Reflections on Twenty Years of Electric Power Research at HICSS

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Abstract
The Electric Power Track activities at HICSS began twenty years ago. This is an account of its history, its focus, and its impact over those years.

1. Introduction

This paper is being written as an account of my recollections of the twenty-year evolution of the Electric Power Systems (EPS) Track at HICSS on the occasion of the celebration of the half-century of the Conference. I initiated the Track in 1996 and as a result, the first set of papers were presented at HICSS-30 in January of 1997 on the Big Island of Hawaii. These recollections are very personal and as such they contain all the distortions that time and memory recall creates. Since these are my recollections (my written records are not as complete as I would have liked) there are bound to be some omissions and inaccuracies for which I apologize. Also, I am a technical writer and writing this type of historical narrative is unfamiliar to me. Nevertheless, it is my hope that the passion and enthusiasm I felt for the activity that took place over the past twenty years will be apparent.

To begin with some context, the Hawaiian International Conference on Systems Sciences (HICSS) held it's first meeting on Oahu, Hawaii in January of 1968. Its organizers were all involved in the evolution of what we refer to today as the Internet. While I have always been involved in the electric power business, and while many of the HICSS founders were schooled as electric engineers in curricula that included electric power, they became known for their contributions to the new field of computer communications. The ALOHAnet, a pioneering computer networking system developed at the University of Hawaii, became operational in June 1971, and was the first public demonstration of a wireless packet data network. Development of the ALOHA network was begun in September 1968 at the University of Hawaii under the leadership of Norman Abramson along with Franklin Kuo, Wes Peterson and others. According to [1], "The genesis of the Hawaii International Conference on System Sciences (HICSS) according to Norm Abramson, one of it founders, was to address a concern among a number of people intimately involved in computing at the University of Hawai'i that Hawai'i might be considered too remote by many people and somehow left out of the mainstream of activity in this exciting field. He and a small group of colleagues decided to start a conference to "bring potential collaborators and colleagues to

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Hawai'i and make sure they were not left isolated out in the Pacific Ocean." While its founders were especially interested in computer and communication subjects, over time HICSS has evolved to a general-purpose conference that provides " a forum for the exchange of ideas, research results, development activities, and applications" and "brings together qualified interdisciplinary professionals in a highly interactive environment." It was into this environment that the topic of electric power was eventually integrated as a Track some thirty years later.

2. A Short History of the evolution of the Electric Power Track at HICSS

In 1996 (HICSS-29) there were 5 Tracks, one of them was entitled Digital Documents. This Track was chaired and organized by M. Stuart Lynn who I knew from his days at Cornell University as Vice President for Information Technologies. Immediately prior to HICSS-29 Stuart had left Cornell to head the Office of Information Resources & Communications in the University of California's Office of the President. The invitation to attend HICSS-29 to present work in the next years Track on Digital Documents came as a result of work a colleague, Arvid Eide, who was then Associate Dean of Engineering at Iowa State, and I were doing in conjunction with a major 5-year NSF educational initiative [2]. At the end of the 1996 HICSS conference Ralph Sprague, who was slated to become the sole HICSS Conference Chair the following year (and until two years ago was the only HICSS Conference chair I ever knew), asked me if I would like to organize next years session on Digital Documents. I said no, but that I would like to organize a new Track on electric power. After some discussion Ralph agreed that I could organize a track-like activity to be embedded in an incubator track. It was clear that Ralph was interested in re-inventing HICSS by expanding its scope, improving its quality image, and in general growing the Conference. So the organization of a power session to be held in 1997 began.

In 1997 (HICSS 30) Ralph Sprague became the sole HICSS Conference Chair and, in addition to those duties he also chaired two of the five Tracks at the Conference, one entitled "Digital Documents" and another entitled "Advanced Technologies". The Advanced Technology Track was divided into four areas: Engineering Complex Computer Systems; Modeling Technologies and Information Systems; Restructuring the Electric Power Industry: Emerging Issues, Methods and Tools; and Techniques for Safety Critical Software Development. The Advanced Technologies Track was the Track where Electric Power first appeared at the Conference and I was its Coordinator. It was in effect a 16-paper mini-track with the title "Restructuring the Electric Power Industry: Emerging Issues, Methods and Tools".

