

The Evolution of Planning Software

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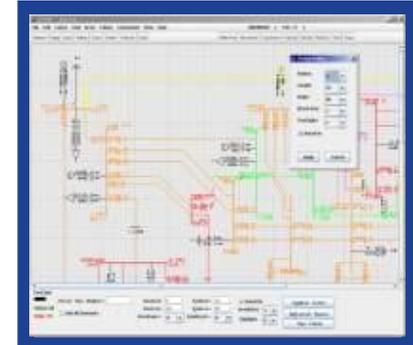
GE Energy Consulting



Global team
of experts



Understand
customer needs



Create
solutions

Since the early 1900's our consulting team has provided industry expertise on:

Studying and understanding the economic and physical operation of electric power systems including generation and grid planning, system optimization, asset valuation, competitive power markets, and energy policy implications



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Concorda Suite from GE Energy

Comprehensive software for power systems planning



PSLF

performs fast and accurate analysis of large-scale power systems using a powerful load flow, dynamics, and short circuit simulation engine



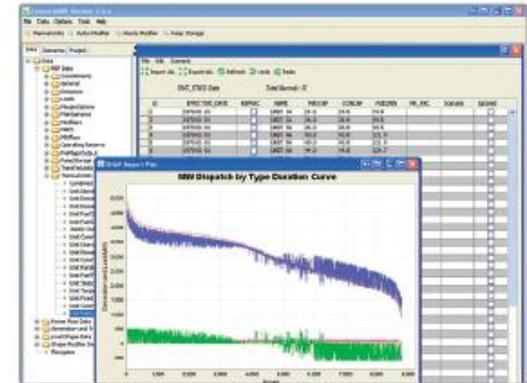
MARS

provides accurate generation system reliability assessments and is widely used for ensuring system resource adequacy



MAPS

allows highly detailed generation and transmission modeling while performing full nodal and zonal economic analyses

