DR. ALEX PAPALEXOPOULOS, PH.D.

SUMMARY OF QUALIFICATIONS & PROFESSIONAL EXPERIENCE

Dr. Alex Papalexopoulos is the CEO & Chairman of ZOME Energy Networks, Inc. Initially the lead investor in ZOME's Series A financing in 2011, by 2012 he had assumed the role of CEO. Today he is the leader of two companies: ZOME and his long-time consulting firm, ECCO International. ZOME is his product company, ECCO his consulting company, and there are overlaps between the two. Dr. Papalexopoulos splits his time between ZOME and ECCO. ZOME, with its ColorPower cloud-based product line, was of immediate interest to Dr. Papalexopoulos due to its simplicity and new paradigm it offers the electric utility sector for flexible Distributed Energy Resource (DER) optimization.

Dr. Papalexopoulos, a renowned energy expert, is an authority in energy market design and implementation and founded ECCO International, a specialized Energy Consulting Company, in 1998. ECCO provides consulting and software services worldwide to a wide range of clients such as Governments, Regulators, Utilities, Independent System Operators, Generators, Marketers, Traders and Software vendors. Alex has designed some of the most complex energy markets in the world including North and South America, Western and Eastern Europe and Asia. He has been heavily involved in the implementation of the reforms of the energy sector in Greece pursued by the European Union, the European Central Bank and the International Monetary Fund. He is currently leading the design and implementation of the energy markets in Poland, Greece, Israel and Cyprus.

ECCO is involved in some of ZOME's professional services for ZOME's clients. ECCO provides energy consulting services in the areas of industry restructuring, public policy and market analysis, energy market design and implementation, smart grid and renewable energy, power systems operations and real-time control and DER local markets, including Energy Storage Resources, Electric Vehicles, and Demand Response.

IEEE Fellow, Author, and Energy Thought Leader and Speaker

Dr. Alex Papalexopoulos has made substantial contributions in the areas of network grid optimization, power market design, transmission pricing and real-time control functions. He is a sought-after industry leader, renowned expert and IEEE distinguished speaker. Prior to forming ECCO International in 1998, Dr. Alex Papalexopoulos worked at the Pacific Gas and Electric Company in San Francisco, California where he was Director of the Electricity Restructuring Group. He has published numerous papers in refereed scientific journals and conferences and has given numerous invited presentations in leading institutions in the U.S. and other countries including Canada, Switzerland, England, Baltic States, Greece, Spain, Austria, Cyprus, Poland, Japan, South Korea, Egypt, Saudi Arabia, Mexico, Chile and Argentina. He has organized and trained various

organizations in the area of energy market design and chaired numerous panels and special sessions in IEEE. He is the 1992 recipient of PG&E's Wall of Fame Award and the 1996 recipient of IEEE's First Prize Paper Award. He is a Fellow of IEEE for his contributions to Optimal Power Flow and related technologies in electric power systems. Alex received the Electrical and Mechanical Engineering Diploma from the National Technical University of Athens, Greece and the M.S. and Ph.D. degrees in Electrical Engineering from the Georgia Institute of Technology, Atlanta, Georgia. In 2016 he was bestowed the award of the honorary Professor at the University of Patras, Patra, Greece.

HISTORICAL INFORMATION

Dr. Papalexopoulos is a renowned energy expert in energy market design and implementation, energy simulation, regulation, analysis and computational techniques with specialization in grid, transmission and merchant functions, pricing, power systems operations, power generation, transmission planning, transmission and power contracts, system dynamics, AGC and real-time control. He has made substantial scientific contributions in the field of power engineering and he is an authority in the areas of network grid optimization, energy market design, and transmission pricing, ancillary services, congestion management, competitive bidding, and implementation of EMS/AGC advanced applications and real-time control functions and forecasting in a utility environment. He has extensive experience in project management, software development, planning, preparation of capital and expense budgets, and system integration of large scale software projects and large-scale R&D projects for solving complex power system grid, transmission, merchant and operational problems, large engineering and planning relational databases and information systems.

Dr. Papalexopoulos has been heavily involved in many major industry restructuring initiatives and energy market design efforts around the world, including, USA, Canada, Poland, Hungary, Greece, Cyprus, Israel, France, Switzerland, Japan, Argentina, Spain, Baltic States and Albania. Specifically, for California, USA, he has been a key designer of the energy market since its inception in 1994. As a director of the Electric Industry Restructuring Group at PG&E, he was one of the key market designers of the California Power Exchange (PX) and the California Independent System Operator (ISO). Specifically, Alex was a major player in developing the rules and protocols for the energy auction and bidding, trading and business systems, ISO ancillary services auction, ISO transmission pricing and ISO EMS operations and implementing policies to facilitate PG&E's Transmission Direct Access program. In 1995 he led PG&E's Transmission Business Team during the Phase I filing with the FERC for the formation of the ISO and the PX. In 1996 he led PG&E's ISO Business Rules and Protocols Team and worked with the other California IOUs, Munis, regulators, major customers and other stakeholders, for developing the ISO's policies and business functions. In 1997 he led the development and implementation of the ISO Business Systems and he was responsible for coordinating the implementation and testing of all PG&E transmission systems that interface with the California PX and the ISO. He was also heavily involved in developing policies to advance PG&E's transmission business interests in the new competitive environment.

Since June of 1998 Dr. Papalexopoulos is president and founder of ECCO International, Inc., a specialized Energy Consulting Company, that provides consulting and software services within and outside the U.S. to a wide range of clients such as Regulators, Governments, Transmission Utilities, Independent System Operators, Power Exchanges, Marketers, Brokers and Software vendors. These services range from EMS/AGC operations, strategic planning, particularly industry restructuring and the introduction of competition into traditional transmission utility markets, competitive bidding, market trading, direct access planning, public policy analysis, auditing utility practices, simulation and optimization, energy market design, smart grid and Distributed Energy Resources (DER) local market design, renewable energy development, Energy Storage, Electric Vehicle and Demand Response, pricing negotiation and strategy, and related topics concerning industrial organization and information economics.

ECCO International has also been involved in the restructuring of several electricity markets around the world including North America, South America, Western and Eastern Europe and Asia. It has designed some of the most complex energy markets in the world.

Most notably, since 1998 he has been instrumental in supporting the California ISO in the area of market design during the first few years of actual operation and during the California energy crisis. He was the overall technical lead of a major initiative to restructure the energy market, develop the Nodal Locational Pricing based energy market and develop the tariffs in California. From 2005 thought 2008 he led the development of the energy market rules for the Greek Transmission System Operator and the drafting of the Business Manuals for the Greek energy market. From 2006 through 2009 he led the ECCO team which participated in the design and implementation of the Texas Nodal energy market. Since 2009 he has been the key designer of the Polish energy market, the first nodal energy market in Europe. He has also been a key consultant to the Greek Government and the PPC on energy reforms pursued by the EU/ECB/IMF including the liberalization of the energy market in Greece, the privatization of PPC generation and transmission assets, the creation of PPC transmission and distribution subsidiaries, the creation of the new energy market structure and the drafting of the new Codes. In 2011 he was the key designer of the pool-based energy market for the country of Hungary. He is currently the key designer of the reformed market in Greece for the harmonization of the wholesale Greek energy market with the Pan-European energy market. He is also heavily involved with the restructuring of the wholesale energy market in Cyprus consistent with the EU guidelines and the restructuring of the energy market in Israel.

Dr. Papalexopoulos has published numerous papers in refereed scientific journals and conferences, drafted numerous reports and has given numerous invited presentations in leading institutions. He has organized and trained various organizations in the area of energy market design and chaired numerous panels and special sessions in IEEE. He is the 1992 recipient of PG&E's Wall of Fame Award, and the 1996 recipient of IEEE's PES First Prize Paper Award. Dr. Papalexopoulos is a Fellow of IEEE.

EDUCATION

- M.E. and E.E. Diploma, National Technical University of Athens, Greece
- M.S., E.E., Georgia Institute of Technology

- Ph.D., E.E., Georgia Institute of Technology

EMPLOYMENT HISTORY

- ZOME Energy Networks, Inc., President, CEO & Chairman of the Board, 2012-present
- ECCO International, Inc., President, CEO and Founder, June 1998-present
- PG&E, Director, Electric Industry Restructuring Group, 1997-1998
- PG&E, Project manager, Western Power Exchange (WEPEX), 1995-1997
- PG&E, Team Leader, Systems Engineering/Operations Research, 1993–1995
- PG&E, Supervisor, Systems Engineering/Operations Research, 1992–1993
- PG&E, Senior Systems Engineer, 1991–1992
- PG&E, Systems Engineer, 1989–1991
- PG&E, Energy Control Center rotational assignment, 1988–1988
- PG&E, Systems Engineer, Energy Management System (EMS) developer 1985–1988
- Georgia Institute of Technology, Research and Teaching Graduate Student, 1980–1985
- Public Corporation of Electricity, Athens, Greece (while a student), 1979–1980

PROFESSIONAL HISTORY PRIOR TO ZOME ENERGY NETWORKS

ECCO International, Inc.,
President, CEO and Founder, since June 1998

ECCO International provides specialized consulting and services and expert advice in numerous restructuring and market design initiatives worldwide. The following represents a partial list of ECCO International's regional and worldwide activities:

1. **CENTRICA, UK:** In 2017 ECCO partnered with Centrica PLC in UK to jointly develop the first organized Nodal, LMP Local Energy Market (LEM) in the distribution level in the world. The new market will produce Locational marginal Prices at the distribution level (DLMPs). The ECCO will be responsible for developing the market design and rules and protocols of the Local Energy Market and the software of the market platform. The market platform will consist of a Distribution Power Flow (DPF) and an economic model which will clear the offers and bids of Distributed Energy Resources (DERs) and produce DLMPs and schedules for various time intervals. The purpose of this project is to leverage smart-grid technology and micro-grid supply to maximize the value of DERs to the grid.

   The project is divided into Phases over the course of 3-years. In Phase-1 ECCO will provide;

   - Market report
   - ECCO Stakeholder Support
   - Distribution Power Flow (DPF) API Support Spec – Data Exchange Specification

- Definition of LEM - Glossary Terms
- Potential Use Cases (Business Cases)
- Facilitation of a Stakeholder Symposium
- Market Design and associated Rules and Protocols
- Generic Dispatch Power Flow and Single-Step Market Clearing Engine
- Vision Document with the associated gap and technology assessment
- Customized LEM Market solution for one Business Case (highest ranking business case from the priority list)

Phases 2 and 3 will be adapted based upon lessons learned in Phase 1.

2. **INDEPENDENT POWER TRANSMISSION OPERATOR, GREECE (IPTO):** In 2017 ECCO was engaged by the IPTO to provide auditing and certification services of its updated market software systems. This includes the auditing and certification of all the ALSTOM Market software applications for all markets and the homegrown software support systems required for settling various market applications under the jurisdiction of the IPTO.

   ECCO will perform a detailed and comprehensive analysis of the Market Management Software (MMS) software Functional Design Specifications (FDS). ECCO will also thoroughly review the relevant sections of the Grid Control and Power Exchange Code for Electricity ("Code") and its updated revisions to assess the compliance of the MMS against the requirements stated in the Code. Furthermore, ECCO will consolidate the test cases that IPTO has performed on the MMS in a comprehensive Test Book specifically designed for the certification of the software by the ECCO developed methodology. If variances are identified, additional tests will be executed by the IPTO with the support of ECCO to correct these variances. The correction of the variances will be required to achieve the best possible score. Finally, ECCO will track the test results and map them to software specifications to validate the correct functioning of the MMS.

   In the course of the mapping efforts among the regulatory requirements extracted from the Code, the MMS specifications extracted from the FDS, and the test cases in the MMS Test Book, ECCO will perform a complete mapping of all regulatory requirements and validate the correct functioning of the MMS.

   Finally, ECCO will develop a certification report that summarizes the MMS certification metrics as of the date of the report. ECCO as part of this project is expected to repeat the process till the best possible score is achieved.

3. **8MINUTENERGY (8ME), SOLAR Developer, USA**: In 2017 8ME retained ECCO International Inc. to review various development RES projects. The first project is related to the Mount Signal Solar Farm V (The Project). The scope of the Project is to perform the following tasks, and render an opinion on the following:

   - Interconnection Agreement
   - Power Purchase Agreement
   - Applicable sections of CAISO Tariff

- Regulatory Requirements as they pertain to Resource Adequacy

Deliverable:

The deliverable is a report containing an opinion with respect to "Full Capacity Deliverability" and "Commercial Viability."

4. The second Project is to analyze the status of the Lotus Solar Farm, CAISO Queue 723, interconnected at the Borden substation in Fresno California. The scope of the Project is to perform the following tasks, and render an opinion on the following:

    - Interconnection Agreement
    - Power Purchase Agreement
    - Applicable sections of CAISO Tariff

    Deliverable:

    The deliverable is a report containing an opinion with respect to "Full Capacity Deliverability" and "Net Qualifying Capacity."

    The purpose of the report is to examine and identify potential issues with obtaining and maintaining Full Capacity Deliverability (FCD) and the full Net Qualifying Capacity (NQC) upon the Commercial Operation Date (COD).

5. **REGULATORY AUTHORITY of ENERGY, GREECE (RAE):** in 2016 ECCO was retained by RAE to execute a simulation study to analyze the implications of the methodology for the determination of the hydro energy offers minimum threshold in the Day-Ahead Wholesale Greek Electricity (DAS) Market, which has been proposed by the Greek Market Operator (LAGIE) and decided by RAE under Decision 207/2016. As part of this project ECCO also executed a simulation study of the Greek wholesale electricity market in order to analyze the impact of certain parameters, used for the determination of the hydro energy offers minimum threshold of the various hydro stations, on the expected Day-Ahead Market (DAS) prices. The impacts on the DAS SMP prices was determined via simulations of the Greek wholesale electricity market by deploying ECCO's proprietary energy simulation software platform, ProMaxLT™.

6. **Trans Bay Cable, Inc.**: in 2016 Trans Bay Cable (TBC) contracted with ECCO to execute two separate energy market analysis studies by deploying its proprietary energy simulation software platform, called of ProMaxLT™. The first, Phase1A, is a study to evaluate and quantify the market and reliability benefits of the Trans Bay Cable (TBC) HVDC Transmission Project in the California energy market. The second study, Phase 1B, is to investigate and quantify the ramping benefits of the TBC HVDC system to the California energy market.

    Phase 1A

The stated goal of the Phase 1A simulation study is to execute a detailed energy market simulation analysis for a 10-year period (2017 to 2026) by deploying the CAISO TEAMS methodology. The study is deploying actual and projected generation and transmission models and the Security Constrained Unit Commitment (SCUC) modules of ProMaxLT™ to quantify the stated economic benefits provided to the ratepayers by the TBC HVDC for the study period.

Phase 1B

The stated goal of the Phase 2A simulation study is to execute a detailed energy market simulation analysis to evaluate, analyze and quantify the value of "ramping" of the TBC HVDC Project to the CAISO energy market and the transmission grid by deploying detailed actual generation and transmission models and the 15 minute and the 5 minute Security Constrained Economic Dispatch (SCED) Real Time market modules of the ProMaxLT™. The study will also analyze the historical ramping swings of the 15 minute/5 minute market dispatch instructions from the CAISO and determine the exact nature of the observed swings.

7. **European Network of Transmission System Operators for Electricity (ENTSO-E):** In 2016 ECCO was awarded a contract from ENTSO-E to analyze the current configuration of the preferred European energy market architecture and propose alternative configurations that can lead to more efficient market outcomes. Specifically, the current market architecture is based on large Bidding Zones (Zonal Model) where market activity is taking place between the Bidding Zones. This architecture is causing, as a result of many factors including the massive penetration of Renewable Energy Sources, large re-dispatch costs within the Bidding Zones that are not visible to the market. The key objective of the project is to analyze the benefits of transitioning the current market architecture to much smaller Bidding Zones. The analysis will focus on impact of smaller Bidding Zones tomMarket Liquidity, market power & concentration, effective competition, accuracy and robustness of price signals and long term hedging effects. The project will also evaluate practical and feasible ways of assessing small Bidding Zones and methodologies for defining the optimal Bidding Zonal configuration.

8. **TRANE, Inc.:**

Phase-1 – CAISO Energy Market Analysis

In 2016 TRANE acquired the services of ECCO to evaluate and determine the economic "value" of its integrated portfolio of assets in California consisting of Distributed Energy Resources (DERs) including energy storage and demand response. The services include the execution of a market study to analyze and estimate the revenues linked to the deployment of these assets by the SCE-requested hybrid procurement auction. The market study will focus on the revenue potential of two revenue sources:

- Estimation of the Day-Ahead Market revenues

- Estimation of the Real Time Market mileage revenues

ECCO will also assist TRANE with the offer to the SCE auction and the development of the Purchase and Sale Agreement (PSA) of TRANE with SCE. The specific scope of this Task are:

- Review and assist in the drafting of the Purchase and Sale Agreement (PSA) for the SCE Preferred Resource Pilot RFO. The TRANE offer will likely be a "Behind the Meter" (BTM) Hybrid offer, thus there will be no pro forma PSA. If this is the case, then one must be negotiated with SCE Terms and Conditions in the areas of Performance and Settlement need to be considered carefully in order for TRANE to realize the anticipated revenue stream.

- Structuring the SCE proposal and the PSA for the SCE PRP RFO bid in consideration of the results from the Market Study. SCE will utilize a Net Present Value evaluation to select offers.

Phase-2 – TRANE IT infrastructure Topology Analysis

With respect to assuring the TRANE offer meets SCE's technical requirements, ECCO staff will provide the following assistance to TRANE:

- Review existing TRANE technology, along with its current technology partner and their proposed solution(s). This review will allow ECCO to understand the technology and functionality TRANE will be offering and will also allow ECCO to advise TRANE on how its offer will align with SCE's requirements.

- Provide inputs on the high-level network topology that will be required for the overall solution. ECCO will review conceptual designs/detailed designs and provide feedback, alternative options for consideration and recommended solutions.

9. **1Energy, Inc.**: In 2016 1Energy retained ECCO to conduct a study to identify, analyze and evaluate the potential revenue streams of energy storage assets from wholesale energy markets and from grid applications in several ISO markets in the US. This work is relevant to 1Energy's contract with the Snohomish Public Utility Districts (SnoPUD) and Bonneville Power Authority (BPA) how to best utilize distribution level storage assets to provide both grid and market benefits. This work will compliment SnoPUD's research and development project with BPA to determine how utilities and the BPA might interact to achieve joint gains from the use of storage assets.

   In the Storage Energy Resources Study, ECCO will identify all potential revenue sources from participating in California ISO, PJM and ERCOT energy, ancillary service and capacity markets that are directly applicable to the use of SERs. Market

products and their specific requirements of participation will be identified and analyzed. Other non-market transmission and distribution applications that can provide revenues to SERs will be also identified and analyzed. Conflicts between participation in the ISO markets and in other non-market applications will be analyzed and presented. Finally, ECCO will analyze and propose certain requirements for storage participation in the California ISO, PJM and ERCOT wholesale markets.