The focus of the papers presented in this mini-track collectively involved a cross-disciplinary look at issues associated with the worldwide movement to restructure electric power systems. The call for papers for this mini-track indicated that it was "especially interested in identifying the effects and impacts of institutional change (proposed or in place). It is especially interested in new tools and methodology,

that is, the technical underpinnings needed to transition the system from the old to the new. Therefore, papers on topics related to the affected elements of restructuring of an electric power industry were of special interest." The papers presented covered a range of issues from institutional to technical and from policy to educational. The first paper in the session described four possible scenarios for future systems and makes the point that the future US electric power system may contain versions of all of them and not just one. It also laid the foundation for technical work that would need to be done to see these scenarios emerge in an orderly fashion. Ten of the remaining sixteen papers dealt with various elements of these technical issues. One paper addressed the educational challenges of a curriculum for the restructured industry. The remaining papers focused on technical challenges that existed because the system was comprised of certain elements and needed to operate in harmony regardless of the institutional arrangements that govern the people who plan and operate the system.

It is also important to understand the general state of the electric power business in the U.S. prior to 1997 when the first "power track" began at HICSS-30. A watershed event for the electric power industry occurred in 1965 with the occurrence Northeast blackout. Widespread outages such as this were previously unheard of. At the time all US utilities were vertically integrated, highly regulated, and were for the most part, very reliable and economic. University research programs in electric power were almost non-existent. In 1977 another blackout occurred just as the US Department of Energy began operation on October 21, 1977. University power programs in the US were beginning to re-vitalize because a US DOE predecessor, the Energy Research and Development Administration (ERDA), had initiated a program called Systems Engineering for Power pioneered by Lester Fink. His vision was that certain key areas of electric power needed attention and they needed the expertise of disciplines other that electric power engineering, especially the area of control and information systems. Many of today's elder statespersons work in the field of electric power today because of that program.

I participated in the development of the Systems Engineering for Power program by spending my first sabbatical leave from Cornell in Washington, DC at Lester's request in 1979-80. Seven years later, from 1987–88, I went to the National Science Foundation at their request to establish a new program in electric power systems research (which is still in existence) and in 1996 I became the Founding Director of the newly established Power Systems Engineering Research Center (PSerc), a National Science Foundation Industry/University Cooperative Research Center. The Center was established as an NSF I/UCRC by myself (Cornell), Peter Sauer (Illinois), Robert Lasseter (Wisconsin), Felix Wu/Shmuel Oren (Berkeley) and James Momoh (Howard). PSerc is also still in existence today as a 13-school consortium.

As the Director of the new Center I was looking for several ways to foster the fledgling community of researchers, to focus the work, and to make the work of

the PSerc center and the wider community available to the power industry through publication of results in a recognized and accessible forum. In 1996 Ralph Sprague offered me one opportunity by allowing me to organize what today is the Electric Energy Track (EES) at HICSS.

The PSerc leadership and the five member school researchers enthusiastically supported the idea. The first electric power session was held in 1997 at HICSS-30 with 16 papers being presented. Over the next five years, from 1996 to 2001, PSerc grew to twelve schools and as member schools were added so were researchers. In addition, a wider network of industry consultants, industry engineers, National Laboratory researchers, and others who were associates or collaborators with PSerc researchers began to submit papers to the activity. We were well on our way to establishing a sustainable HICSS Track.

3. Organization of the Track

From the beginning a Track planning process was established that has been used every year to plan the program for the following year. This process has contributed strongly to the creation of the talented pool of HICSS Electric Energy System Track alumni. The EPS Track (a term I use here to refer to the Track with its several titles used over the years) has always consisted of two days of sessions, eight sessions in all, with three or four papers per one-and-one-half-hour session. That structure limits the total paper count to a maximum of thirty-two papers. The planning process consists of a nominal two-hour session the morning of the fourth day of the conference, after all Electric Power Track papers have been presented. The session is announced several times during the formal Track paper sessions and everyone is encouraged to attend. The Track Chair is responsible for running the meeting. The meeting usually begins with a review of the basic tenets under which the Track operates. These tenets include: (1) everyone who presents a paper must, to the extent possible, attend the full two days of paper presentations. Those who present their paper and leave are not invited back, (2) senior researchers should present papers. Student presenters, while allowed in certain circumstances, should be by exception, (3) written papers are required with few if any exceptions and all papers will be submitted to the review process, (4) Minitrack Chairs are expect to actively recruit papers from excellent researchers in areas important to the conference and (5) discussions and interchange is of paramount importance during the conference.

