

HOSSEIN AKHAVAN-HEJAZI

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EDUCATION

University of California Riverside, Riverside, CA
Ph.D., Electrical Engineering - Power Systems/ Smart Grid 2016
Thesis: *Optimal operation of energy storage units in power transmission and distribution networks.*

Amirkabir University of Technology, Tehran, Iran
M.Sc., Electrical Engineering - Power Systems 2011

Iran University of Science and Technology, Tehran, Iran
B.Sc., Electrical Engineering 2008

KNOWLEDGE AREAS

Battery Energy Storage:	Battery operation algorithms, battery testing, modeling, system design and planning.
Power system analysis:	Power/energy systems operation and planning, electricity market operations.
Smart & Sustainable grid:	Distribution grid modeling, Distributed Energy Resources.
Optimization:	Stochastic programming, convex relaxations, decomposition.
Energy Data analysis:	Statistical analysis, time-series analysis, state estimation.

TECHNICAL SKILLS

Programming:	Python, Go, MATLAB
Development Tools/Tech:	Docker, gRPC, GraphQL, KubeFlow, AirFlow
Optimization Software:	CPLEX, GUROBI, Pyomo, ORtools
Power System Software:	PSCAD, Simulink, Power World, DIgSILENT, SAM
Real Time Digital Simulator (RTDS):	Hardware-in-Loop (HIL) Testing
Miscellaneous:	Linux, GitOps (Gitlab, CICD, etc.)

EXPERIENCE

Market Optimization Engineer Dec. 2019-present
Data Science and Optimization team, Energy Platform, Shell Energy (Royal Dutch Shell)

24x7 Optimization Module for Quick Start Gas Generators in ERCOT.

Design and development of 24x7 optimization module for scheduling and bidding operations of eight quick start gas generator assets in ERCOT day-ahead and real-time markets. Deployed the application in dev, stage and prod environment using Airflow DAGs.

24x7 Trade Management Module for Italian Wind Turbines

Design and development of 24x7 optimization module for position management and bidding of thirteen wind turbine assets in European day-ahead and intra-day markets. Deployed the application in dev, stage, and prod via KubeFlow DAGs.

24x7 Position Management and Dispatch Module for Portfolio of Behind-the-Meter Assets

Design and development of 24x7 optimization module for position management and bidding, for a portfolio of behind-the-meter assets in ERCOT day-ahead and real-time markets. Deployed the application in dev, stage, and prod via gRPC micro-service.

Design and implementation of proof-of-concept for solving asset optimization via ORtools protocol buffers/ gRPC.

Design of complete data model in protobuf, for assets optimization and trading.

Professional Researcher/ Research Faculty

2017-2019

Winston Chung Global Energy Center, University of California at Riverside

Detailed Modeling of Batteries in Optimal Battery Energy Storage System (BESS) Operation: Variable Cell Balance and Capacity:

The current optimization-based algorithms to operate grid-tied BESS typically do not look much under the hood of the BESS, i.e. the device-level characteristics of the batteries. We propose a new BESS scheduling optimization framework that accounts for features such as cell-to-cell variations in (a) maximum capacity, (b) charge level balance, and (c) internal resistance. The proposed framework is in the form of tractable mixed integer linear programs (MILP). Several techniques has been used to convert the original problem in the from of MILP.

Quantification of Forecast Error Impact on Model Predictive Control of BESS Operation for Demand Charge Reduction.

The load/generation forecast used in BESS MPC algorithms include some deviations from real-time values. Although the forecast and operating states of the system is frequently updated, such errors have impact on operation efficiency of BESS. In this work we develop optimization-based mathematical models to quantify the impact on two types of BESS MPC algorithms in demand peak shaving application.

Probabilistic Load Forecasting Using Non-parametric Conditional Density Estimation.

In this project we develop and implement algorithms for probabilistic forecasting of the demand. The approach is based on estimating the non-parametric kernel-based joint distribution of the demand and affecting factors, e.g. temperature, from historical data. The conditional probability distributions are then estimated based on given values of predicted affecting factors.

Optimized Cell Removal to Enhance Operation of the Used Battery Packs with Variable Capacity Cells.

