International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

A Survey on VLSI Based Energy Conservation Techniques

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Abstract: ***Comprehensive design automation capability for energy distribution networks is further developed to much more flexible yet effective system. The new system capabilities include power load distribution and transfers, equipment upgrading, geospatial-aware network optimization, outage identification, contingency planning and loss analysis. These features are enabled by advanced simulation, analysis and optimization engines that are adapted from those available in the traditional VLSI design automation area. Various kinds of energy distribution systems are being compared in this paper and it include details of plug-in hybrid electric vehicles, power system modeling, artificial parameter homotopy methods, factorization in network sensitivity computations and power distribution planning. The state electricity profile of U.S is analyzed for the betterment and progression of our country.***

Keywords: Electronic Design Automation; Energy Distribution Networks; Plug in Hybrid Electric Vehicles; Artificial parameter Homotopic Methods

1. Introduction

Ever since its introduction in the late 1800s, electricity has been an integral part of human life. While the reliability of electric energy supply varies significantly across the world and consumption per person varies across about 4 orders of magnitude, for many it is completely in the background. In fact it is depended on for so many aspects of lives like lighting, refrigeration, entertainment, and transportation that are largely take it for granted. In much of the world, electric energy generation and delivery is so important that it is controlled by the government. In some areas, however, market de-regulation has been instituted leading to a more open market where many providers can compete to provide the needed services. This is the case in many states in the USA, including Texas where this research was performed.

De-regulation creates an open market for energy distribution where competition is intense and profit margins are relatively small. In fact, some of the local electric energy cooperatives in the Texas area are non profits and return any excess profits to their members. The result of this situation is that US industrial R&D investment in the area of energy distribution is quite small compared to -say- the Electronics industry. While there has been no Moore1 in the energy distribution area, recent developments are definitely changing the area. These include:

- Development of new green sources of energy such as wind, tide, and large-scale solar that are not constant and therefore significantly change the patterns of energy flow in the network.
- Large scale deployment of small distributed sources of energy via small-scale solar installations which act to amplify local variability in loading over time.
- The introduction of new types of loads, specifically electric vehicles which are expected to create significant disruption to the grid due to large demand and temporal characteristics

These changes are expected to make the energy distribution market significantly more dynamic and can be viewed as an opportunity to do constructive research in this area. The paper reviews an excellent opportunity for the application of the large body of work in Electronic Design Automation (EDA) to the emerging and important area of energy distribution network design, analysis, and optimization [1], [2].

EDA is a category of software tools for designing electronic systems such as printed circuit boards and integrated circuits. The tools work together in a design flow that chip designers use to design and analyze entire semiconductor chips. Before EDA, integrated circuits were designed by hand, and manually laid out. Some advanced shops used geometric software to generate the tapes for the Gerber photo plotter, but even those copied digital recordings of mechanically drawn components. The process was fundamentally graphic, with the translation from electronics to graphics done manually.

In 1981, U S Department of defense began funding of VHDL as a hardware description language. In 1986, Verilog, other popular high level design language, was first introduced as a hardware description language by Gateway Design Automation. Simulators quickly followed these introductions, permitting direct simulation of chip designs: executable specifications. In a few more years, back-ends were developed to perform logic synthesis. Current digital flows are extremely modular. The front ends produce standardized design descriptions that compile into invocations of cells, without regard to the cell technology. Cells implement logic or other electronic functions using a particular integrated circuit technology. Fabricators generally provide libraries of components for their production processes, with simulation models that fit standard simulation tools.

Analog EDA tools are far less modular, since many more functions are required, they interact more strongly, and the components are less ideal. EDA for electronics has rapidly increased in importance with the continuous scaling of semiconductor technology. Some users are foundry operators, who operate the semiconductor fabrication facilities, and design-service companies who use EDA software to evaluate an incoming design for manufacturing readiness. EDA tools are also used for programming design functionality into FPGAs.

An electric power distribution system is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage ranging between 2 kV and 35 kV with the use of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near the customer premises. Distribution transformers again lower the voltage to the utilization voltage of household appliances and typically feed several customers through secondary distribution lines at this voltage. Commercial and residential customers are connected to the secondary distribution lines through service drops. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub transmission level.

The modern distribution system begins as the primary circuit leaves the substation and ends as the secondary service enters the customer's meter socket by way of a service drop. Distribution circuits serve many customers. The voltage used is appropriate for the shorter distance and varies from 2,300 to about 35,000 volts depending on utility standard practice, distance, and load to be served. The distribution circuits are fed from a transformer located in a substation, where the voltage is reduced from the high values used for power transmission. Conductors for distribution may be carried on overhead pole lines, or in densely populated areas, buried underground. Urban and suburban distribution is done with three-phase systems to serve residential, commercial, and industrial loads.

Distribution in rural areas may be only single-phase if it is not economical to install three-phase power for relatively few and small customers. Only large consumers are fed directly from distribution voltages; most utility customers are connected to a transformer, which reduces the distribution voltage to the relatively low voltage used by lighting and interior wiring systems. The transformer may be pole-mounted or set on the ground in a protective enclosure. In rural areas a pole-mount transformer may serve only one customer, but in more built-up areas multiple customers may be connected. In very dense city areas, a secondary network may be formed with many transformers feeding into a common bus at the utilization voltage. Each customer has a service drop connection and a meter for billing. A ground connection to local earth is normally provided for the customer's system as well as for the equipment owned by the utility.

