ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

IJIRSET

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

Appraisal of Smart Grid Modeling and Simulation Tools

Mr. Rajasekar.E[1], Mr. Satheeshkumar.G.S[2], Mrs. Lizzy Nesa Bagyam.M[3]

PG Scholar, Power Electronics and Drives, Erode Sengunthar Engineering College. Thudupathi, Erode, India [1]

Assistant Professor, Department of EEE, Erode Sengunthar Engineering College. Thudupathi, Erode, India [2]

Assistant Professor, Department of EIE, Kongu Engineering College, Perundurai, India [3]

Abstract—The rising Smart grid behind today's electricity supply introduces many challenges. One characteristic is the organization of a range of software that drive these new systems at different domains (generation, transmission, distribution and consumption) and nodes of the Smart grid network. Managing such concerted, distributed, evolving and heterogeneous scheme of Systems requires a systematic move towards to support more standardized processes and commodities to accomplish the Smart grid hallucination. This paper presents analysis of smart grid modeling and simulation tools. The smart grid is a recent trend to minimize the losses and maximize the customers. Now a day's Smart grid is controlled, protected and run by various types of simulation software's .So this papers is analysis software's having advantages, disadvantages, performance calculation's and cost wise.

Keywords—Smart Grid, simulation tools.Generation, transmission, distribution and consumption, smart meter

I. INTRODUCTION

This work introduces current research in the field of software management for Smart grid applications. It is based on literature reviews and initial formulation of requirements for both the Smart grid and its software, and case studies that will be established with industrial partners. The rising Smart grid has introduced new-fangled challenges for the management of software across different electricity domains and organizational boundaries. The Smart grid is made up of loosely coupled system of systems. This means that many systems and software with various ownership and management boundaries are interconnected to provide end-to-end services among stakeholders, as well as among intelligent devices.

The smart grid software's are evolution and safety criteria in Smart grid applications. How have to the Smart grid software be intended to make the Smart grid safe and flexible to breakdown, as healthy as allowing well again management of its software evolution. Assuming that we have an operational Smart grid as a System of Systems, this means that the internal state of a distributed Smart grid "node" (its code, code activation pointers and data) may not be fully visible or controllable beginning the exterior. How be able to we then enforce a "secure" performance, similar to avoiding blackouts. So as to is, how be able to ascertain that the local nodes (with all their collaborative and decision-making incompleteness, Defects, version skews, etc.) Will manage to offer a concerted and safe state at most times. This paper additional discusses a number of challenges by means of the management of the Smart grid.

II.UNLOCK CHALLENGES BY MEANS OF THE ORGANIZATION OF SOFTWARE IN SMARTGRID.

There are a lot of open challenges approximately software organization in Smart grid and which require a practical and sensible investigate approach

i) The Smart grid is a development of the conventional electricity grid. In other words, the usual electricity supply will be efficient through re-engineering, version, alteration and updates. ii)The Smart grid is a mesh of heterogeneous systems and networks with varied software organization at the dissimilar domains.iii)The Smart grid introduces a dispersed move towards to electricity generation and supply in

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

difference to a more centralized approach in the existing grid. The inoculation of "green" sources (wind, solar, etc.) of power to the grid, together as of mass generation centers and households, is a main characteristic in today's Smart grid.iv) The Smart grid characteristic various software, stakeholders, owners, organization limits, legislative boundaries and regulators. V) The Smart grid marketplace will establish a new self-motivated in provisos of business, selling and giving out of electricity.vi) Cyber security is significant to the Smart grid. The Smart grid is envisioned to come with high robustness and safety.

III.COMPARISON OF LATEST SIMULATION SOFTWARES

A high level of complexity is obvious in managing the variety of software, owners, organization boundaries, governmental boundaries and regulators involved in the smart grid. Today, consensus favors Smart grid initiatives at strategic levels that can accommodate the coexistence of and evolvement through several generations of IT standards and technologies (models, software and devices).

i)Potential for change in the system(s) from any direction (that is, from stakeholders or ingredient system as healthy as from evolving business requirements).

ii)Less inevitability concerning stakeholders needs, knowledge advances and constituent performance that is characteristic in a surroundings with no central control.

iii) Failures with causes or collision further than the character system boundary.

iv) Constrain in terms of new development and evolution because of existing collection of design choices.

i) WITH POLYSUN FOR SMARTGRID

Relationship among battery storage and thermal storage in the early stages of preparation, the customer looks for an answer that combines maximal solar energy storage with minimal power consumption on or after the grid. In a primary stage, Polysun helps finding the appropriate battery storage and size it sufficiently. In a moment point, Polysun will evaluate the option of thermal energy storage, which is based on a warm up pump supplying household hot water. The self-consumption rate of the PV fitting can be greater than before by feeding the PV power surplus to the heat pump. Polysun calculates the resultant enlarge of the PV own utilization rate. In addition, Polysun enables the consumer to work out and get better the annual coefficient of presentation of the heat pump and at the same time reduce the power consumption from the grid.