10. **Imperium Capital, LLC:** In 2016 Imperium contracted with ECCO to execute a market analysis study for the year 2020 for the valuation of a CCGT facility located in the CAISO footprint. As part of the project ECCO will prepare a base case power flow model. The model will be based on the CAISO model data that is publically available. ECCO will run a full production simulation of 2020 with the Wind and Solar schedules developed by CAISO for their 33% renewable study. ECCO will also use historical unit outages from the CAISO OASIS website to include forced and planned maintenance outages on the production profile. All hours of year 2020 will be processed sequentially. In addition ECCO will update the generation fleet to include the planned retirements, upgrades and additions to the generation fleet for the study period.

    ECCO will deploy historic offer and bid data obtained from the publically posted offers and bids on the CAISO OASIS data repository. This information represents the bids and offers for specific resources used to generate proxy bids in the simulation runs. Ancillary services requirements and ancillary services bids will also be fully represented in the simulations including the new proposed Flex-Ramp A/S. This is one of the unique features that differentiates our simulation platform from other platforms in the market today.

    This study will also consider issues such as carbon credits and resource adequacy payments to help determine the full valuation of the facility.

11. **Public Utilities Authority (PUA - Israel):** In 2016 the PUA awarded a contract to ECCO to develop a market (or pseudo-market) based approach for pricing electricity at the wholesale level according to an economic rational that is consistent with optimal dispatch of resources and explicit recognition of fixed and operating costs as well as physical constraints. The pricing system will serve to determine the economic value of energy produced by the IPPs and by the IEC and provide correct incentives for investment, production and consumption of electricity over time and space. The ultimate goal will be to develop and implement a protocol for economic dispatch, congestion management, ancillary service provision and corresponding remuneration schemes that are consistent with best practices in reformed electricity markets around the world.

    The market study will focus on the following topics:

    - Analyze current processes and procedures that may result in market failure to IEC and to IPPs; the analysis will be performed by technology types and type of

Market Participant including co-generators, renewables, IEC, IPPs selling directly to consumers, IPPs selling to the system operator, etc.

- Analyze current processes and procedures that may impact the level of competition in the electricity market between IEC and IPPs by their type of technologies and operational regime.

- Propose regulatory intervention mechanisms, including methodologies and tools, which may be required by the PUA for the efficient operation of the market.

- Provide samples of market crises and market failures occurred in other countries along with reasoning, lessons learned and actions taken to fix the market problems.

- Provide relevant recommendations to PUA, as concluded from the market analysis, to ensure best electricity market development in the short term (5 years) and medium term (up to 15 years).

- Analyze the potential impact and proper responses to possible transmission grid constraints in the coming years (based on information to be supplied by the PUA).

The execution of all Tasks will draw upon ECCO's international experience from similar markets (at least 3 other countries will be deployed as examples) taking into account the regulation of the energy market in Israel, and the fact that all costs of all players, including the IEC and IPPs are controlled and determined by the regulator on the basis of normative costs and tariffs. The study will also consider any additional relevant market issues that may arise as a result of the close interaction between ECCO and the PUA staff over the course of the engagement.

12. **HELLENIC DISTRIBUTION NETWORK OPERATOR (HEDNO)**: in 2015 ECCO was awarded a major project to provide an assessment of the requirements for the implementation of the Energy Management System (EMS) and Market Management System (MMS), develop the technical needs and functional specifications and draft the Tender documents for the Islands of Crete and Rhodes in Greece. Specifically, the systems covered under this contract were EMS, system operations, MMS, market operations, IT infrastructure, SCADA, Corporate Systems and communications. The services will cover two main phases and include, initial design and organization, the drafting of integrated technical and operational specifications and the final documents that will be used for tendering of the aforementioned systems. The initial design and organization (Phase I) will include an analysis of the current systems, the determination of the requirements based on the approved Code and the regulatory framework for the electricity market, and the description of the required processes of all essential systems. The drafting of the detailed technical, operational specifications and Tender documents (Phase II) will also include all the processes and algorithms for system operations and market functions.

13. **POLISH TRANSMISSION SYSTEM OPERATOR (PSE):** In 2015 ECCO was awarded a contract to provide support to PSE for the development of the RFP technical specifications of the Market Management Systems (MMS) to support the new Nodal LMP proposed market architecture. ECCO was the key designer of the PSE LMP-based energy market. This is the first LMP-based market in Europe. This project includes the development of the protocols and provisions for the interface between the MMS and the Energy Management System of the PSE and the network model maintained in the EMS environment. This market will transition the existing market structure in Poland from a zonal based market model to a nodal LMP-based energy market. This market will deploy a bid-based Unit Commitment clearing mechanism where all resource and system constraints will be included in the clearing. Further a detailed transmission model will all transmission base case and contingency case constraints will be fully represented in the market clearing and consequently will be fully priced at the market solution. The new market model includes all standard market applications including Day-Ahead Market, Intra-Day Market, Real-Time Market, Market Power Mitigation, Reliability Unit Commitment, Financial Transmission Rights, Settlements, Cross Border Trading, etc.

14. **CODA ENERGY Inc.:** In 2015 ECCO was contracted by CODA ENERGY, Inc. to evaluate the value of behind-the-meter energy storage assets and maximize their revenue streams derived from their participation in "behind-the-meter" and wholesale energy markets. The project involves two Phases. In the first Phase, ECCO will identify all potential revenue sources from participating in various ISO markets that are directly applicable to the Li-ion behind-the-meter energy storage assets, specifically batteries with up to 2 hours discharge time duration. This project also involved the development of the present day value of behind-the-meter energy storage assets considering available applications and revenue streams and identify potential future value.

    In the second Phase, ECCO will perform a set of studies of the CAISO Day Ahead market to provide an estimate of the value to be achieved from the addition of storage resources. These studies will be performed using actual bids and other pertinent data obtained from the CAISO OASIS web site. ECCO is in a unique position to perform these studies as we have successfully mapped all the major resources onto the network so that we can perform an accurate simulation of the CAISO DA market including the effects of congestion and ancillary services bids. A full annual simulation will be performed to obtain an estimate of the potential revenues from the storage plant.

    ECCO will also implement a stochastic-based methodology for preparing optimal bid schedules for the storage plant using forecasted DA clearing prices for energy and ancillary services.

15. **TERNA S.A. ("TERNA"), GENERATOR, GREECE:** In 2015 ECCO was awarded a contract to provide consulting and software services to simulate, analyze and quantify the expected benefits of TERNA's Projects of Common Interests (PCI) hydro projects. The project included the ccollection of actual, forecasted market and

operational data for the year 2021 and the execution of a simulation study of the Greek wholesale energy market to determine the expected benefit's of TERNA's PCI hydro projects. The project also included the development of a sensitivity analysis and the range of benefits (lower bound and upper bound). ECCO deployed its proprietary energy software platform, ProMaxLT™, for the execution of the simulation study.

16. **ALGONQUIN POWER:** In 2016 Algonquin acquired the services of ECCO to assist them with the conversion of the Sanger Energy Facility from its existing Qualifying Facility (QF) designation to a Market Resource operating within the CAISO energy market. ECCO provided Algonquin with a risk analysis of operation as well as a detailed list of specifically applicable rules and regulations that apply to their unique position in the CAISO market.

    In 2014 and in 2015 ECCO conducted a thorough review of Algonquin Powers' proposed PPA associated with a combined-cycle facility operating in California. The facility currently operating under PURPA will be losing its current classification. As a result, Algonquin is looking to re-negotiate the terms with a LSE. In order to assure they receive full value for the facilities output and capability, Algonquin Power contracted with ECCO to assess the PPA and provide guidance on acquiring more favorable terms.

    In 2010 ECCO provided consulting and training services on wholesale energy market issues related to the ISO New England and the California ISO. Topics included the Capacity Markets and the Ancillary Services markets.

17. **EUROPEAN COMMISSION:** In 2014 ECCO was awarded a contract by the European Commission to review the proposed market changes in Cyprus, develop the business plan to move forward with the new market implementation, assess and propose the organizational structure as well as develop new procedures and the IT infrastructure in support of the updated Transmission System Operator of Cyprus (TSOC). The Regulator in Cyprus, CERA, has proposed a new market architecture based on the Net-Pool Model, which includes a combination of Bilateral Contracts and a Pool structure.

    The Business Plan includes a description of the tasks, an implementation schedule with the duration of each task, the resources required for each task, deadlines, critical paths and milestones. The project also includes the identification of personnel requirements and TSO Cyprus organizational structure for the management of the new proposed electricity market architecture and the establishment of procedures and information exchange protocols. It also includes the identification and description of information technologies and systems required to implement the proposed electricity market including required databases for market participants and other market-related systems typically used in electricity markets similar to the electricity market in Cyprus.

18. **REGULATORY AUTHORITY of ENERGY, GREECE (RAE):** in 2014 ECCO was awarded a contract by RAE to propose a high level design for the wholesale energy market in Greece consistent with the EU guidelines and the Target Model. The Project included the following:

- Detailed analysis and specification of alternative scenarios and a recommendation of a complete set of market arrangements for the Greek wholesale electricity market which will be fully compatible with the ENTSO-E network codes and ACER FG regarding the operation of the EU internal market. The main elements of the study included definition of the roles and interests of the main stakeholders and market participants for the forward, day ahead, intra-day and balancing markets, etc.), design of the Forward Electricity Market (forward energy contracts with obligation of physical delivery, bilateral contracts, OTC etc), Nominations (Spot-Market integration/delivery), Clearing, and Settlement, design of the Cross – border forward arrangements in line with the corresponding ACER Framework Guidelines (FG) and ENTSO-E Network Code (NC), design of the Day-Ahead Market (DAM) in line with the Price Coupling arrangements and the PCR options (including the pre & post coupling operations), design of the Intra-Day Market (IDM) and the Balancing Market (BM) along with Clearing and Settlement arrangements.

- Development of a detailed roadmap for a step-wise evolution of the Greek electricity market towards internal market reform and full adaptation to the EU target model requirements. The roadmap was accompanied by a detailed action-plan for each organization involved (RAE, ADMIE, LAGIE, Market Participants etc.) indicating the main-milestones and relative risks. Special consideration was given to the required modifications for applying the PCR algorithm to the day-ahead stage which will allow participation to the day-ahead price coupling with neighbouring countries.

- Review of the primary legislation towards the proposed market design.

- Support during the consultation phase including presentations of the final high level market design to the stakeholders as well as written answers and clarifications to selected comments received during the consultation phase.

19. **TRANSMISSION SYSTEM OPERATOR OF CYPRUS (TSOC):** In 2014 ECCO was engaged by the Transmission Operator of Cyprus (TSOC) to assist with the overall design and implementation of the proposed Net-Pool based energy market. This major engagement includes the following three (3) projects:

Project 1:

This project involves the development of the Tenders for the Market Management Systems (MMS). This project includes the preparation of the Tender documentation, consistent with the Cyprus law and applicable regulations, including the detailed

technical and operational specifications, the detailed implementation plans of the MMS, and the necessary tests and delivery procedures. It also includes the preparation of the criteria for the selection of the successful Contractor and the compliance tables taking into account Cyprus legislation and relevant EU directives. It also includes the preparation of the hardware specifications required to support the new market and the warranties and the maintenance provisions.

Project 2:

In this project ECCO will assist the TSOC with the technical assessment of the vendor responses and assist with the negotiations. ECCO will prepare an Evaluation Report which will contain a clear recommendation as to which of the Tenders is considered most suitable and for what reasons and who should be proposed to be awarded the contract or invited for contract negotiations. ECCO will also compile the Contract Documents for signature by the software contractor and the Cyprus TSO.

Project 3:

ECCO will prepare the Trading & Settlements Rules (TSR) Code document for the new proposed Net-Pool Based market architecture for energy and ancillary services. This project includes the preparation of the detailed rules and protocols that every market participant should adhere to. The TSR Code must be compliant with any Cyprus laws, CERA decisions, decrees, etc.

20. **PACIFIC GAS AND ELECTRIC COMPANY:** In 2014 ECCO was awarded a contract by Pacific Gas and Electric Company to develop ground-breaking methodologies and software to assist PG&E to implement optimal bidding strategies for its Energy Storage Resources (ESRs) for the wholesale energy market in California. Modeling of the stochastic characteristics of ESR assets posed unique challenges for the development of a practical algorithm and software for bidding ESRs into the CAISO market. As part of this effort ECCO developed various realistic market scenarios and decided on a plan for determining optimal bids to schedule storage energy and/or ancillary services into the CAISO market. In addition, ECCO developed a realistic software platform for calculating the bids and test them as necessary by executing extensive energy simulations.

    The software is based on a stochastic MIP-based algorithm to perform a rolling window optimization to determine the optimal intra-day bid adjustments on an hourly basis to the previously cleared Day Ahead energy and ancillary services bid schedules. The objective is to maximize the expected profit from Intraday Schedules, allowing for the stochastic forecast of real-time prices. The stochastic MIP formulation is used with weighted multiple time series of RT prices to determine a distribution of optimal RT adjustments to the previously cleared DA schedules. This methodology was chosen, among others, in order to develop a solution that would be computationally tractable for multiple resources.

21. **MARKET OPERATOR, GREECE (MO):** In 2014 ECCO executed an audit and certification study of the ALSTOM Market Settlements software applications of the Day-Ahead Scheduling (DAS) market.

    Specifically, ECCO performed a detailed and comprehensive analysis of the DAS Market Settlements Software (MSS) and the MMS software Functional Design Specifications (FDS). ECCO thoroughly reviewed the relevant sections of the Grid Control and Power Exchange Code for Electricity ("Code") and its proposed revisions to assess the compliance of the DAS MSS against the requirements stated in the Code.

    ECCO consolidated the test cases that the MO had performed on the DAS MSS in a comprehensive Test Book specifically designed for the certification of the software. ECCO developed methodology. Finally, ECCO tracked the test results and mapped them to software specifications to validate the correct functioning of the DAS MSS.

    In the course of the mapping efforts among the regulatory requirements extracted from the Code, the MSS specifications extracted from the FDS, and the test cases in the MSS Test Book, ECCO performed a complete mapping of all regulatory requirements and validated the correct functioning of the DAS MMS.

    Finally, ECCO developed a certification report that summarized the DAS MSS certification results as of the date of the report. ECCO as part of this project committed to repeat the process until a perfect score was achieved.

22. **MIDCONTINENT INDEPENDENT SYSTEM OPERATOR (MISO):** From 2013 till 2015 ECCO was engaged at MISO to develop outage management methodologies for incorporating outages in the wholesale energy market. The objective of this project was for ECCO staff to perform power engineering analysis and related tasks to support the study of transmission and generation outages submitted by MISO. Power engineering analysis includes AC and DC contingency analysis and transient stability analysis for predefined faults. Work also included coordinating and communicating with MISO Transmission Operators, neighboring Transmission Operators, and MISO operations personnel to establish mitigation plans such as Operating Guides. ECCO staff are working directly with MISO engineers.

    During this effort ECCO worked with MISO keeping the scope definition flexible so it could changed as MISO's business needs evolved during the contract period.

23. **CALIFORNIA IOU-RPS STUDY**: In 2013 ECCO along with Energy and Environmental Economics (E3) was awarded a contract to execute a large scale study to investigate the impact on the power system in California of a 50 Percent Renewables Portfolio Standard (RPS) in California in 2030. The study was funded by the Los Angeles Department of Water and Power (LADWP), Pacific Gas and Electric Company (PG&E), the Sacramento Municipal Utilities District (SMUD), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE), ("the utilities") to examine the operational challenges and potential consequences of meeting a higher RPS. This study was conducted by ECCO International, in partnership with Energy and Environmental Economics (E3). An

independent advisory panel of experts from industry, government and academia was commissioned to review the reasonableness of the assumptions and to provide input on the study. The California Independent System Operator (CAISO) also provided input on key study assumptions.

The utilities asked ECCO/E3 to study the following questions:

1. What are the **operational challenges** of integrating sufficient renewable resources to achieve a 50% RPS in California in 2030?
2. What **potential solutions** are available to facilitate integration of variable renewable resources under a 50% RPS?
3. What are the **costs and greenhouse gas impacts** of achieving a 40% or 50% RPS by 2030 in California?
4. **Would an RPS portfolio with significant quantities of distributed renewable generation be lower-cost** than a portfolio of large-scale generation that requires substantial investments in new transmission capacity?
5. What are some **"least regrets" steps** that should be taken prior to—or in tandem with—adopting a higher RPS?
6. What **remaining key issues must be better understood** to facilitate integration of high penetration of renewable energy?

ECCO deployed its energy simulator, ProMaxLT™ (System Flexibility Assessment Option) to analyze the operational challenges for four scenarios provided by the Utilities. The four scenarios were designed to meet California's incremental RPS[1] needs between 33% and 50% RPS in different ways:

1. **Large Solar Scenario** meets a 50% RPS in 2030 by relying mostly on large, utility-scale solar PV resources, in keeping with current procurement trends.
2. **Small Solar Scenario** meets a 50% RPS by 2030 by relying mostly on larger, distributed (1 – 20 MW) ground-mounted solar PV systems. This scenario also includes some new larger wind and solar plants.
3. **Rooftop Solar Scenario** meets a 50% RPS by 2030 relying in large part on distributed residential and commercial rooftop solar PV installations. This scenario also includes some new larger wind and solar. New rooftop PV systems beyond the current net energy metering cap are assumed to count as a renewable generation source towards meeting the state's RPS; system owners are assumed to be compensated at the cost of installing and maintaining the systems (i.e. rooftop PV is priced at cost in the revenue requirement calculation).
4. **Diverse Scenario** meets a 50% RPS in 2030 by relying on a diverse portfolio of large, utility-scale resources, including some solar thermal with energy storage and some out-of-state wind.

[1] This study assumes that a 50% RPS is defined in the same way as California's current 33% RPS. The standard requires generation from eligible renewable resources to be equal to or exceed 50% of retail sales. Large hydroelectric resources do not count as eligible renewable resources.

In addition, the study analyzed two scenarios that can serve as reference points against which to compare the costs and operational challenges of the 50% scenarios:

1) **33% RPS Scenario** meets a 33% RPS in 2030, representing an extension of the resource portfolio that is already expected to be operational to meet the state's current 33% RPS in 2020.
2) **40% RPS Scenario** meets a 40% RPS in 2030 by relying mostly on large, utility-scale solar PV resources.

The geographical scope of the analysis was a combination of the CAISO, LADWP and the Balancing Area of Northern California (BANC) Balancing Authority Areas. All scenarios assumed that significant investments and upgrades to both the California electrical grid and the state's fleet of thermal generators occur between 2013 and 2030, including the development of a newer, more flexible fleet of thermal generation.

24. **SUNEDISON:** Since 2013 ECCO has been engaged by SunEdison to provide a variety of consulting and software services to improve its operations. SunEdison develops, finances, operates and monitors solar energy solutions worldwide, ranging from some of the world's largest solar deployments to residential customers' rooftops. SunEdison is a subsidiary of MEMC Electronic Materials (NYSE: WFR), a global leader in polysilicon and silicon wafer manufacturing, the foundation upon which most solar cells and semiconductor devices are built. ECCO International has been contracted by SunEdison to provide expert metering services and improve its operational readiness. As part of the work, ECCO has developed a comprehensive metering strategy for SunEdison's Orion facility. The metering strategy was created to clearly define output measurement points of the Orion plant that serves two customers through a single transformer. The strategy defines measurements on the low-side of the transformer and the subsequent single metering point on the high-side and how the transformer losses are to be accounted for settlements purposes.

