The Electric Generation Expansion Analysis System (EGEAS) Software

2019 EPRI Update

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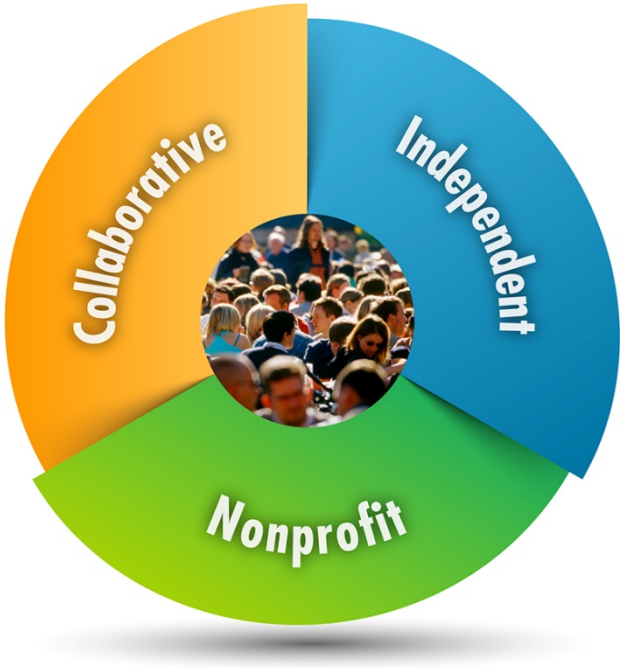
Electric Power Research Institute (EPRI)

- **Non-profit** — EPRI is a non-profit, scientific research consortium founded in 1973 to perform objective research and development related to the generation, delivery and use of electricity for the benefit of the public.
- **Mission** — "Advancing ***safe, reliable, affordable*** **and** ***environmentally responsible*** electricity for society through global collaboration, thought leadership and science & technology innovation."
- **Membership**:
  - Includes IOUs, POUs, Co-ops, Munis, IPPs, ISO/RTOs…
  - In the U.S., EPRI participants generate more than 90% of the electricity delivered.
  - EPRI has 450+ participants in more than 30 countries.
- **Principal locations** — Palo Alto, CA, Charlotte, NC, Knoxville, TN, and Washington, D.C.

Three Key Aspects of EPRI



"Together…Shaping the Future of Electricity"

EGEAS is Managed by EPRI's Research Program 178 on *Integrated Planning, Market Analysis and Technology Assessment*

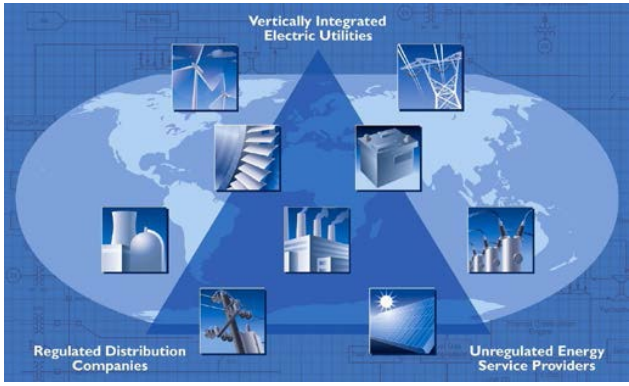
- **Project Set 178A** – Technology Cost and Performance
  - Maintains updated cost and performance data for 18 power generation and storage technologies
  - Produces EPRI's annual Technology Assessment Guide (TAG)
  - Manages EPRI's TAGWeb ™ software tool
- **Project Set 178B** – Integrated Energy Network Planning and Market Analysis
  - Explores and develops new analysis tools and methods to address current and future power system planning issues.
  - Conducts research on the dynamics of natural gas markets and prices, and interactions between fuels and power markets
  - Develop methods and tools to address uncertainty and risk in electric company resource planning

Status of EGEAS at EPRI

- EGEAS is a mature, commercial software product.
- EPRI members funded the original development of EGEAS in 1983, and enhancements through v10 (2014).
- Since 2014, EPRI has updated EGEAS with funding provided by MISO, supplemented with internal EPRI funds:
  - Version 11 (2015)
  - Version 12 (2017)
  - Version 13 (2018)
- EPRI continues to be interested in developing new versions of EGEAS, but we can only do so if 3rd parties pay the full cost of software development and EPRI SQA testing.

Overview of EPRI's Electric Generation Expansion Analysis System (EGEAS) Software

- EGEAS is a state-of-the-art modular production costing and capacity expansion software package.
- EGEAS is used by electric company planners and others to develop and evaluate integrated resource plans, avoided costs, plant life management plans, and environmental compliance plans.



- EGEAS accommodates dispatchable generation sources (e.g., coal, natural gas, nuclear, hydro), demand-side management (DSM) and renewables resources (e.g., wind, solar PV).
- EGEAS was the forerunner of the current generation of planning simulation and optimization models, and continues to be used today by a number of electric companies and regional planning organizations (e.g., MISO).
- Learn more about EGEAS here: http://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002009567 and here: http://eea.epri.com/models.html#tab.=3

Important EGEAS Features

- Includes dynamic programming algorithm to develop candidate portfolios from identified alternatives meeting a reliability constraint (e.g., maintain 10% capacity reserve margin).
- Conducts minimum present value revenue requirements (PVRR), or lowest electric rate economic ranking of candidate portfolios dispatched with an existing and future set of assets.
- Once data inputs are set-up, many different scenarios can be run to test different generation plans easily and quickly.
- Economic analysis based on present worth method — simple and easy to understand and explain results.
- EGEAS is used by electric utilities (e.g., FPL), state regulators (e.g., WI PSC), and various regional planning organizations (e.g., MISO)
- Results are easily understood, and well accepted by regulators.