This project is aimed at developing algorithms for automating and optimizing the BESS asset management. During the operation life of the BESS, the battery pack may develop a condition where the capacity of some cell reduce much greater than the rest of the pack. Th

PI, Co-PI, and key personnel in more than 17 title proposals submitted to CEC, DOE, ARPA-E, UCOP, etc., Including the funded projects:

Smart Batteries: Self-Healing by Self-Reconfiguration at the Cell Level. (UCR SEED GRANT)

Demonstration of Smart Combustion Technology using Natural Gas Fuel Quality Sensor. (CEC-GFO-17-501)

Advanced Integrated Building Energy Management Technology Demonstration in a Permanent Supportive Housing Facility. (CEC-GFO-16-309)

Internet of Things and Ubiquitous Sensing in University Building Energy Management; Design Optimization and Technology Demonstration. (CEC-GFO-16-309)

Post-doctoral Fellow

2016 - 2017

Smart Grid Research Lab, University of California at Riverside

Utility-scale implementation of a battery-assisted distribution feeder peak-shaving system:

Developed offline and online stochastic optimization frameworks for peak-shaving on an industrial 12 kV distribution feeder using batteries located at UCR CE-CERT micro-grid. Utilized the RPU SCADA data to predict the feeder load using ARMA models. *This project involved extensive programming in MATLAB, data analysis, statistical modelling, Monte-Carlo simulation, and stochastic optimization.*

Lab-scale implementation of a P-HIL testbed for grid-connected battery systems.

Graduate Researcher

2012 - 2016

Smart Grid Research Lab, University of California at Riverside

Utility-scale independent energy storage bidding in electricity market for multiple revenue streams.

Formulated stochastic optimization for energy storage bidding in day-ahead electricity market. Developed models for participation of independent energy storage in energy and reserve market. Obtained convex approximations for the non-linear, non-convex storage operation problem. Implemented a stochastic unit-commitment problem to calculate input bus prices/shadow prices. Studied the PJM market structure for demand resources participation in two settlement markets of energy/ancillaries. *This project was part of my research towards the PhD dissertation. It involved programming, optimal power flow and unit-commitment modeling, study of bidding and market clearance procedures, statistical modeling and Monte-Carlo simulations, optimization and decomposition techniques.*

Energy storage operation in distribution systems via chance-constrained stochastic programming:

Developed non-parametric CC-OPF for energy storage operation in distribution systems. Developed convex approximation of CC-OPF for energy storage operation in distribution systems. Developed mathematical models for battery storage characteristics, analysis of cost, sizing, and coordinated charging of battery storage. Developed a test data set for electric vehicle fleet applications in smart grid research. *This project involved extensive programming in MATLAB, distribution grid modeling, and advanced stochastic modelling.*

HIL testing of VAR control in distribution grids via optimal operation of four-quadrant battery chargers.

Graduate Intern

June 2014 - September 2014

Energy Management Department, NEC Laboratories America

Risk-constrained market optimization and bidding of utility-scale battery storage systems in two-settlement market:

Developed an optimization for operation of battery storage based on NYISO two-settlement market. Formulated a cost/revenue model and a revenue- risk model for energy storage system bidding/operation. Obtained tractable models for battery features such as efficiency and wear cost.

Graduate Researcher

2011 - 2012

Electrical Engineering Department, Texas Tech University

Distribution system optimal expansion planning with distributed energy resources.

This project was implemented using MATLAB scripts. Distribution system was modeled via three-phase unbalanced power flow.

Analysis of the impacts of large scale automated demand response on the electric market operations.

Graduate Researcher

2009 - 2011

Electrical Engineering Department, Amirkabir University of Technology

Modeling dynamic characteristics of distribution systems based on the measurements of PMU.

Security-constrained co-allocation of energy and reserve in electricity market.