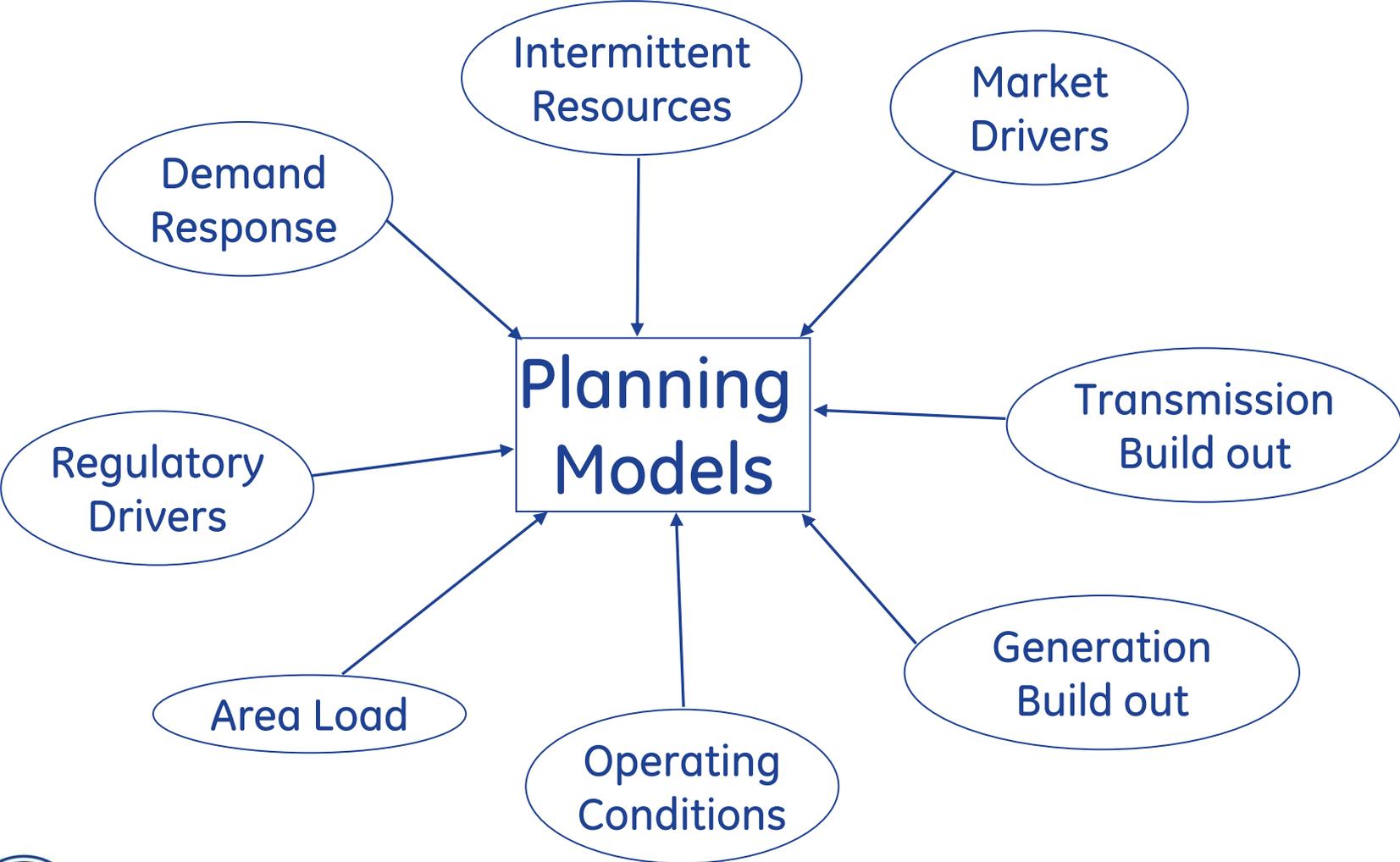


For more information please visit www.ge-concorda.com or email us at concordasuite@ge.com



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Planning Trends – A Complex World



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Planning Trends - How we see things changing?

Availability of data – Obtaining good, consistent data from sources is becoming increasingly difficult

Larger scope and size - ISO's are performing large-scale analysis and inter-ISO planning groups are forming (FERC Order 1000)

More uncertainties – Driving towards simulation of exhaustive scenario lists...places premium on execution performance

Diverse applications – No longer involving single application analysis...multiple applications interacting to determine results...close coupling of applications and focus on usability is valuable

Compliance standards – Reliability organizations are demanding higher fidelity models, consistent data, and more detailed analysis. Examples: small signal analysis and comprehensive contingency analysis.

Planning Software Trends

Advanced modeling

Integration of demand response into simulations/modeling
Advanced load modeling (single-phase load representation)
New HVDC models

Renewables modeling

Large-scale integration analysis
Accurate modeling of dynamic response of renewables
Environmental modeling

Market modeling

Participant behavior modeling
Ancillary services modeling
Economic transmission planning
Value of demand response and dynamic pricing
Portfolio optimization
Load as a market participant (PHEV, appliances, etc.)
Impacts of renewables on market prices

