The Electric Generation Expansion Analysis System (EGEAS) Software
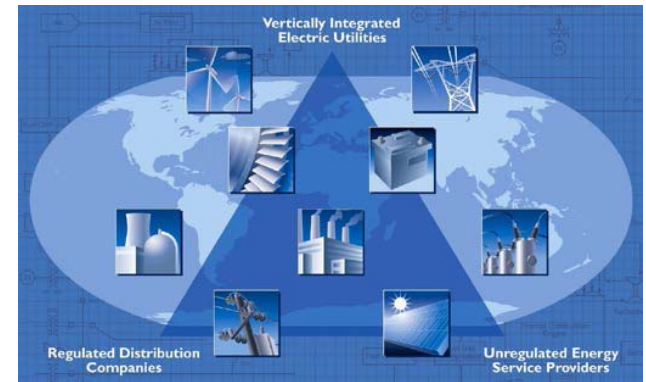## 2016 EPRI Update

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

- EGEAS is a state-of-the-art modular production costing and generation 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, gas, nuclear), demand-side management (DSM) and renewable energy sources.

- EGEAS was the forerunner of the current generation planning simulation and optimization models, and continues to be used today by a number of electric companies and regional planning organizations (e.g., MISO).

- To learn more about EGEAS, please visit EPRI.com here: http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001016192 and here: http://eea.epri.com/models.html#tab.=3

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Short History of EGEAS

- EPRI originally developed EGEAS in 1983 as a research project. Key contractors included Stone & Webster Engineering Corp. and the MIT Energy Lab.

- In the 1990s, Stone & Webster Management Consultants Inc. developed a graphic user interface (GUI) to ease data input.

- In 2013, EPRI reactivated EGEAS v9.02.

- In April, 2014, EPRI released v10 – an updated and integrated version including a new GUI and improved "back end."

- In June 2015, EPRI released the current EGEAS v11.

- Q4 2017: EPRI plans to release EGEAS v12.
  - Software development by NG Planning
  - Financial support provided by MISO

- Q4 2018: EPRI plans to release EGEAS v13.
  - Software development by NG Planning
  - Financial support provided by MISO

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EGEAS has Evolved to Meet the 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 "dump energy " penalty and State RPS

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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.

- Simple economics based on present worth method - easy to understand and explain results.

- EGEAS is used by electric utilities, state regulators and various regional planning organizations.

- Results are easily understood, and well accepted by regulators.

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EGEAS Version 10 & 11 — Key Enhancements

- One-stop software licensing via EPRI or EPRI software "commercializers," such as NG Planning LLC.

- Consolidated EGEAS, the Graphic User Interface (GUI), DSMLINK, and RPWorkstation programs

- Eliminated Finance+ and Riskmin programs which are no longer supported or used

- Updated all EGEAS users guides and manuals:
  1. Capabilities Manual*
  2. Users Guide*
  3. DSMLink Manual
  4. RPW Users Guide

- Two new features were added in v11:
  1. Dump Energy Penalty Factor
  2. Renewable Portfolio Standard (RPS) Constraint

- Updated to operate with Windows Vista, Windows 7 (32-bit and 64-bit), and Windows 8.

Notes: *At MISO's request, EPRI made the Capabilities Manual and Users Guide are available online for free to the public. Visit: http://eea.epri.com/models.html#tab.=3 .

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Renewable Portfolio Standards (RPS) Constraint

- EGEAS v11 includes new regional Renewable Portfolio Standard (RPS) constraints.

- EGEAS users can now create regional annual RPS constraints directly in EGEAS.

- EGEAS users now can develop optimized generation expansion plans that comply with the annual RPS requirements over the study period.

Dump Energy Penalty Factor

- "Dump energy" refers to electricity expected to be generated in EGEAS from a proposed generation asset portfolio that is greater than the amount needed to meet forecasted demand.

- EGEAS v11 incorporates a new "dump energy penalty factor," so the cost of dump energy can be directly "charged" a financial or other type of penalty.

- EPRI and NG planning worked with MISO to define appropriate methods to apply the dump energy penalty.

- Previously, EGEAS simply noted how much dump energy would be produced, and priced dump energy at the cost of the resources producing it for each generation expansion plan.