MECHANISM OF PHOTOVOLTAIC SYSTEMS ON AN EAST-WEST SLANTING ROOFS

Captivating into account the grid constancy, it is an advantage if photovoltaic installations are increasingly installed on east-west roofs. The photovoltaic systems with south compass reading are causing a problem for the transmission grid with their manufacture peak at midday. On one hand, a somewhat lower energy manufacture is usual for the same component area on east-west roofs. But on the previous furnish there is a larger usable roof area on east-west roofs and consequently higher yields can be obtained. To evaluate the yield dissimilarity Polysun offers the necessary degree of detail in its simulation.

For the valuation of different photovoltaic systems it is important, that not only the orientation of the module fields is taken into account, but also the assortment of the inverter. A low dimensioned inverter has the feature to limit the maximal power. As well as the east-west compass reading, this has the effect of a better dispersed energy production over the day at the cost of a slightly reduced energy production.

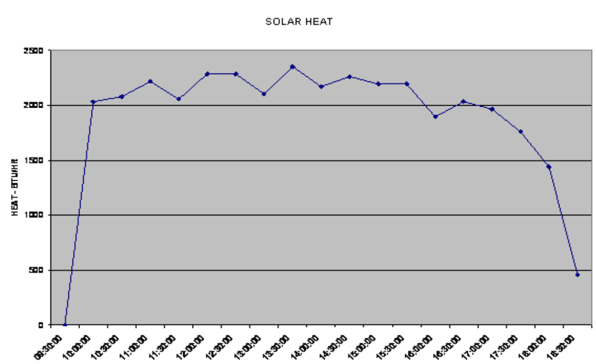

Fig.1 Polysun software-Solar output

ii) SMART GRID SIMULATION WITH GRID LAB-DSOFTWARE

Grid LAB-D is an innovative power system simulation tool that provides expensive in sequence to users who

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

intend and work electric power transmission and distribution systems and to utilities that aspiration to take benefit of the most recent smart grid technology. It incorporates superior modeling techniques with high-performance algorithms to bring the newest in end-use load modeling tools incorporated with three-phase disturbed power gush, and trade market systems. In the past, the inability to efficiently model and assess smart grid technologies has been a fence to implementation.

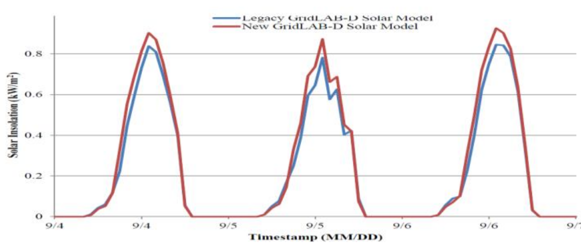

Fig.2 Grid LAB-D -Solar Model

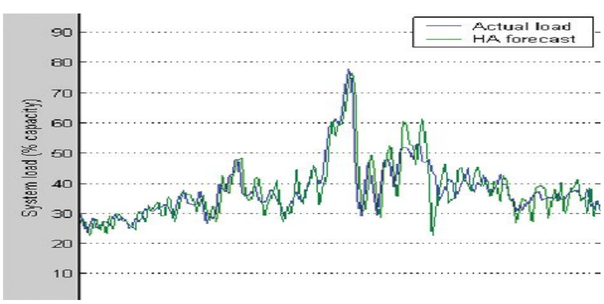

Fig.3 Grid LAB-Power flow and controls

Some types of electrical simulations may be complete with Grid LAB-D, but what sets it separately is its ability to simulate insists association. The customer may recognize the simulation occasion parameters. The smallest time step value is one second and the main is one hour. Simulations in excess of a time border of several natural lives can also be total using this software.