In addition, ECCO has worked closely with SunEdison to provide a detailed time-line associated with all mandatory documentation and due dates for the expected grid connections as required by the CAISO. ECCO has lead the CAISO metering application process on behalf of SunEdison for several facilities. As part of the effort, ECCO has prepared, submitted and obtained approval of the following required documents; Metering Scheme Overview, Metering One-line, Metering System 3-line, GIS Site Location information, Meter Calculation Worksheet, Metering Communications Drawing, Compensation Calculation to POR, CAISO Metering Certification forms, SCADA Point identification of critical plant data, including calculated values related to plant status and System component access information.

SunEdison has planned facilities in the central valley (Fresno Area) that are currently under construction. As part of the interconnection process, PG&E and the CAISO had conducted impact studies. PG&E had conducted a study which concluded that one project "may" impact neighboring (or 3rd party systems). Two 3rd parties

requested compensation from SunEdison for over $3.8M in upgrades to accommodate these facilities. ECCO performed a review of the planning studies used by CAISO and the aforementioned 3rd parties. ECCO reviewed the data and methodology and provided comments based on industry practices and standards related to impact studies. In addition ECCO performed a set of detailed power flow studies using the base cases supplied by SunEdison from the CAISO secure website and from the 3rd parties. As a result of the work ECCO performed, the 3rd party compensation claims were dropped.

SunEdison plans to operate qualifying PV Solar facilities within the defined North American Electric Reliability Council (NERC) regions. As such, facilities of a prescribed capacity fall under the Compliance criteria established by the NERC. ECCO implemented a strategy, corporate guidelines and NERC compliance procedures. This effort ensured that SunEdison would have adequate information related to the application of the NERC criteria within North America. In addition, ECCO provided SunEdison with sufficient detail that allows SunEdison management to move forward with its investment plans ensuring NERC compliance.

In addition, SunEdison has commenced operation of qualifying PV Solar facilities within the California ISO (CAISO) footprint. These facilities are located within the franchise territories of all the major IOUs in California, Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E). The operation of these facilities is based on appropriate Power Purchase Agreements (PPAs) and, where applicable, associated Operations & Maintenance (O&M) Agreements related to each specific plant. ECCO provided expert consulting services to the SunEdison management for the implementation of corporate guidelines, operational procedures and processes for ensuring adequate compliance with CAISO's business practices and operating procedures.

ECCO has also developed and delivered a “Settlements Simulation” application which allows SunEdison to evaluate various CAISO Settlement Charge codes along with the expected operating profile of the proposed facility. The purpose of this Project was to assist the asset managers assess the exposure and potential impact of various charges on the facilities' revenue stream.

SunEdison has also looked to ECCO to provide support and consulting services related to a revenue recovery proceeding for a large 250MW PV Solar facility operating in Southern California. There were some operational issues associated with the facility resulting from lack of clarity of instructions by the Scheduling Coordinator. ECCO assisted SunEdison in the evidentiary portion of the proceedings successfully defending SunEdison's position.

25. **Recurrent Energy (RE):** Since 2014 ECCO has been engaged by Recurrent Energy (RE) to provide a variety of consulting and software services for supporting its business operations for PV Solar projects and developing a comprehensive integrated information management system. The RE's business plans include expansion of its scope of services for PV Solar projects to include direct

responsibility for operations and maintenance (O&M) of the projects in addition to their current core project development and asset management services. Further, RE has plans to manage PV Solar projects that will be participating in energy markets, e.g., CAISO and ERCOT. Recognizing the need to comply with PPAs and applicable industry and market-based regulations and protocols, RE understands that it has to improve its current business processes and information management system capabilities (IPP Platform) to support multiple business functions during the lifecycle of PV Solar projects. The new IPP Platform and associated software applications and databases will be integrated with select existing applications currently in use by RE.

In 2015 ECCO assisted RE in reviewing its PPAs to quantify the risk exposure of utility-scale PV Solar facilities which operate in competitive energy markets, such as California and Texas. While participating in these markets offer significant opportunity, they also involve risks in the form of financial penalties. ECCO reviewed these PPAs to assess the dollar-value associated with the market risk exposure, developed a settlements simulation process, developed a risk assessment methodology and determined the level of risk based on criteria agreed-upon with RE, including revenues at risk due to non-compliance, unreported schedule changes or outages, etc.

ECCO also assisted RE in developing its business processes and its software acquisition process which involves the development of a Request for Proposal (RFP), solicitation of offers from bidders, demonstrations by select bidders, evaluation of bids, negotiations, contract award and project implementation.

In 2016 RE retained ECCO to assist with managing its Staff Orientation, Mentoring and Support Services and the implementation of its IT systems associated with Registrations, Integration with operating projects and RE-OPS Settlements integrating planned project activities and corporate goals.

26. **NETWORK OF AEGEAN ISLANDS FOR SUSTAINABILITY (DAFNI)**: In 2013 ECCO was awarded a major project to provide an assessment of the requirements for the implementation of the Energy Management System (EMS), Market Management System (MMS) and Electric Vehicle Charging Stations (EVCS), develop the technical needs and functional specifications and draft the associated Tender documents for the following five Non-Interconnected Island (NII) in Greece, Lesvos, Limnos, Santorini, Milos and Kithnos. Specifically, the systems covered under this contract were EMS, system operations, MMS, market operations, IT infrastructure, Corporate Systems, SCADA, communications and specifications for Electric Vehicle Charging Stations. The services covered three main phases and included, initial design and organization, the drafting of integrated technical and operational specifications and the final documents that will be used for tendering of the aforementioned systems. The initial design and organization (Phase I) included an analysis of the current systems, the determination of the requirements based on the approved Code and the regulatory framework for the electricity market in the islands, and the description of all required processes of all essential systems, EMS,

MMS, SCADA, IT architecture, and EVCS. The drafting of the detailed technical and operational specifications (Phase II & III) included all the processes and algorithms for the system operations and market functions, IT and communications architecture, SCADA and EVCS. The project was successfully completed on-schedule.

27. **HELLENIC DISTRIBUTION NETWORK OPERATOR (HEDNO):** In 2013 ECCO was engaged by HEDNO to provide consulting services for designing the smart metering IT infrastructure for a pilot project of 160,000 smart meters to be rolled out by 2017 in five regions in Greece. The EU had set into motion a set of climate change and energy policy objectives for 2020 and beyond. Attaining these objectives required a substantial change in the energy infrastructure throughout Europe. Core objectives of the EU policy are increased integration of renewable resources (wind, solar, geothermal), improving grid reliability, and developing new markets for energy so that consumers have access to low cost energy. To achieve these goals the basic delivery and measurement infrastructure needs to be improved upon, and it is with this objective that this project is being undertaken.

    ECCO worked with HEDNO to provide an overview of business model considerations in the context of designing, deploying, and operating a smart meter network to support the EU directives. Key components included the establishment of a Vision Document which detailed goals and objectives, success criteria, as well as metrics to measure progress. Additionally, the work supported identification of various types of constraints that may limit the implementation of the various business cases and ultimately whether the program achieves a positive return on investment.

    In 2014 ECCO was retained under contract by HEDNO to develop and draft the Tenders for the procurement of smart meters and the implementation of the project. This included participation in the public consultation process, the collection of all comments by the potential bidders, the analysis of the comments and the revision of the Tender documents.

28. **INDEPENDENT POWER TRANSMISSION OPERATOR, GREECE (IPTO):** From 2012 till 2014 ECCO was engaged by IPTO to provide auditing and certification services of its market software systems. This included the auditing and certification of all the ALSTOM Market Settlements software applications and the homegrown software support systems required for settling various market applications under the jurisdiction of the IPTO. These homegrown settlement functions included System Charges, Uplift applications, Ancillary Services, Public Service Obligations, Capacity Assurance, Cost Recovery functions, Metering Data Validation, Energy Data Calculation, Complementary Settlement Report Publishing, Penalties Module and Transmission Rights Settlements.

    ECCO performed a detailed and comprehensive analysis of the Market Settlements Software (MSS) and the MMS software Functional Design Specifications (FDS). ECCO also thoroughly reviewed the relevant sections of the Grid Control and Power Exchange Code for Electricity (“Code”) and its proposed revisions to assess the

compliance of the MSS against the requirements stated in the Code. Furthermore, ECCO consolidated the test cases that IPTO has performed on the MSS in a comprehensive Test Book specifically designed for the certification of the software by the ECCO developed methodology. It identified variances and additional tests required to be executed by the IPTO to correct these variances. The correction of the variances was required to achieve a perfect score. Finally, ECCO tracked the test results and mapped them to software specifications to validate the correct functioning of the MSS.

In the course of the mapping efforts among the regulatory requirements extracted from the Code, the MSS specifications extracted from the FDS, and the test cases in the MSS Test Book, ECCO performed a complete mapping of all regulatory requirements and validated the correct functioning of the MMS.

Finally, ECCO developed a certification report that summarized the MSS certification progress and metrics as of the date of the report. ECCO as part of this project is committed to repeat the process till a perfect score was achieved.

29. **EDF-RE:** In 2013 and 2014 ECCO was awarded a contract by the EDF-RE to model and analyze future conditions for 2016 and 2018 in the Texas ERCOT market to determine the impact of an increasing penetration of wind generation on the transmission grid. The models ECCO developed were based on the ERCOT model data available through the ERCOT Planning Web Site. ECCO augmented the models as necessary with planned changes to the transmission system to match the corresponding study year(s). ECCO used all data related to active and reactive power flow analysis required for a full AC simulation of the ERCOT transmission grid. Market and operational conditions along with ancillary services requirements and ancillary services bids were fully represented in the simulations as well. The study used a Monte-Carlo method to include forced outages on the production profile. All hours of the study years were processed sequentially in the simulations. ProMaxLT™ used exactly the same transmission models as used by ERCOT for clearing its nodal market to model the effect of transmission constraints on the transmission grid. ECCO has been using this formulation for nodal market simulation and price forecasting Monte-Carlo studies for many years very successfully on the West Coast.

30. **GOOGLE:** Since 2013 ECCO has been under contract with Google to conduct electric grid and distribution reliability assessment studies of the grid connections feeding into several Google facilities. ECCO deploys for these reliability assessment studies its own proprietary software platform, called SYSREL™. SYSREL™ is a complex and highly configurable platform for executing studies for transmission and distribution reliability assessments.

    One facility is located within the Midcontinent Independent System Operator's service territory ("MISO Site"). The second datacenter is located in the Southwest Power Pool's service territory ("SPP Site"). The project included the collection of power supply topology and equipment information at the most granular level. This data is used in the Monte Carlo modeling of the elements most likely to contribute to

failure modes of the power feed to the facilities. For example, for the MISO Site, ECCO performed a detailed Monte Carlo modeling of the 345kV transmission line between specific locations in the network, including modeling of common weather events that would trigger an outage of both line segments feeding into the substation and an outage of the substation itself. ECCO collected storm and severe weather probability information as well as failure probability information for the components of the electric supply. ECCO then performed a full Monte Carlo study that determined the basic load point reliability indices for each connection point for each site. As part of the deliverable ECCO computed and provided, average load point failure rates (failures per year) per high-voltage utility feed, average annual load point outage duration times, probability distributions of failure rate and outage duration and representative cumulative distribution functions (CDF).

ECCO performed a reliability assessment of the network supplying a facility located in the Georgia Power Territory. Based on the analysis, ECCO proposed updates to the substation and transmission tower design that Google will use to reduce its exposure to potential severe weather events that can expose the facility to loss of supply.

Similarly, ECCO performed a reliability assessment of the network supplying a facility located in the Netherlands, in the TenneT system. This study utilized advanced reliability study techniques that evaluated the LOLP index over a period of 9,800-years. TenneT is unique in that it has virtually all its facilities underground, dramatically increasing network reliability. ECCO deployed its proprietary software SysREL™ for the execution of the study.

31. **HELLENIC EXCHANGE GROUP (HELEX):** In 2013 ECCO was commissioned by the Hellenic Exchange Group S.A. to design a Forwards and Futures Energy Derivatives Market for the South East Europe. A growing number of countries worldwide have recently restructured their electric power sectors to introduce competition, improve services to consumers and deal with the environmental challenges of our times. Usually, this results in the introduction of competitive wholesale and retail Electricity Markets, and Derivatives Contracts on electricity, both Over-the-Counter and Exchange-traded, providing a variety of contract provisions to meet the needs of the electricity market participants.

    Medium-term and long-term Derivatives Markets organized in Exchanges, complement the Spot Market for wholesale electricity, by reducing risk since a) they reduce the quantity of energy that trades at the more volatile spot price, b) mitigate market power since suppliers and load representatives enter the Spot Market with more balanced positions, and c) foster the investment environment by improving revenue predictions. In the medium term, an Electricity Derivatives Market lets suppliers and load representatives lock in energy prices and quantities. In the long term, a Derivatives Market ensures that adequate resources are available when they are most needed.

For the implementation of this project, an extensive research and analysis of the Central Western European, Nordic, Italian and Turkish Futures Markets has been carried out. Based on this research and analysis, ECCO developed and proposed a specific design of a transparent Derivatives Market in Greece which will clear electricity products for the entire South East European region. The objective of this market is the formation of an applicable market scheme which will provide a reliable reference signal to market participants, while taking into consideration the special characteristics of the region. As part of the this Project, ECCO also embarked on a major outreach effort to enlist as many Market Participants in the region as possible to participate in the Energy Derivatives market.

It should be noted that the Forward Market is an integral part of the so-called "Target Model", which is expected to be implemented by all European countries in the years to come as part of the EU Internal Market development project.

32. **NREL (National Renewable Energy Laboratory):** From 2013 till 2015 ECCO was under contract with NREL to execute studies to simulate with realistic market models and operational data different market mechanisms that can analyze the missing money problem and improve market operations. The study will also propose methods to provide incentives for resources to be available and flexible in the long-term to meet the needs associated with higher penetration of wind and solar PV generation.

    The work in the first Phase involved the definition of a base case study using the full and detailed network model of ERCOT and a set of defined change cases with pre-determined penetration levels of intermittent renewable supply. Based the analysis of the simulation results, ECCO developed a report that contained the analysis of the market outcomes and the impacts of high penetration of wind and solar PV generation on the condition of revenue adequacy in the market under study.

    The work focused on the impacts of project(s) in 2016. ECCO ensured that the ERCOT network model was properly represented with published upgrades for the year studied including any thermal plant additions and/or retirements. ECCO deployed for the study its unique and proprietary energy software platform, ProMaxLT™.

33. **ELECTRIC POWER RESEARCH INSTITUTE (EPRI):** From 2013 till 2015 ECCO was under contract with EPRI to study the impact of variable generation on the California ISO energy markets. EPRI has been actively researching the impacts of increased penetration of variable generating resources (VG), such as RES generation, on the reliable operation of energy markets.

    ECCO is in a unique position to perform realistic modeling of CAISO price behavior, scheduling, dispatch and transmission flows based on our extensive experience in executing detailed system flexibility simulation studies. During the project, ECCO utilized actual historical bid data publicly posted by the CAISO as a base for the simulations. A full DC transmission grid for the study year of 2015 was deployed and

used to determine the impacts of a defined level of VG penetration on the CAISO-administered network. The work focused on the impact of VG on both ramping requirements and the effects on the network itself. ECCO ensured that the CAISO network model was properly represented with published upgrades for 2015 including any plant additions and retirements. This is the first study, we are aware of, that included a full transmission model in the Monte-Carlo simulations for stochastic-based system flexibility assessment.

The specific scope of this project was as follows:

1. Execute a system reliability analysis of the CAISO grid by deploying ECCO's energy software platform, ProMaxLT™, and utilizing a full transmission model to understand if or when transmission constraints may cause lack of system flexibility and when these constraints should be considered in the study set-up.

2. Include system flexibility considerations in the study to analyze the trade-offs between various options including committing flexible generation, curtailing RES generation, or allowing flexibility violations in the form of ramping up/down requirements in the presence of high penetration of RE generation. Analyze the uncertainty of variables and capture the stochasticity of RES generation using a modified Monte-Carlo simulation technique which is already implemented in our software platform.

3. Develop sensitivities with transmission build out to alleviate congestion and with fast start / flexible generator additions to demonstrate how transmission impacts and other flexible resources can provide flexibility.

4. Calculate flexibility metrics for the system based on previously developed metrics which EPRI will provide (post processed metrics).

5. Include the effect of the Day Ahead, Hour Ahead and Real-Time Markets and the inherent problems that can occur when unexpected changes in renewable output and load forecasts occur in the study period.

34. **PENNSYLVANIA-JERSEY-MARYLAND ISO (PJM):** In 2012 ECCO International was engaged by PJM to assist in the design and implementation of the communication protocols of the PJM's Advanced Control Center (AC^2) Program. The AC^2 program involved the design and development of new information technologies and the construction of a second data and control center for operating the PJM grid and markets functions. The program was designed to improve the security and resiliency of PJM's business functions and to enhance the quality and availability of services to PJM's members. Central to the AC^2 program was the development of a new and secure open architecture to share information between business systems and applications. In addition, the program included the redesign and replacement of legacy technologies, including PJM's Energy Management System (EMS), and the upgrading of major components of the Market Management System (MMS). ECCO Subject Matter Experts (SMEs) were responsible for the testing of the DNP

communication subsystem for the AC^2 program based on the Siemens' acceptance test plan. In addition to functional tests, the work included verifying that AC^2 access to all RTUs via PJMNet was robust and secure. We assisted with the development and testing of encrypted DNP/IP access to RTUs via the Internet as well as testing the PJM Information Model Manager (the Network Model) using the new IMM product from Siemens. ECCO also acted as the Lead trainer to PJM users on the ICCP configuration and testing using IMM. We were also responsible for updating the PJM ICCP NICD (Network Interface Control Document) and the ICCP Workbook (sets naming and semantic standards) based on the growth of PJM's membership and expanded control area and based on the new AC^2 system.

35. **MIDCONTINENT INDEPENDENT SYSTEM OPERATOR (MISO):** From 2010 to 2012 ECCO International provided consulting services and assistance to the Midcontinent ISO in the area of modeling and use of the Dispatcher Training Simulator (DTS). Our work includes but was not limited to the following specific issues: a) recommending and implementing changes in the modeling of the unit parameters to ensure accurate DTS representation of system frequency response to events such as sudden loss of large units or relay action resulting in electrical islands, b) recommending and implementing changes in the DTS treatment of unit control status schedules provided by the Unit Dispatch System of the Day Ahead/Real Time Energy and Ancillary Services Market system along with changes to training session handling of unit ramp rates in the simulation of events with severe system impact, and c) providing advice and assistance in preparing more realistic system representation by DTS in Power System Restoration drills to prepare the System Operators for rare but possible system events. Further, ECCO provided advice and assistance in regression testing of the DTS functionality as affected by the underlying EMS software version changes to ensure a seamless transfer of model updates and other data changes that occur over time in a power system.

36. **GOVERNMENT OF GREECE (HR):** In 2011 ECCO International along with the National Bank of Greece and Guggenheim Partners (A New York Hedge Fund) was awarded a major contract for providing financial and technical services for the project "ELIOS" from the Hellenic Republic. The objective of the project "ELIOS" was to develop over the course of several years substantial photovoltaic energy in Greece for exports to European countries (physical and virtual sales). The income from the project was to be allocated to reduce government debt. The scope of work included:

    1. Strategic review of the EU RES landscape and the regulatory framework associated with RES deployment
    2. Review of the current status of the national and international transmission grids.
    3. Assessment of the required investments to develop a cross-European energy transmission infrastructure.
    4. Assessment of the required changes of the wholesale energy market in Greece for the integration of substantial RES penetration in the transmission grid.
    5. Assessment of the operational and grid changes required for the integration of substantial RES penetration in the transmission grid.