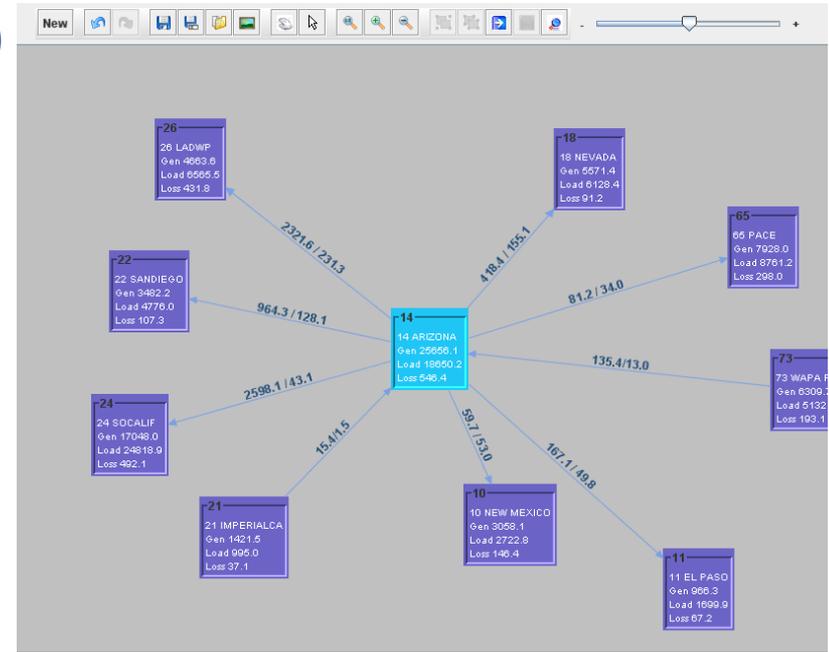
Data Visualization and Exchange

GIS visualization of results
Advanced/customized data searches
Standard exchange formats

Tighter EMS integration



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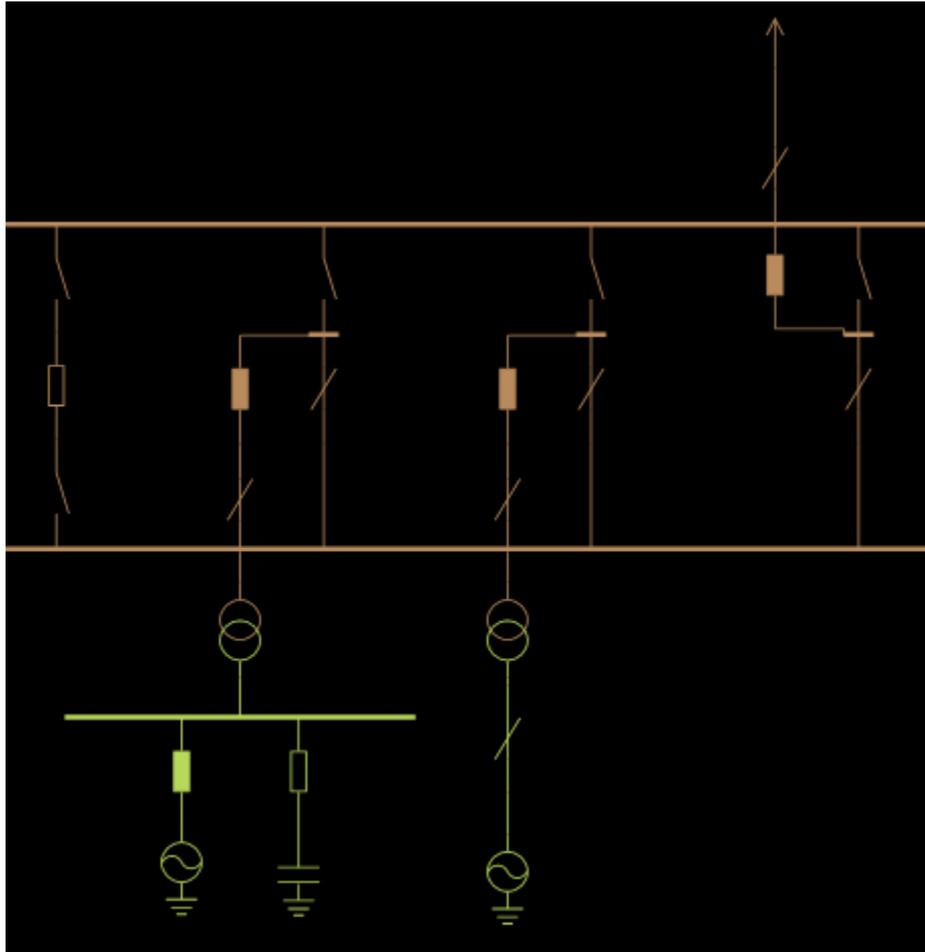


