Research, Teaching, and AI in Power Systems Engineering

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About Me

EDUCATION AND PROFESSIONAL EXPERIENCE

2020–2023 — **Ph.D., Electrical Engineering**
University of Tennessee, Knoxville

2022 — **Research Intern**
Argonne National Laboratory

2023–2025 — **(Senior) Research Engineer**
Pacific Northwest National Laboratory

2026–now — **Assistant Professor**
Kansas State University

Research Mission

INTELLIGENT POWER (IP) LAB AT KSU

Advance power systems through inverter-based resources (IBRs) and artificial intelligence (AI) to enable secure, resilient, and economical power supply.

Device physics
Models & stability

→

Control capability
Modes, parameters & reserves

→

Secure & economic operation
Planning, dispatch & validation

→

AI-enabled decisions
Physics-grounded agents

IEEE Power & Energy Society Prize Paper

2026 IEEE PES PRIZE PAPER AWARD

Awarded paper

Virtual Inertia Scheduling (VIS) for Real-Time Economic Dispatch of IBR-Penetrated Power Systems

1 ACTIVE IBR PARTICIPATION

Deployment and scheduling enter system-level decisions.

2 DYNAMICS-AWARE DECISIONS

Dynamic behavior enters planning and operation.

> **This paper marks two system-level shifts. This also accommodates emerging data center loads.**

IBR-Rich Power Systems

Security-Constrained Operation of IBR-Dominated Power Systems: Static and Dynamic Security Across Preventive and Corrective Decisions

Buxin She, *Member, IEEE*

***Abstract*—Inverter-based resources (IBRs) couple power system operation to fast dynamics and controller-dependent responses. Their configurable capabilities are reshaping the formulation and coordination of security-constrained operation. This paper presents a two-axis view: static versus dynamic security and preventive versus corrective decision timing. Preventive scheduling is extending from static post-contingency feasibility toward dynamic security, while corrective operation spans equilibrium-based corrective actions and trajectory-based control. A generic formulation represents this change and makes the preventive–corrective tradeoff explicit. Existing formulations, methods, and capability representations are reviewed and synthesized within this framework. The surveyed work yields two findings. First, IBR capability can expand the feasible set or relieve security constraints, reducing operating cost or improving security performance. Second, shared capability and constraints across formulations determine whether that capability remains operationally deliverable. These findings motivate future research in IBR capability characterization and quantification, joint scheduling, and scalable solution frameworks.**

***Index Terms*—Corrective control, dynamic security, inverter-based resources, power system security, power system stability, security-constrained operation.**

I. Introduction

POWER system security depends on coordinated actions before and after a prescribed contingency. North American Electric Reliability Corporation (NERC) specifies an Operational Planning Analysis and associated operating plans for anticipated conditions [1]. Within this process, preventive scheduling denotes the optimization-based selection of pre-contingency commitment, dispatch, topology, and operating configuration. After a disturbance, preconfigured automatic response and real-time assessment precede post-contingency corrective action [2].

Classical security-constrained operation represents much of this chain through static post-contingency feasibility. Security-constrained unit commitment (SCUC), security-constrained economic dispatch (SCED), and security-constrained optimal power flow (SCOPF) impose network and operating limits for prescribed contingencies [3]–[5]. DC formulations enforce active-power balance, line-flow limits, and applicable reserve or ramping requirements. AC formulations additionally repre-

Vision paper

- **Transition:** static ↔ dynamic security; preventive scheduling ↔ corrective action.
- **Extension:** extends to planning and guides device-level power electronics by defining required capabilities.

AI for Power Systems

CAPABILITY PROGRESSION

1 → 2 → 3 → 4

CLASSICAL AI
fitting · predicting
optimization · control

LLM
understand
communicate

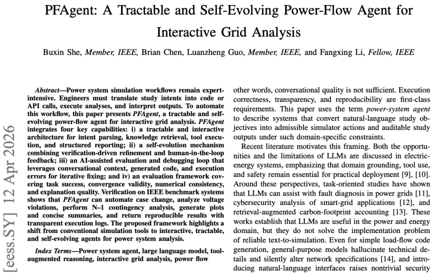
AGENT
plan · use tools
learn · adapt

WORLD MODEL
anticipate real-world
consequences

Artificial General Intelligence (AGI)

> **More capability requires stronger physical grounding and verification, particularly in power systems tasks.**

A Tractable and Self-Evolving Power-Flow Agent



PFAgent: A Tractable and Self-Evolving Power-Flow Agent for Interactive Grid Analysis