6. Assessment of the control coordination mechanisms required to enable RES transfers to other countries
7. Assessment of the statistical transfer option as an alternative to physical transfers
8. Identification of potential monetization schemes for HR
9. Financial advisory services to the HR related to the structuring, development and implementation of the ELIOS project
10. Financial advisory services to the HR related to the Transaction structuring and execution.

37. **PUBLIC POWER CORPORATION (PPC), NATIONAL UTILITY OF GREECE:** In 2009 ECCO was retained by PPC and the Greek Government to execute various important studies and develop strategic plans related to the liberalization of the Greek energy market. Specifically, ECCO developed a comprehensive plan for opening up the Greek wholesale energy market pursuant to the policies of TROIKA (EU/ECB/IMF). The plan included physical sales of lignite plants and other equivalent economic and contractual measures including Energy Swaps, Contracts for Differences and VPP Auctions for auctioning off Virtual Power Plant (VPP) capacity. The plan also included the design of the simultaneous ascending-clock VPP auction with discreet rounds, dynamic bids, discreet rounds, activity rules, information disclosure, etc.

    The Project also included the development of the plans and the implementation of the creation of the Independent Power Transmission Operator (IPTO) and Independent Distribution Operator (HEDNO), both subsidiaries of PPC. ECCO participated in the study of the scenarios for the unbundling of the IPTO from the Vertical Utility. Emphasis was placed in the study of the following three options: 1) the ownership unbundling model, 2) the Independent System Operator (ISO) model and 3) the Independent Transmission Operator (ITO) model. Finally the ITO model was adopted.

    In 2010 ECCO performed a detailed simulation of the Greek energy market with a time horizon up to 2019 by deploying ECCO's proprietary and advanced simulation software platform, ProMaxLT™, for determining the economic value of each power plant for developing a strategy for PPC for the divestiture of its power plants.

    In 2011 ECCO executed a study of the mechanism for the breakup of the HTSO into two functions, the Market Operator (LAGIE) and the System Operator (ADMIE). It developed the new Codes of these two new organizations. The ADMIE was absorbed in 2012 by the IPTO, subsidiary of PPC, and the LAGIE became an independent Company.

    In 2011 ECCO developed the Operating Agreement that included the detailed terms and provisions of the commercial and operating relationship between the MO and the ITO.

In 2012 ECCO was engaged by PPC to develop a roadmap, the design of the auction and an implementation plan for the implementation of the VPP financial products for PPC for the liberalization of the energy market in Greece pursuant to the policies of TROIKA (EU/ECB/IMF).

38. **POLISH TRANSMISSION SYSTEM OPERATOR (PSE):** In 2009 ECCO International was awarded a multi-year contract to design the first LMP-based market in Europe. This project focused on the design of the market rules and protocols of the new market architecture for the Polish energy market including incentives for generation capacity expansion. It included the development of the general rules of the new market model and the high level problem formulation and proposed solution to each key element of the market architecture, the incorporation of comments from the PSE and the Market Participants and the development of revised final market rules and protocols. Furthermore, this work included support in dissemination of the new market architecture including development of Presentation material of the new market architecture and all other support required to secure the successful completion of the market redesign project.

    The market functions included the development of the market and business rules for the Day-Ahead Market (DAM) for energy, transmission and ancillary services, the Residual Unit Commitment (RUC) for reliability purposes, the Hour-Ahead Market (HAM) for energy, transmission and ancillary services, the Real Time Market (RTM), and the Market Power Mitigation (MPM) procedures, the Financial Transmission market (FTR), the Cross Border Exchange Trading Market, Reliability Must Run (RMR) scheduling, Capacity and Generation Adequacy Markets, the Data Registry and the Outage Coordination function, LMP transmission pricing and network modeling, and the metering, settlements and billing functions. The incorporation of the Polish detailed transmission network in the clearing of these markets was one of the key contributions of this work.

    In addition ECCO International was retained by PSE to perform a comprehensive cost benefits analysis of implementing the new LMP-based energy market. The scope of this work was to quantify the effects and the impacts to the energy market outcome, system dispatch, and resulting production system costs for the Polish power system under two scenarios: a status quo case (“Base Case”) in which scheduling and settlement are based on the current zonal market design, and a case in which LMP based market model is implemented (“Change Case”). The work also included a quantification of the effects and impacts that the market paradigm would have on the Polish market.

    To perform this analysis ECCO deployed our advanced energy and transmission market simulation software, called ProMaxLT™. The simulations were based on a security-constrained dispatch model that enables the simulation the operation of the electricity market over time. This model assumed short-run marginal cost bidding, performed a MIP-based Unit Commitment and a least cost dispatch subject to system, and transmission constraints (base and contingency constraints), and calculated hourly energy schedules and Ancillary Services (AS) awards and LMP

prices for energy and AS. ECCO performed simulations of the generation dispatch under the proposed nodal and existing zonal market assumptions for a five-year period 2013-2017 using ProMaxLT™.

In this study the annual production cost were used as the primary economic indicator. These costs were measured and analyzed. The production cost difference reflected the potential social benefits (social welfare gain) to the PSE footprint of the proposed market design. The transition to the new market design was shown to improve and streamline the process of security constrained commitment and dispatch of generating units and resulted in market efficiencies. Lower production costs will ultimately benefit electricity consumers in the PSE market. In the study the treatment and pricing of local congestion under the new market design, the benefits to the consumers and the impact on generation siting decisions was quantitatively analyzed and evaluated.

In 2011 ECCO was retained by PSE to develop market coupling mechanisms for harmonizing the new proposed, LMP-based energy market architecture with the other energy markets of the EU member states. This was the third Phase of the project for transitioning PSE's existing market structure from a zonal based market model to a nodal LMP-based energy market with a bid-based Unit Commitment clearing mechanism where scarce transmission resources are fully embedded in the market clearing and consequently are fully priced at the market solution.

From 2002 to 2003 ECCO provided consulting services in developing and implementing various elements of the wholesale energy markets in Poland, including scheduling, transmission pricing, RMR scheduling and generation adequacy, and the real- time market.

39. **ERCOT (Electric Reliability Council of Texas, Inc.):** In 2011 ECCO International was awarded a contract by ERCOT to conduct a transmission reliability study for the state of Texas for the years of 2014 and 2017. In the study ECCO performed NERC Mandated LOLP studies incorporating the entire transmission network and accounting for the increased amount of intermittent resource supply. This study was ground-breaking since it did not only account for the uncertainties of total energy supply and demand but it also accounted for "deliverability" associated with the transmission constraints which exist in a power system. ECCO has developed and implemented a sophisticated advanced Reliability Assessment simulator that deploys a detailed transmission model coupled with MIP/LP optimizers and sequential Monte-Carlo simulations to perform transmission based system reliability studies especially in the presence of high penetration of RES resources in the grid.

In 2013 ERCOT, as part of their new methodology and best engineering practices related to long-term load forecasting techniques, engaged ECCO to re-run all the LOLP system reliability cases with the load forecasts developed by their new methodology and determine the impact on the LOLP outcomes. ECCO executed the new study, re-ran the cases, compared the differences and provided a report tracking any variation in the final results.

40. **ERCOT (Electric Reliability Council of Texas, Inc.):** From 2006 to 2010 ECCO International was a lead consultant in designing, developing and implementing the Texas Nodal market. Services to ERCOT included extensive support in developing the design of the Day-Ahead Market (DAM) for energy, transmission and ancillary services, the Residual Unit Commitment (RUC) for reliability purposes and the Real Time Market (RTM) based on the Security Constrained Unit Commitment (SCUC) and Security Constrained Economic Dispatch (SCED) methodologies that include the full transmission network of ERCOT, the Congestion Management market, EMS/AGC redesign, EMS/AGC interfaces to market systems, Network Modeling, State Estimation and other EMS functions, and various settlements and billing functions. It also included the CRR markets, LMP transmission pricing, the requirements development, business analysis, detailed software specifications and implementation of the market software systems to support the new Texas Nodal Market. Furthermore, ECCO participated in the testing of market system software that includes a detailed network model, wrote test cases and prepared test data, and successfully performed Unit Testing of market applications.

    ECCO also assisted ERCOT in developing all business processes associated with Congestion Revenue Rights (CRR) allocations, CRR Auctions and Bilateral Ownership Transfers and provided extensive support in developing the ERCOT controlled network. Further, it assisted ERCOT in developing a comprehensive CIM-based data model including all necessary extensions into the standard CIM dictionary that forms the basis for the EMS and MMS proprietary databases and designed and implemented the Web Services program to support the market systems that include a detailed transmission model for the Texas Market.

    As part of the Texas Nodal Market implementation project which was completed in 2012, ECCO managed the Operational Readiness and Testing/Infrastructure (ORT/INF), Nodal monitoring implementation, coordinated the two-phase external Security Assessment and the IT Readiness effort to facilitate the transition of operations from the Nodal program staff (consultants) to ERCOT's internal IT Operations staff. Towards the completion of the project ECCO also led the development of Cyber Security Patch Management Strategy. These requirements were driven partly by the North American Reliability Council's Critical Infrastructure Protection (NERC CIP) policy requirements and partly by the overall number of systems and applications. This process encompassed the lifecycle from monitoring software vendors for patches through the release pipeline all the way to production implementation and subsequent monitoring and verification.

41. **NEW YORK INDEPENDENT SYSTEM OPERATOR (NYISO):** In 2011 ECCO International was engaged by the NYISO to develop the Functional and Design Specifications for Pump Storage Hydro (PSH) resources that may participate in the wholesale energy markets at the NYISO. Currently PSH resources are not optimally scheduled in the normal course of the Security Constrained Unit Commitment (SCUC) application that is used for market clearing. The mode of operation is pre-determined and is an input to the SCUC market process. As a result the market results are sub-optimal. In this project ECCO International developed the models

that will allow PSH resources to be scheduled economically by the market clearing software as either a generator or a pump, with the ability to switch operation in an optimal manner from one mode to the other and vice versa.

42. **MOTOR OIL HELLAS S.A.:** In 2011 ECCO International was awarded a contract to develop a business plan and a road map for MOTOR OIL HELLAS S.A. to successfully participate in the energy retail business. The specific Tasks included:

    1. Development of the best strategy for securing energy through trading activities, wholesale market purchases, imports, etc.
    2. Development of a human resource plan to best meet the needs of Motor Oil in the retail energy business
    3. Development of the optimal company structure
    4. Development of the optimal IT infrastructure
    5. Definition and description of the software tools required for a successful operation, including a trading information system, a system for participation in the PTP auctions, and a Retail Management software system that includes a CRM and a Billing system.
    6. Description of basic functions including economic analysis where consulting or internal expertise is required.
    7. Development of a risk minimization management plan which is critical for successful operations in the Greek retail market.

43. **CALIFORNIA INDEPENDENT SYSTEM OPERATOR (CAISO):** ECCO has been under contract with the CAISO from its inception in 1998 till 2006 to provide expert advice and consulting services on market design of various market elements and on the development and implementation of software systems required to support the development and implementation of the energy market in California.

    In 1998 and 1999, ECCO developed an Optimal Power Flow (OPF) to simulate the congestion management software in production and performed studies to evaluate the effectiveness of zonal congestion management, research alternative transmission loss allocation methods, and compare the one-part versus two-part ancillary services bid evaluation methods. We performed extensive transmission studies and worked on developing a detailed network model. We also designed the source-sink model for transmission rights in congestion management, software for transmission right usage curtailment, the 10-minute dispatch and settlement software, and software for price-responsive energy trades, all successfully placed in production. Further, we assisted the CAISO in the definition and development of a Firm Transmission Right product and the design of its auction, and played a key major role in the ancillary services market redesign initiative.

    In 2000, ECCO International successfully participated in the Congestion Management Reform (CMR) initiative, where we laid out the design for real-time economic dispatch and settlement. It was our job to develop models for incorporating nomograms and operating procedures as constraints in congestion management and real-time economic dispatch, and developed procedures for

deriving commercial network models. In support of the CMR, we conducted simulations and analysis on the locational nodal price dispersion within the CAISO controlled grid.

In 2001, ECCO International was awarded a contract to develop the design for a forward energy market based on unit commitment that includes California's full transmission network. ECCO staff developed procedures for market power mitigation and calculated cost-based market clearing prices for use in refunds mandated by the Federal Energy Regulatory Commission (FERC). ECCO developed applications for committing resources at least cost, based on incremental heat rates and applicable fuel prices. In addition ECCO developed applications for evaluating Generator interconnections with respect to transmission congestion.

From 2002, till 2006 ECCO International was a lead consultant in the Market Design 2002 (MD02) and subsequently the Market Redesign and Technology Upgrade (MRTU) projects. In MD02, ECCO designed the congestion revenue right allocation and auction process and the real-time market consisting of multi-interval Security Constrained Unit Commitment (SCUC) and Security Constrained Economic Dispatch (SCED) that includes the full transmission network of California. ECCO staff conducted numerous simulation studies, and developed load aggregation concepts, pricing rules, and settlement procedures and formulae for forward and real-time markets and cost allocation mechanisms. From 2002 till 2006 Dr. Papalexopoulos was the overall technical lead of the Market Redesign and Technology Upgrade (MRTU) project at the CAISO for the development and implementation of the LMP-based energy market in California. This included the development of the software requirement specifications and market and business rules for the Day-Ahead Market (DAM) for energy, transmission and ancillary services, the Residual Unit Commitment (RUC) for reliability purposes, the Real Time Market (RTM), and the Market Power Mitigation (MPM) procedures, Congestion Revenue Rights (CRR) market, Reliability Must Run (RMR) scheduling, Capacity and Generation Adequacy Markets, EMS/AGC redesign, EMS/AGC interfaces to market systems, Market Interfaces, LMP transmission pricing, and network modeling and various settlements and billing functions. The incorporation of the California's detailed transmission network in the clearing of these markets was the key contribution of this work.

Also from a project perspective ECCO was responsible for the review of the design specifications, business analysis, detailed software specifications, implementation, test case drafting, test data preparation, and pre-FAT, FAT and SAT testing of the market software systems to support the new CAISO markets. In 2006 ECCO completed successfully the Site Acceptance Test (SAT) for the baseline functionality of both the Forward and Real-Time Markets. Finally, ECCO staff provided additional expertise to policy makers at the CAISO on formulating new policies regarding implementation of resource adequacy requirements and many other elements of the evolving electricity markets in California in order to secure generation investments and other activities to ensure FERC compliance. ECCO International SMEs also

provided guidance for the software integration via service-oriented architecture and provided technical support for Common Information Model (CIM) market extensions.

44. **NEW ENGLAND ISO (ISO-NE):** In 2010 ECCO was engaged by the ISO-NE to provide expert advice and consulting services in analyzing various elements of the Forward and Real Time markets and scheduling algorithms including Lagrangian based and Mixed Integer Programming (MIP) based Units Commitment algorithms.

    In 2011 and 2012 ECCO conducted several studies to enhance the efficiency of the ISO NE markets. These studies include the detailed simulation of the Day-Ahead Market, Reliability Unit Commitment (RUC), and Real-time Commitment and SCED functions.

    The first effort involved the tuning and benchmarking of a Unit Commitment simulator to replicate the behavior of the production Reliability Market software. It also studied the economic impacts of proposed changes to the Unit Commitment objective function, including a change from a commitment-cost objective to a production-cost objective. The analysis focused on the impacts on Bid Production Costs, Locational Marginal Prices, Uplift/Make-Whole payments, and generator revenues. Also, the impact on the commitment of specific units and fuel-types (oil, peakers, combined-cycle, etc.) was assessed.

    It also analyzed the impact of virtual bidding on Unit the Commitment Uplift/Make-Whole payments in the ISO-NE market. The goal was to determine if the virtual bids/offers should be responsible for Uplift payments, like other generation and energy sources. The hope is to increase the efficiency of the ISO-New England markets by properly assigning the resulting costs.

    The final study looked at the costs associated with increasing Ancillary Service Requirements. These costs include LMPs, Generator Revenues, and Uplift Costs. Also, the real-time costs of the various Ancillary Services was determined for two years of simulated markets.

    In 2013 ECCO was engaged by the ISO NE to develop stochastic-based Security Constrained Unit Commitment algorithms for clearing wholesale energy markets.

45. **HUNGARIAN TRANSMISSION SYSTEM OPERATOR COMPANY Ltd (MAVIR):** In 2011 ECCO was retained by MAVIR to provide consulting and software services for developing a pool-based co-optimized market for Energy and Ancillary Services for the country of Hungary. This work included the development of the general rules of the new energy market architecture, the development and support of presentation material of the new market architecture and the support required to secure the successful completion of the market redesign project. ECCO performed a comparative study to evaluate the costs/benefits for transitioning from a self-scheduling energy market where energy and ancillary services are procured separately and the market clears with no visibility of system and resource constraints to a co-optimized and integrated energy and ancillary services market.

46. **INDEPENDENT ELECTRICITY SYSTEM OPERATOR (IESO):** From 2007 to 2011 ECCO was retained by the IESO to provide consulting and auditing services to IESO for several Reliability Must Run (RMR) units. This included the collection of scheduling and billing data, the review of the agreements related to voltage control and real power dispatching of the plants under pre-defined network system conditions, the identification of conditions that may have created unnecessary expenses that were included in the billing costs and the evaluation and analysis of any plant operations that were deemed beyond the agreement's pre-defined schedules that may have caused an adverse impact on the security and the reliability of the network. Finally, ECCO International has been involved for several years in performing an audit to determine the practices adopted by the plants to meet the good utility practices and standards in the areas of fuel consumption, scheduled maintenance, unit ramping, plant functionality, electrical services, plant's electrical auxiliary system requirements, forced outage rates, losses, deliverability of power project fixed costs and costs of labor, equipment, contractors.

47. **SOLAR CELL HELLAS, GREECE (Major Solar Energy Developer with 300 MW of Solar Energy Projects):** ECCO International was awarded a contract in 2011, along with (ADN Capital Ventures) to act as SCH's sole advisor and provide financial and technical services to SCH for its Solar Energy Projects in Greece. These services included:

    1. Determining financial, commercial and technical priorities;
    2. Reviewing project finance models provided by SCH;
    3. Reviewing financial analysis provided by SCH and evaluating project performance under various assumptions;
    4. Reviewing of key Project agreements;
    5. Assessing Project funding requirements, both short and longer term;
    6. Developing a financing strategy for the Projects;
    7. Analyzing debt markets and selecting target banks and other financial institution to raise Project funding;
    8. Requesting term sheets from targeted financial institutions for providing funding and/or insurance or guarantees for such funding to SCH Projects;
    9. Preparing SCH for discussions and negotiations with potential funding sources;
    10. Negotiating term sheets of selected targets for Projects;
    11. Negotiating documentation through to execution of agreement.

48. **INTEGRYS:** In 2010 ECCO provided training on the new Locational Marginal Pricing (LMP)-based energy market in California. The focus of the training was on the Integrated Forward Market, the Scheduling Infrastructure and Business Rules (SIBR) system, the Inter-SC Trades and the Import/Export Modeling.