Simulation Performance

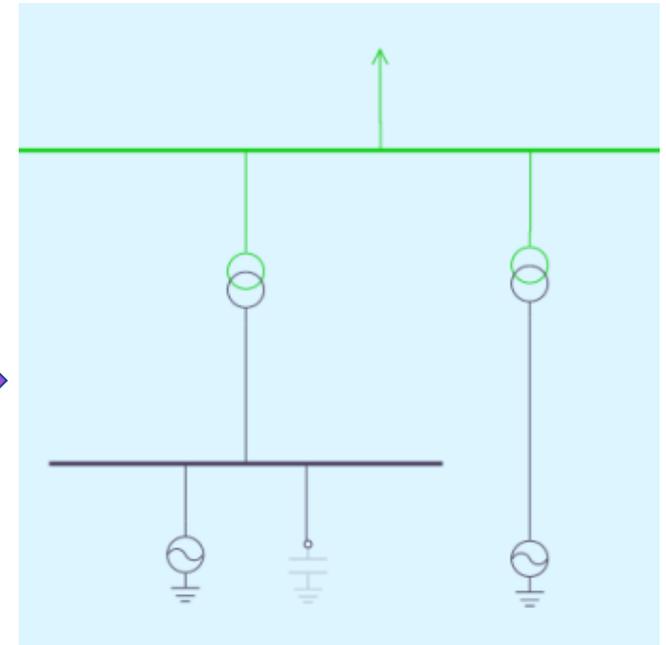
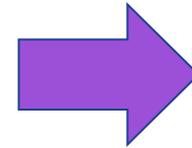
Parallel Computing

Sensitivities/scenarios increasing
Contingency lists increasing
System complexity increasing