At that point statistics concerning the just completed track session are presented (paper acceptance rate, number of conference and Track attendees, session attendance numbers, etc.) and the results evaluated through open discussion. Next, new topics deemed important for next year are developed through discussion, the mini-track chairs for next years meeting are chosen, and the outline of next years program is completed. This planning session is usually attended by upwards of 20 participants.

After the planning session is complete the minitrack chairs write their proposal for next year based on the discussion and the Track Chair integrates them into a

proposal that is submitted to the HICSS leadership for consideration.
Electric power did not become a full-fledged track until HICSS-34 in 2001. The four years from 1997 to 2001 the topic of electric power was embedded in the Advanced Technologies Track and then in the Emerging Technologies Track for the next three years. By 1999, HICSS-32, the structure of the electric power activity looked essentially as it does today. The number of sessions, eight over 2 days, was the same but historically the number of papers per session was smaller. Today four papers per session or 32 papers is the norm. In the early days, that was rare. There were 22 papers in 1999 and I must admit, I liked that leisurely pace and the additional time for dialog it created.

The first formal electric power track held in 2001 was called the Complex Systems Track until 2005. In 2005 the track was suspended by the HICSS Board for 2006 (HICSS-39). The activity was continued as a "Symposium on Electric Power Systems: Reliability, Control, and Markets". It was one of two Symposia that year and therefore did not have mini-tracks. When the dust settled the following year and the data compiled, thanks to Ralph Sprague electric power was found to be a consistently top-notch activity that brought status and visibility to the conference. Many of the papers were highly cited, the speakers were top notch and included a Nobel Prize winner[1], Vernon Smith, and the sessions were, and still are, the most consistently well attended during the conference. This was a major turning point for the group. As a result in 2007 the Track was re-established as the Electric Power Systems Restructuring: Engineering, Economics and Policy Track. It has continued as a Track each year since then under various names but always involving electric power or electric energy in the title.

In 2010 I invited Tom Overbye to co-chair the track with the idea that he would eventually assume the role of sole Track Chair and he accepted. I was planning on stepping down within three years, as I was unsure of my ability to continue to travel to Hawaii. I retired from Cornell University in 2010 and had limited travel resources. Yet, here it is, 2017, and I am still the track co-chair!

Evolution of Track themes – from Restructuring to Transactive Energy

At the time the electric power HICSS track activity began the electric power industry was beginning to deal with a major path of change. FERC orders 888 and 889 Final Rule was implemented on April 24, 1996. Rule 888 ordered transmission open access and the promotion of wholesale competition through open access non-discriminatory transmission services by public utilities. Order 888 mandated that utilities unbundle their generation services,

[1] Vernon Smith shared the 2002 Nobel Memorial Prize in Economic Sciences. with Daniel Kahneman. Vernon is currently American professor of economics at Chapman University's Argyros School of Business and Economics and School of Law in Orange, California. Much of the research that earned Smith the Nobel Memorial Prize in Economic Sciences was conducted at the University of Arizona between 1976 and 2001.

which meant basically they could not own both generation and transmission assets. The order also required the separation of marketing functions for these newly disaggregated services, and required transmission owners to provide open access to their energy rate schedules and their transmission assets. This meant the end of vertical integration and the establishment of markets for generation for a large segment of electric energy providers. 889 ordered the creation of an open access information system, called an OASIS and described Standards of Conduct. These orders provided for "open access" and are the basis for todays operation.

These orders also encouraged the creation of Independent System Operators (ISOs) and Regional Transmission Operators (RTOs). On December 20, 1999 FERC issued Order 2000 in order to try and correct some of the design faults inherent in the ISO structure.