49. **Wal-Mart:** In 2009 and 2010 ECCO provided consulting and training services on wholesale energy market issues related to the New York ISO and the ERCOT markets. Topics included, Demand Response, Capacity Market, Day-Ahead and

Real-Time Markets, Reliability Unit Commitment, Market Power Mitigation, Settlements, Registration, Financial Transmission Rights and Virtual Bidding.

50. **ENERGY RETAILER:** in 2009 ECCO provided training and advice about participation in the newly established CAISO LMP market. The training included information about how the market operates, time frames and unique characteristics as well as advice on strategies for market participation and hedging.

51. **PACIFIC GAS AND ELECTRIC COMPANY:** In 2009 and 2010 ECCO provided support to PG&E in transitioning PG&E to the LMP-based energy market in California. This included providing support, consulting and software services for LMP and CRR evaluations. ECCO deployed its advanced energy market simulation software, ProMax™, to simulate the CAISO market on a daily basis to perform LMP price validation, energy market design analysis and benchmarking studies. PG&E also deployed ECCO's CSS™ software tool to perform CRR analysis and evaluation studies.

    In 2011 ECCO deployed ProMax™ to perform a simulation study to gain insights into the Convergence Bidding (CB) markets and their impact on the physical markets. This analysis provided substantial insights into the interaction of virtual and physical markets and how CBs are treated in the Unit Commitment process relative to physical bids (including relative to fixed demand). The analysis assisted PG&E to prepare their CB strategy, understand the impacts of other bidders on LMPs and the resultant cost of power they procure in the CAISO market. The focus of the study was also to study the effectiveness of the Nodal Limit Constraints in securing AC Power Flow convergence in the SCUC of the Integrated Forward market (IFM), and the impact of these constraints on the LMP price formation.

    In 2011 ECCO also performed a study to replicate the CAISO Day-Ahead Market results for select Seasonal, On and Off-Peak dates during the 2010 study horizon. The objective of the study was to establish a policy decision relative to a system loss allocation process being discussed for implementation by the CAISO. PG&E relied heavily upon the work produced by the ECCO study for formalize their position. For this study ECCO performed a detailed comparison of the ProMax™ calculated prices and network flows on the major interfaces to those available on CAISO's OASIS system. There was particular emphasis placed on the major WECC paths such as PATH15 and PATH26 and PACI, Palo Verde and NOB.

52. **TERNA S.A. ("TERNA"), GENERATOR, GREECE:** In 2009 and 2010 ECCO provided consulting services to analyze and quantify the value of Pump Storage Hydro (PSH) facilities provides to System Operations in Greece in the presence of high penetration of Renewable Energy Resources (RES) and especially wind generation. In this study we focused on quantifying by deploying simulations the reliability benefits only PSH facilities provide to the system. The simulation was based on actual data of the Greek generation and transmission data and the current rules of the wholesale energy market (the DAS market) administered by the HTSO. As part of the study we also deployed the market prices produced from the energy

simulations to calculate the capacity payments to the proposed PSH facilities along with the cost savings due to pump operation where PSH facilities pay low prices at night to pump and sell energy during the day at higher prices. The analysis and quantification study was executed by deploying ECCO's advanced energy and transmission market simulator, ProMaxLT™. The Greek energy market rules were included in the market clearing of our platform software for accurate results along with a detailed transmission model of the Greek transmission grid.

53. **ENTEGRA POWER SERVICES:** In 2009 and 2010 ECCO provided extensive training and consulting services on the new Locational Marginal Pricing (LMP)-based energy market in California, including Forward and Real-Time markets, scheduling, Ancillary Services and congestion management, Reliability Unit Commitment, Imports & Exports, Transmission pricing in an LMP market environment and impacts on LMPs of various events such as outages (resource & network), participant bidding, loop-flows, and load forecasting errors. It also performed an analysis of the risks, opportunities and costs for becoming a dynamic resource. The analysis focused on the Hourly vs. 5-min Real-Time Energy settlement, Block Energy Accounting, Regulation and Operating Reserves and HASP and Real-Time Congestion.

    ECCO used its proprietary energy and transmission market simulation software package, ProMax™, simulated the CAISO's Day Ahead Market Clearing process and performed an extensive analysis of the energy market outcomes, such as schedules, market clearing prices, ancillary services prices, congestion and congestion prices at all congested paths taking into account bids from the market participants, the load forecast, and forecast plant and transmission outages. This analysis provided insights on the impact of various parameters, such as outages, on the market results, such as the LMPs.

    Finally, ECCO performed an analysis and developed bidding import/export strategies at various Scheduling Points and various markets and market products. The analysis focused on the consistent energy price differences and congestion in DAM and HASP/RT, arbitrage opportunities and any relevant tariff issues, Congestion Revenue Rights in DAM, Export self-schedule limitations in RTM, Unused TOR/ETC transmission capacity reservation on inter-ties, Convergence Bidding, Historical congestion patterns and NPTO compensating injections.

54. **SOUTHERN CALIFORNIA PUBLIC POWER AUTHORITY (SCPPA):** In 2009 ECCO provided training on the new Locational Marginal Pricing (LMP)-based energy market in California with emphasis on the Scheduling Infrastructure and Business Rules (SIBR) system.

55. **JPMORGAN CHASE BANK:** In 2009 ECCO provided training on the new Locational Marginal Pricing (LMP)-based energy market in California. The focus of the training was on the Integrated Forward Market, the Real Time Market and the Hour-Ahead Scheduling Process, the Reliability Unit Commitment, Market Power

Mitigation, the Scheduling Infrastructure and Business Rules (SIBR) system, LMP Pricing, and the Congestion Revenue Rights Markets.

56. **RBS SEMPRA COMMODITIES:** In 2009 ECCO provided training on the new Locational Marginal Pricing (LMP)-based energy market in California. The focus of the training was on the Integrated Forward Market, the Real Time Market and the Hour-Ahead Scheduling Process, the Reliability Unit Commitment, Market Power Mitigation, the Scheduling Infrastructure and Business Rules (SIBR) system, Bilateral Contracts, LMP Pricing, and the Congestion Revenue Rights Markets.

57. **RES DEVELOPER:** in 2008 ECCO was retained to perform analysis for developers of renewable power plants to predict the exposure of renewable resources to curtailment due to system operation constraints or congestion over a 20 year life expectancy of the power plant. This detailed technical analysis was performed for the project investors and financiers.

58. **ELECTRIC POWER RESEARCH INSTITUTE (EPRI):** From 2008 till 2009 ECCO was under contract to investigate a new approach and enabling technology to connect retail and wholesale energy markets. The test case was the California energy market. The objective was to develop a decision support tool to inform energy retailers of various wholesale energy costs demand response can avoid. Such a tool could be used in operational timeframes to provide a financial link between retail incentives for demand response and actual wholesale market conditions. The objective was to design operational strategies, specify requirements and specifications for the development and implementation of a decision support tool for triggering demand response.

    ECCO, as part of this project, provided consulting services on the California ISO settlement methodology for the collection of current and future charge types. The services included identification of the types of charges sensitive to demand response, documentation simplifying the derivation of associated settlement calculations, and identification of information sources required as inputs to the calculations. ECCO provided advice on how to estimate settlements for charge types that are most sensitive to demand response.

    ECCO reviewed business requirements collected from energy retailers and advised on compatibility of the requirements with system implementation plans of the CAISO. Advice included modification of business requirements and contribution of additional requirements to ensure compatibility with future CAISO market and settlement system upgrade plans. Further, ECCO delivered a modified business requirements and a software design specification document that was subsequently used for the implementation of the IT Demand Response software system.

59. **NORTHERN CALIFORNIA POWER AUTHORITY (NCPA):** In 2008 ECCO provided training and consulting services on the new Locational Marginal Pricing (LMP)-based energy market in California. This included training and consulting on Forward and Real Time markets, Scheduling, Settlements, CRR market, LMP transmission

pricing, and network modeling, and the development and implementation of the software systems to support the new CAL ISO markets.

60. **MIRANT:** in 2008 ECCP provided training and consulting services on the new Locational Marginal Pricing (LMP)-based energy market in California. This included training and consulting on Forward and Real Time markets, Scheduling, Settlements, CRR market, LMP transmission pricing, and network modeling, and the development and implementation of the software systems to support the new CAL ISO markets.

61. **PUBLIC POWER CORPORATION (PPC), NATIONAL UTILITY OF GREECE:** In 2008 ECCO was engaged by PPC to develop the energy market design, rules and protocols and the Code for the Non-Interconnected Islands. In 2009 ECCO executed a study for calculating the cost of integrating Renewable Energy Resources (RES) into the grid in the Non-Interconnected Islands of Crete, Rhodos, Ikaria and Lesvos) as a function of the penetration level. The services that were analyzed were Regulation, Tertiary Reserves and Unit Commitment. Reliability studies were also performed to analyze the impact on reliability of RES as a function of the level of penetration. ECCO deployed its advanced simulation platform, ProMaxLT™, to perform this study.

    In 2004 ECCO was engaged by PPC to provide expert advice and consulting services on analyzing various aspects of the Greek wholesale energy market.

62. **REGULATORY AUTHORITY of ENERGY, GREECE (RAE):** in 2007 and 2008 ECCO provided under contract with RAE expert advice and consulting and software services on various new market elements RAE was contemplating for the Energy market in Greece. Specifically, ECCO deployed its advanced energy market simulation software, ProMaxLT™, to analyze the Real-Time Dispatch market (RTD) and the design of the Tertiary Reserve market in Greece.

    In 2001 and 2002 ECCO was retained by RAE to provide expert advice on the development and implementation of various markets in the Greek energy sector, including, scheduling, day-ahead and real-time markets, and a capacity market to ensure generation adequacy and sufficient reserve margins.

63. **HELLENIC TRANSMISSION SYSTEM OPERATOR, GREECE (HTSO):** From 2007 to 2009 ECCO was awarded a contract by the HTSO to develop eight (8) Business Market Manuals (BMMs) that included detailed market and business rules that the Market Participants in Greece use to participate in the Greek energy market. The content of these Business Manuals was consistent with the Greek Electricity Code but contained much more detailed information that is required by the Market Participants to participate in the market. The Manuals were: a) Day-Ahead Manual (DAS), b) Dispatch and Intra-Day Scheduling Manual (DS), c) Capacity Assurance Mechanism Manual, d) Settlements Manual, e) Unit Cost Manual, f) Metering Manual, g) General Provisions Manual and h) Glossary Manual.

As part of this project, ECCO also led the development and implementation of an ***e-Library*** software tool to be used by the Market Participants as a vertical search engine for document management, on-line training, etc. All Business Market Manuals, regulatory filings, operating procedures, etc., were housed in the e-Library.

In 2008 and 2009 ECCO was also engaged by the HTSO to provide auditing and certification services of the new interim ALSTOM-based market clearing software. The software included the Day-Ahead market, the Dispatch Scheduling Market, the Real-Time market, the Ex-Post Pricing function, and the Market User Interface.

64. **PACIFIC GAS AND ELECTRIC COMPANY:** In 2007 ECCO provided training and consulting services on the new Locational Marginal Pricing (LMP)-based energy market in California, including Forward and Real-Time markets, scheduling, Ancillary Services and congestion management, Scheduling Infrastructure and Business Rules (SIBR), and settlements and billing functions.

    In 2002 and 2003 ECCO provided consulting services and power system analysis expertise on various transmission planning, operational and settlement functions. It performed various interconnection studies for new generation capacity in California.

65. **SOUTHERN CALIFORNIA EDISON (SCE):** In 2007 and 2008 ECCO provided training and consulting services on the new Locational Marginal Pricing (LMP)-based energy market in California, including Forward and Real-Time markets, scheduling, Ancillary Services and congestion management, Scheduling Infrastructure and Business Rules (SIBR), and settlements and billing functions.

    In 2009 and 2010 ECCO International provided support to SCE in transitioning SCE to the LMP-based energy market in California. This included providing support in redesigning its existing market and settlements systems and providing consulting and software services for LMP and CRR evaluations.

    From 2009 till 2012 ECCO deployed its advanced energy market simulator suite, ProMaxLT™, to simulate the LMP-based market in California, predict long-term LMP prices and perform detailed CRR studies with a one year to 10 year time horizon using a detailed Full Network Model (FNM) of the California transmission grid.

66. **E.ON. US:** In 2007 ECCO conducted a study and provided a report to assist E.ON U.S. to make resource allocation decisions when confronted with the opportunity or obligation to serve various levels of additional Non-Conforming Loads (NCLs) principally arc furnace type steel mill customers. ECCO's detailed analysis of NCLs revealed a cyclical load pattern consisting of a "peak" duration of approximately 9 to 11-minutes with a drop off to a minimum for approximately 3 to 4-minutes. NCL greatly impacts an electric utility's ability to meet Area Control Error (ACE) minimum compliance. The analysis relied on data of the E.ON U.S. system including ACE, unit data, tie-line flows, arc furnace melt cycles, characteristics of NCLs, etc. ECCO used this data to perform a detailed analysis by selecting specific time periods and

variations of generation and load to determine the reliability impacts of NCLs using accepted engineering practice and approved standards.

The report provided the results on the reliability impacts (i.e., frequency regulation characteristics) of NCL for various E.ON U.S system conditions. ECCO performed two separate impact assessments as part of the project using additional NCLs that were added to the E.ON U.S. system in the future. The assessment studies focused on the NERC reliability standards and the impact the NCLs would have on the ability of E.ON U.S. to consistently comply with NERC CPS1 and CPS2 criteria.

67. **A GENERATOR:** In 2007 ECCO provided consulting services on market development and energy design issues in the Mid West and Eastern Unites States.

68. **A SOFTWARE DEVELOPER:** In 2007 ECCO provided consulting services related to rigorous testing, leading software Quality Assurance program. The work of QA testing required the primary capabilities of XML scripting accompanied by Web-based Applications testing.

69. **HELLENIC TRANSMISSION SYSTEM OPERATOR, GREECE (HTSO):** From 2006 till 2008 ECCO was the key consultant to the HTSO in developing the energy market design that included major modifications proposed by ECCO and approved by the RAE and the Greek Ministry of Development. The project also included the detailed energy market requirements and functional, and design specifications that were used to implement the new EMS and Market Management software (MMS) platforms. The new design included improved DAS, DS, ExPIP and RTD market applications, settlements, EMS/AGC systems, Metering and RTU systems, Cross Border trading algorithms, Capacity Assurance Mechanisms, Inter-TSO systems, Validation systems, Load Forecast, Market User Interface, Registration Systems, Reporting, Communication and Publishing systems. ECCO also developed the Tenders for the implementation of the EMS and MMS systems.

    In 2005 ECCO International prepared for the HTSO the Terms of References (RFP) for the development and implementation of the Interim Software System for clearing the Day-Ahead and Real-Time Markets. This RFP contained the design of the Day-Ahead Scheduling (DAS), Intra-Day Dispatch Scheduling (DS), Real-Time Dispatch (RTD) and Ex-Post Imbalance Pricing (ExPIP). Furthermore, it included Day-Ahead and Imbalance Settlements, Market User Interface Capability, and Integration of the Interim System with the existing infrastructure at the HTSO including the current EMS/AGC system.

70. **MMC ENERGY:** In 2006 ECCO provided consulting services and expertise on Ancillary Services bidding, Certification and AGC support.

71. **AUSTIN ENERGY:** In 2006 and 2007 ECCO provided expert advice and consulting services to prepare Austin Energy for the new Texas Nodal Market. This included a needs assessment and a gap analysis study, a capability assessment study, the development of an RFI and the evaluation of software vendors for providing software

services in the areas of EMS, Market Systems, Scheduling and bid creation, Deal Capture, and transaction evaluation, and Settlements and Billing systems required to support AE's operations under the Texas Nodal Market.

72. **EMA:** In 2004 ECCO provided consulting services to EMA in the area of utility load forecasting.

73. **HELLENIC TRANSMISSION SYSTEM OPERATOR, GREECE (HTSO):** In 2003 ECCO International was retained by the HTSO to assist the HTSO in providing an independent comprehensive review and analysis of the transitional power contracts. This analysis included a detailed review of the proposed transitional contracts, identification of the market elements that may cause problems and recommendations, where appropriate, of rules and protocols that may need to be modified or altered in any way in order to produce an internally consistent and efficient capacity market in Greece.

    In 2002 ECCO International was engaged in a series of activities to assist the HTSO in developing and implementing the Greek national energy market. Specific tasks included the design of the transmission constraints on the Hellenic transmission network in the Day-Ahead market, transmission loss analysis, the design of financial interconnection options for hedging against congestion fees, the design of signing long term ancillary services contracts and recovering the cost through uplift, and the design of capacity assurance mechanisms. ECCO International proposed a staggered capacity obligation for Suppliers for five years into the future, and a must-offer obligation for Producers with capacity contracts. ECCO International further participated in the proposed market design evaluation of Day-Ahead and Real-Time markets, demand side bidding, Day-Ahead scheduling, bid formatting, balancing adjustments, imbalance SMP calculation methodology, design of preliminary and final settlements and the design of an imbalance settlement based on balancing energy accounting and uninstructed deviation penalties. The detailed review resulted in the identification of rules that may cause a problem and recommendations, where appropriate, of rules and protocols that may need to be modified or altered in any way in order to produce an internally consistent and efficient wholesale electricity market in Greece.

74. **ELECTRIC POWER RESEARCH INSTITUTE (EPRI):** From 2002 through 2003, ECCO (along with Profs. Robert Wilson and Shmuel Oren) was under contract with EPRI to develop an integrated methodology that combines the engineering and economic perspectives on system operations. This goal stemed from the advent of restructured wholesale markets and the altered role of vertically integrated utilities. The operations of the physical system and the market system are now intertwined and mutually dependent. Reliability and commerce are two aspects of a larger system that requires a unified approach. Engineering management of the grid now depends on wholesale markets to obtain needed resources; in addition, engineering management must support and facilitate the efficient functioning of wholesale markets. Conversely, the design and operation of markets are strongly affected by engineering practices and availability of grid resources. Methods that in the past

focused narrowly on one aspect must now be enhanced and extended to cope with the tight interconnections among aspects of the overall system. These considerations in daily operations also apply to long-term planning and investments in new facilities.

ECCO in this project did not challenge well-established principles of engineering management of the grid, nor economic principles of market design. Instead, the goal was to enable the application of both types of principles to a consolidated system in which engineering management can support and utilize markets for energy, reserves, and transmission; and conversely commercial activities in markets are consistent with operating procedures and protocols and enhance system security and reliability.

In this project ECCO elaborated the parallels and differences between engineering and economic perspectives that derive from the commonalities and differences between the physical and market systems. It then evaluated several areas in which a unified perspective suggests new operational procedures that are more effective in dealing with problems arising in restructured markets. ECCO also demonstrated how the interface between the physical and market subsystems affects each – suggesting changes in engineering management to take account of market effects, and conversely, how the design of markets should be adapted to resource constraints and operating procedures. Finally, ECCO demonstrated how a blend of engineering and economic methodologies offers better prospects for dealing with problems in which a narrow perspective might imply conflicts between the two approaches.

In 2001 ECCO executed a study for EPRI to develop and analyze the basic alternative energy market structures evaluate their pros and cons and conducted of a survey of actual operational markets, in USA, Europe and Latin America.