Operations to Planning Example



Breaker-Node Modeling

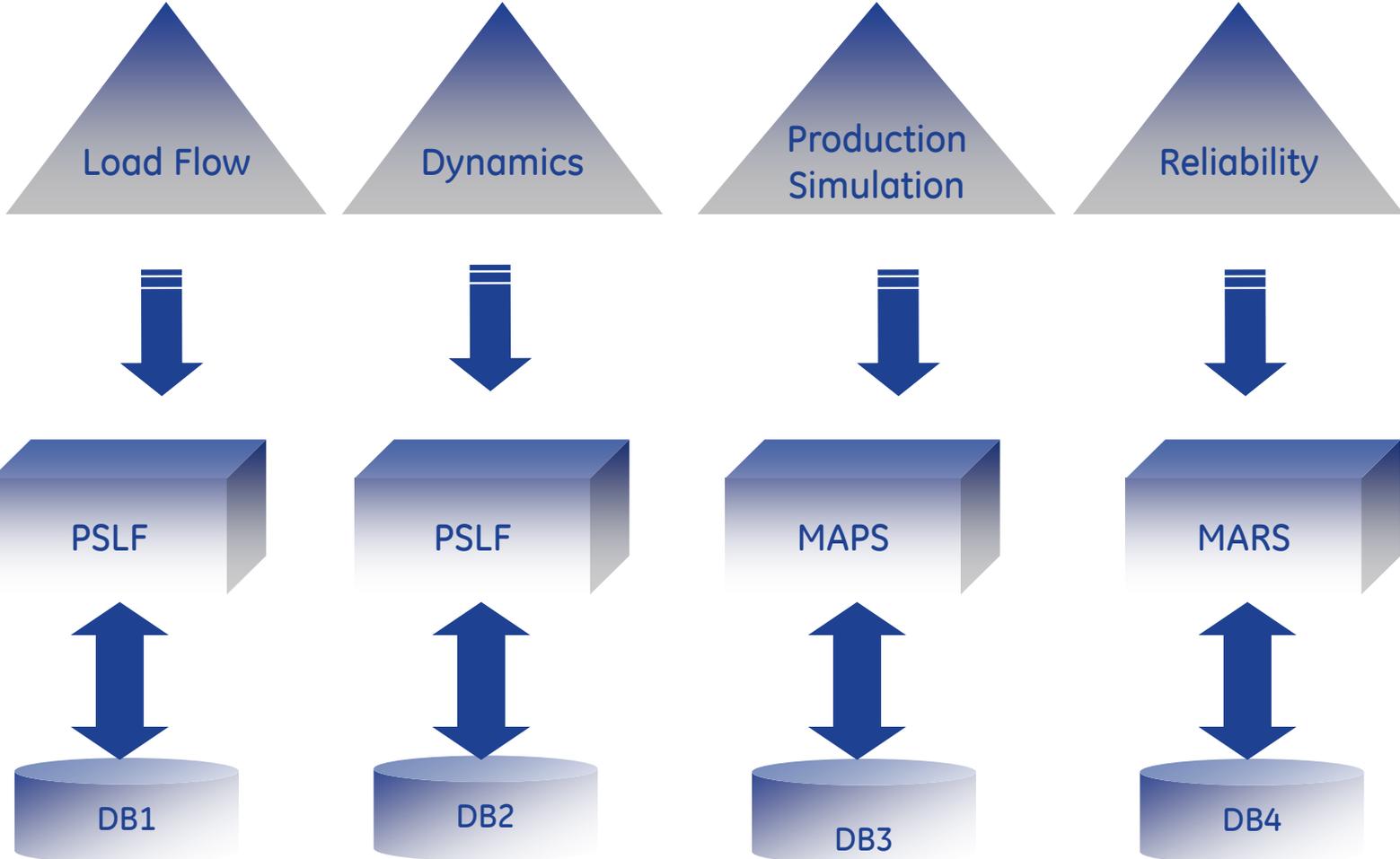


Bus-Branch Modeling



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Planning Tools Data Model Example



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Common Planning Data

Sampling of Data Elements	PSLF	MAPS	MARS
Transmission equipment data	X	X	
Transmission topology	X	X	
Interface Limits	X	X	X
Area load data	X	X	X
Generation dispatch	X	X	X
Forced outage data		X	X
Operating nomograms		X	X
Generation data	X	X	X
Maintenance data		X	X



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Our HPC experience

Internal HPC for ~5 years

Used for MAPS (production simulation) and MARS (reliability simulation)

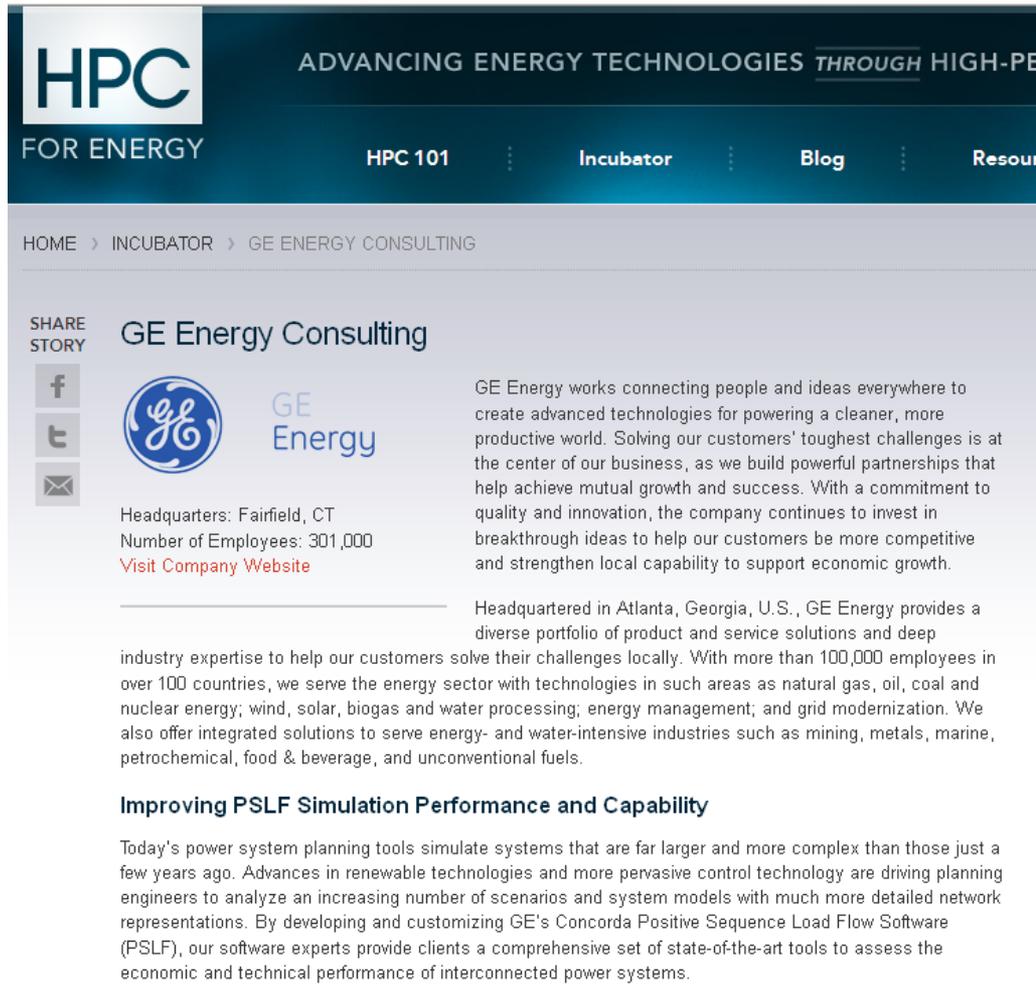
Developed commercial solutions for all 3 products (PSLF, MAPS, MARS) with licensees