In 1997 when the first Track papers were presented almost all of them dealt with various problems associated with restructuring the industry. In 1996 I had met Jay Nunamaker who was chairing the Track on Collaboration Systems and Technology at HICSS. At the time Jay was a Professor at the University of Arizona and Head of the Center for the Management of Information that he founded in 1985. He was involved in a research program in collaborative processes and technologies that included collaborative writing. So, I approached him with an idea to host a group of electric power researchers at his facility where we would collaboratively write a document outlining our collective vision for the "end game" for restructuring. With the help of Tom Schneider, who was then at the Electric Power Research Institute (EPRI), we organized the activity and the group went to Arizona to collaboratively write using the tools Jay and his lab were developing. The first paper [3] in the first Electric Power session at HICSS-30 is entitled "Underlying Technical Issues in Electricity Deregulation". It reports on the outcome of the workshop and summarizes its findings. The paper is the collective work of the following workshop participants:

Fernando Alvarado, U. of Wisconsin
Jeremy Bloom, EPRI
Hung-po Chao, EPRI
Chris DeMarco, U. of Wisconsin-Madison
Ian Dobson, U. of Wisconsin-Madison
Thomas W. Gedra – U. of Oklahoma
Robert H. Lasseter, U. of Wisconsin
Shmuel Oren – U. Calif. - Berkeley
Thomas J. Overbye, U. of Illinois
Dennis Ray, U. of Wisconsin-Madison
Peter W. Sauer, U. of Illinois
Thomas R. Schneider, EPRI
Richard Schuler, Cornell University
Robert J. Thomas, Cornell University
James S. Thorp - Cornell University
Pravin Variaya U. Calif. - Berkeley
Ali Vojdani, EPRI
Martin Wildberger – EPRI

So, HICSS had an impact from the beginning.

While many of early HICSS papers were concerned with the move to wholesale markets for generation, they were always grounded in either engineering or economic issues or both. Computing, simulation, and data issues, among others, were also present driven by the

idea of designing a competitive supply side market while preserving the reliability and economic efficiency of the aggregate system under the the obligation to serve a fixed-price regulated demand side.

After a time wholesale market design began to focus on what was needed for the provision of the six ancillary services through market mechanisms. The six services are: (1) scheduling and dispatch, (2) Var support, (3) frequency regulation, (4) spinning reserves, (5) supplementary reserves, and (6) energy imbalance. So, the Track began seeing papers addressing these topics.

As policy changes in Washington began driving the integration of renewable energy resources, principally wind and solar, into large-scale electric supply and delivery systems, the research began to shift in that direction. The intermittent nature of these technologies is especially challenging and remains a vigorous research topic today.

Today there is also great interest in topics of demand response, micro grids, and storage. Storage is the Holy Grail for electric power systems and will be a real game changer is it becomes economical, efficient, and and widely deployed. A good deal of research is beginning to take place on developing a transformation of the distribution network to a more active player. The topic should provide fodder for research for years to come.

The term Transactive Energy is beginning to enter the lexicon of electric power research. A transaction is an exchange or transfer of exchangeable products, services, rights, or funds. According to [4], "Transactive energy refers to the use of a combination of economic and control techniques to improve grid reliability and efficiency." This rubric puts some formality to much of the work that has been evolving at HICSS and elsewhere for some time now. There is no doubt that we will see more work in this area for some time to come.

There were many memorable moments over the years. In addition to the presentations by Nobel Prize winner Vernon Smith, there were presentations by CEO of the PJM Interconnection, Terry Boston, The CEO of the NYISO, Steve Whitley, and HECO Vice President Karl Stahlkopf, among other luminaries. One of the most memorable presentations was by my colleague Richard Schuler. The group had just finished listening to a paper presentation when a blackout occurred and the room went dark except for the light from the computer screens. The next speaker announced that he couldn't present his paper without his PowerPoint slides. What to do? Dick Schuler stood and said "I'll give my talk, I don't need to use my slides". He proceeded to present his paper without notes in a room lit only by computer screens and cell phones. When he was done the lights came back on and the session continued without missing a beat. Amazing!