Several modules have been urbanized by the scientific neighbourhood and are available on Source Forge. The main Grid LAB-D modules are a weight control module (insist side management beneath growth), a dependability unit for evaluating SAIDI and SAIFI indexes next grid mechanization, a market module to simulate an electrical energy market, a unit for genuine occasion calculation, state changing loads in real time and a module counting models for profit, industrial and agricultural loads. A module to simulate a communications network was recently added. The software is being developed by the neighbourhood; consequently, confident functions are not easily reached to everyone, are lacking documentation or are not final.

The software is also used for load flow calculations on the distribution networks. Grid LAB-D was used to evaluate energy conservation gained from voltage control (CVR) on the distribution network. Twenty-four types of distribution circuits with loads were modelled with Grid LAB-D, in order to model this conservation. These models are available with the software.

As previously mentioned, this software was developed for large scale simulations. We can therefore simulate grids with tens of thousands of homes, each with its respective residential load, as well as large size sharing networks. Grid LAB-D also makes it likely to replicate these grids at the same time on different computers.At its core, Grid LAB-D has an advanced algorithm to simultaneously determine the state of millions of independent devices, each described by models and equations relevant to the particular domain. Grid LAB-D does not require the use of reduced-order models to describe the aggregate behaviours of the system (but may when appropriate). Rather, it relies on advanced physical models to describe the interdependencies of each of the devices. This helps to avert the danger of erroneous or misapplied assumptions. The advantages of this algorithm over traditional finite difference-based simulators are that it:
1) handles unusual situations much more accurately,
2) Handles widely disparate time scales, ranging from Sub-seconds too many years; and 3) is very easy to integrate with new models and third-party systems.

iii)OPENDSSSIMULATION SOFTWARE
The Open DSS is a comprehensive electrical power system simulation tool primarily for electric utility authority sharing systems. It ropes almost all incidence domain (sinusoidal steady state) analyses commonly performed on electric utility power distribution systems. In addition, it supports many new types of analyses that are designed to meet future needs related to smart grid, grid modernization, and renewable energy investigates. The Open DSS tool has been support of various research and consulting projects requiring distribution scheme psychoanalysis. A lot of the features found in the agenda were at first intended to support the analysis of distributed generation

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

interconnected to utility distribution systems and that continues to be an ordinary use. Additional features support psychotherapy of such equipment as energy efficiency in power delivery and vocal in progress flow. The OpenDSS is planned to be for an indefinite period expandable so that it can be easily modified to meet future needs.

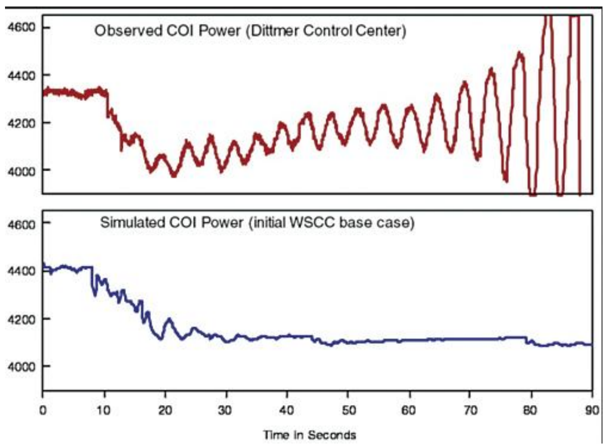

Fig.4 Open DSS-Grid Output Control.

Calculation of losses in a wind farm collection system: Losses in a wind farm collection system vary according to the power delivered by wind turbines, which fluctuates over time. This calculation can be done traditionally, taking into account average wind turbine power output. In exchange, with OpenDSS, and using the power delivered by each wind turbine each hour of the year, the calculation of total losses for all hours is done in a few code lines only, unlike traditional tools that require heavier programming, often consisting of data exchange interfaces that perform poorly in terms of execution time.

Calculation of the effect of a cloud passing over a solar power plant: When clouds pass in an area with photovoltaic panels, electricity generation will be down for a few moments (from a few seconds to a few minutes) and then resume according to a slope of just a few seconds. If these generation variation data are known, OpenDSS can easily help to determine voltage drop on the bus to which the solar generation is connected. We can therefore determine whether or not there will be timed operation of the transformers with tap changers or capacitor banks to regulate this voltage variation.

Impact of the arrival of electric cars on the electrical distribution network: The analysis capacities of OpenDSS make it possible to evaluate the impact of connecting electric vehicles to the power grids. EPRI used OpenDSS to analyze the impact on the Hydro Quebec grid.

Short circuit analysis using the Monte Carlo loom: OpenDSS makes it possible to carry out short circuit analysis using the Monte Carlo loom. The software without human intervention generates short circuits arbitrarily and finds the circuit solution under these conditions.

