RP/EGEAS OVERVIEW

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Part 1: Resource Planning Overview

Brief History of EGEAS

- Developed in 1983 as an EPRI research project
- Primary contractors – Stone & Webster Engineering Corp. and MIT Energy Lab.
- Previous version release dates:

  - 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

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Brief History of EGEAS (Cont.)

- Up to version 9.02, EGEAS was maintained and licensed by Stone & Webster until December 1997

- After 1997, version 9.02 was maintained and licensed by EPRI

- Current version 10 – April 2014, can be licensed from EPRI or NG Planning LLC

- Next version 11 – Scheduled for April 2015

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Resource Planning Overview

- Find "BEST" expansion plan to meet projected customer demands, taking into consideration:
  - Low cost energy
  - Acceptable system reliability
  - Operating system flexibility
  - Fuel supply security & diversity
  - Environmental regulations
  - Corporate financial health

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Resource Planning Overview

- Low Cost Energy:
  - Capital costs of new plants
  - Operating costs of generation system
  - Minimize sum of capital & operating costs

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Resource Planning Overview

- Acceptable System Reliability:
    - Loss-of-Load Probability: 1 day/10years
    - Unserved or unmet energy: MWh/year
    - Percent reserve margin: 15%

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Resource Planning Overview

- Operating System Flexibility:
  - Mix of different types of resources
  - Baseload – operates around the clock
  - Intermediate – 8 to 12 hours per day
  - Peaking – few hours per day

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Resource Planning Overview

Characteristics	Baseload	Intermediate	Peaking
Operating Hours/day	24	8 – 12	1 -2
Operating Costs	Low	Medium	High
Capital Costs	High > $2000	Medium $800-$1000	Low $600-$800
Plant Types	Coal Hydro	Gas CCs Hydro	Gas CTs Hydro
Typical Mix	50 – 70%	20 – 30%	10 – 20%

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Resource Planning Overview

- Fuel supply security & diversity:

  - Fuel security

    - Dual fuel, multiple suppliers, multiple sources, etc.

  - Fuel diversity

    - Nuclear, coal, natural gas, oil, hydro, wind, solar, etc.

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Environmental Regulations

- Clean Air Act Amendments of 1990 (CAAA)
  - SO_2, O_3, CO, and PM-10
- Recent EPA Regulations
  - CWIS – Cooling Water Intake Structures
  - CCR – Coal Combustion Residuals
  - CSAPR – Cross State Air Pollution Rule
  - MATS – Mercury and Air Toxics Standards
- Greenhouse Gases (GHG)
  - Carbon emissions reduction

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Corporate Financial Health

- Investor-Owned Utilities
  - Financing requirements
  - Cash flow requirments
  - Level and quality of earnings
  - Dividends