Brief History of EGEAS

- 1983 — EPRI originally developed EGEAS as a research project. Key contractors included Stone & Webster Engineering Corp. and the MIT Energy Lab.
- 1990s — Stone & Webster Management Consultants Inc. developed a graphic user interface (GUI).
- 2013 — EPRI reactivated EGEAS v9.02.
- 2014 — EPRI released EGEAS v10, an updated and integrated version with a new GUI and improved "back end."
- 2015 — EGEAS v11 released
- 2017 — EGEAS v12 released
- 2018 — EGEAS v13 released

EGEAS Continues to Evolve to Meet Needs of Electric Company Planners, Regulators, ISOs and Others

- Version 1 – 1983 Initial release
- Version 2 – 1985 Storage optimization, Must-run, Spinning reserve
- Version 3 – 1986 Purchase & sale contracts, Incremental costs
- Version 4 – 1989 Financial constraints
- Version 5 – 1990 Fuel constraints, Multi-area modeling
- Version 6 – 1990 Emission Constraints, System average rate
- Version 7 – 1993 Revenues, Avoided costs, Risk analysis
- Version 8 – 1996 Multi-Parameter Gamma method
- Version 9 – 1997 Bid-based pricing
- Version 9.02 – 2007 Cost and Revenues report; Ability to change measurement units; increase # of plant types and load blocks
- Version 9.02 – 2013 Reactivated by EPRI
- Version 10.0 – 2014 Integrated GUI and underlying EGEAS code; removed Finance + and RISKMIN
- Version 11.0 – 2015 Added (i) “dump energy “ penalty factor and (ii) State RPS constraints
- Version 12.0 – 2017 (i) Added “rate-based” environmental constraints; (ii) New output reports for generating capacities; and, (iii) Removed numeric constraints / increased limits on variables
- Version 13.0 – 2018 Multiple new enhancements

EGEAS Version 13 Key Enhancements

1. Improved modeling of distributed energy resources (DERs);
2. Removed excess non-dispatchable technology (NDT) fatal error;
3. Allowed “must-run” status to be changed by segments;
4. Increased the maximum number of emission types to 50;
5. Increased the maximum number of NDTs to 200;
6. Increased maximum NDT units for a given NDT technology to 10,000; and,
7. Added copying and pasting data with tables in the graphic user interface (GUI)

New DER Modeling Capabilities in EGEAS v13

- Load modification for non-dispatchable technologies (NDTs) can be done in greater detail, with 16 time periods (segments) per month (segment), to better capture relationships between the system load and renewable generation sources.
- New options allow input of load and NDT data at 5-minute time intervals to improve accuracy for modeling DERs.
- Now can use excess NDT generation to charge multiple storage units.

EGEAS Version 13 – Development

- Collaboration between MISO, EPRI & NG Planning
- MISO provided funding for EPRI to develop v13, and "beta" tested v13 and provided feedback.
- NG Planning developed the v13 software code
- EPRI managed the software project and conducted software quality assurance testing for both the pre- and final production software versions.
- EGEAS v13 released November 2018, and is available on EPRI.com here: http://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002009567

EGEAS v13 Software Package

- EGEAS v13 executable
- Users' manuals:
  1. Capabilities manual*
  2. Users guide*
  3. DSMLink manual
  4. RPW users guide
- Installation "ReadMe" file
- Data and results for several worked examples
- Compatible with Windows v7 (32-bit & 64-bit), v8.1, and v10.

Notes: * The EGEAS v13 Capabilities Manual and Users Guide are available online for free to the public. Visit: http://eea.epri.com/models.html#tab.=3 .

EGEAS Version 13 — Pricing & Licensing

- EGEAS can be licensed from EPRI or an EPRI-licensed software "commercializer," such as NG Planning LLC
- EPRI charges $40,000 for a new EGEAS v13 license
  - One-time license cost; no annual license maintenance fee
  - No limit on the number of users in a single company
  - Existing v12 licensees can upgrade for $5,000
  - EPRI software commercializers may charge different fees
- Members of EPRI research Program 178 & PSET-178(B) receive an EGEAS license at no additional cost beyond membership fees.
- EGEAS v13 can be ordered and downloaded here:
  - http://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002009567

End-user Support and Services are only Provided by Licensed 3rd-Party "Commercializers"

- EPRI licenses 3rd parties to commercialize EGEAS and provide end-user support, including:
  - Sublicensing EGEAS to new users and existing users;
  - Providing EGEAS software training, installation, support and maintenance services; and,
  - Providing consulting services with EGEAS.
  - Any "qualified" firm can apply to be an EPRI commercializer.
- NG Planning is an EPRI licensed EGEAS commercializer.
- EPRI does not provide these services to end users.

EPRI Collaboration with NG Planning LLC

- EPRI and NG Planning have collaborated for many years on development of new enhanced versions of EGEAS
- NG Planning is an EPRI licensed EGEAS commercializer
- NG Planning coordinates annual EGEAS User Group meetings
- NG Planning has helped to increase the EGEAS user base by sublicensing EGEAS to state PUCs and electric companies, and by providing training and technical support to end users.
- NG Planning also has assisted EPRI with conducting various EGEAS analyses, including EPRI's recently completed CA microgrid analysis.

Contact Information

Together...Shaping the Future of Electricity

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