Reactive power and voltage control (Volt Var Control):

In order to reduce consumed energy and losses, electric power companies use capacitors and voltage regulators at the station or on the line to keep voltage within the recommended limits. This new approach to voltage regulation requires measuring voltage at the end of the grid. Numerous scenarios of load flow over the year can be studied with this dynamic tool.

iv) SMART GRID SIMULATION WITH APREMSOFTWARE

APREM was initially developed for Monte Carlo type reliability simulations. It can therefore simulate loops of thousands of iterations with topological (generator or working or non-working line, open or closed circuit breaker, etc.) or parametric (load or generation change) changes at each iteration. A topological validation tool is also included to prevent non-convergence of the electrical calculation in the event of an invalid topology consequential, for instance from the islanding of a PQ load subsequent the lost of the source, upstream. This means that APREM is specialized in simulations where parameters must be changed with each iteration. An optimized version for a fixed network topology is currently being developed.

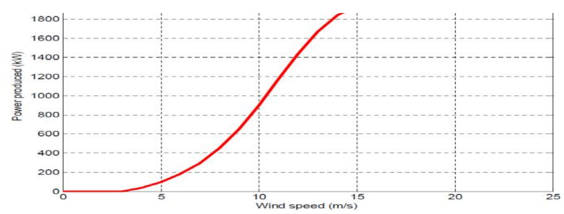

Fig.5 APREM-wind turbine power curve

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

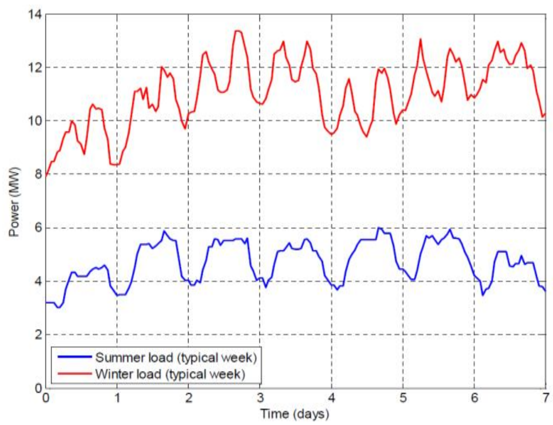

Fig.6 APREM-Load for a distribution line for a week in summer and winter

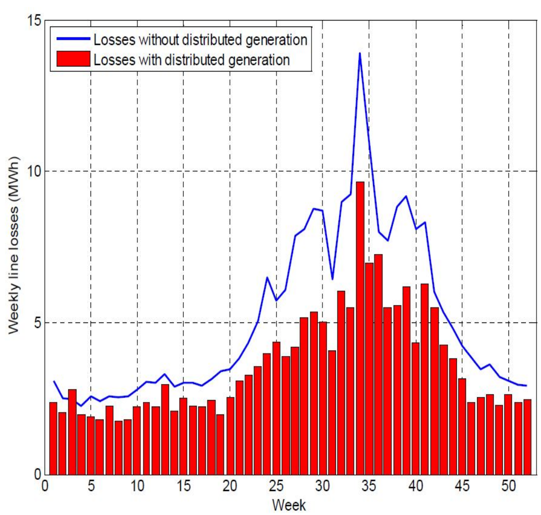

Fig.7 APREM-Weekly line losses with (red) and without (blue) distributed generation calculated with the line 4 model

v)MATLAB

Real power grid cannot be used for testing and validation. Either digital or 'analogy' simulators are needed for system simulation. Modelling interdependencies of infrastructure accompanying the Power grid, including sensors, control, communication network and Computational components using software simulation is challenge. Modelinga system device with finer granularity and at the same modelling a large system is challenges.