2. Literature Survey

1974, Chen et al [3] developed Power system modeling**.** The main advantages for adopting this technique were due to the accelerated developments and ability to manage risk and the potential to reduce technology and commercial risk, and rapidly screen and rank options and tradeoffs, thereby accelerating deployment.

The electrification of many processes through technological advances resulted in the continuous development and evolution of the electric power system over the last one hundred plus years. As an example, in U. S. A. today, more than one third of energy consumption is in the form of electric energy. The modern day electric power system is responsible for generating, transmitting and delivering more than one third of the total consumed energy. With this progress, the complexity of the system has grown. To manage this complex system, monitoring, control and operation functions are computer assisted. The systems for computer control of electric power systems have evolved as computer and monitoring technology evolved. Throughout the years, these systems have been named “Control Centers”, “Energy Management Systems (EMS)”, “Independent System Operations”, etc. The names reflect the changing emphasis in the functions of these control centers. In this covers term Energy Management System

The EMS concept comprises hardware and software for the purpose of monitoring and controlling the power system. Typically, the function of monitoring is fully automated. Control functions, however, are either automated or manual. Energy Management Systems have evolved from the traditional dispatcher's office. The dispatcher had in his reach supervisory equipment. Based on his experience, he would monitor the supervisory equipment and will control the system appropriately. The control was manually executed upon communication between the dispatcher and local operator. As size and complexity of the system grew, this approach was not adequate. A number of incidents indicated that the security of the system, defined as the ability to operate in synchronism under possible random disturbances, cannot be guaranteed with this simple approach. Out of this need, a comprehensive and integrated approach to monitor and control a power system has emerged. An Energy Management System comprises four major components:

1) Supervisory Control and Data Acquisition (SCADA) System
2) Computers
3) User Interface
4) Applications Software.

An integral part of an EMS is the power system dispatchers that have the responsibility of operating the system. Many control functions require human input or authorization. This means that the system dispatcher must take many decisions in the course of operating the system. The issue of what control functions require human input/authorization and what are fully automated (closed loop control) is a moving target driven by technological advances. It is also dependent upon the management decisions.

Supervisory Control and Data Acquisition: - SCADA system stands for **S**upervisory Control and Data Acquisition system. As the name implies, it consists of two subsystems. The supervisory control subsystem consists of hardware which (a) display at a central location (energy management system EMS) the status of circuit breakers and voltage regulating devices (capacitors, generator voltage regulators, etc.); (b) allow remote tripping of breakers, changes of transformer tap, etc. In most cases, supervisory control is a manual function, i.e., the dispatcher at the control center will initiate a command to open/close a breaker. The data acquisition subsystem consists of: remote terminal equipment for interfacing with power system instrumentation and control devices; interfaces with communication channels; and master station equipment for interfacing with the system control center. The local equipment communicates with the energy management system via dedicated or non-dedicated communication channels. Communication media have evolved over the years, from telephone circuits to microwave to fiber optic links. Analog data is scanned periodically, typically every one second to a few seconds. Each scan is triggered by the EMS at the prescribed interval by using a request to all remote stations to send in data. Data is received at the energy management system in a random order.

Status data is also processed in the same way as analog data except that there are two ways of reporting status changes. The first way is to send in all status information from all remotes at the required intervals regardless of whether or not there has been a change. This approach requires a software routine at the EMS to check each new status with the old status to determine any changes. Considering the very large number of status points that is monitored in a power system, this approach represents a sizable computational burden. The second way is to send status data from the remote only when there has been an actual change of status. Normally the system operates in a quasi-steady state mode. If there are any status changes, only certain numbers of stations are involved. For this reason, the second method results in a better overall system response.

It is important to note that advances in hardware, software and communications have revolutionized the way the SCADA system operates. The technology is in a fast pace evolution. It is not uncommon today to have a SCADA system which comprises subsystems of old technology and subsystems of newer technologies. Independently of system configuration, SCADA system manufacturer and computer configuration, the end result of the SCADA system function is to collect a set of system data every sampling period. It consist of breaker status, disconnect switch status, transformer tap setting, real power (MW) flow measurements, reactive power (MVAr) flow measurements, voltage magnitude (kV) measurements and phase of voltage measurements.

At the energy management system, the data is processed with software which: (1) initiate the collection of data and place them in the data base, (2) error-checking, (3) conversion to engineering units, (4) limit-checking, and (5) generate a reliable system model which is interfaced with application programs. In summary, the Supervisory Control and Data Acquisition System generate a filtered set of data for each data collection cycle.

In 1980, Swamy et al [4] developed alternate approach to deriving sensitivity formulas for linear time invariant networks. For a general linear time-invariant network it is shown that the sum of the sensitivities, of any order, of a network function over different parameter sets is invariant. An expression is derived for calculating the sum of $(k+l)^{th}$ order sensitivities knowing the same for k^{th} order sensitivities. It is also shown that lower bounds for the quadratic sensitivity index may be obtained by using the first order sensitivity invariants.