SELECTED REFEREED PUBLICATIONS

Journal Papers

- J1 **H. Akhavan-Hejazi**, Z. Taylor, , H. Mohsenian-Rad, “Optimal Cell Removal to Enhance Operation of Aged Battery Storage Systems”, *IEEE Trans. on Sustainable Energy*, vol. 12, pp. 739-742, January 2021.
- J2 Z. Taylor, **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “Optimal Operation of Grid-Tied Energy Storage Systems Considering Detailed Device-Level Battery Models”, *IEEE Tans. on Industrial Informatics*, vol. 16, pp. 3928-3941, September 2019.
- J3 Y. Zhan, M. Ghamkhari, **H. Akhavan-Hejazi**, D. Xu, H. Mohsenian-Rad, “Cost-Aware Traffic Management under Demand Uncertainty From a Colocation Data Center User’s Perspective”, *IEEE Trans. on Services Computing*, January 2018, Online early Access.
- J4 Z. Taylor, **H. Akhavan-Hejazi**, E. Cortez, L. Alvarez, S. Ula, M. Barth, H. Mohsenian-Rad, “Customer-side SCADA-assisted Large Battery Operation Optimization for Distribution Feeder Peak Load Shaving”, *IEEE Tans. on Smart Grid*, vol. 10, no. 1, pp 992-1004, January 2019
- J5 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “Power Systems Big Data Analytics: An Assessment of Paradigm Shift, Barriers, and Prospects”, *Energy Reports*, vol. 4, pp 91-100, November 2018
- J6 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “Energy Storage Planning in Active Distribution Grids: A Chance-Constrained Optimization with Non-Parametric Probability Functions,” *IEEE Trans. on Smart Grid*, vol. 9, no. 3, pp. 1972-1985, May 2018.
- J7 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “Optimal Operation of Independent Storage Systems in Energy and Reserve Markets with High Wind Penetration,” *IEEE Trans. on Smart Grid*, vol. 5, no. 2, pp. 1088-1097, March 2014.
- J8 **H. Akhavan-Hejazi**, A. Araghi, B. Vahidi, S. Hosseini, M. Abedi, H. Mohsenian-Rad, “Independent Distributed Generation Planning to Profit Both Utility and DG Investors,” *IEEE Trans. on Power Systems*, vol. 28, no. 2, pp. 1170-1178, July 2013.
- J9 **H. Akhavan-Hejazi**, H. Mohabati, S. Hosseini, M. Abedi, “Differential Evolution Algorithm for Security-Constrained Energy and Reserve Optimization Considering Credible Contingencies,” *IEEE Trans. on Power Systems*, vol. 26, pp. 1145-1155, August 2011.

Book Chapters

- B1 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “Optimal Operation of Independent Storage Systems in Energy and Reserve Markets with High Wind Penetration,” in *Energy Storage for Smart Grids: Planning & Operation for Renewable and Variable Energy Resources*, Edited by P. Du and N. Lu, Elsevier, 2014.

Conference Papers

- C1 Z. Taylor, **H. Akhavan-Hejazi** , H. Mohsenian-Rad, “Power Hardware-in-Loop Simulation of Grid-connected Battery Systems with Reactive Power Control Capability,” in Proc. of North American Power Symposium (NAPS), September 2017, Morgantown, WV.
- C2 Z. Taylor, **H. Akhavan-Hejazi** , E. Cortez, L. Alvarez, S. Ula, M. Barth, H. Mohsenian-Rad, “Battery-assisted distribution feeder peak load reduction: Stochastic optimization and utility-scale implementation.” In Proc. of Power and Energy Society General Meeting (PESGM), July 2016, Boston, MA.
- C3 **H. Akhavan-Hejazi**, B. Asghari, R. Sharma, “A joint bidding and operation strategy for battery storage in multi-temporal energy markets,” in Proc. of the *IEEE PES Innovative Smart Grid Technologies Conference*, Washington, DC, Feb. 2015.