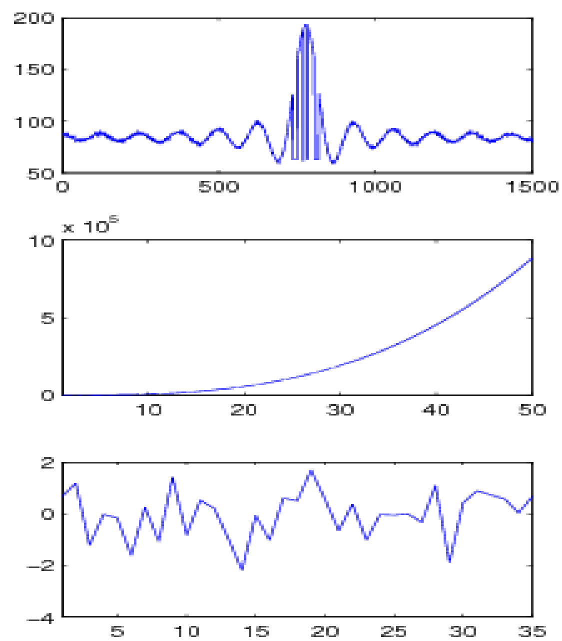

Fig.7 MATLAB-Smart Grid input and output voltage.

vi)SIMULATION WITH NEPLAN

a) Professional support for initial network data entry
b) Verification of network data, for example by calculating load flows and short-circuit currents with the help of NEPLAN.

It is difficult to know which are the most used in the world. Network simulation software developers do no publish the number of sold licences. Additionally, they propose different approaches and user interface functionalities, depending on their targeted clients. Utilities have different needs and objectives than consulting engineers or project developers, for instance. Different types of software are therefore available on the market. They all propose same kind of mathematical models (line and cable parameter calculation, load flow, short-circuit, stability, protection coordination, harmonics, etc.)but the user interface can be quite different.

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

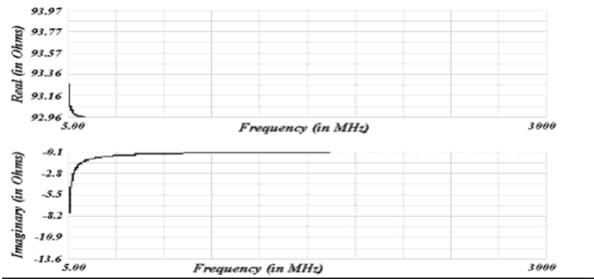

Fig.9 NEPLAN -Frequency calculation at peak load

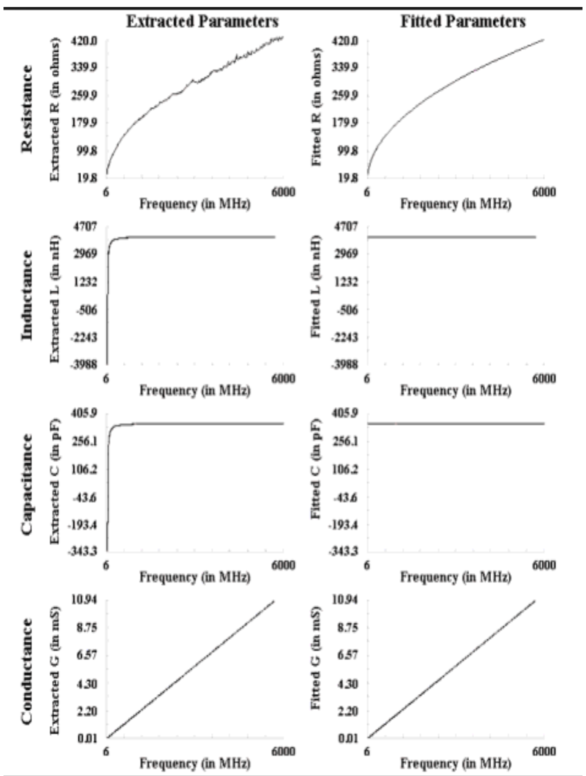

Fig.8 NEPLAN -Frequency calculation

vi)SIMULATION WITH SCADA SOFTWARE

FUTURE OF SMART GRID SCADA SYSTEMS

The primary drivers behind the smart grid are the improved reliability, efficiency, and sustainability of existing power systems. There is rapidly growing interest in smart grid investments that reach beyond meter reading and extend to automation technologies that actively monitor transmission. The smart grid enables automated optimization of the entire electrical T&D infrastructure between the power plant and the customer. This encompasses everything from revenue metering, system protection, and substation and distribution. From an implementation perspective, the smart grid is predicated on building a secure digital reporting and automation infrastructure on top of an underlying communications infrastructure. At substations and individual distribution feeders, it is the supervisory control and data acquisition (SCADA) devices that actually perform the wide range of data collection, sharing, and coordinated control actions that make the system more efficient and reliable. These SCADA systems are key elements of the emerging smart grid.