75. **CAP GEMINI ERNST & YOUNG LLC:** Dr. Alex Papalexopoulos has been a special consultant to the ISO Solutions Group in the Cap Gemini Ernst &Young's Energy and Utilities Consulting Practice from 1998 to 2004. He provided expert advice to CGE&Y clients around the world on electric industry restructuring, market design and software systems issues for developing Independent System Operators and Power Exchanges. He assisted CGE&Y in their bid efforts for developing software systems for the electricity markets for various clients in North America and Europe. These clients included IESO Canada, ISO New England, RTO Alliance, Grid America, Portland General Electric, Pacific Corp., and Entergy. He also assisted CGE&Y in developing strategy and products to serve various market participants that participate in the ISO and PX markets.

76. **ERCOT (ELECTRIC RELIABILITY COUNCIL OF TEXAS, Inc.):** In 2003 ECCO International participated in performing a cost benefits analysis of the proposed LMP based energy market model that would replace the Zonal wholesale energy market in Texas. ECCO assisted in drafting the theoretical and practical underpinning of the LMP pricing that became part of the ERCOT Cost-Benefit Study Other Market Impact Analysis (OMIA), including the approach and the results. It was intended to

address impacts other than those included in the energy modeling aspects of the Cost-Benefit Study (the EIA) and the Implementation Impact Analysis of that study (the IIA). The analysis investigated several critical Significant Design Changes and measured the impacts of each change against a series of Commercial Impacts. The most substantial positive impacts that were found in the study are the following: the decrease in operational challenges for ERCOT associated with using portfolio information from market participants; the increased efficiency from the use of improved dispatch given unit-specific information rather than ERCOT-estimated information from the portfolios and from the combined capacity and energy optimization offered by the DAM; and the increased price discovery for specific locations. The most substantial adverse impacts were the following: the added complexity of the centralized, nodal market; a potential for risk shifts between the users of the grid; and the algorithmic and implementation risks of implementing the new market structure.

77. **GOVERNMENT OF ALBANIA:** In 2002 ECCO International provided expert advice and consulting services to key members of the Ministries of energy, finance, and economy, the National Agency of Energy (NAE), the regulator (ERE), and the vertically integrated utility (KESH) in various areas, including the development of a comprehensive energy policy, including unbundling options and reorganization of the dominant player, KESH, improvement of electricity security and reliability, design of tariffs that encourage conservation, development of a regional power market in the Balkans, and development of a commercial energy market.

78. **KOREA POWER EXCHANGE (KPX): In 2002** ECCO provided a review of the design specifications, business analysis, detailed software specifications, implementation, test case drafting, test data preparation, and pre-FAT, FAT and SAT testing of the market software systems to support the new KPX Cost-Based Pool (CBP) market.

79. **JAPAN, KYUSHU:** In 2001 ECCO International was retained by Kyushu Electric Power Co. (Kyushu EPCO) to execute a study of various unbundling options including ownership unbundling and various forms of functional unbundling. Another objective of the study was to review the experiences of electricity market reforms in the U.S. and Europe as represented by California, Pennsylvania-New Jersey-Maryland (PJM), Texas (ERCOT), Nord Pool, the United Kingdom (NETA) and Germany. Given the vast diversity among these power systems in terms of physical characteristics, institutional structure and historical condition, each reform experience is unique. The study focused on the detailed evaluation of various options for unbundling the transmission business of the utility from the vertically integrated structure of the utility and the development of a recommendation that best served the interests of the company.

    In Japan, power market liberalization began with the passage of the amendment of the Electric Utility Law on March 21, 2000. Under the new law, the retail power market was partially liberalized for high-voltage consumers with demand above 2 megawatts and 20 kilovolts. The liberalized market accounted for about 30 percent

of the total electricity sales in Japan. By lifting electricity price regulations and allowing entry of new power suppliers, the liberalization of the market attracted various domestic and foreign companies, including trading and energy companies, to enter the market. As foreign companies established their base in Japan, it was expected that pressure would increase for the government to broaden the scope of competitive markets for electricity.

Kyushu EPCO's expressed preference was to implement minimal changes to the current system. They also preferred the utility's generation and sales sections to remain bundled. Separation of the utilities' transmission sections was intended to serve the larger objectives of restructuring the power industry in Japan and to ensure fair competition among all users of the transmission grid.

ECCO International executed a detailed overview of the experiences in various jurisdictions in the US and Europe and analyzed the various options for unbundling the transmission business from the utility. We developed the advantages and dis-advantages of each option and developed a recommendation that best served the interests of the utility given the current market conditions in Japan and the policy directives of the Government. The recommend option ensured that all parties engaged in trading power have equal access to transmission on nondiscriminatory terms. This structure would enable independent producers and utilities' generation sections to compete fairly for sales to direct-access customers.

The recommended solution was that in Japan the best approach would be to establish within the utility a separate legal entity that is a regulated for-profit subsidiary responsible for both grid operations and transmission investments. The transmission subsidiary should be separate in terms of asset ownership, governance, management, personnel, finances, and accounting. The subsidiary would be required to provide open access on nondiscriminatory terms and it would be excluded from practices that bias commercial transactions. It should be regulated by a national authority that specifies the obligations imposed on the transmission subsidiaries for adherence to national standards, regarding both engineering and commercial operations, that ensure a reliable and efficient transmission system for the entire nation. For commercial matters, these standards should establish uniform methods of scheduling, operational procedures, and charging for losses, reserves, balancing services, and congestion pricing of the inter-ties between utilities. Information about both the national transmission system and each regional grid should be made available equally to all market participants, including the generation and sales sections of each utility as well as customers and independent power producers.

80. **LCG:** In 2001 ECCO provided expert advice in analyzing forward and real time market data for various ISO markets in the US.

81. **PIERCE ATWOOD (Law Firm):** In 2001 and 2002 ECCO provided expert advice on electric industry restructuring and market design issues for the Albanian market.

82. **POWER PLANT DEVELOPMENT:** In 2001 ECCO provided consulting services for supporting a developer on a natural gas simple gas turbine cycle for 500MW peaking power plant in northeast USA. The project will use the most advanced GE's gas turbine technology.

83. **POWER PLANT DEVELOPMENT:** In 2000 ECCO provided consulting services for developing an 1,100MW natural gas combined cycle power plant project in North Carolina, USA. The project's configuration is three gas turbines on two steam turbines with duct firing. The project used GE's technology for both the gas and steam turbines.

84. **GOVERNMENT OF ARGENTINA:** From 2000 to 2001 ECCO provided expert advice to the Ministry of Energy and Economy on various matters concerning the electricity market in Argentina, including generation bidding, transmission modeling, transmission pricing, auction of Firm Tradable Rights, generation adequacy and capacity auctions, etc. The work on FTRs focused on the interplay of FTRs and market power. A design was proposed for monitoring and reducing market power of FTR holders. The work on generation Adequacy and Capacity Market auctions focused on evaluating the current methodology and proposing a new Capacity Auction design to resolve the following existing problems: a) the lack of clear definition of the type of capacity that is currently procured, and b) the determination of the capacity prices and their volatility.

85. **SPAIN, REGULATORS:** In 1999 ECCO provided expert advice on electric industry restructuring and energy market design issues related to physical bilateral contracts.

86. **BALTIC STATES, UTILITIES:** In 1999 and 2000 ECCO provided consulting services on electric industry restructuring and market design issues related to pooling arrangements.

87. **WORLD BANK:** In 1999 ECCO provided expert advice on electric industry restructuring and the ancillary services markets.

88. **A SOFTWARE DEVELOPER:** In 1998 ECCO provided consulting services on scheduling and Unit Commitment functions, electric industry restructuring, and market design.

89. **A SOFTWARE DEVELOPER:** In 1998 ECCO provided consulting services on electric market designs electric industry restructuring, and software design issues.

90. **BONNEVILLE POWER ADMINISTRATOR:** In 1998 ECCO provided expert advice on electric industry restructuring matters including transmission modeling, transmission pricing, congestion management and ancillary services.

91. **POWER PLANT DEVELOPMENT:** In 1998 ECCO provided consulting services for developing a 750MW natural gas combined cycle power plant project in Southwest Michigan, USA. The project's configuration is two gas turbines on one steam turbine with duct firing during summer.

Major Accomplishments at ECCO International Inc. include:

Dr. Alex Papalexopoulos has designed and implemented some of the most complex energy markets in the world. He has provided extensive consulting and software services in restructuring projects including USA, Canada, Poland, Hungary, Greece, Cyprus, Israel, France, Switzerland, Japan, Argentina, Spain, Baltic States and Albania. He has led the development of the ECCO's energy market simulation software, one of the most successful simulation platforms in the market today. It has been used by ISOs/TSOs, Utilities, Generators, Regulators and financial institutions. Also he has provided consulting and software services to various Market Participants on strategic bidding, market design, LMP/CRR studies, operations and EMS/AGC to clients such as Generators, Utilities, and Municipalities.

Specific accomplishments at ECCO include:

- Led the economic evaluation of an HVDC cable in the California energy market by executing extensive energy simulation studies.
- Led the economic evaluation and the revenue potential of a CCGT power plant in the California energy market by executing extensive energy simulation studies.
- Led the preparation of the Polish TSO in the Tendering process for the development and implementation of the new LMP-based energy market in Poland.
- Led the design, analysis and development of the Electricity Codes for the new wholesale market for the country of Cyprus.
- Led the development of a Storage Analysis and Market integration project for a storage assets developer in California.
- Led the development of an optimal bidding strategy for storage assets in the wholesale market for a major utility company in California.
- Led the design of the new reformed wholesale energy market in Greece for the harmonization of the market with the Pan-European energy market.
- Led the development of the specifications and Tenders of the Energy Management System, Market Management System and the Electric Vehicle Charging Stations for the Non-Interconnected Islands in Greece.
- Led the development of the specifications and Tenders of the first Pilot Smart Metering Project in Greece which calls for the roll-out of 260,000 smart meters by 2016).
- Led the auditing and certification of the Market Settlements software run by the Hellenic Market Operator and the Transmission System Operator.
- Led the execution of a major simulation study for the analysis of renewable generation penetration for the Utilities in the State of California under different PV penetration scenarios.
- Led the Auditing and Certification of the Energy Settlements software of the Greek wholesale energy market.
- Led the design of an Energy Derivatives Market for the Hellenic Exchange Group.
- Led the transmission studies and extensive energy simulations to support the installation of substantial PV capacity in Greece for exports to Northern Europe.

- Key designer of the development of a divestiture plan of PPC generation and transmission assets pursuant to policies by the EU/ECB/IMF for the liberalization of the energy market in Greece.
- Key designer of the economic and contractual measures including Energy Swaps, Contracts for Differences and VPP Auctions for auctioning off Virtual Power Plant (VPP) capacity in the Greek energy market.
- Key designer of the simultaneous ascending-clock VPP auction with discreet rounds, dynamic bids, discreet rounds, activity rules, information disclosure, etc.
- Key developer of the new market rules and Codes for the Market Operator (MO) and the System Operator (SO), the two new organizations which will be created after the break-up of the HTSO. The SO will be absorbed in 2012 by the ITO the transmission subsidiary of PPC, and the MO will become an independent Company.
- Key developer of the Operating Agreement which includes the detailed terms and provisions of the commercial and operating relationship between the MO and the ITO.
- Key energy market designer of the pool-based energy market for the country of Hungary (MAVIR).
- Key energy market designer of the new LMP-based market architecture of the Polish Transmission System Operator (PSE), the first LMP-based market in Europe. The market architecture includes a Day-Ahead Market, an Hour-Ahead Market, a Real-Time Market, a Financial Transmission Rights (FTR) market, a Cross-Border Trading Market, A Reliability Unit Commitment function, Market Power Mitigation, and a Capacity Market.
- Led the development of T&D system charges and cost allocation mechanisms for the PSE system.
- Led the development of the mathematical formulation of the market coupling between the Nodal based market architecture in Poland and the Power Exchange based energy markets of neighboring countries.
- Provided major revisions to PSE for improving the real-time balancing market.
- Developed an integrated analytical approach for identifying and resolving gaming opportunities in the Polish wholesale energy market.
- Developed an integrated analytical approach for incorporating the RMR units in the day-ahead market scheduling in the Polish wholesale energy market.
- Heavily involved in developing triggering methodologies for Demand Response (DR) resources in California.
- Led the execution of a study and an extensive analysis of the energy market in California including schedules, market clearing prices, ancillary services prices, congestion and congestion prices at all congested paths under different scenarios taking into account bids from the market participants, the load forecast, and forecast plant and transmission outages, bidding strategies, arbitrage opportunities, etc.

- Led the development of the business plan and a risk minimization management plan for a major Greek Market participant.
- Led the execution of a major study to quantify the value of Pump Storage Hydro (PSH) facilities provides to System Operations in Greece in the presence of high penetration of Renewable Energy Resources (RES) and especially wind generation.
- Led the development of the market rules for the non-Interconnected Islands of Greece.
- Led the analysis and evaluation of integrating Renewable Energy Resources into the Greek transmission grid.
- Key market designer of the Greek energy market for the Hellenic Transmission System Operator (HTSO).
- Led the development of the Business Market Manuals for the new energy market of the HTSO in Greece.
- Heavily involved in developing the design, the detailed specifications, and the RFPs for the EMS and Market Systems of the HTSO.
- Developed key design rules for the capacity market in the Greek energy sector to ensure generation supply adequacy and reserve margins.
- Proposed activity rules in the market design for eliminating gaming in the real-time market of the Greek energy sector.
- Led the team which provided consulting services to Austin Energy that included a needs assessment and a gap analysis study, a capability assessment study, the development of an RFI and the evaluation of software vendors for providing software services in the areas of EMS/AGC, Market Systems, Scheduling and bid creation, Deal Capture, and transaction evaluation, and Settlements and Billing systems required to support AE's operations under the new Texas Nodal Market.
- Provided extensive training on market issues to various Market Participants in California on the new LMP-based market in California including Generators, Utilities, and Municipalities.
- Overall Technical Lead of the Market Redesign and Technology Upgrade (MRTU) Project at the CAL ISO that substituted the zonal-based energy market model in California with a Locational Marginal Pricing based model. Heavily involved in developing and implementing the new market design in California; this includes tariff filing, developing market rules and business processes, drafting design specifications and RFPs for vendor selection, and implementing design specifications to support various markets including Transmission Modeling, Transmission Pricing, Forward and Real Time markets, EMS/AGC, State Estimator, Congestion Management, Ancillary Services, Unit Commitment, Reliability Unit Commitment, Locational Marginal pricing, Congestion Revenue Rights Capacity, etc.
- Led the development of methodologies and mechanisms for Transmission Planning and Generation Interconnection Processes for the CAL ISO.

- Played a key role in every redesign effort in the CAL ISO markets since its inception.
- Participated in the design of the CAL ISO FTR market.
- Played a key role in the CAL ISO's Congestion Management Reform (CMR) effort including the development of congestion management, real-time dispatch, the development of the Commercial Model.
- Led a CAL ISO study for conducting an analysis of the locational nodal price dispersion within the ISO Controlled Grid.
- Led a CAL ISO study for analyzing the benefits and potential problems of the Market Separation principle in the CAL ISO's congestion management.
- Led a CAL ISO study for analyzing the benefits and problems of the Zonal and Nodal based congestion management methodologies.
- Led a CAL ISO study with the Los Alamos National Lab for evaluating the feasibility of producing locational marginal prices for the entire Western Transmission Grid.
- Participated in the CAL ISO's Market Stabilization Core Team to design a Unit Commitment based Forward Energy Market.
- Heavily involved in the redesign of the CAL ISO markets under the MD02 Initiative and consistent with FERC's SMD, including, LMP transmission pricing, Full Network Model development, CRR market design, development, RFP development and vendor selection, and system implementation, Forward Market design, development, RFP development and vendor selection, and system implementation.
- Involved in drafting and commenting on various CAL ISO positions in response to FERC Rulings.
- Developed a Pool based model for the energy market in Albania.
- Developed a capacity auction model for the energy market in Argentina.
- Drafted a major recommendation for Detroit Edison for Resolving the Loop-Flow Problem between Detroit Edison and the IMO, in Toronto, Canada. The Analysis and results were presented to the Minister of Energy, Science and Technology, Ontario, Canada.
- Assisted CGE&Y in the implementation of business software systems to support the wholesale energy market at the IESO, Toronto, Canada.
- Assisted CGE&Y in the implementation of the software systems to support the wholesale energy market at the RTO Alliance.
- Assisted a software vendor in the design of the real-time markets and the implementation of the software for real-time markets at the RTO Alliance.
- Proposed an overall framework for developing a real time market in Kyushu, Japan, with the focus on the benefits and problems of uniform price auctions vs. pay-as-bid energy auctions.
- Assisted ERCOT in performing a cost/benefits analysis of the LMP based energy market model.
- Key designer of the energy market pool for the Baltic States.

- Heavily involved in the design of the Financial Rights market, the Capacity Market and the scheduling processes for the Transmission System Operator of Argentina.
- Key designer of a comprehensive energy policy, the improvement of electricity security and reliability and the design of tariffs for the country of Albania.

PACIFIC GAS AND ELECTRIC COMPANY,
1985 – June 1998

Dr. Papalexopoulos joined PG&E in 1985 and got heavily involved in developing advanced applications for PG&E's EMS/AGC system. This included the definition of PG&E's needs and functional and design specifications, development, implementation, factory acceptance testing, field testing, installation, training, customization, maintenance, migration strategies, support and consulting for power, network, forecasting, scheduling and training EMS applications. He also worked on the development of power system analytical methods and software in a number of other areas, including optimization, grid modeling, dynamic and voltage stability, internet/intranet applications for the QFs, bidding systems for resource acquisitions, and costing methodologies for transmission services.

He also worked on project management, feasibility studies, risk analysis, and contract negotiation and administration. He was also heavily involved in developing models and software to support the PG&E's policies in various California Public Utilities Commission (CPUC) and Federal Energy Regulatory Commission (FERC) electric industry restructuring proceedings.

Dr. Papalexopoulos was responsible from 1993 to 1997 for the development and implementation of advanced methodologies and models, software and systems to support the new competitive market structures in the emerging energy marketplace in California. Prior to his restructuring experience he was responsible for the development of methodologies, advanced models, software, large databases and information systems to support PG&E's EMS/AGC, system operations, grid and merchant operations, transmission planning, transmission and power contracts and power generation. He was also involved in providing consulting services to internal PG&E clients on integrating computer systems, such as the Energy Management System with UNIX workstations and PG&E LAN/WAN systems.

Major accomplishments at PG&E include:

- Led PG&E's Business Team for developing the Phase I filing with the Federal Energy Regulatory Commission (FERC) for the formation of the California ISO and the PX.
- Led PG&E's Business Team for developing the Phase II filing with the FERC for the formation of the California ISO and the PX.