- Municipal Agencies
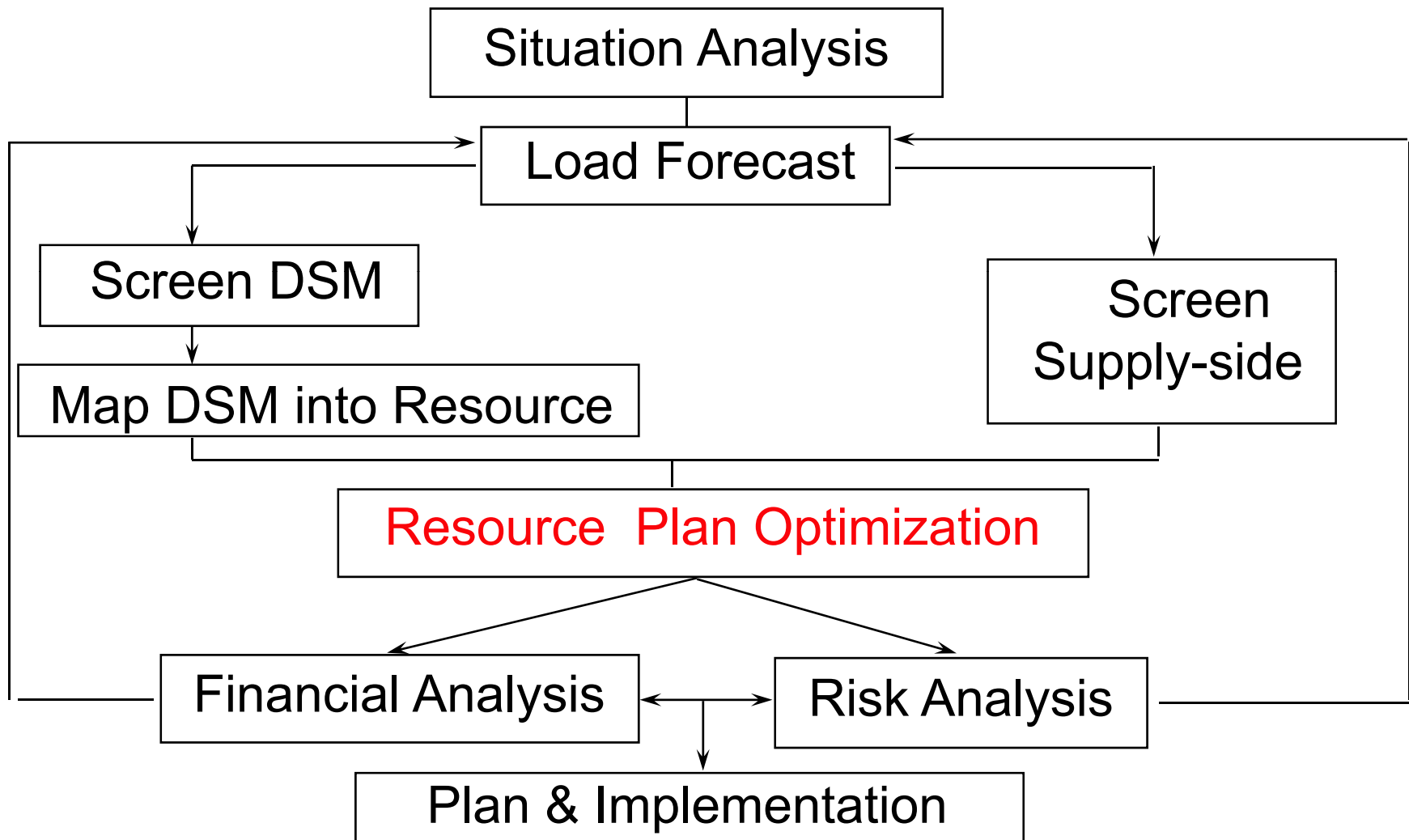 - Interest & other coverages
  - In-lieu of taxes

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Classical Planning Method –
Using Separate Planning Models

1. Capacity or reliability model to determine new capacity requirements

2. Production cost model to determine total system operating costs

3. Economic model to combine capacity and production costs on a present worth basis

4. Iterate steps 1-3 for different expansion plans, until you reach the approximate lowest cost plan

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Optimization Method –
Using a Single Planning Model Like EGEAS

1. Automates the classical planning method, and evaluates all possible combinations of plans to reach the least-cost plan

2. Input load forecast, costs and characteristics for existing resources and purchase power contracts and for all future potential planning options

3. Run the optimization model, sit back, relax, enjoy a cup of coffee, and get the right answers.

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Integrated Resources Planning Process

Situation Analysis → Load Forecast → Screen DSM → Map DSM into Resource / Screen Supply-side → Resource Plan Optimization → Financial Analysis / Risk Analysis → Plan & Implementation

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RP WORKSTATION

- RPW (EPRI)
- EGEAS (EPRI)
- DSMLINK (EPRI)