Best Papers

Every Track, and there are now eight of them, give an award for the single best paper in each Track each year. Current practice is for the Track Chairs to announce the awards, each in turn, at a special ceremony held on the last day of the Conference after lunch and before

the final afternoon sessions begin. It has been my distinct pleasure to have handed the award to every electric power Track winner since 1997. The award, in addition to the recognition it conveys, consists of a certificate mounted in a Koa wood frame. Koa is a wood native to Hawaii and is legendary in terms of its sacred and highly revered heritage. Best paper nominations are provided to the Track Chair(s) by the mini-track Chairs. All of the nominations are indicated each year in the conference program. The winner from the list of nominations are chosen by the Track Chairs through a process involving a small Committee that varies from year to year.

It is interesting to peruse the list of best papers for both the range of content and the range of disciplinary expertise. There are electrical engineers, mechanical engineers, operations research, computer engineers and scientists as well as economists. Sometimes engineers and economists are authors of the same paper. There are university professors, National Laboratory personnel, electric industry practitioners and consultants involved in authoring best papers.

In 2005, the year of HICSS 39, electric power was not a Track or even a part of another Track. It was one of two Symposia and therefore did not have mini-tracks and therefore there was no best paper awarded.

The following is a list of best papers awarded over the twenty years of the electric power Track:

HICSS-30: A Simulation Tool for Analysis of Alternative Paradigms for the New Electricity Business
T.J. Overbye, P.W. Sauer, G. Gross, M.J. Laufenberg and J.D. Weber

HICSS-31: A Transmission-Constrained Unit Commitment Method
Chung-Li Tseng, S. S. Oren, C. S. Cheng, Chao-An Li, A. J. Svoboda, R. B. Johnson

HICSS-32: Market Power and Price Volatility in Restructured Markets for Electricity
Tim Mount

HICSS-33: Understanding Price Volatility in Electricity Markets
Fernando Alvarado, R. Rajaraman

HICSS-34: Network Control as a Distributed Dynamic Game
S. Talukdar and E. Camponogara

HICSS-35: Visualization and Animation of Inverter-Driven Induction Motor Operation
A.P. Sakis Meliopoulos, W. Gao, George J. Cokkinides

HICSS-36: Experimental Studies and Modeling of an Information Embedded Power System
S.P. Carullo and C.O. Nwankpa

HICSS-37: Coordinated Interchange Scheduling and Opporunities Cost Payment: A Market Proposal to Seams Issues
Jie Chen, James S. Thorp, Tim Mount

HICSS-38: Assessment of NPCC Area Interconnection Reliability Benefits
Philip A. Fedora and Glenn E. Haringa

HICSS-39: No Electric Power Track. Electric power was one of two symposia for which no best paper was awarded.

HICSS-40: Towards Reliable Computation of Large-Scale Market-Based Optimal Power Flow
Hongye Wang, Robert Thomas

HICSS-41: An Integrated Architecture for Demand Response Communications and Control
Michael LeMay, Rajesh Nelli, George Gross, and Carl Gunter

HICSS-42: Infrastructure Protection in the Ancient World
Michael Assante

HICSS-43: Combining Phasor Measurements to Monitor Cutset Angles
Ian Dobson, Manu Parashar, and Chelsea Carter

HICSS-44: Topological Models and Critical Slowing Down: Two Approaches to Power Systems Blackout Risk Analysis
Paul Hines, Eduardo Cotilla-Sanchez, Seth Blumsack

HICSS-45: The Manufacture of Potable Water: Case Analyses of Electric System Alternatives
Richard D. Tabors, Siddarth Nagendraprasad, Ayoob Hussain, Mounir Ayntrazi, Jonathan A. Brant

HICSS-46: Dynamic Simulation Study of the Frequency Response of the Western Interconnection with Increased Wind Generation
P. Mackin, R. Daschmans, B. Williams, B. Haney, R. Hunt, J. Ellis, J. H. Eto

HICSS-47
Electricity Restructuring, Consumer Prices and the Cost of Capital: Lessons for the Modeling of Future Policy
Leonard S. Hyman, Richard E. Schuler