Buxin She, *Member, IEEE,* Brian Chen, Luanzheng Guo, *Member, IEEE,* and Fangxing Li, *Fellow, IEEE*

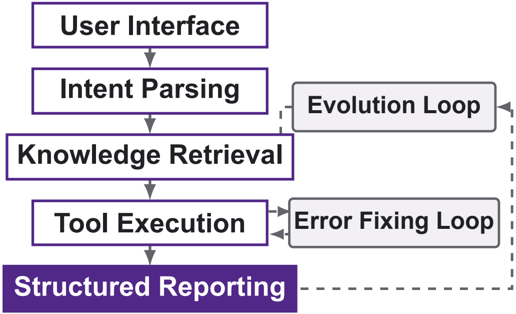
[eess.SY] 12 Apr 2026

***Abstract*—Power system simulation workflows remain expert-intensive. Engineers must translate study intents into code or API calls, execute analyses, and interpret outputs. To automate this workflow, this paper presents *PFAgent*, a tractable and self-evolving power-flow agent for interactive grid analysis. *PFAgent* integrates four key capabilities: i) a tractable and interactive architecture for intent parsing, knowledge retrieval, tool execution, and structured reporting; ii) a self-evolution mechanism combining verification-driven refinement and human-in-the-loop feedback; iii) an AI-assisted evaluation and debugging loop that leverages conversational context, generated code, and execution errors for iterative fixing; and iv) an evaluation framework covering task success, convergence validity, numerical consistency, and explanation quality. Verification on IEEE benchmark systems shows that *PFAgent* can automate case change, analyze voltage violations, perform N–1 contingency analysis, generate plots and concise summaries, and return reproducible results with transparent execution logs. The proposed framework highlights a shift from conventional simulation tools to interactive, tractable, and self-evolving agents for power system analysis.**

***Index Terms*—Power system agent, large language model, tool-augmented reasoning, interactive grid analysis, power flow**

other words, conversational quality is not sufficient. Execution correctness, transparency, and reproducibility are first-class requirements. This paper uses the term *power-system agent* to describe systems that convert natural-language study objectives into admissible simulator actions and auditable study outputs under such domain-specific constraints.

Recent literature motivates this framing. Both the opportunities and the limitations of LLMs are discussed in electric-energy systems, emphasizing that domain grounding, tool use, and safety remain essential for practical deployment [9], [10]. Around these perspectives, task-oriented studies have shown that LLMs can assist with fault diagnosis in power grids [11], cybersecurity analysis of smart-grid applications [12], and retrieval-augmented carbon-footprint accounting [13]. These works establish that LLMs are useful in the power and energy domain, but they do not solve the implementation problem of reliable text-to-simulation. Even for simple load-flow code generation, general-purpose models hallucinate technical details and silently alter network specifications [14], and introducing natural-language interfaces raises nontrivial security



Research Summary

2026 year to date | Paper pipeline

Leading Work

Stream	Work
Agentic AI	PFAgent: tractable, self-evolving PF agent
Benchmark	PFBench for LLM-based power-system agents
IBR operation	IBR capability in security-constrained operation
Planning	Inertia-aware GFM storage planning (NAPS)
Grid access	Cost of Delayed Grid Energization (NAPS)
VIS + AI	Drift-aware DNN-assisted VIS (NAPS)
SMR data center	SMR–data-center cogeneration TEA

Collaborative Work

Stream	Work
AI education	Bridging AI and power-system education
Safe RL	Physics-informed safe RL for GFM control
AIDC modeling	Workload-aware BESS–AIDC scheduling
DC dynamics	Data-center modeling & parametric analysis

Selected proposal activity

NSF
Grid-Q; secure VDC testbed.

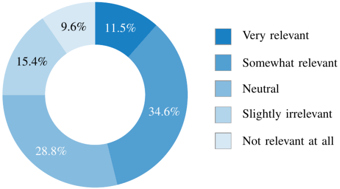
DOE OE / EPSCoR
H-PRAVOR; grid agents.

DOE Genesis
HAGRID; partner concepts.

K-State SEI
Secure Power for Kansas DCs.

AI for Power System Education

Generic examples miss the domain



Only **11.5%** found image-based AI examples very relevant to power-system applications.

Barriers appear before the first model

	Graduate n=20	Faculty n=14	Industry n=10	Undergrad n=8	Overall N=52
Lack of background	9	6	5	5	**25**
Hardware limits	6	8	4	3	**21**
Env. setup	6	5	2	2	**15**
OS differences	3	2	2	1	**8**
Debugging	3	0	0	1	**4**

The leading barriers are **background knowledge**, **hardware**, and **environment setup**.