- C4 H. Darvishi, A. Darvishi, **H. Akhavan-Hejazi**, “Integration of demand side management in security constrained energy and reserve market,” in Proc. of the *IEEE PES Innovative Smart Grid Technologies Conference*, Washington, DC, Feb. 2015.
- C5 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, A. Nejat, “Developing a test data set for electric vehicle applications in smart grid research,” in Proc. of the *IEEE Vehicular Tec. Conf.*, Vancouver, BC, 2014.
- C6 Chenye Wu, **H. Akhavan-Hejazi**, H. Mohsenian-Rad, Jianwei Huang “PEV-based P-Q Control in Line Distribution Networks with High Requirement for Reactive Power Compensation”, in Proc. of the *IEEE PES Innovative Smart Grid Technologies Conference*, Washington, DC, Feb. 2014.
- C7 **H. Akhavan-Hejazi**, H. Mohsenian-Rad, “A Stochastic Programming Framework for Optimal Storage Bidding in Energy and Reserve Markets,” in Proc. of the *IEEE PES Innovative Smart Grid Technologies Conference*, Washington, DC, Feb. 2013.
- C8 **H. Akhavan-Hejazi**, Z. Bahar, H. Mohsenian-Rad, “Challenges & Opportunities in Large-Scale Deployment of Automated Energy Consumption Scheduling in Smart Grid,” in Proc. of the *IEEE Conf. on Smart Grid Communications*, Tainan, Taiwan, Oct. 2012.
- C9 **H. Akhavan Hejazi**, M. Abedi, H. R. Mohabati, M. Hajizade, “A New Approach for Fast Identification of Distribution System Dynamic Model from Measured Data,” in Proc. of the *International Conference on Clean Electrical Power*, Ischia, Italy, 2011.
- C10 **H. Akhavan-Hejazi**, M. Hejazi, G. Gharehpatian, M. Abedi, “Distributed Generation Site and Size Allocation Through a Techno Economical Multi-objective Differential Evolution Algorithm,” in Proc. of the *IEEE Power & Energy Int. Conference*, Kuala Lumpur, Malaysia, 2010.

PROFESSIONAL SERVICES

Committee Chair, UCR Conference on Energy Storage Technologies and Applications, 2018-2019.

Co-Chair of Control and Operation Symposium, IEEE Smart Grid Communications Conference, 2018.

Technical Program Committee Member, IEEE Smart Grid Communications Conference, 2014-2017.

Technical Program Committee Member, IEEE Global Communications Conference, 2016.

Technical Program Committee Member, Smart Grid Inspired Future Technologies Conference, 2016.

Technical Program Committee Member, IEEE Vehicular Technology Conference, 2014.

Reviewer for IEEE Transactions on Power Systems, Smart Grid, and Sustainable Energy.

FELLOWSHIPS & AWARDS

Dissertation Year Award, University of California, Riverside, Graduate Division, 2015

Dean’s Distinguished Fellowship Award, University of California, Riverside, Graduate Division, 2012

Dean’s Sybil Harrington Living Trust Fellowship, Texas Tech University, Graduate School, 2011

PROPOSAL WRITING EXPERIENCE

Summary: During my PhD. and Postdoc, I was actively involved in developing the technical documents, such as Technical Narrative, Scope of Work, etc. for several proposals. Here is a select list:

- *UCOP-2018 UC-NLCRT*: UC-Lab Center for Electricity Distribution Cybersecurity. (**Awarded: \$3M**)

- *CEC-GFO-16-304*: Internet of Things and Ubiquitous Sensing in University Building Energy Management; Design Optimization and Technology Demonstration. (**Awarded: \$2.5M**)
- *CEC-GFO-16-309*: Advanced Integrated Building Energy Management Technology Demonstration in a Permanent Supporting Housing Facility. (**Awarded: \$2.1M**)
- *CEC-EISG-EISG-13-04*: PEV-Based Active and Reactive Power Compensation in Distribution Networks: Design Optimization and Technology Demonstration. (**Awarded: \$100K**)
- *CEC-GFO-16-303-G3*: Optimized Large Vehicle Battery Recycling for Grid Integrated Applications. (Declined: \$1.0M)
- *CEC-GFO-15-313-G3*: Exploiting PMU Data to Enable Bi-directionality, Enhance Reliability, and Improve Efficiency in California Distribution Feeders. (Declined: \$1.7M)
- *RPU-EI-14*: Monitoring and Control of PVs, Battery Storage Systems, and EV Chargers at a 12 kV Industrial Substation Feeder Level. (**Awarded: \$100K**)
- *RPU-EI-15*: Exploiting PMU Data at RPU's 12 kV Industrial Feeder; Innovative Data Analytics and Optimal Energy Resource Operation. (Declined: \$100K)
- *DoE-FOA-1616*: Learning-Enhanced Algorithms, DER Synthesis. (Declined: \$1.5M)
- *DoE-FOA-1493*: Tackling Market Economics and Grid Reliability Risk Tradeoffs in Market Aggregation of Demand Resources; A Decentralized Approach Driven by Big Data. (Declined: \$300K)