf*

9. *State of Wyoming Wind Energy Costing Model, June 2010, author, http://legisweb.state.wy.us/2010/WyomingWindModel_7_01_2010.pdf*

10. *Recommendations for Documentation of Seattle City Light Energy Delivery Capital Expenditures, February 2010, contributor, http://clerk.seattle.gov/~ordpics/31219exA.pdf*

11. *California Public Utilities Commission, 33% Renewables Portfolio Standard Implementation Analysis, Preliminary Results, June 2009, contributor, http://www.cpuc.ca.gov/NR/rdonlyres/1865C207-FEB5-43CF-99EB-A212B78467F6/0/33PercentRPSImplementationAnalysisInterimReport.pdf*

12. *California Public Utilities Commission, Energy Division Straw Proposal on LTPP Planning Standards, June 2009, contributor, http://www.cpuc.ca.gov/NR/rdonlyres/1865C207-FEB5-43CF-99EB-A212B78467F6/0/33PercentRPSImplementationAnalysisInterimReport.pdf*

13. *California Public Utilities Commission, Survey of Utility Resource Planning and Procurement Practices for Application to Long-term Procurement Planning in California, September 2008, http://www.cpuc.ca.gov/NR/rdonlyres/029611EA-D7C7-4ACC-84D6-D6BA8515723A/0/ConsultantsReportonUtilityPlanningPracticesandAppendices09172008.pdf.*

14. *Remote Renewable and Low-Carbon Resource Options for BPA, May 2008, author, http://www.ethree.com/public_projects/BPA_options.html*

15. *Load-Resource Balance in the Western Interconnection: Towards 2020, Western Electric Industry Leaders Group, January 2008, co-author, http://www.weilgroup.org/E3_WEIL_Complete_Study_2008_082508.pdf*

16. *Umatilla Electric Cooperative 2008 Integrated Resource Plan, January 2009, author.*

17. *Lower Valley Energy 2007 Integrated Resource Plan Update, February 2007, author.*

18. *Idaho Legislative Council Interim Committee on Energy and Technology and Energy and Environmental Economics, Inc., 2007 Idaho Energy Plan, January 2007. http://www.legislature.idaho.gov/sessioninfo/2007/energy_plan_0126.pdf*

19. *Base Case Integrated Resource Plan for PNGC Power, April 2006, author.*

20. *Integrated Resource Planning for Coos-Curry Electric Cooperative, August 2005, author.*

21. *Integrated Resource Planning for Lower Valley Energy, December 2004, author.*

22. *"A Forecast Of Cost Effectiveness: Avoided Costs and Externality Adders", prepared for the California Public Utilities Commission, February 2004, contributor.*

23. *Stepped Rate Design Report, prepared for BC Hydro and filed with the BCUC, May 2003, contributor.*

24. *Convergence: Natural Gas and Electricity in Washington, editor and principal author. Washington Office of Trade and Economic Development, May 2001. http://www.energy.cted.wa.gov/Papers/Convergence.htm*

25. *2001 Biennial Energy Report: Issues and Analyses for the Washington State Legislature, contributing author. Washington Office of Trade and Economic Development, February 2001. http://www.energy.cted.wa.gov/BR2001/default.htm*

26. *Study of Electricity Taxation, contributing author. Washington Department of Revenue, December 1999. http://www.energy.cted.wa.gov/papers/taxstudy.doc*

27. *Washington Energy Indicators, author. Washington Department of Community, Trade and Economic Development, February, 1999. http://www.energy.cted.wa.gov/Indicators99/Contents.htm*

28. *Washington State Electricity Study, contributing author. Washington Department of Community, Trade and Economic Development and Washington Utilities and Transportation Commission, January 1999. http://www.energy.cted.wa.gov/6560/finalapp.htm*

29. *Our Energy Future: At a Crossroads. 1997 Biennial Energy Report, contributing author. Washington Department of Community, Trade and Economic Development, January 1997. http://www.energy.cted.wa.gov/BIENREPO/CONTENTS.HTM*

30. *Washington State Energy Use Profile 1996, contributing author. Washington State Energy Office, June, 1996. http://www.energy.cted.wa.gov/FILES/PRFL/BASE02.HTM*