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Part 2: Overview of EGEAS

EGEAS - Overview

Electric

Generation

Expansion

Analysis

System

Version 10.0

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EGEAS Software Components

ORTH → EDIT → CANAL → REPORT

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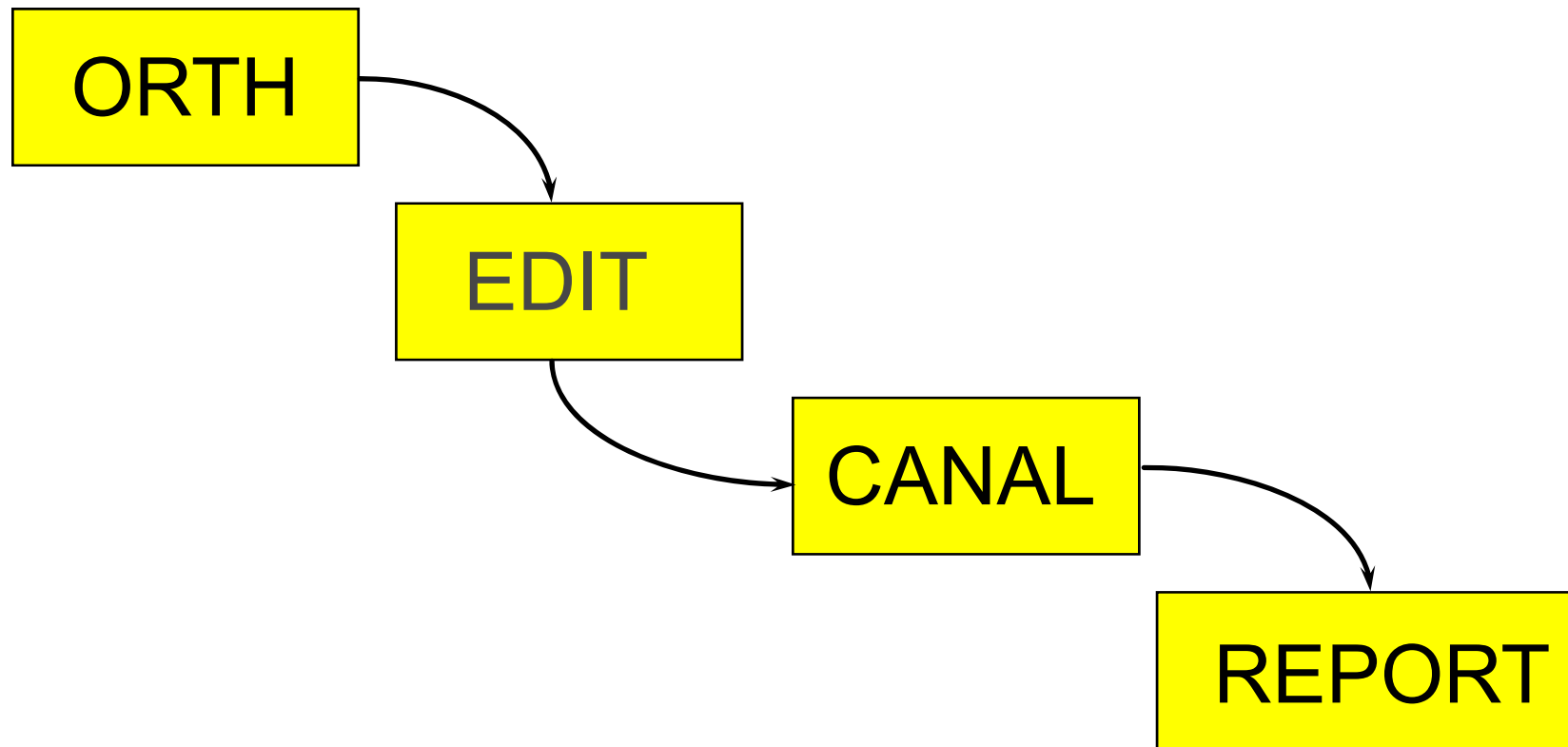
EGEAS − Purpose and Functions

- Primary Purpose - Find the optimum (least-cost) integrated resource plan for meeting demand by expanding both supply-side and demand-side resources

- Objective Functions:
  - Present value of revenue requirements
  - System levelized average rate

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Optimization Methods

- **Dynamic Program (DP)** is based on the enumeration of all possible combinations of resource additions while meeting user-specified constraints.

- **Generalized Bender's Decomposition** is a non-linear technique based on an iterative interaction between a linear master problem and a non-linear probabilistic production costing sub-problem.

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Additional Optimization Methods

- **Screening Curve Option** - Produces (cost by capacity factor) results for evaluating large numbers of alternatives.

- **Pre-specified Pathway Option** - Provides more detailed analysis of an expansion plan than is computationally feasible within an optimization. Also allows user-defined plans to be analyzed.

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Optimization Constraints Utilized

- Reliability

  - Reserve margin - maximum or minimum

  - Unmet energy - maximum

  - Loss-of-Load probability – maximum

- Tunneling

  - Used to specify the upper and lower limits of the annual and/or cumulative number of resource additions available for consideration

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Optimization Constraints (continued)

- Environmental
  - Optimize to a pollutant cap level
  - Incorporate system, site or unit limits

- Fuel use
  - Limited fuel
  - Target fuel use
  - Take-or-pay fuel

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Supply-Side Alternatives

- Thermal units

- Retirement of existing facilities

- Staged resources

- Life extension

- Hydro

- Storage

- Non–Dispatchable Technologies (NDT)