- Heavily worked in the process of obtaining regulatory approval for the formation of the ISO and the PX from the FERC. Heavily involved in advising Cameron McKenna LLP, the law firm in charge of the FERC filings, on policy and technical matters related to the ISO and PX filings.
- Played the role of the key interface of technical and business issues between the ISO and the California market participants, the Scheduling Coordinator User Group, during the development phase of the ISO as directed by the ISO/PX Restructuring Trust.
- Led PG&E's definition team for developing the rules and protocols for the ISO Business Systems.
- Led the ISO's Business Team for designing the ISO Business Systems as part of the initial ISO start-up team. In that capacity, he led a) the negotiations with the ISO vendor of the ISO Business Systems development contract (ISO Alliance contract), b) the translation of complex ISO Tariff requirements into detailed statements of work, c) the resolution of ISO systems staging and policy issues, d) the oversight of software construction and testing, e) the management of contract change orders and f) the management of the interfaces between the ISO Business and Operational Systems.
- Heavily involved in developing the rules and protocols for pricing transmission in the California electricity markets.
- Heavily involved in developing the rules and protocols for the ISO operations.
- Heavily involved in developing the rules and protocols for the PX energy auction and the PX Business Systems.
- Heavily involved in the design of the PX Business Systems.
- Heavily involved in the development of the RFPs for the procurement of the operational, scheduling, market and business software systems for the California ISO.
- Led the coordination and integration efforts of all PG&E software systems that interface with the California ISO and the PX.
- Served as an invited member of the Inter-Market Efficiency Group (IMEG), organized by the ISO/PX Restructuring Trust, to study the interactions between the ISO and the PX sequential energy, congestion and ancillary services markets and develop rules and protocols to improve the overall efficiency of the California market.
- Heavily involved in defining and developing methodologies and software to advance PG&E's policies in the areas of bidding, congestion management, transmission, settlements and billing, over-generation protocols, scheduling, losses, load aggregation, load profiling and metering and ancillary services for the PX and the ISO.
- Involved in developing rules and protocols for Direct Access at PG&E.
- Involved in the development of the technical specifications and business rules for direct access data management in the new California energy market.

Resulting specifications were adopted by the CPUC and are now implemented into various metering services systems.

- Involved in the development of PG&E's metering data system for providing metering data to the PX for real-time settlements.
- Involved in the development and design of the ISO's Unaccounted-for-Energy and load profiling functions and PG&E's distribution loss factor calculation methodologies.
- Heavily involved in preparing the ISO and PX development schedules and cost estimates including facilities, hardware, software and Quarterly Expenditure plans.
- Heavily involved in developing the specifications, proposal evaluation and contract resolution for the PG&E's EMS.
- Developed and implemented PG&E's External Network Equivalent program for the EMS.
- Led PG&E's efforts in defining, designing, developing and implementing PG&E's Optimal Power Flow (OPF) function for the EMS. Established PG&E's performance requirements for OPF algorithms for on-line control.
- Led PG&E's efforts in defining, designing, developing and implementing PG&E's Transmission Constrained Economic Dispatch (TCED) function for the EMS. This development was the first of its kind in the utility industry in enhancing a power system's real time control capabilities.
- Led PG&E's efforts in defining, designing, developing and implementing PG&E's Short-Term System Load Forecasting function for the EMS.
- Led PG&E's efforts, over the course of several years, in defining, developing, testing, enhancing and bringing into production use the Real-Time Sequence functions that form the foundation of all advanced EMS applications functions that assist operators in managing the electric generation and transmission system in a secure, reliable and optimal manner. The developed models are in production use by system operators at PG&E.
- Led PG&E's efforts in defining, developing, testing, enhancing and bringing into production support software for the Real-Time Sequence functions to optimally install SCADA units in PG&E's service territory and to estimate network parameters in real-time.
- Led PG&E's efforts in designing and testing the State Estimation for PG&E's EMS.
- Participated in the design and implementation of the AGC for the PG&E's EMS.
- Performed studies to determine AGC performance in the presence of Non-Conforming Loads.
- Improved AGC performance with Non-Conforming Loads to comply with NERC's A1 and A2 criteria.
- Directed the application and enhancement of a computer program to evaluate the impact of generation additions at different PG&E locations on the system losses and on the loading of the transmission system. The developed model was

instrumental in influencing the California Public Utilities Commission (CPUC) to adopt virtually every PG&E position in the Biennial Resource Plan Update (BRPU) proceedings.

- Managed the development of transmission planning projects that enable PG&E to assess the vulnerability of the transmission system to voltage instability and evaluate its steady state security margins. The developed models are in production use by operations planners.
- Led PG&E's efforts in defining, designing, developing and implementing PG&E's Artificial Neural Network Based Short-Term System and Area Load Forecasting function for system operations.
- Led PG&E's efforts in defining, designing, developing and implementing a distributed processing-based system for Security Analysis.
- Led PG&E's efforts in defining, designing, developing and implementing an OPF-based voltage control optimizer to manage voltage control in real-time.
- Led PG&E's efforts in defining, designing, developing and implementing an OPF-based power transfer evaluator to maximize power transfers in real-time.
- Led PG&E's efforts in defining, designing, developing and implementing an External Network Equivalent program suitable for OPF applications.
- Led PG&E's efforts in defining, designing, developing and implementing a large database to manage Inter-Utility energy transactions.
- Led PG&E's efforts in defining, designing, developing and implementing a large internet based information system for managing more than $130 million in payments to Qualifying Facilities.

Georgia Institute of Technology,
1980–1985

- **Teaching:** Experienced in teaching and organizing electrical engineering courses in senior level.
- **Research and Development:** Participated in EPRI sponsored R&D projects to develop techniques for analysis and design of power system systems. Co-investigator on the following research projects: "Power System Grounding" and "Soil Parameter Estimation." Programs are being marketed by EPRI.
- **Ph.D. Dissertation:"** Modeling Techniques for Grounding Power Systems," Ph.D. Dissertation, Georgia Institute of Technology, 1985.

Public Corporation of Electricity,
Athens, Greece

While a student, developed a computer program to regulate system voltages in the distribution level.

AWARDS

- Honorary Professor at the University of Patras, Patra, Greece, 2016
- Fellow of IEEE, 2000

- Recipient of the 1996 IEEE First Price Paper Award for the paper entitled “An Implementation of a Neural Network Based Load Forecasting Model for the EMS”, 1996
- Honorary member of the first class to be inducted into Georgia Institute of Technology’s Council of Outstanding Young Engineering Alumni, 1995
- PG&E’s Wall of Fame Award, 1992
- Certified As An In-Company Diversity Awareness Trainer, 1992
- PG&E’s Research and Development Department’s Pathfinder Award, 1991
- Member of Sigma Xi
- Protective Relaying Conference Certificate of Appreciation, 1982
- National Fellowship Foundation Award for Best Academic Achievement at the National Technical University of Athens, Greece, 1980

SOCIETIES

Fellow Member of IEEE
Member: IEEE, Power Engineering Society, Control Systems Society
Member: U.S. Expert Advisor to CIGRE Task Force 38-04-02, “Application of Optimization Techniques to Study Power System Network Performance”
Co-chair IEEE Subcommittee on Intelligent Systems
Member: Sigma Xi

IEEE

Dr. Papalexopoulos has been involved with the IEEE Power Engineering Society in the following capacities:

- Computer and Analytical Methods Subcommittee
- System Control Subcommittee
- Power System Operations Subcommittee
- Power System Control Centers Working Group
- Static Security Assessment Working Group
- Dynamic Security Assessment Working Group
- Voltage Stability Working Group
- Operating Economics Working Group
- Intelligent Systems Applications Working Group
- Load Forecasting Working Group
- Transmission Access and Non-Utility Generation Task Force

ADVISORY

Served in an advisory capacity and member on the following committees:

- Med Power, Member of the Scientific Programme Committee and the International Advisory Committee, 2016
- IEEE Power Engineering Society (PES) Editorial Board of the IEEE Power Engineering Review, 1997-2001.

- Power Industry Computer Applications (PICA) Technical Committee, 1997-2003.
- Power Systems Computation Conf (PSCC) Technical Committee, 1997-1999.
- Technical Program Committee for the 1995 IEEE International Symposium on Circuits and Systems, 1994–1995.
- EPRI's Dynamic Security Analysis Project, 1993–1996.
- EPRI industry advisor to several EPRI sponsored projects, 1991–1998.

REFEREE

Frequent reviewer of IEEE transaction papers and NSF large scale proposals over $1 million and invited panelist in engineering roundtable meetings and conferences.

INVITED PRESENTATIONS

Dr. Alex Papalexopoulos has been an invited speaker and consultant on electric industry restructuring issues and application of information technologies to power system transmission grid and merchant business lines in the U. S. and other countries including Switzerland, Baltic States, Greece, Cyprus, Spain, Austria, Poland, Japan, Australia, Hong Kong, Albania, Mexico, Chile and Argentina. Examples include:

- "Precise Mass-Markets Energy Demand Management Through Stochastic Distributed Computing for a Sustainable Energy Future," Invited Speaker at the NREL ESIF Workshop on Frontiers in Distributed Optimization and Control of Sustainable Power Systems, Golden, Colorado, January 27, 2016.
- "Next Generation of Energy Grids," Invited Speaker at the University of Patras, Patra, Greece, January 8, 2016.
- "Evolution of the Wholesale Energy Markets in Europe," Invited Speaker at the Pontificia Universidad Catolica de Chile, Santiago, Chile, October 15, 2015.
- "Renewable Energy Integration and Flexibility market Products," Invited Speaker at the Pontificia Universidad Catolica de Chile, Santiago, Chile, October 15, 2015.
- "Power Market Design Architectures and Renewable Energy Integration Challenges," Invited Speaker at the 3nd Hellenic Forum for Science, technology and Innovation, NCSR Demokritos, Athens, Greece, July 1, 2015.
- "RES Integration Challenges: Market Problems and Potential Solutions," Invited Speaker at the Large-Scale Renewable Integration in Electricity Markets Workshop, Thessaloniki, Greece, June 5, 2015.
- "Next Generation Energy Market Design Structures: Challenges & Potential Solutions," Invited Speaker at the 8th Hellenic Conference of Electrical and Electronic engineering students, Patra, Greece, April 4, 2015.

- “Next Generation Energy Market Design Structures for Sustainable Development: Challenges and Potential Solutions,” Invited Speaker at the 9th Mediterranean Conference on Power Generation, Transmission Distribution and Energy Conversion (MedPower 2014), Athens, Greece, November 3, 2014.
- “Energy Market Design Evolution,” Invited Speaker at an IEEE Workshop, San Francisco, California, September 3, 2014.
- “Energy Market Design Structures for Sustainable Development,” Invited Speaker at the 2nd Hellenic Forum for Science, technology and Innovation, NCSR Demokritos, Athens, Greece, July 4, 2014.
- “The New Reformed Greek Electricity Wholesale Market and its Harmonization with the EU Directives,” Invited Speaker at the A-Energy Investment Forum, Athens, Greece, July 3, 2014.
- “Electricity markets: What Are They, Why We Need Them and How Do They Work?” Invited Speaker at the ONR/NSF-Funded Industry Workshop, Napa, California, February 8, 2014.
- “Electricity & Sustainable Energy Sector: Regulation & Strategic Goals for Greece and the EU,” Invited Speaker at a Workshop organized by KANTOR, Megaron Mousikis, Athens, Greece, January 30, 2014.
- “Potential for Smart Energy & Grids: The Challenge and the Solutions,” Invited Speaker at the DAFNI Workshop, Athens, Greece, January 24, 2014.
- “Wind, Solar and Market Related Matters,” Invited Speaker at the LOLE Best Practices Working Group, Vancouver, Canada, July 26, 2013.
- “The Prospects of the Solar PV Market and Preconditions for their Penetration in Electrical Networks,” Invited Speaker at the HELAPCO Workshop, Athens, Greece, July 4, 2013.
- “Smart Grid: Business Issues and Proposed Solutions,” Invited Speaker at the 2st HELAS International Investment Forum, Athens, Greece, July 2, 2013.
- “Sustainability and Transition to a Low Carbon Economy through Markets,” Invited Speaker at the 2st HELAS International Investment Forum, Athens Greece, July 2, 2013.
- “Energy Market Design Models,” Invited Speaker at DOE, Washington DC, June 26, 2013.
- “Demand Response: How Did my Home Get Smarter than Me,” Invited Speaker at a Forum sponsored by the California Foundation on the Environment and the Economy, Napa, California, September 27-28, 2012.
- “Project HELIOS: Investment and Infrastructure Challenges,” Invited Speaker at a Forum sponsored by the Foreign Trade of Austria, Vienna, Austria, March 23, 2012.

- "International Experience, Challenges and Solutions with Large Scale Penetration of RES," Invited Speaker at the 1st HELAS International Investment Forum, Athens Greece, January 20-21, 2012.
- "Project HELIOS: Infrastructure and Market Challenges," Invited Speaker at the 1st HELAS International Investment Forum, Athens Greece, January 20-21, 2012.
- "The Challenges of the Harmonization the Greek Electricity Market Architecture with the Pan European Target Model," Invited Speaker at the 26th CIGRE Conference, Athens Greece, December 15-16, 2011.
- "Challenges and a Road Map for the Next Generation Energy Market Design Structures," Invited DLP Speaker at the IEEE Greece PES Chapter, Athens Greece, October 6, 2011.
- "Transmission Policies to Unlock America's Renewable Energy Resources," Invited Speaker at the 2011 Program on Energy and Sustainable Development (PESD), Stanford University, California, September 15-15, 2011.
- "The California Experience from the Deregulation of the Electricity Industry, Current Market Design and Challenges for the Future," Invited Speaker at the 7th Seoul International Conference on the Electricity Market, Seoul, Korea, June 16-17, 2011.
- "Practical Experience and Lessons Learned from Nodal Electricity Markets," Invited Speaker at the Workshop on Nodal Markets sponsored by the PSE (Polish TSO), Warsaw, Poland, January 21, 2011.
- "Challenges of the Next Generation Energy Market Design," Invited Speaker at the 25th CIGRE Conference, Athens Greece, December 3-4, 2009.
- "Competitive Market Models and Infrastructure Investments: Lessons Learned and a Roadmap for The Future," World Forum on Energy Regulation IV, Athens Greece, October 18-21, 2009.
- "Energy Market Design Models," Invited Speaker, University of Thessaloniki, Greece, April 10, 2009.
- "Lessons Learned from Past Electricity Design Models and a Roadmap for the Generation Design Models," Invited Speaker, Lefcosia, Cyprus, January 20, 2009.
- "California Energy Crisis: What happened, Who's to Blame and Lessons Learned," Invited Speaker, Public Power Corporation, Athens, Greece, November 7, 2008.
- "Probabilistic Planning and Operation of Power Transmission Systems in a Competitive Market," Invited Speaker at the EES-UETP Workshop, NTUA Campus, Athens Greece, November 12-14, 2007.

- "A critical Review of Power Market Design and Competitive Electricity Markets," Invited speaker at a Conference sponsored by the IEEE Greece Power Chapter, Athens Greece, February 11, 2005.
- "Wholesale Energy Market Design: Lessons Learned and Market Design of Various Markets," Tutorial, invited speaker at the MED 2002 Conference, Athens Greece, November 7, 2002.
- "The California Energy Crisis: What Went Wrong and What Is the Likely Framework of the New Market Structure," Invited Speaker at the Hong Kong Symposium on Deregulation, Hong Kong, May 21, 2001
- "Enabling Technologies & Systems for the Business-Driven Electric Utility Industry," Invited Speaker at the 2nd European Conference sponsored by the EPRI and organized by Decision Systems International, Vienna, Austria, November 2-4, 1999
- "Competitive Generation in a restructured electric industry," Invited Speaker at the 3rd Greek National Energy Conference on Energy & Development '98 sponsored by the European Union, Athens, Greece, May 7-8, 1998
- "Market design for Power Exchanges and Independent System Operators," Invited Speaker at Siemens Empros Power Systems Control, Minneapolis, Minnesota, March 2-3 1998.
- "The California Experience: Numerous Private Power Companies," Invited Speaker at the 2nd Meeting of the Electrical Sector, Madrid, Spain, March 11-12, 1997
- "Electric Industry Restructuring in California," Invited Speaker in the seminar series "Aula de regulacion Para La Industria Electrica" at the Instituto de Investigacion technologica (IIT), Madrid, Spain, June 11, 1996.
- "Congestion Management in a competitive market structure," IBERDROLA, Madrid, Spain, June 12, 1996.
- "Operational requirements for an implementation of an on-line Optimal Power Flow and experience with various OPF packages in a practical environment," invited speaker at the SVOR/ASRO Conference, Zurich, Switzerland, October 14–16, 1992.

IEEE AND OTHER CONFERENCE PRESENTATIONS

Invited chair, speaker and panelist in almost every IEEE/PES meeting and other scientific conferences since 1990 in various areas including renewable integration, smart grid operations, storage modeling, demand response, transmission utility operations, real time control, operations planning, transmission planning, power generation, electric industry restructuring and energy market design subjects related to

Power Exchanges, Market Operators and Independent System Operators. Examples include:

- "Impact of the Transmission Grid on the Operational System Flexibility," PSCC 2016, Genova, Italy, June 22, 2016.
- "Renewable Integration: Flexible Products and Market Design," IEEE/PES General Power Meeting, Denver, Colorado, July 29, 2015.
- "The Impact of Transmission and Market Modeling on Flexibility in California," IEEE/PES General Power Meeting, Denver, Colorado, July 27, 2015.
- "Complexity in Wholesale Electricity Markets: How Far Is Too Far?," IEEE/PES General Power Meeting, Washington DC, July 27-31, 2014.
- "Performance-Based Pricing of Frequency Regulation in Electricity Markets," FERC Technical Conference: Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software, Washington DC, June 23-25, 2014.
- "Market Design for the Simultaneous Optimization of the Day-Ahead Market and the Reliability Unit Commitment Applications," 2013 IREP Symposium -Bulk Power System Dynamics and Control -IX, Crete, Greece, August 25-30, 2013.
- "A Distributed Computing-Based Stochastic Control Approach to the Demand Response for the Mass Market," IEEE/PES General Power Meeting, Vancouver, Canada, July 21-25, 2013.
- "Next Generation of Market Applications Required to Manage Grid Volatility," IEEE/PES General Power Meeting, Vancouver, Canada, July 21-25, 2013.
- "MIP Based System Flexible Capacity Requirements Determination," FERC Technical Conference: Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software, Washington DC, June 24-26, 2013.
- "Performance-Based Pricing of Frequency Regulation in Electricity Markets," 2nd Workshop on Active Power Control from Wind Power sponsored by NREL & EPRI, Denver Colorado, May 17, 2013.
- "The new Generation of Demand Response Algorithms," 8th Mediterranean Conference on Power Generation, Transmission Distribution and Energy Conversion (MedPower 2012), Calgari, Italy, October 1-3, 2012.
- "Distributed Computing and Stochastic Control for Demand Response in the Day Ahead and Real Time Markets," FERC Technical Conference: Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software, Washington DC, June 26-28, 2012.
- "Island of Crete Wind Integration Study," Utility Wind Integration Group Spring Technical Workshop, San Diego, California, April 24-26, 2012.