31. *Model Documentation Report: Transportation Sector Model of the National Energy Modeling System, contributing author. Decision Analysis Corporation of Virginia. Prepared for Energy Information Administration, March 1994.*

Ren Orans

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ENERGY AND ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Managing Partner

Dr. Orans founded Energy and Environmental Economics (E3) in 1989. An economist and engineer, he has focused throughout his career on the challenges facing the electricity industry. He is a trusted advisor to a broad range of clients that have included government agencies, utilities, system operators, regulators, independent power producers, energy technology companies, public interest organizations, and investors. He has led E3 teams on numerous high-impact and high-profile projects that have required both rigorous technical analysis and the ability to effectively distill actionable insights to help E3's clients make informed decisions as they develop innovative projects, programs or policies.

Dr. Orans' pioneering work in utility planning has centered on the design and use of area and time-specific (ATS) marginal costs for both pricing and evaluation of grid infrastructure alternatives. This seminal work has led to detailed area costing applications in pricing, marketing and planning for many utilities throughout North America. He is an expert in designing wholesale transmission tariffs and has served as an expert witness in regulatory proceedings on retail rate design and wholesale transmission pricing, including that of Canada's three largest utilities -- BC Hydro, TransEnergie and Ontario Power Generation.

In a recent forward-looking study, Dr. Orans provided his expertise to California's energy and environmental regulators in evaluating the operational challenges, feasibility and cost consequences of a higher Renewables Portfolio Standard (RPS) in California by 2030[1]. This assessment included technical input from the California Independent System Operator (CAISO) as well as independent reviews from a distinguished four-member advisory panel. The study utilized E3's first-in-class Renewable Energy Flexibility (REFLEX) model. Additionally, in consultation with advisors to California's Governor and principals and staff from the energy agencies and the CAISO, E3 has developed a set of technology deployment scenarios that meet California's goal of reducing Greenhouse gas (GHG) emissions to 80% below 1990 levels by 2050[2], using E3's California PATHWAYS model -- an infrastructure-based GHG and cost analysis tool that captures the interactions among the buildings, industry, transportation, and electricity sectors of the entire California economy, which becomes increasingly important in a low carbon future.

E3, in collaboration with Lawrence Berkeley National Laboratory (LBNL) and Pacific Northwest National Laboratory (PNNL) has also conducted research for a recently published report *Pathways to Deep Decarbonization in the United States*[3] for the Deep Decarbonization Pathways Project (DDPP) -- an initiative led by the Sustainable Development Solutions Network (SDSN) and the Institute for Sustainable Development and International Relations (IDDRI). The DDPP is a collaborative global initiative to explore

[1] https://ethree.com/public_projects/renewables_portfolio_standard.php
[2] https://ethree.com/public_projects/energy_principals_study.php
[3] http://unsdsn.org/wp-content/uploads/2014/09/US_DDPP_Report_Final.pdf

how individual countries can reduce energy-related CO2 emissions through a transformation of energy systems, a transition referred to by the DDPP as "deep decarbonization."

Dr. Orans is a respected thought leader who is often asked to share his expertise and vision for the energy industry. He regularly publishes in refereed journals and has taught a graduate course on electric utility planning at Stanford University. He received his Ph.D. in Civil Engineering from Stanford University and his B.A. in Economics from the University of California at Berkeley.

DEPARTMENT OF ENERGY Washington, DC
NATIONAL RENEWABLE ENERGY LABORATORY 1992 – 1993
ELECTRIC POWER RESEARCH INSTITUTE
Lead Consultant

Dr. Orans developed new models to evaluate small-scale generation and DSM placed optimally in utility transmission and distribution systems.

PACIFIC GAS & ELECTRIC COMPANY San Francisco, CA
Research and Development Department 1989 – 1991

Dr. Orans developed an economic evaluation method for distributed generation alternatives. The new approach shows that targeted, circuit-specific, localized generation packages or targeted DSM can in some cases be less costly than larger generation alternatives. He also developed the evaluation methodology that led to PG&E's installation of a 500kW photovoltaic (PV) facility at their Kerman substation. This is the only PV plant ever designed to defer the need for distribution capacity.

