

Forward to the EPSR Special Issue for PSCC 2020

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Nearly a century before the term “smart grid” was coined, engineers relied on computations from “network analyzers” (analog computers used for power flow and stability studies) in order to design and operate electric power systems. As transmission networks became more interconnected in the early 20th century, engineers combined optimization principles with increasingly sophisticated loss models to solve the economic dispatch problems required to efficiently operate large power grids. In the 1950s and 1960s, power system computations were at the forefront of the digital computing revolution. Power system engineers played a pivotal role in the history of computing, including, among their many contributions, the first solution techniques for large-scale systems of sparse nonlinear equations. Power systems remain a key application for advancing computing methods, with engineers pushing the boundaries of knowledge in topics such as differential-algebraic equations for simulating and controlling dynamical power system models, stochastic algorithms for addressing generator and load uncertainties, nonlinear programming for optimizing power system operations, machine learning techniques for a wide range of applications, and many others.

The rapid growth of computing capabilities in the 1950s and 1960s led researchers and practitioners to develop venues for sharing the latest developments in power systems computations. Among the earliest of these venues, the Power Systems Computation Conference (PSCC) has a long and distinguished history. The first PSCC was a spontaneous meeting in Mainz, Germany in 1962, with a proper conference taking place the following year in London. PSCC was subsequently held in Europe every three years until 2014, when the conference switched to a bi-annual cadence in order to accommodate the increasingly fast pace of power systems research in recent years.

The 21st iteration of PSCC held in the summer of 2020 was unlike any before. During the final stages of the conference planning in March 2020, the coronavirus pandemic led to worldwide travel restrictions and lockdowns which continued through the summer. Accordingly, the 21st PSCC was held in an entirely virtual format in place of the planned meeting in Porto, Portugal. With logistical efforts led by João Peças Lopes, chair of the Local Organizing Committee at the Universidade do Porto, the 21st PSCC used a videoconferencing platform to enable the authors to present and discuss their papers with conference attendees

from around the world. The vice-chair and chair of the Technical Program Committee, Daniel Molzahn and Christian Rehtanz, rearranged the conference schedule from four down to two simultaneous tracks with the presentations lasting from the morning through late evening in Europe. The sessions for the 21st PSCC grouped papers on closely related topics while simultaneously considering the local time zones of the authors. Hence, the 21st PSCC consisted of a week-long worldwide virtual discussion on emerging developments in power system computations.

While unable to fully replicate the in-person experience that was originally planned for the 21st PSCC, the virtual format provided some advantages. For instance, by eliminating the need for visas and travel expenses, the virtual platform reduced geographic barriers for conference attendees. The reduction from four to two simultaneous tracks led to fewer scheduling conflicts among the presentations, providing attendees with the opportunity to participate in more of the program. All attendees also had the ability to view video recordings of the presentations and discussions.

These video recordings provide a novel mechanism for advancing PSCC's mission of widely sharing groundbreaking research in power system computations. PSCC maintains publicly available digitized records of all conference proceedings at the main PSCC website, <http://www.psc-central.org>. These records currently include all conference proceedings ranging from the 21st PSCC in 2020 through the 11th PSCC in 1993, and ongoing efforts are digitizing the proceedings for earlier iterations of the conference. Complementing these conference proceedings, all video recordings from the 21st PSCC are also publicly available via links at <http://www.psc-central.org>. PSCC aims to build on the virtual experiences from the 21st PSCC in order to stay at the forefront of the ongoing revolutions in education and knowledge transfer while maintaining the rigor and other characteristics that have historically defined PSCC.