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Demand-Side Management (DSM) Alternatives

- Conservation

- Load management
  - Peak clipping
  - Load shifting
  - Storage
  - Rate design

- Strategic marketing

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EGEAS − Additional Capabilities

- Purchase and sale contracts

- Interconnections with 9 other systems

- Avoided capacity and operating costs

- Customer class revenue and sales

- Environmental tracking and emissions dispatch for up to 8 user-defined variables

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Production Costing Capabilities

- Four capacity levels
  - Rated
  - Operating
  - Emergency
  - Reserve capacities

- Change capacity levels by year and month

- Up to five loading points or blocks
  - Capacities, heat rates and forced outages

- Automatic & fixed maintenance scheduling

- Spinning reserve designations and options

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- Monthly fuel pricing & target limitations
  - Minimum, maximum and target percentages

- Operating and maintenance costs

- Transmission and distribution costs

- Dispatch modifier costs

- Monthly limited energy data

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NG Planning LLC − Services

- Commercial license with EPRI for EGEAS:
  - Sublicense EGEAS to new users
  - Provide RP consulting services using EGEAS

- Partnering with EPRI to make enhancements to EGEAS (Version 11, April 2014 – April 2015)

- Partnering with EPRI to expand EGEAS user base

- Provides maintenance & technical (M&T) support services for EGEAS program

- Provides setup and training services for EGEAS

- Coordinates EGEAS User Group meetings

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NG Planning LLC − User Group Meetings

- Annual meeting – typically late summer/early fall

- Schedule – two half days to accommodate travel

- Participants – open to all EGEAS users

- Past locations – MISO offices in St Paul, MN

- Future locations – open to suggestions/sponsors

- Purposes of user group meetings:

  ➢ Provide a forum for users to exchange information on the use and application of EGEAS

  ➢ Provide a forum for users to suggest and recommend improvements and new enhancements

  ➢ Provide a forum to communicate with EPRI on current related research projects and funding availability

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EGEAS Version 10 − Features

- Consolidation of one-stop licensing process (EPRI or NG Planning LLC)

- Consolidated EGEAS, User Interface, DSMLINK, and RPWorkstation programs

- Eliminated Finance+ and Riskmin programs which are not supported or used

- Added consistent EPRI copyright, logo, and disclaimers to all software

- All programs labeled as version 10.0

- Updated EGEAS Capabilities and all other User's manuals

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EGEAS Version 11− Features

- Two new enhancements will be added:
  - Dump energy penalty factor
    - Add a penalty to the fuel and O&M costs for the energy that needs to be dumped
  - Renewable portfolio standard (RPS) constraint
    - Ensure that a minimum percent of system generation is supplied by certain units
- Fix any known EGEAS program bugs
- Update user's manuals

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EGEAS Applications in General

- Integrated Resource Planning (IRP) Studies

- Production cost analysis

- System reliability analysis

- Emissions compliance and planning

- Renewable portfolio standards analysis

- Plant life management analysis

- Existing plant retirement analysis

- IPP and Cogeneration proposal analyses

- Sensitivity and break-even cost analyses

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Example EGEAS Applications in the U.S.

- MISO – Regional Resource Forecasting, Demand-Side Resources, Renewable Portfolio Standards, EPA Regulations, Value Proposition, and others.

- WPL – IRP study and CN application

- IPL – IRP study and CN application

- WE – IRP study and CN application

- WPS – IRP study and CN application

- WPL/WPS/MGE – Compliance planning study

- SMMPA – IRP study

- PSC of WI – Review IRP studies filed by utilities

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Examples of EGEAS Applications - International

- Malaysia – Long-range resource planning study

- Saudi Arabia – Generation & transmission optimization

- Guam – Long-range resource planning study

- Barbados – Long-range resource planning study

- Egypt – License for EGEAS, Resource planning study

- Israel – License for EGEAS, Gas conversion study

- Thailand – License for EGEAS

- Taiwan – License for EGEAS

- Philippines – License for EGEAS

- South Korea – License for EGEAS

- South Africa – License for EGEAS

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Other Resource Optimization Models

- STRATEGIST by Ventyx

- MARKET POWER by Ventyx

- SYSTEM OPTIMIZER by Ventyx

- PLEXOS by Energy Exemplar

- AURORA by EPIS, Inc.

- UPLAN by LCG Consulting

- ENPEP (WASP) by Argonne National Labs

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