Continued R&D effort



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HPC Research – LLNL HPC For Energy



The screenshot shows the top navigation bar of the HPC For Energy website. The logo 'HPC FOR ENERGY' is on the left, and the tagline 'ADVANCING ENERGY TECHNOLOGIES THROUGH HIGH-PERFORMANCE COMPUTING' is on the right. Below the navigation bar, there are links for 'HPC 101', 'Incubator', 'Blog', and 'Resources'. The main content area features a breadcrumb trail: 'HOME > INCUBATOR > GE ENERGY CONSULTING'. On the left, there is a 'SHARE STORY' section with icons for Facebook, Twitter, and Email. The main article is titled 'GE Energy Consulting' and features the GE Energy logo. The text describes GE Energy's mission and provides information about their headquarters in Fairfield, CT, with 301,000 employees. A link to 'Visit Company Website' is provided. Below the main text, there is a section titled 'Improving PSLF Simulation Performance and Capability' which discusses the company's work on power system planning tools.

HPC FOR ENERGY ADVANCING ENERGY TECHNOLOGIES THROUGH HIGH-PERFORMANCE COMPUTING

HOME > INCUBATOR > GE ENERGY CONSULTING

SHARE STORY

GE Energy Consulting

GE Energy works connecting people and ideas everywhere to create advanced technologies for powering a cleaner, more productive world. Solving our customers' toughest challenges is at the center of our business, as we build powerful partnerships that help achieve mutual growth and success. With a commitment to quality and innovation, the company continues to invest in breakthrough ideas to help our customers be more competitive and strengthen local capability to support economic growth.

Headquarters: Fairfield, CT
Number of Employees: 301,000
[Visit Company Website](#)

Headquartered in Atlanta, Georgia, U.S., GE Energy provides a diverse portfolio of product and service solutions and deep industry expertise to help our customers solve their challenges locally. With more than 100,000 employees in over 100 countries, we serve the energy sector with technologies in such areas as natural gas, oil, coal and nuclear energy; wind, solar, biogas and water processing; energy management; and grid modernization. We also offer integrated solutions to serve energy- and water-intensive industries such as mining, metals, marine, petrochemical, food & beverage, and unconventional fuels.

Improving PSLF Simulation Performance and Capability

Today's power system planning tools simulate systems that are far larger and more complex than those just a few years ago. Advances in renewable technologies and more pervasive control technology are driving planning engineers to analyze an increasing number of scenarios and system models with much more detailed network representations. By developing and customizing GE's Concordia Positive Sequence Load Flow Software (PSLF), our software experts provide clients a comprehensive set of state-of-the-art tools to assess the economic and technical performance of interconnected power systems.

hpc4energy.org



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Typical Workflow...

