Smart Grid Data and Electric Power Load Forecasting

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Impact Statement: RTI will position itself as a specialized player in the energy load forecasting and smart grid analytics market. We will be able to help utility companies to generate success stories by producing "quick wins" leveraging ongoing projects or generating new results based on load forecasting.

1. Introduction *or* Background

Accurate models for **electric power load forecasting** are essential to the operation and planning of a utility company. Load forecasting helps an electric utility to make important decisions including purchasing and generating electric power, load switching, and infrastructure development. RTI has developed methodologies using agent based model simulations and synthetic populations that could help develop a **new electric forecasting paradigm**. In this new paradigm, the forecast of future electricity consumption quantities and geographical locations could be analyzed in concurrent rather than separate models. The "how much", "when" and "where" could be simulated and answered at once in one combined simulation.

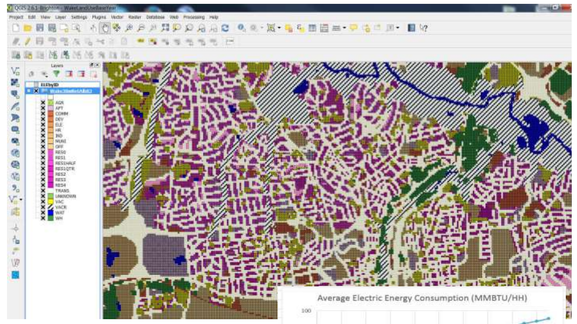
2. Purpose

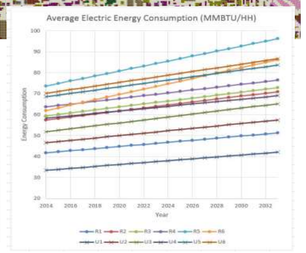
The purpose of this cross-institute effort is the development of an integrated platform to perform **electric power load forecasting**, using large energy datasets, weather data and energy price data. Traditional load forecasting methodologies will be extended by using land-use based simulation techniques with agent based models, micro-simulation and RTI's synthetic population.

3. Methods

- Energy data management system
- Weather data management system
- Energy pricing data management system
- Small area landscape design
- Consumer class load projection rules
- Global forecast and spatial consumer forecast rules
- Synthetic Population
- Model prototype

4. Findings





frequency	blockgrp	st_county_tract	urban	nonurban
31	370010201001	370010201	1360	0
37	370010201002	370010201	1210	0
18	370010201003	370010201	1	0

region	st_county_tract	hh_size	count
370010201011	370010201	1	107
370010201011	370010201	2	85
370010201011	370010201	3	26
370010201011	370010201	4	3
370010201011	370010201	8	5
370010201011	370010201	9	24
370010201021	370010201	1	235
370010201021	370010201	2	179
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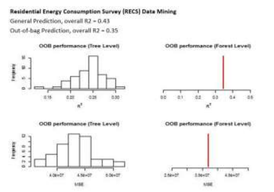

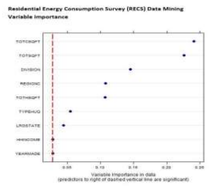

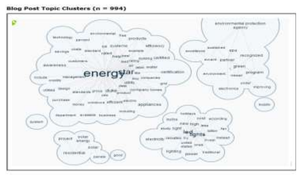

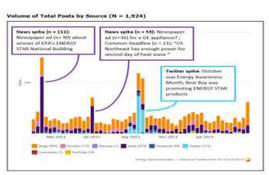

5. Summary

Data Acquisition, Simulation, Analyses, Design

Completed tasks include data acquisitions, the establishment of a data management system, and preliminary data mining and data analyses, including data trends and data forecasting. A small area grid was defined for Wake County as a 55 km (180,000 ft) x 42 km (139,000 ft) rectangle with 0.25 km square cells. A simulation using "Forecasting Populations (FPOP)" was done to generate counts of households by block groups based on number of household members and rural vs urban designation for the state of North Carolina, for 20 years. Software specifications were developed for "the Agent Based Electric Power Load Forecasting" platform (ABELOAD). A set of rules were defined to perform preliminary searches in social media related to energy consumption using the Crimson Hexagon tool for social media monitoring and analysis.