The primary drivers for smart grid implementations vary by region, but all are focused on aspects of improved reliability, efficiency, environmental sustainability, and deferment of large capital expenditures enabled by these gains. Vendors are working hard to address the needs of utilities, but the interviews Pike Research conducted for its recent report on smart grid SCADA systems suggest that their beliefs are falling behind the evolving needs and thinking of their electric utility customers, with utilities focused on basic outage reduction and reliability improvements, while vendors are reaching toward more advanced capabilities associated with distribution optimization. SCADA Platforms and Protocols the ultimate question about substation and feeder automation is what platforms, applications, and communications protocols are required to support the smart grid initiatives being planned and undertaken by utilities in the coming years. For the past decade, the major focus has been on pilot programs and test sites deploying various technologies to compare and contrast their effectiveness in real world situations. The global utility market is now on the threshold of emerging from this pilot program stage and stepping into large-scale implementations. Those vendors that catch the leading edge of this transition with solid solutions for the winning methodologies will

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

be in an enviable position, ready and able to help utilities deploy the next phase of smart grid installations. The results of the pilot programs are being analyzed and the R&D investment choices made today will have a big impact on which companies emerge as the new leaders in smart grid automation. The IEC 61850 protocol is gaining momentum worldwide, but there are still questions about its appropriateness for distribution substation automation projects. Citing technical issues that limit its use for the leading feeder automation applications, some countries with a high focus on distribution-level automation are less likely to adopt the new standard quickly. A growing community of users is advocating and deploying DNP3.0 with Generic Object Oriented Substation Events (GOOSE) as a more practical alternative. Early signs also suggest that the ongoing debate between centralized and distributed automation for technical loss control may be leaning toward a centralized approach, although a hybrid approach is expected to prevail for a few more years. As infrastructure needs continue to vary between developing and developed countries, the focus on transmission-level automation and distribution-level automation varies from place to place.

SCADA SYSTEMS MARKET OUTLOOK AND FORECAST

As a whole, the global smart grid SCADA systems market for transmission and distribution substation and associated distribution feeder automation applications is healthy and growing, according to Pike, though there is significant variability in growth opportunities by application, by region, and device types. Overall global revenue is expected to maintain a 7% compound annual growth rate (CAGR) from 2012 to 2020, with distribution network applications exhibiting a higher growth rate opportunity over transmission substation equipment.

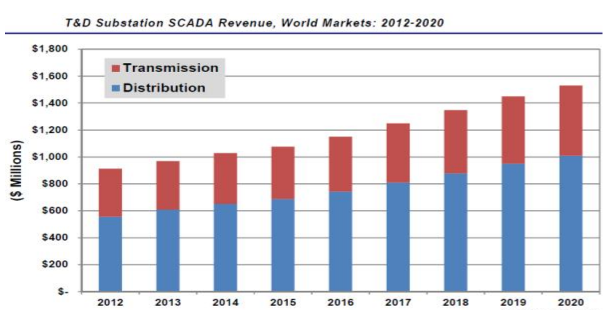

Fig.10 SCADA –T&D Substation

vii) SMART GRID SIMULATION WITH AEPS SYSTEMPLANNINGSOFTWARE

The Alternative Energy Product Suite (AEPS) System Planning tool is a software application for the design, modeling, and simulation of electrical power systems with an emphasis on renewable energy sources (solar, wind, and hydro). The application calculates power generation, consumption, and storage for modeled systems. Power and cost data can be analyzed to optimize the modeled system based on user objectives and priorities.

The Modelling capability supports graphically constructing an electrical power/alternative energy system consisting of site, generation, storage, and load components, including electrical conversion and control hardware. Models can support on-grid and off-grid systems. The Simulation capability generates, consumes, and uses grid and stored power based on the behavioural characteristics and usage profiles (e.g., wind speed, isolation, power generated, power consumed, and storage capacity) captured in the system model components. The Data Analysis capability provides tables and graphs showing energy production versus energy consumption, energy storage behaviours, grid power usage, energy consumption by load device, etc., for comparative analysis, system sizing and balancing, and system design optimization. The Cost Analysis capability captures material and installation costs and rebates, and supports a variety of utility rate plans. Based on these inputs, cost results (including break-even cost and date) are calculated. Cost tradeoffs can be performed based on user/customer objectives and priorities.