HICSS-48: On Bus Type Assignments in Random Topology Power Grid Models
Zhifang Wang and Robert J. Thomas

HICSS-49: The Engineering, Economic and Environmental Electricity Simulation Tool (E4ST): Description and an Illustration of its Capability and Use as a Planning/Policy Analysis Tool
Biao Mao, Daniel Shawhan, Ray Zimmerman, Jubo Yan, Yujia Zhu, William Schulze, Richard Schuler, Daniel Tylavsky

Many of the HICSS papers have lives well beyond their initial publication in the conference proceedings. Many have become journal articles, or appeared in special issues of periodicals. There were two issues of Decision Sciences edited by Andy Whinston devoted to track papers.

Ancillary Activities

In addition to the formal activities Track the group found ways to enjoy the venue and each other's company. In the early days the larger group would set aside an evening to have dinner together at a nice restaurant. One of the more memorable dinners was in 1999 at Mama's on Maui attended by 24 friends and colleagues. In 2000 a group of 14 chartered a boat and went Marlin fishing off the coast of Maui. We didn't catch anything but had a great time.

One of the features of all of the conference hotels is a waterslide located at the pool. The slides on Maui, the Big Island, and Kauai are different but all are fun and not just for kids. The slides on Kauai and the Big Island take about 10

seconds to traverse from top to bottom while the Maui slide is longer and takes about 12 seconds. In 2003 Pete Sauer decided to organize a waterslide competition to be held right after the planning session and before lunch and the best paper award. Rules were established and Pete even had a trophy made in Illinois that he brought with him to award to the winner each year. Competitors would show up at the planning session in bathing suits so as to not waste time changing. In this way they could get in some practice runs before the competition began. There would be a person acting as the timer, usually Pete, with a stopwatch standing at the top of the slide. He would start the timer and, when the splash occurred at the bottom, stop it and record the time. Three runs were permitted but not required and the winner was the person who had the best run out of their three tries. Who can forget the 2007 competition on the big island when, after three runs Tom Overbye and Shmuel Oren's fastest runs were identical in recorded time. The solution was to have a run off. Tom went first and recorded an even better time than his best. Shmuel was determined. He stood at the top of the slide, stared at who knows what, threw himself down the slide landing several feet from the top of the slide with a momentous "thud", and he was off. In the end, he beat Tom's best time by 0.22 seconds in the final run to win his second trophy (he was the 2004 winner as well). The last waterslide competition was held in 2012, the last year Pete attended the conference.

Conclusions

This year, the 50th year of the conference, will be the 21st year of the electric power track in its various incarnations. For me, it has been technically all that I could have hoped for. It has taken place in a venue that is as good as any in the world. The people, the papers, the discussions, and activities have been top notch. My sincere thanks are due to all who have contributed over the years. And a special thanks to Tom Overbye, Pete Sauer, Tim Mount, Dick Schuler, Shmuel Oren, and Richard Tabors for their help in making it the success it has been. And of course, a special thanks to Ralph Sprague for his support over the years.

References

1. Bruce Shriver and Ralph Sprague, "An Encapsulated History of HICSS (1967-1997), 1997. HICSS web site

1. R.J. Thomas, R. D. Barnard, J. Meisel, "On Klopfensteins' Method and Solutions of Nonlinear Equations", Proc. Fourth Hawaii Conference on Systems Sciences, (HICSS-4), 546, January 1971.

2. A. R. Eide and R.J. Thomas, "NELS: a system for creating, archiving and serving digital courseware documents", Proceedings of the Twenty-Ninth Hawaii International Conference on System Sciences (HICSS-29), Volume: 5 , Page(s): 136 -143 vol.5, 1996

3. "Underlying Technical Issues in Electricity Deregulation", Robert J. Thomas and Thomas R. Schneider, Proceedings of the 30th Hawaii International Conference on System Sciences (HICSS-30), Jan 6-10, 1997, Maui, Hawaii

4. “GridWise Transactive Energy Framework”, prepared by the GridWise Architectural Council, January, 2015