92% report at least one barrier before running an AI model.
94% would use or consider a one-click, power-specific hands-on course.

This work is conducted under the IEEE PES Artificial Intelligence in Power Systems Coordinating Committee (AIPSCC).

Hands-On AI Notebooks

Bridging Artificial Intelligence and Power Systems Education Using a Hands-On Executable Framework

Junjie Yin, *Graduate Student Member, IEEE,* Buxin She, *Member, IEEE,*
Xinyu Feng, *Graduate Student Member, IEEE,* Fangxing (Fran) Li, *Fellow, IEEE*

3 Aug 2026

***Abstract*—Artificial intelligence (AI) is increasingly central to power and energy systems, supporting modeling, forecasting, optimization, and control. Yet most existing works emphasize specialized applications and offer little reusable material for newcomers or interdisciplinary learners, who increasingly rely on large language models rather than building their own. This gap points to a need for *engineering-grounded AI* (EGAI), in which AI workflows follow established engineering and power-system domain rules rather than acting as task-agnostic black boxes. Motivated by a community survey of researchers and practitioners, which shows 92% report at least one barrier before running an AI model and 94% want a power-specific hands-on course. This paper presents a framework consisting of open, executable module library that lowers the entry barrier for AI in power systems. The modules follow a progressive difficulty ladder that maps core AI concepts onto representative power-system tasks: (i) foundational deep neural network (DNN) templates for function approximation and load-curve fitting; (ii) a domain-coupled convolutional neural network (CNN) power-flow surrogate for a 5-bus system; and (iii) frontier modules on DNN-**

However, most of the existing academic work still emphasizes high-level research contributions or specialized applications. While these results are valuable to experts, they are not always accessible to beginners, students, or practitioners from other disciplines. For the general public, getting started with AI is still not straightforward: the workflow may seem abstract, the learning curve is steep, and many open-source codes are either too fragmented or lack context.

Therefore, there is a clear need for simple and generic hands-on codes that can lower the entry barrier. By providing progressive examples which start from basic function approximation, then moving to dataset fitting under noisy conditions, and finally to a real-world inspired power system case, we aim to make AI more approachable. Such examples can serve as stepping stones for students, engineers, and interdisciplinary learners, enabling them to quickly grasp fundamental ideas and adapt the methods to their own problems, whether in power

Hands-On Notebook Library

TIER 1: FOUNDATIONAL

01 DNN Function Fitting

02 DNN Load-Curve Fitting

TIER 2: DOMAIN-COUPLED

03 CNN Power-Flow Surrogate
PJM 5-bus system

TIER 3: FRONTIER

04 DNN-Assisted Optimization

05 DRL Battery Storage Control

06 PINN Frequency Dynamics

Open, executable Jupyter notebooks for local or Google Colab use.

Advanced IEEE Course

AI for Power & Energy Systems

What you will learn:

- To identify the relevant fundamentals of artificial intelligence and machine learning for power and energy
- To understand specific power industry needs and challenges regarding AI
- To become familiar with typical applications of AI in power and energy
- To identify future trends of AI applications in power and energy

Courses included in this program:

- AI for Power & Energy Systems: Applications, Challenges, and Opportunities
- AI for Power & Energy Systems: Computation Acceleration in Modeling Analysis and Control
- AI for Power & Energy Systems: Forecasting, Awareness, and Data Augmentation
- AI for Power & Energy Systems: Physics-Informed, Explainable, and Safe AI Applications
- AI for Power and Energy Systems: Generative AI and Large Language Models

Instructors: Fangxing (Fran) Li and Buxin She

Program Overview

- **Program:** A five-hour IEEE program targeting research and industry audiences.
- **Audience:** Power and energy researchers and professionals.
- **Objective:** Build practical AI literacy for engineering challenges.

Supported and organized by IEEE Education Committee
IEEE Power & Energy Society

ECE 685: Power System Design

SENIOR-LEVEL UNDERGRADUATE

~30 STUDENTS • **1 REMOTE**

Steady-state modeling, analysis, and design of interconnected three-phase power systems.

What students learn

1. **Model** components and build a consistent per-unit network.
2. **Analyze** DC and AC power flow and evaluate operating limits.
3. **Design and defend** an interconnected power system.

Combined teaching approach

1. **Handwriting / board work:** develop the reasoning step by step.
2. **Slides:** organize the system and support review.
3. **Executable notebooks:** connect models to computation.

Executable models support defensible engineering decisions.

Takeaways

Power systems

Make IBR capabilities active.

Make decisions intelligent and dynamics-aware.

Education

Make AI use visible and accountable.

Go Wildcats!