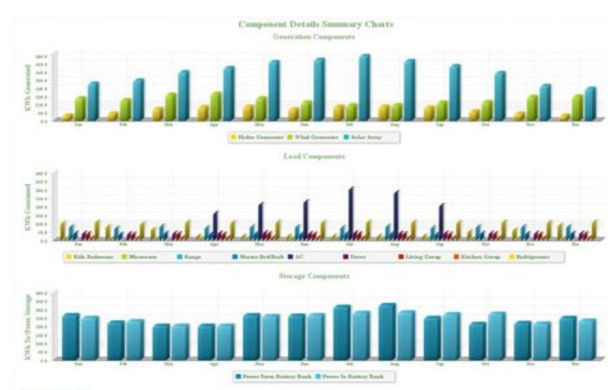

Fig.11 AEPS-Grid Output Voltage

The electricity market needs pricing transparency. The assembled a database of electricity pricing information from more than 3500 electricity providers throughout. There are putting the data in the hands of electricity consumers and companies that assist them, to help everyone make more informed choices about when to use, store, and sell electricity.

IV. DISCUSSION

Voltage control or CVR (Conservation Voltage Reduction). This application aims at optimizing voltage and reactive power compensation to save energy and line losses.

This type of study requires specific capacities on the part of the power grid analysis software applications. First, the software must be able to model the different types of load. The ZIP model is the one most commonly used. This model makes it possible to define the different load behaviours when dealing with a voltage variation.

This model has a few limits, in particular when the time comes to model thermostat-controlled loads (water heater, heating, air conditioning). In the case of these loads, when the voltage drops, the current drops. They therefore behave like constant-impedance loads. However, these devices must operate longer in order to be able to provide the total required amount of power, which risks reducing the diversity of the load and lead to peak load increase. Impact analysis therefore requires a tool for time series simulations. Since Grid LAB-D is the only one of the various software applications to be able to implicitly model this phenomenon, it is of great importance for this type of study. PNNL used this software to evaluate the CVR potential.

In order to be able to compare the three software applications, only the ZIP model will be used. With these various software applications the impact of the conservation voltage control on the annual energy conservation of a distribution line can be simulated. Given the complexity and length of this calculation, we notice an even wider gap between APREM's calculation time performance and that of the other software. Voltage regulation can be easily programmed with the three software applications. With the Grid LAB-D, there is even already a device that does this operation directly. Moreover, if we had wanted to integrate the thermostat-controlled circuits, only the Grid LAB-D would have this function already built-in.

This study has not integrated var control (capacitor control). However, since capacitor modelling is already built into the three software applications, the integration of this control could have been done by the three applications. The problem and control would have become more complex, and the calculation time longer.

V.CONCLUSION AND FUTUREWORK

This testimony presents various up to date power grid simulation tools for conducting occasion sequence studies. The widespread characteristic in the middle of these software applications is that they are unlock source code and obtainable for free online or on application. This equipment creates ring simulations comparatively trouble free when compared to the living equipment, including, in the heart of one time belongings. Every of these various software applications offer dissimilar potential. Grid LAB -D is additional particular for studies that comprise modeling suburban loads, APREM is dedicated in reliability studies, and OpenDSS is purposeful in annual time progression studies.

The conclusions of this statement are based on two belongings with the intention of be able to be simulated with the various software applications. Every application performed in a different way and their use has been categorized. Although the applications were show to be competent of management together studies, their computation time and effortlessness of use vary significantly. In support of the type of studies obtainable, OpenDSS had the best presentation in terms of computation time. Nevertheless, for ease of use, APREM stands absent beginning the respite. In the case of Grid LAB-D, the kind of study obtainable did not do fairness to this software's potential. In fact, if suburban load modeling had been obligatory, it is the only software that would have solved the difficulty in a sensible time border for the user, with no having to program new functions oneself. Since these software applications are still life form urbanized, it will be attractive in the prospect to go after their own developments and appraise their collision on the business-related software market.

REFERENCES

[1] F. Milano, L. Vanfretti, "State of the Art and Future of OSS for Power Systems," 2009 IEEE PES General Meeting, Calgary, July 2009.

IJIRSET

ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)

On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

[2] R.C. Dugan, R. F. Arritt, T. E. McDermott, S. M. Brahma, K. Schneider, "Distribution System Analysis to Support the Smart Grid," 2010 IEEE PES General Meeting, Minneapolis, July 2010.

[3] C. Kwok, F. De Léon, A. Morched, CYME International "Survey of Studies and Anlysis Tools Used for Assessment of Distributed Generation Integration in Canadian Distribution Systems," CanmetENERGY report number 2006-070, May 2006.

[4] R.C. Dugan, "Open Distribution Simulations System Workshop: Using Open DSS for smart distribution simulations," EPRI PQ Smart Distribution 2010 Conference and Exhibition, Québec, June 14-17, 2010.