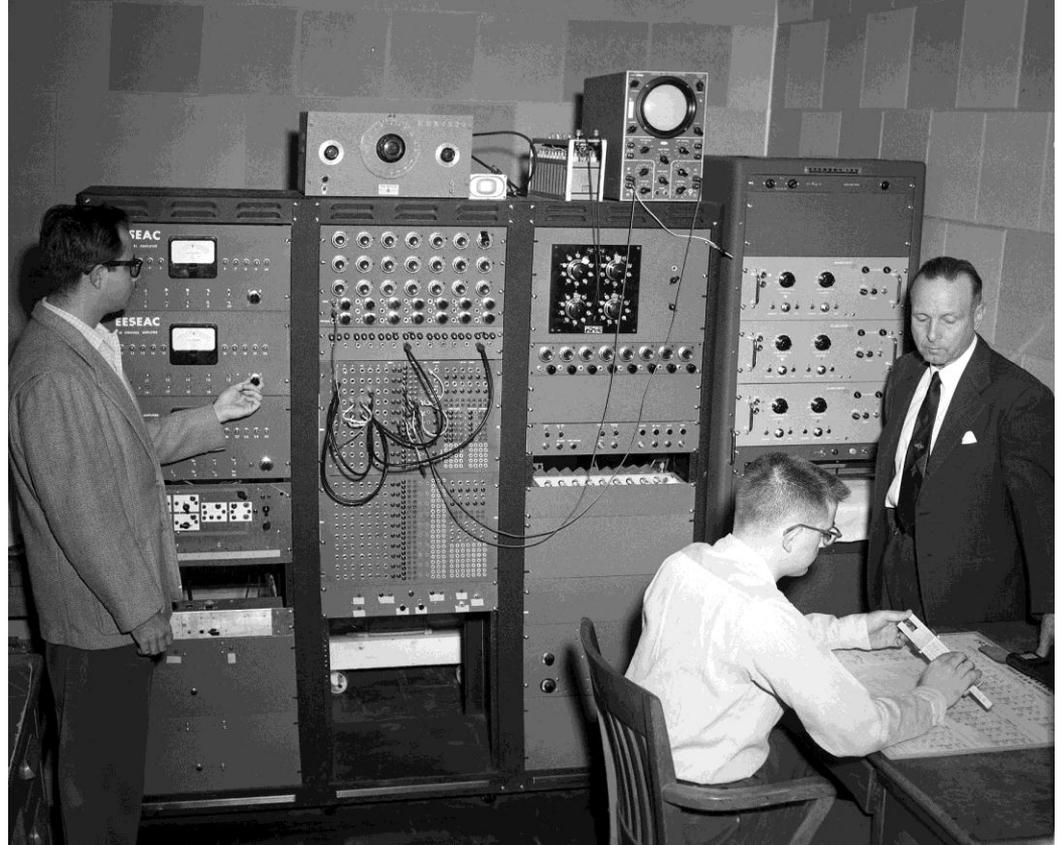
Shared machines (or worse, personal machines)

No failover if a machine dies

Everyone works just a little bit different

No centralized data storage

Support challenges



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Performance Benefits MAPS/MARS

MAPS HPC:

Full EI studies, with post processing,
one year finishes within approximately
2 hours

Would take >70 hours on a single
desktop machine

MARS HPC:

One licensee went from 16 hours to 30
minutes

PSLF HPC:

Specialized contingency analysis went
from 4 hours to 7.5 minutes



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Performance Benefits

Don't decide how to trim
down your study system...
model it all!

Detailed modeling of
neighbor interaction

Hourly resolution

Details for every
component in your system



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Cloud-based HPC Solutions (HPCX)

Currently performing groundwork to ID most cost effective solutions

Not tying ourselves to a specific “cloud”

Custom GUI for job scheduling

Scheduler divides work to maximize performance

Output data storage on cloud

Fast data transfer

Potential post-processing on cloud

Working on analytics for viewing results



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Conclusions

The Power System is becoming increasingly complex

New planning tools will need to be developed to support complexity

Standards and interoperability are critical enablers

Available data will increase exponentially...how will it be leveraged?

Market rules will likely be modified and must be reflected in tool development

Power systems analysis is data intensive...applications need to allow easy data viewing and editing

Developing solutions to take advantage of advances in hardware are essential



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Questions, Comments?