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EGEAS Version 11 — Current Pricing & Licensing

- EGEAS can be licensed from: (i) EPRI, or (ii) an EPRI licensed software "commercializer," such as NG Planning LLC

- EPRI charges $30,000 for a new EGEAS v11 user license
  - One-time license fee; no annual license maintenance fee
  - No limit on the amount of users in a single company
  - Existing registered licensees of <u>v10 only</u> can obtain a one-time upgrade to v11 for $5,000 from EPRI
  - EPRI software commercializers may charge different fees than EPRI

- Members of EPRI research programs 178 and 178b receive an EGEAS v11 license at <u>no additional cost</u> beyond their program membership fees.

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Current Status of EGEAS at EPRI

- EPRI members funded the original development of EGEAS in 1983, and version enhancements through v9.02 in 2013.

- EPRI has continued to update EGEAS with funding provided by MISO supplemented with internal EPRI funds.

- Research program #178b on "*Integrated Portfolio Planning and Market Analysis*" is the "home" of EGEAS at EPRI

- EPRI continues to be interested and willing to coordinate development of new versions of EGEAS, but only so long as 3rd parties pay the full cost of software development and EPRI software quality assurance testing.

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EGEAS End-user Support and Services is Provided by 3rd Party "Commercializers"

- EPRI has licensed other firms to commercialize EGEAS, and provide end-user support services, including:

  – Sublicensing EGEAS to new users

  – Providing resource planning consulting services with EGEAS

  – Providing EGEAS software training, installation, support and maintenance services

- EPRI does <u>not</u> provide direct end-user support or training

- EPRI does <u>not</u> provide direct end-users with maintenance, consulting or technical support services

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EGEAS Version 12 — Software Development

- MISO provided EPRI with funding to develop v12.

- Includes developing and testing of a pre-production "beta" v12 with MISO early in 2017.

- EPRI's Software Quality Assurance (QA) process to be completed for both the *beta* and *final production* versions.

- EPRI is in the process of working with MISO now to begin development of EGEAS v13 for delivery in Q4, 2018.

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EGEAS v12.0* is Now Being Developed and Will Incorporate Three New Enhancements

1. Remove existing numeric constraints and increase limits on key variables and basic plant and other quantities beyond the current numeric limit of 999 units.

2. Inclusion of rate-based emissions constraints (e.g., lbs CO_2 / MWh) to facilitate Clean Power Plan related analyses.

3. New output report showing all four types of generation capacities for EGUs (i.e. rated, operating, emergency, and reserve capacities).

*EGEAS v12.0 is planned to be released in Q4, 2017.

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Key Enhancements for EGEAS v13

1. Add simultaneous rate-based <u>and</u> mass-based emission constraints.

2. Allow "must-run" status to be changed by segments.

3. Increase the maximum number of emission types.

4. Increase the maximum number of NDTs.

5. Increase maximum NDT units for a given NDT technology.

6. Remove fatal error for excess non-dispatchable technology (NDT).

7. Add copying and pasting data with tables in the graphic user interface (GUI).

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EPRI Collaboration with NG Planning LLC

- EPRI has provided NG Planning with a license to commercialize EGEAS

- EPRI and NG Planning continue to collaborate to explore development of new enhanced versions of EGEAS

- NG Planning coordinates the annual EGEAS User Group meeting with MISO

- NG Planning has helped to increase the EGEAS user base by licensing EGEAS to state PUCs and several electric companies, and by providing training and technical support to end users.

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In 2015, EPRI Awarded John Lawhorn of MISO an Environment Sector *Technology Transfer Award*

"Using the Electric Generation Expansion Analysis Software System (EGEAS) to Address Electric Sector Planning and Reliability Challenges"

Challenge

MISO wanted to expand use of EGEAS among its members to facilitate communication and planning for the proposed federal Clean Power Plan.

Solution

MISO brought EGEAS to the attention of the Organization of MISO States (OMS), and helped OMS members purchase EGEAS and obtain training.

Results and Benefits

- Ten of the 15 states in MISO's region now use EGEAS. Several state public utility commissions and electric companies in MISO's region are using EGEAS.

- MISO helped promote and expand the EGEAS User's Group.

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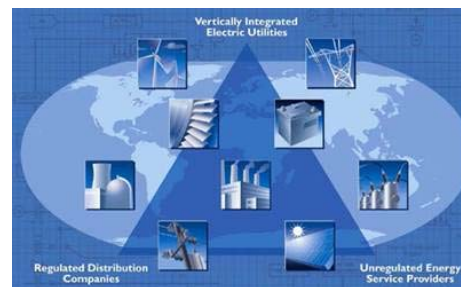
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Together…Shaping the Future of Electricity

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