6. Potential for Impact

Business Potential

The business objective of this initiative is to position RTI as a specialized player in the smart grid analytics market. RTI could leverage our solid background in analytics, information management, modeling techniques and data management with our understanding of energy related problems and the impacts of global climate change and renewable energy alternatives in energy consumption and generation.

Advances in Energy Forecasting

RTI is well positioned to start the development of an integrated platform to perform **electric power load forecasting**, using large energy datasets, weather data and energy price data. Traditional load forecasting methodologies will be extended by using land-use based simulation techniques with agent based models, micro-simulation and RTI's synthetic population. RTI can lead the load forecasting field make progress in two specific directions: improved research in statistics, artificial intelligence and analytics, and better understanding of the load dynamics and its statistical properties to implement appropriate models.

Demand-side management

RTI can lead the development of a demand-side management (DSM) system that simulates a **smart micro-grid** in a modern city with smart homes and appliances. The simulation will include real-time analytics for current overall consumption and generation of electric energy. The simulation will also use energy consumption forecasting. The DSM system will encourage consumers to modify their level and pattern of electricity usage. Scenarios can be designed to create financial incentives to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as nighttime and weekends.

Support to Energy Industry

In addition to providing support on analytic projects in their pipeline that limited resources prevent them from addressing, RTI may be able to help them achieve "quick wins" through small new or existing projects.

- Enhance existing Transformer Load Management Systems by adding, for example, micro-simulation via agent based models, and by the use of geographically located synthetic households from RTI's synthesized human population database.
- Enhance its position as a leading organization working in renewable energy systems. Load forecasting models can also be used to study renewable energy feeder penetration. Utilities are mandated to achieve a certain threshold for distributed generation (DG) that can be interconnected to a grid on each individual distribution feeder. However, there are reliability and quality implications of the electrical service provided to customers when adding renewable energy sources to the grid.
- Energy theft and diversion continues to increase in both volume and complexity. Electricity theft and revenues lost from illegal connections, unbilled consumption, and non-payment are difficult to quantify. Utility theft poses a safety issue to the community, and causes higher rates for customers and lost revenue for the company. RTI can offer services to classify utility theft/diversion through analytics and utility based reports.

7. Limitations

- Limited by data quality, especially fine-scale migration and urban development data.
- FPOP has not been rigorously calibrated or used to reproduce observed demographic or migration patterns.

More Information

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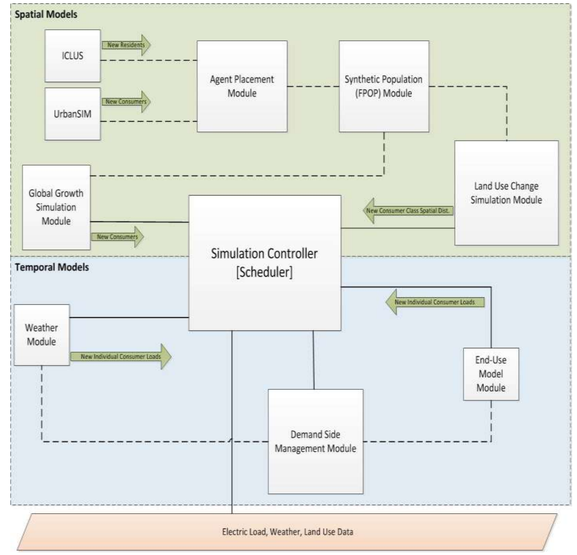
8. Next Steps

Agent-Based Electric Power Load Forecasting (ABELOAD) system.

The purpose of ABELOAD is to forecast the future electricity consumption quantities and geographical locations. ABELOAD uses steps that traditionally have been used in electric load forecasting to predict where future consumers will be, by class, based on land-use patterns, to forecast how much electricity consumers will use and when by class, and finally to combine the two forecasts to obtain a forecast of the where, what and when of future electric load. ABELOAD improves the traditional models by adding micro-simulation techniques to compute individual electric energy consumption.



repast · Java · mongoDB · MySQL · OpenLayers™ · python · R · Quantum GIS

9. References

[1] Willis, Lee. Spatial Electric Forecasting. Second Edition, 2002. ISBN: 0-8247-0840-7. Marcel Dekker, Inc.

[2] Wheaton, W.D. et al. (2009). Synthesized Population Databases: A US Geospatial Database for Agent-Based Models. RTI Press publication No. MR-0010-0905. Research Triangle Park, NC: RTI International.

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