The program of the 21st PSCC built on the high technical standards developed throughout the conference's long history. The rigor of the PSCC review process is comparable to or tougher than many power engineering journals, leading to acceptance rates below 40% in recent iterations of the conference. With 739 paper submissions, the 21st PSCC shattered the previous record for the number of submissions (a 21% increase over the 19th PSCC in 2016). This record number of submissions led to a very competitive acceptance rate of 30% for the 21st PSCC. Demonstrating the worldwide reach of PSCC, the submitted papers included contributions from Europe (51%), North America (17%), South America (15%), Asia (12%), Australia (4%), and Africa (1%). The conference program was selected by a Technical Program Committee (TPC) consisting of 53 leading power systems researchers from a similar global distribution. Each paper submission was assigned to a TPC advocate who managed the review process. This process resulted in a total of over 2350 reviews from over 1350 unique reviewers. After curating the reviews, the TPC selected the conference program at an in-person meeting in Dortmund, Germany during January 2020. The conference organizers greatly appreciate the TPC members' efforts in managing the reviews for the record number of submissions, the reviewers' time and

energy spent evaluating the papers, and the authors' trust in PSCC to evaluate and showcase their work.

Corroborating the high technical standard established by PSCC, the 21st PSCC features a new partnership with Elsevier through the journal *Electric Power Systems Research* (EPSR). All accepted and presented papers are jointly included in both the conference proceedings, available at <http://www.psc-central.org>, and in this PSCC 2020 Special Issue of EPSR. The conference organizers thank the Elsevier team for this partnership and for all of their assistance, especially Carlo Alberto Nucci, Editor-in-Chief of EPSR; Kathleen Ahamed-Broadhurst, Executive Publisher; and Shruti Venkiteswaran, Journal Manager.

The papers in this PSCC 2020 Special Issue address a wide range of traditional topics (e.g., power quality, state estimation, stability analyses, electromagnetic transients, protection, etc.) along with a number of emerging research directions. Continuing trends from previous iterations of PSCC, other popular topics included uncertainty management; energy markets; aggregation of flexible loads and distributed resources; control of microgrids, power electronics, and HVDC; and optimal power flow algorithms. Perhaps unsurprisingly given its prominence in computing more generally, there were also a particularly large number of papers related to machine learning, with sessions focused on applying machine learning to optimization and control problems, wind power prediction, and demand forecasting as well as sessions on physics-informed machine learning and data-driven modeling techniques. Other notable topics included power system resiliency, multi-energy systems, TSO-DSO coordination, energy storage, and electro-mobility. Finally, the program included two invited survey papers titled "Fundamentals of Power Systems Modelling in the Presence of Converter-Interfaced Generation" and "Big Data Analytics for Future Electricity Grids" which review recent theory and applications in these maturing research areas.

In addition to the papers, the conference also included a full-day tutorial session titled "Modelling and Planning of Multi-Energy Systems" which provided a detailed look at integrating electric power systems with natural gas, hydrogen, district heating, and other energy networks. The conference also included a roundtable discussion titled "Machine Learning for Power Systems: Present & Future". This roundtable discussion featured presentations from six provocateurs from both academia and industry who were tasked with having a spirited discussion on the merits of this emerging research area. The 21st PSCC concluded with a panel discussion titled "Translating Power Systems Research into Practice" which shared four panelists' experiences in taking research work on software and methods for power system analysis into "real-world" use. The panelists included junior and senior entrepreneurs who discussed their experiences in running start-up companies as well as representatives from a transmission system operator and a large vendor who are interested in commercializing innovations from the research community. The video recordings for all paper presentations, the tutorial sessions, the roundtable, and the panel are all publicly available via <http://www.psc-central.org>.

In this Special Issue of EPSR, the organizers of the 21st PSCC are proud to present a technical program that we believe lives up to the tradition of excellence

established for PSCC. We are also glad to have conducted a successful virtual conference in spite of the coronavirus pandemic. Nevertheless, we recognize that all the attendees of the 21st PSCC were no doubt were looking forward to visiting the beautiful city of Porto. Accordingly, we are happy to invite you to join us in person from June 27th to July 1st, 2022 in Porto where we plan to hold the 22nd PSCC. We look forward to sharing both engaging technical discussions and city's world-famous port wine with you in two years!