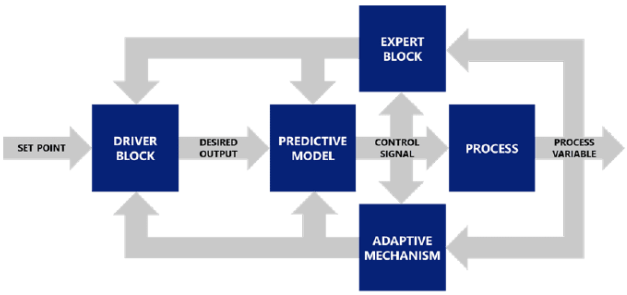
Adaptive Predictive Expert Control Optimizer



- A self-tuning artificial intelligence mechanism
- An add-on to the existing distributed control system (DCS)
- A potentially important technology in the transition to the net-zero carbon economy
- Represents one of a series of commercially available AI technologies

Key Research Question

The composition of global power generation fleets is continuing to evolve with the rapid growth of renewable energy. Improving operational flexibility, equipment reliability, and power production efficiency in this environment requires adapting many conventional base load power plants and refining their controls.

EPRI's Process Controls and Automation program (Program 227) is assessing an artificial intelligence (AI) technology that can be used to improve power plant operation during electric load following on a grid with growing penetration of variable renewable energy resources.

The technology under evaluation is an adaptive predictive expert (ADEX) control optimizer based on a self-tuning artificial intelligence mechanism that was designed to improve power plant controllability and adaptability. By demonstrating this technology at a power utility host site, this assessment is intended to evaluate and quantify the improvements on enabling faster ramping rates and stable low load operation. This demonstration will represent an additional step toward enhancing the operational flexibility of a gas turbine combined cycle (GTCC), specifically for steam temperature or drum level operation.

Objective

The objective of this project is to demonstrate the process of implementing an ADEX Optimizer to improve steam temperature or drum level control on a GTCC. While the application of the ADEX technology through this project will be the first implementation in the U.S. on a GTCC, the ADEX Optimizer was validated in relevant environments and reached a technology readiness level (TRL) of 7-8.

In addition to enabling faster ramping rates and providing stable low load operation, this project aims to quantify heat rate minimization and reduce thermal stress, fatigue, and creep to critical components of a heat recovery steam generator (HRSG) system in a GTCC. Quantification of performance benchmarks to be determined are intended to include steam temperature or drum level stability (e.g., max deviation from setpoint, settling time, percentage of overshoot, and standard deviation of the error between the reference setpoint and the process variable), ramping rates increase, units' reliability increase, lower load operation benefits, and material damage reduction (e.g., thermal stress, fatigue, and creep) of critical components. Results and research will be collaborative with the following EPRI programs: Heat Rate and Flexibility: Generation Fleet Optimization (P223), Boiler Life and Availability Improvement (P214), Power Plant Piping (P215), and Heat Recovery Steam Generators (P218).

Approach

The main goal of demonstrating this technology at a power utility host site is to evaluate this new control mechanism on a full-scale power plant. In addition, four non-host funders of this project will provide suggestions and recommendations and help identify challenges and benefits surrounding the implementation of this technology.

The ADEX Optimizer will be connected to the distributed control system (DCS) as an add-on to the existing control logic of the host site unit. Once the communication between the ADEX server and the power unit is established, the collection of data and the development of an ADEX simulator will be performed. Following successful simulation, EPRI's team, ADEX, and the host site will convene on the most

relevant tests to be performed in the unit without affecting operational activities. Then, the ADEX Optimizer will progressively take over the control of the critical variables of the selected processes.

Research Value

The assessment in this project represents the evaluation of one of a series of commercially available AI technologies. Power plant operators will have the opportunity to access the implementation path of an innovative AI technology designed to provide a self-tuning approach of critical control loops, such as steam temperature and drum level in a HRSG system. The regular maintenance required for these control loops to increase the operational flexibility of GTCC makes this evaluation a critical step toward the full automation of a HRSG during electric load following procedures. The end goal of EPRI R&D Program 227 in the assessment of this and other AI technologies available in the market is to provide insights on the advantages and disadvantages of each technology. The experience of using these technologies will be shared based on the main results achieved, implementation challenges and hurdles, and simplicity on keeping those technologies enabled without operation intervention.

Deliverables

Funders will receive the following material as deliverables for the project:

- Presentation for each phase of the project with project status and initial learnings
- Detailed final report:
  - Assessment of ADEX Technology
  - Outline of installation and process for implementation
  - Performance analysis and comparison with previous operational performance, such as steam temperature or drum level stability, ramping rates increase, and others performance benchmarks previously mentioned.

Price of Project

The project is priced differently for the host site funder and for the non-host funders with the following criteria:

- $100,000 for the host site funder
- $50,000 for each non-host funder

This project qualifies for Self-Directed Funds (SDF), Tailored Collaboration (TC), or Co-Funding. One host site funder and four non-host funders are required to perform this evaluation.

Project Schedule

This project will be divided in two phases with a duration of three months per phase and it is planned to kick off in the spring of 2023. Project will commence once a host site funder and four non-host funders have joined the project.

Who Should Join

Utilities who have or are planning to fully automate the HRSG section of a GTCC are encouraged to join this project. Utilities interested in advanced process control, control loop performance optimization, and centralized operation will also benefit from the participation in this project.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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