ELECTRIC POWER RESEARCH INSTITUTE Palo Alto, CA
Consultant 1988 – 1992

Dr. Orans developed the first formal economic model capable of integrating DSM into a transmission and distribution plan; the case study plan was used by PG&E for a $16 million pilot project that was featured on national television.

DEPARTMENT OF ENERGY Washington, DC
Lead Consultant 1989 – 1990

Dr. Orans was the lead consultant on a cooperative research and development project with the People's Republic of China. The final product was a book on lessons learned from electric utility costing and planning in the United States.

PACIFIC GAS & ELECTRIC COMPANY San Francisco, CA
Corporate Planning Department 1989 – 1992

Dr. Orans was the lead consultant on a joint EPRI and PG&E research project to develop geographic differences in PG&E's cost-of-service for use in the evaluation of capital projects. Developed shared savings DSM incentive mechanisms for utilities in California.

PACIFIC GAS & ELECTRIC COMPANY — San Francisco, CA
Rate Department Economist — 1981 – 1985

As an economist at PG&E, Dr. Orans was responsible for the technical quality of testimony for all electric rate design filings. He was also responsible for research on customers' behavioral response to conservation and load management programs. The research led to the design and implementation of the first and largest residential time-of-use program in California and a variety of innovative pricing and DSM programs.

Education

Stanford University — Palo Alto, CA
Ph.D. in Civil Engineering

Stanford University — Palo Alto, CA
M.S. in Civil Engineering

University of California — Berkeley, CA
B.A. in Economics

Citizenship

United States

Refereed Papers

1. *Woo, C.K., I. Horowitz, B. Horii, R. Orans, and J. Zarnikau (2012) "Blowing in the wind: Vanishing payoffs of a tolling agreement for natural-gas-fired generation of electricity in Texas," The Energy Journal, 33:1, 207-229.*

2. *Mahone, A., B. Haley, R. Orans, J. Williams (2011) "Electric Vehicles and Gas-Fired Power: A Strategic Approach to Mitigating Rate Increases and Greenhouse Price Risk," Public Utilities Fortnightly (Dec 2011) 42-50, available at: http://www.fortnightly.com/exclusive.cfm?o_id=918*

3. *Alagappan, L., R. Orans, and C.K. Woo (2011) "What Drives Renewable Energy Development?" Energy Policy, 39: 5099-5104.*

4. *R. Orans, F. Pearl, A. Mahone (2010), "A Modest Proposal: After Cap and Trade", Brookings Institute*

5. *Orans, R., C.K. Woo, B. Horii, M. Chait and A. DeBenedictis (2010) "Electricity Pricing for Conservation and Load Shifting," Electricity Journal, 23:3, 7-14.*

6. *Olson A., R. Orans, D. Allen, J. Moore, and C.K. Woo (2009) "Renewable Portfolio Standards, Greenhouse Gas Reduction, and Long-line Transmission Investments in the WECC," Electricity Journal, 22:9, 38-46*

7. *Orans, R., M. King, C.K. Woo and W. Morrow (2009) "Inclining for the Climate: GHG Reduction via Residential Electricity Ratemaking," Public Utilities Fortnightly, 147:5, 40-45.*

8. *Woo, C.K., E. Kollman, R. Orans, S. Price and B. Horii (2008) "Now that California Has AMI, What Can the State Do with It?" Energy Policy, 36, 1366-74.*

9. *Orans, R., S. Price, J. Williams, C.K. Woo and J. Moore (2007) "A Northern California - British Columbia Partnership for Renewable Energy" Energy Policy, 35:8, 3979-3983.*

10. *Lusztig, C., P. Feldberg, R. Orans and A. Olson (2006) "A Survey of Transmission Tariffs in North America," Energy-The International Journal, 31, 1017-1039.*

11. *Woo, C.K., A. Olson and R. Orans (2004), "Benchmarking the Price Reasonableness of an Electricity Tolling Agreement," Electricity Journal, 17:5, 65-75.*

12. *Orans, R., Woo, C.K., Clayton, W. (2004)"Benchmarking the Price Reasonableness of a Long-Term Electricity Contract," Energy Law Journal, 25: 2, 357-383.*

13. *Orans, R., Olson, A., Opatrny, C., (2003) "Market Power Mitigation and Energy Limited Resources," Electricity Journal, 16:2, 20-31.*

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