[5] A. Maitra, K.S. Kook, J. Taylor, A. Giumento, "Grid Impacts of Plug-in Electric Vehicles on Hydro Quebec's Distribution System," 2010 IEEE PES Transmission and Distribution Conference and Exposition, New Orleans, April 2010.

[6] R.T. Guttromson, D.P. Chassin, S.E. Widergren, "Residential Energy Resource Models for Distribution Feeder Simulation," Power Engineering Society General Meeting, IEEE, 2003.

[7] D.J. Hammerstrom, R. Ambrosio, T.A. Carlon, J.G. DeSteese, G.R. Horst, R. Kajfasz, L.L. Kiesling, P. Michie, R.G. Pratt, M. Yao, J. Brous, D.P. Chassin, R.T. Guttromson, O.M. Jarvegren, S. Katipamula, N.T. Le, T.V. Oliver, and S.E. Thompson. "Pacific Northwest GridWise™ Testbed Demonstration Projects; Part I. Olympic Peninsula Project". PNNL-17167, Pacific Northwest National Laboratory, Richland, WA, October 2007.

[8] J. J. Allemong R J. Bennon P. W. Selent, "Multiphase Power Flow Solutions Using EMTP andNewtons Method," IEEE Transactions on Power Systems, Vol. 8, No. 4, November 1993, pp. 1455-1462.

[9] Natural Resources Canada, Retscreen International, "Clean Energy Project Analysis," 3rd Edition, January 2006, p. Eole 16.

[10] W.H. Kersting, "Distribution System Modeling and analysis," 2nd edition, CRC Press, p.57.

[11] A. George, C. Cai, D. Aliprantis, and L. Tesfatsion, "Effects of Price-Responsive Residential Demand on Retail and Wholesale Power Market Operations", July 2012.

[12] J. Price and H. Sanders, "Concepts for a Wholesale Grid State Indicator to Enable Price Responsive Demand", 2013.

[13] V. Hamidi, K. S. Smith, and R. C. Wilson, "Smart grid technology review within the transmission and distribution sector," in Proc. Innov. Smart Grid Technol. Conf. Eur. (ISGT Eur.), 2010.

[14] T. Basso and R. DeBlasio, "Advancing smart grid interoperability and implementing NIST's interoperability roadmap," in Proc. NREL/CP-550-47000, Grid-Interop Conf. 2009, Nov. 2009.

[15] D. H. O. McQueen, P. R. Hyland, and S. J. Watson, "Monte Carlosimulation of residential electricity demand for forecasting maximumdemand on distribution networks," IEEE Trans. Power Syst., vol. 19,no. 3, pp. 1685–1689, Aug. 2004.

[16] A. Capasso,W. Grattieri, R. Lamedica, and A. Prudenzi, "A bottom-up approach to residential load modeling," IEEE Trans. Power Syst., vol.9, no. 2, pp. 957–964, May 1994.

[17] G. Xiong, C. Chen, and S. Kishore, "Smart (In-home) power schedulingfor demand response on the smart grid," Proc. IEEE PES Innov.Smart Grid Technol. (ISGT), 2011.

[18] S. Shao, M. Pipattanasomporn, and S. Rahman, "An approach for demandresponse to alleviate power system stress conditions," in Proc.IEEE Power Energy Soc. Gen. Meet., Jul. 2011, pp. 24–29.

[19] S. Kishore and L. V. Snyder, "Control mechanisms for residential electricitydemand in smart grids," in Proc. IEEE Int. Conf. Smart GridCommun., Oct. 2010, pp. 443–448.

[20] A. J. Conejo, J. M. Morales, and L. Baringo, "Real-time demand responsemodel," IEEE Trans. Smart Grid, vol. 1, no. 3, pp. 236–242,Dec. 2010.

[21] A.Mohsenian-Rad and A. Leon-Garcia, "Optimal residential load controlwith price prediction in real-time electricity pricing environments,"IEEE Trans. Smart Grid, vol. 1, no. 3, pp. 120–133, Sep. 2010.

[22] A. Mohsenian-Rad, V. W. S. Wong, J. Jatskevich, R. Schober, and A.Leon-Garcia, "Autonomous demand-side management based on gametheoreticenergy consumption scheduling for the future smart grid,"IEEE Trans. Smart Grid, vol. 1, no. 3, pp. 320–331, Dec. 2010.