- “A Focus on Improving Performance of the Day Ahead Market: A Market Participant Perspective,” FERC Technical Conference, Washington DC, June 27-29, 2011.
- "Simulation Methodologies and Modeling of Co-optimized Energy and Reserve Electricity Markets," MedPower 2010 Conference, Agia Napa, Cyprus, November 7-10, 2010.
- "Friction between Energy Markets and System Operation and its impact on Market Efficiency," IEEE/PES General Power Meeting, Minneapolis, Minnesota, July 25-29, 2010.
- "Market Simulations for LMP Forecasting," IEEE/PES General Power Meeting, Calgary, Canada, July 26-30, 2009.
- "Transmission Modeling and Risk Analysis in Financial Transmission Rights Markets," MedPower 2008 Conference, Thessaloniki, Greece, November 2-5, 2008
- "FTR/CRR Allocation/Auction Strategies and Methodologies: A Market Participant Perspective," IEEE/PES General Power Meeting, Pittsburgh, Pennsylvania, July 20-24, 2008.
- "Design of an Efficient Ancillary Services Market," IEEE/PES General Power Meeting, Tampa, Florida, June 24-28, 2007.
- "Theoretical and Practical Considerations in Implementing and Using a Reliability Unit Commitment (RUC) in Restructured Electricity Markets," IEEE/PES General Power Meeting, Montreal, Quebec, Canada, June 18-22, 2006.
- "Theoretical and Practical Considerations in Developing and Using LMPs," IEEE/PES General Power Meeting, Montreal, Quebec, Canada, June 18-22, 2006.
- "Lessons Learned from Energy Market Design Models and a Road Map for the Next Generation Design Models," IEEE/PES General Power Meeting, Montreal, Quebec, Canada, June 18-22, 2006.
- "The Role of Advanced Modeling and Advanced Software in a Restructured Environment," IEEE/PES General Power Meeting, San Francisco, California, June 12-16, 2005.
- "Market Clearing Mechanisms," IEEE/PES/PSCE Meeting, NY, NY, Oct 10-13, 2004.
- "Overview of the New SMD-based Market Design in California," IEEE/PES General Power Meeting, Toronto, Canada, July 13-17, 2003.
- "Experience with the Strategic Behavior in California Markets," IEEE/PES Summer Meeting, Chicago, IL. July 23, 2002.

- "Industry Perspective on FERC's Standard Market Design," IEEE/PES Summer Meeting, Chicago, IL. Jul 23, 2002.
- "On the Operation and Pricing of Real-Time Competitive Electricity Markets," IEEE/PES Winter Meeting, New York, NY, January 29, 2002.
- "The Alliance RTO Market Design," IEEE/PICA Conference, Sydney, Australia, May 2001.
- "The Role of Analytical Modeling and Software in California's Deregulated Electricity markets," IEEE/PES Summer Meeting, Seattle, WA, July 19, 2000.
- "Firm Transmission Rights," IEEE/PES Summer Meeting, Edmonton, Canada, July 1999.
- "Competitive Electricity Market: The Role of Transmission," IEEE/PICA Conference, Santa Clara, CA, May 18, 1999.
- "Electric De-Regulation: One Year after in California," IEEE, Industry Applications Society, Oakland East Bay Chapter, April 22, 1999.
- "Key Issues in Energy Trading," IEEE/PES Winter Meeting, NY, NY, Feb 2, 1999.
- "Congestion Management Practices," Forward Power Markets & Price Forecasting Conference organized by The Center for Business Intelligence, Washington, DC, October 15-16, 1998.
- "How Transmission Affects Locational Energy Pricing," IEEE/PES Winter Meeting, NY, NY, Feb 2, 1999.
- "Congestion Management by an Independent System Operator," University of California Energy Institute, Berkeley, California, March 20, 1998.
- "The California Independent System Operator & Power Exchange: Current Status, Predictions and Observations," IEEE/PES Winter Meeting, Tampa, Florida, February 3, 1998.
- "Developments in OPF and Congestion Management," IEEE/PES Winter Meeting, Tampa, Florida, Feb 4, 1998.
- "Are we ready for Retail Wheeling in California in 1998," 18th Annual North America Conference of USAEE/IAEE on International Energy Markets, Competition and Policy, San Francisco, CA, September 9-10, 1997.
- "Power Marketing, Generation Bidding and Power Exchange Groups," IEEE/PES, PICA '97, Columbus, OH, May 13, 1997.
- "Intelligent Systems Applications in a Competitive Industry Environment," IEEE/PES Winter Meeting, New York, New York, February 4, 1997.
- "Optimal Power Flow: Advances and Current Issues," IEEE/PES Summer Meeting, Denver, CO, August 1, 1996.

- “Technical Challenges under Open Access,” IEEE/PES Winter Meeting, Baltimore, MD, January 25, 1996.
- “Load Forecasting and Procurement in the New Competitive Environment,” IEEE/PES Summer Meeting, Portland, OR, July 27, 1995.
- “Industrial Research in Electric Power Engineering,” IEEE/PES Summer Meeting, Portland, OR, July 25, 1995.
- “Intelligent Load Forecasting,” IEEE/PES Winter Meeting, New York, NY, February 1, 1995.
- “Challenges to On-Line OPF Implementation,” IEEE/PES Winter Meeting, New York, New York, January 31, 1995.
- “Load Forecasting: A Contact Sport,” IEEE/PES Summer Meeting, San Francisco, CA, Jul 27, 1994.

SHORT COURSES

Invited Speaker in numerous short courses related to transmission utility business and electric industry restructuring organized by IEEE, EPRI and other educational and private organizations. Recent examples include the following:

- “Electricity Market Design,” Workshop Organized by the Transmission Business School, Chicago, IL, May 16-29, 2016.
- "Market Designs in High Renewable Penetration Systems: What’s Working and What’s Not," 5th Annual Hawaii Power Summit: Charting the Path to 100% Renewable Power in 2045, Workshop organized by the EUCI, Honolulu, HI, January 27-28, 2016.
- "Flexible, Fast-Start and Intra-Hour Dispatch Resources and Tools," Workshop organized by the EUCI, Anaheim, CA, December 10-11, 2015.
- “Electricity Market Design,” Workshop Organized by the Transmission Business School, Chicago, IL, June 22-26, 2015.
- "Variable Energy Resource Contracts in the CAISO Markets," Workshop organized by the EUCI, Los Angeles, CA, December 8-9, 2014.
- “Electricity Market Design,” Workshop Organized by the Transmission Business School, Chicago, IL, June 16-19, 2014.
- “Market Design,” Workshop Organized by the Transmission Business School, Chicago, IL, June 17-20, 2013.
- “Congestion Management,” Organized by the Transmission Business School, Chicago, IL, June 17-20, 2013.

- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 18-21, 2012.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 18-21, 2012.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 14-17, 2010.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 14-17, 2010.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 15-18, 2009.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 15-18, 2009.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 16-19, 2008.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 16-19, 2008.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 18-21, 2007.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 18-21, 2007.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, June 5-8, 2006.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, June 5-8, 2006.
- "Market Design," Workshop Organized by the Transmission Business School, Chicago, IL, May 23-26, 2005.
- "Congestion Management," Organized by the Transmission Business School, Chicago, IL, May 23-26, 2005.
- "Investment and Trading in Electric Energy in the Restructured Environment," Workshop organized by Decision Systems International, Madrid, Spain, September 18-20, 2000.
- "Ancillary Services Markets in the Restructured Electric Power Industry," Workshop organized by Decision Systems International, Madrid, Spain, September 20-22, 2000.

- "Investment and Trading in Electric Energy in the Restructured Environment," Workshop organized by Decision Systems Int., Montreal, Quebec, Canada, May 2000.
- "Ancillary Services Markets in the Restructured Electric Power Industry," Workshop organized by Decision Systems International, Montreal, Quebec, Canada, May 2000.
- "Optimizing Transmission Business Practices," Workshop organized by the Center for Business Intelligence, Chicago, October 18-19, 1999.
- "The Post-Implementation ISO Operations, Markets & ISO alternatives," Workshop organized by the Intl. Business Communications, Sacramento, CA, October 28-30, 1998.
- "Forward Power Markets & Price Forecasting," Workshop organized by the Center for Business Intelligence, Washington DC, October 15-16, 1998.
- "Baltic Countries Electric Industry Restructuring Workshop," USAID/Electrotek Concepts Inc., Riga, Latvia, March 9-13, 1998.
- "Winning Strategies and Practical Risk Management in the California Electric Power Market," Workshop organized by CALPOL, San Francisco, California, Jan 14-15, 1998.
- "Succeeding in the California Power Market," Workshop organized by Infocast Inc., San Francisco, California, December 4-5, 1997.
- "PX Seminar Series on Real-Time Operations," San Diego Gas and Electric (SDG&E) Headquarters, San Diego, California, November 17, 1997.
- "Transmission and Pricing," Center for Business Intelligence, Houston, TX, Nov 1997.
- "Security Issues in an Open Access Environment," EPRI Workshop on Dynamic and Voltage Security Assessment, Palo Alto, California, October 10, 1997.
- "CENTREL Roundtable Energy Forum," USAID/Electrotek Concepts Inc., Warsaw, Poland, September 16-18, 1997.
- "Database Implications of Retail Wheeling and State Requirements," 14th Biennial IEEE/PES Control Center Workshop, Minneapolis, Minnesota, October 21-23, 1996.
- "Artificial Neural Networks with Applications to Power Systems," Video Tutorial Course, Sponsored by the IEEE PES and the IEEE Educational Activities, NTSC Product No. HV6961, Copyright 1996 IEEE.
- "Optimal Power Flow: Solution Techniques, Requirements & Challenges," Video Tutorial Course, Sponsored by the IEEE Neural Networks Council, the IEEE PES and the IEEE Educational Activities, ISBN: 0-7803-4010-8, Copyright 1996 IEEE.

- "Utility Restructuring: Operational, Institutional & Economic Issues," Workshop organized by Decision Systems International, San Francisco, CA, March 26-28, 1996.
- "Baltic Power Pooling Workshop," USAID/Electrotek Concepts Inc., Riga, Latvia, February 27-March 1, 1996.
- "Modern Load Forecasting for Control & Operation in the Competitive Era," Workshop organized by Decision Systems International, San Francisco, California, November 13-15, 1995.

PUBLICATIONS

1) "Current Division in Substation Grounding Systems," (with A. P. Meliopoulos and R. P. Webb), *Proceedings of the 1982 Protective Relaying Conference*, May 1982.

2) "Estimation of Soil Parameters from Driven Rod Measurements," (with A. P. Meliopoulos, R. P. Webb and C. Plattner), IEEE Transactions on Power Apparatus and Systems, Vol, PAS–103, No. 9, pp. 2579–2585, September 1984.

3) "Frequency Depended Modeling of Grounding Systems," (with A. P. Meliopoulos), Midwest Power Symposium, 1985.

4) "Interpretation of Soil Resistively Measurements: Experience with the Model SOMIP," (with A. P. Meliopoulos), IEEE Transactions on Power Apparatus and Systems, Vol. PWRD–1, No. 4, pp. 1420–150, October 1986.

5) "Frequency Dependent Characteristics of Grounding Systems," (with A. P. Meliopoulos), IEEE Transactions on Power Apparatus and Systems, Vol. PWRD, No. 41, pp. 1073–1080, October 1987.

6) "Short-Term Electric Load Forecasting Using Linear Regression," (with Timothy C. Hesterberg), American Statistical Association Proceedings, pp. 608–612, New Orleans, August 1988.

7) "Large-Scale Optimal Power Flow: Effects of Initialization, Decoupling and Discretization," (with Carl F. Imparato and Felix F. Wu), IEEE Transactions on Power Apparatus and Systems, Vol. PWR5–4, pp. 748–759, May 1989.

8) "A Regression-Based Approach to Short-Term System Load Forecasting," (with Timothy C. Hesterberg), IEEE Transactions on Power Systems, Vol. 5, pp. 1535–1547, Nov. 1990.

9) "Real-Time Control And Operation of Power Systems,"(with L. H. Fink, B. Avramovic, M. M. Adibi, L. S. Van Slyck, F. F. Wu), Proceedings from the Workshop On Real-Time Control And Operation Of Electric Power Systems

(sponsored by the U. S. Department of Energy), pp. 75–87, Denver, Colorado, Nov. 19–21, 1991.

10) "The Discrete Shunt Controls in a Newton Optimal Power Flow," (with W-H. Edwin Liu and William Tinney), IEEE Trans on Power Systems, Vol. 7, pp. 1509–1518, Nov. 1992.

11) "A Least Squares Solution for Post Optimal Power Flow Sensitivity Calculation," (with S. V. Venkatesh and W-H. Edwin Liu), IEEE Transactions on Power Systems, Vol. 7, pp. 1394–1401, August 1992.

12) "Operational Requirements for an Implementation of an On-Line Optimal Power Flow and Experience with Various OPF Packages in a Practical Environment," SVOR/ASRO Conference, Zurich, Switzerland, October 14–16, 1992.

13) "Short-Term System Load Forecasting Using an Artificial Neural Network," (with Shangyou Hao and Tiemao Peng), presented at the Second International Forum on Applications of Neural Networks to Power Systems, Yokohama, Japan, Apr 19–22, 1993.

14) "Discrete Shunt Device Based Voltage Control in an Adjusted Power Flow Solution," (with W-H. Edwin Liu and Joseph Bright), presented at the 11th Power Systems Computation Conference (PSCC), Avignon, France, August 30–September 4, 1993.

15) "Application of Neural Network Technology to Short-Term System Load Forecasting," (with Shangyou Hao and Tiemao Peng), presented at the Athens Power Tech Conference, Athens, Greece, September 5–8, 1993.

16) "External Network Modeling-Recent Practical Experience," (with Ken Kato, W. L. Snyder, S. Vemuri, M. L. Oats, G. C. Contaxis, J. Singh, R. A. Smith, S. C. Savulescu), IEEE Transactions on Power Systems, Vol. 9, pp. 216–228, Feb 1994.

17) "Cost/Benefits Analysis of An Optimal Power Flow: The PG&E Experience," (with Shangyou Hao, W-H. Edwin Liu, Ziad Alaywan, Ken Kato), IEEE Transactions on Power Systems, Vol. 9, pp. 796–804, May 1994.

18) "An Implementation of a Neural Network Based Load Forecasting Model For the EMS," (with Shangyou Hao and Tiemao Peng), IEEE Transactions on Power Systems, Vol. 9, pp. 1956–1962, November1994.

19) "Distributed Processing for Contingency Screening Applications," (with Shangyou Hao and Tiemao Peng), presented at the 94 IEEE Summer Power Meeting, San Francisco, California, July 1994.

20) “External Network Modeling for Optimal Power Flow Applications,” (with Shangyou Hao), presented at the 94 IEEE Summer Power Meeting, San Francisco, California, July 1994.

21) “Application of Radial Basis Function Neural Network Model for Short-Term Load Forecasting,” (with Damitha K. Ranaweera and Norma F. Hubele), IEE Proceedings–General Transmission. Distribution, Vol. 142, No. 1, pp. 45–50, January 1995.

22) “Application of a fuzzy set method in an Optimal Power Flow,” (with Xiaohong Guan and W-H. Edwin Liu), Electric Power System Research proceedings, May 1995.

23) “On the Nonlinear Properties of Feedforward Neural Networks,” (with Tiemao Peng), Engineering Intelligent Systems, Vol. 4, No. 2, pp. 67–74, June 1996.

24) “Reactive Power Pricing and Management,” (with Shangyou Hao), 96 WM 189–1 PWRS, presented at the 96 IEEE Winter Power Meeting, Baltimore, February 1996.

25) “Challenges to Optimal Power Flow,” (with J. A. Momoh, R. J. Koessler, M. S. Bond, B. Stott, D. Sun and P. Ristanovic). 96 WM 312–9 PWRS, presented at the 96 IEEE Winter Power Meeting, Baltimore, February 1996

26) “Security Boundary Visualization for Systems Operation,” (with James D. McCalley, Shimo Wang and Roger T. Treinen), 96 SM 565–2 PWRS, presented at the 96 IEEE Summer Power Meeting, Denver Colorado, July 1996.

27) “Cost Allocation in Electric Power Networks Using Cooperative Game Theory,” (with Harry Singh, Shangyou Hao and Manos Obessis), presented at the 12th Power Systems Computation Conference (PSCC), Dresden, Germany, August 19–23, 1996.

28) “Artificial Neural Networks with Applications,” IEEE Power Engineering Society Tutorial 96 TP 112–0, pp. 71–89, February 1996.

29) “Optimal Power Flow: Solution Techniques, Requirements and Challenges,” IEEE Power Engineering Society Tutorial 96 TP 111–0, pp. 36–51, February 1996.

30) “Power Auctions and Network Constraints,” (with Harry Singh and Shangyou Hao), presented at the 30th International Conference in System Sciences, Maui, Hawaii, January 7-10, 1997.

31) “Consumer Cost Minimization in Power Pool Auctions,” (with Harry Singh and Shangyou Hao), presented at the 97 IEEE PICA Conference, Columbus, Ohio, May 11-16, 1997.

32) “Congestion Management in a Competitive Environment,” IEEE Power Engineering Society Tutorial 97, presented at the 97 IEEE PICA Conference, Columbus, Ohio, May 11-16, 1997.

33) “Transmission Congestion Management in Competitive Electricity Markets,” (with Harry Singh and Shangyou Hao), IEEE Transactions on Power Systems, Volume 13, No. 2, May 1998.

34) “Application of Optimization Techniques to Study Power System Network Performance,” CIGRE Tutorial 97, Task Force 38.04.02, Paris, France, November 1997.

35) “Consideration of Multi-Part Bids in WEPEX: A response to Steve Stoft,” Electricity Journal, December 1997.

36) “Auctions for Ancillary Services,” (with Harry Singh), presented at the 31st International Conference in System Sciences, HICSS-31, Hawaii, January 5-8, 1998.

37) “Congestion Management by an Independent System Operator,” (with Harry Singh and George Angelidis), presented at the 3rd Annual Power Conference, University of California at Berkeley, California, March 20, 1998.

38) “Competitive Procurement of Ancillary Services by an Independent System Operator,” (with Harry Singh), IEEE Transactions on Power Systems, Vol. 14, No. 2, May 1999, pp 498 – 504.

39) “The California Electricity Market: Basic Design and Initial results,” (with Harry Singh), accepted for publication at the Electricity Journal.

40) “Operation of a Real-Time Market,” (with Harry Singh and George Angelidis), presented at the International Symposium on Bulk Power Systems Dynamics and Control –IV Restructuring, Santorini, Greece, August 24-28, 1998.

41) “Forecasting Power Market Clearing Price and Quantity Using a Neural Network Method,” (with Feng Gao, Xiaohong Guan and Xi-Ren Cao), presented at the IEEE/PES Summer Power Meeting, Seattle, Washington, 2000.

42) “On the Various Design Options for Ancillary Services Markets,” (with Harry Singh) presented at the 34th International Conference in System Sciences, HICSS-34, Hawaii, January 3-5, 2001.

43) “Alternative Design Options for a Real-Time Balancing Market,” (with Harry Singh) presented at the 2001 IEEE PICA Conference, Sydney, Australia, May 19-24, 2001.

44) “Challenges in Real-Time Electricity Market Design,” (with George Angelidis) presented at the 2001 Euro – PES, Sixth IASTED International Conference on Power and Energy Systems, Rhodes, Greece, July 03 – 06, 2001.

45) “On the Operation and Pricing of Real-Time Competitive Electricity Markets,” (with George Angelidis) presented at the 2002 IEEE/PES Winter Power Meeting, New York, New York, January 29, 2002.

46) “Transmission Rights Alternatives,” (with Roger Treinen) presented at the MED POWER 2002 Conference, Athens, Greece, November 5, 2002.

47) “Pricing Energy and Ancillary Services in Integrated Market Systems by an Optimal Power Flow,” (with Tong Wu, Mark Rotheleder, and Ziad Alaywan) presented at the IEEE PES General Meeting, Toronto, Canada, July 13-18, 2003.

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