In 1986, Bjomson et al [5] came out with an idea of electric power distribution for industrial plants.In 1993, Melvelle et al [6] worked on artificial parameter homotopy methods for the DC operating point problem. Efficient and robust computation of one or more of the operating points of a nonlinear circuit is a necessary first step in a circuit simulator. This paper discusses the application of so-called globally convergent probability-one homotopy methods to various systems of nonlinear equations that arise in circuit simulation. The so-called “coercivity conditions” required for such methods are established using concepts from circuit theory. The theoretical claims of global convergence for such methods are substantiated by experiments with a collection of examples that have proved difficult for commercial simulation packages that do not use homotopy methods. Moreover, by careful design of the homotopy equations, the performance of the homotopy methods can be made quite reasonable.

Robust computation of the direct current (dc) operating point(s) of a VLSI circuit is a theoretically and practically difficult problem. For certain circuits-primarily analog designs-engineers spend large amounts of time “fighting” a simulator to obtain an operating point of their circuit. In some cases, the difficulty of obtaining an operating point signals that something is wrong with the circuit, and indicates that a redesign is needed. However, in other cases, the difficulty is simply an artifact of the simulator’s algorithm used to find an operating point. In such cases, the designer’s time spent finding an operating point has contributed nothing to the design process.

In this method homotopy methods are discussed for the operating point problem. The homotopy approach involves forming a simplified version of the circuit whose operating point is needed, finding an operating point of this easier circuit, then ‘‘sweeping” some quantity to generate a trajectory of solutions. The terminus of the sweep is the operating point of the original circuit. The HAM distinguishes itself from various other analytical methods in four important aspects. First, it is a series expansion method that is not directly dependent on small or large physical parameters. Thus, it is applicable for not only weakly but also strongly nonlinear problems, going beyond some of the inherent limitations of the standard perturbation methods. Second, the HAM is a unified method for the Lyapunov artificial small parameter method, the delta expansion method, the Adomian decomposition method, and the homotopy perturbation method.

The greater generality of the method often allows for strong convergence of the solution over larger spacial and parameter domains. Third, the HAM gives excellent flexibility in the expression of the solution and how the solution is explicitly obtained. It provides great freedom to choose the basic functions of the desired solution and the corresponding auxiliary linear operator of the homotopy.

Finally, unlike the other analytic approximation techniques, the HAM provides a simple way to ensure the convergence of the solution series.

The homotopy analysis method is also able to combine with other techniques employed in nonlinear differential equations such as spectral methods and Pade approximants. It may further be combined with computational methods, such as the boundary element method to allow the linear method to solve nonlinear systems. Different from the numerical technique of homotopy continuation, the homotopy analysis method is an analytic approximation method as opposed to discrete computational method. Further, the HAM uses the homotopy parameter only on a theoretical level to demonstrate that a nonlinear system may be split into an infinite set of linear systems which are solved analytically, while the continuation methods require solving a discrete linear system as the homotopy parameter is varied to solve the nonlinear system.

Solving nonlinear problems is inherently difficult, and the stronger the nonlinearity, the more intractable solutions become. Analytic approximations often break down as nonlinearity becomes strong, and even perturbation approximations are valid only for problems with weak nonlinearity. This introduces a powerful new analytic method for nonlinear problems homotopy analysis that remains valid even with strong nonlinearity.

In 2000, Chen et al [7] made a study on fault analysis in power system and protection of circuits. The main advantages were its efficient energy usage. Protection improved circuit performance and makes it reliable. There observed a demerit and that was, fault is unintentional and undesirable. The study resulted in the performance depends on faultless circuits. Analysis must be done and circuits must be protected.

A fault in an electrical power system is the unintentional and undesirable creation of a conducting path (a short circuit) or a blockage of current (an open circuit). The short-circuit fault is typically the most common and is usually implied when most people use the term fault. We restrict our comments to the short-circuit fault. The causes of faults include lightning, wind damage, trees falling across lines, vehicles colliding with towers or poles, birds shorting out lines, aircraft colliding with lines, vandalism, small animals entering switchgear, and line breaks due to excessive ice loading. Power system faults may be categorized as one of four types: single Line-to-ground, line-to-line, double line-to-ground and balanced three-phase. The first three types constitute severe unbalanced operating conditions. It is important to determine the values of system voltages and currents during faulted conditions so that protective devices may be set to detect and minimize their harmful effects.

The time constants of the associated transients are such that sinusoidal steady-state methods may still be used. The method of symmetrical components is particularly suited to fault analysis. Computation of fault currents in power systems is best done by computer. The major steps are summarized below:

- Collect, read in, and store machine, transformer, and line data in per-unit on common bases.
- Formulate the sequence impedance matrices.
- Define the faulted bus and *Zf*. Specify type of fault to be analyzed.
- Compute the sequence voltages.
- Compute the sequence currents.
- Correct for wye-delta connections.
- Transform to phase currents and voltages.

Thus fault analysis is performed and corrections are made. As prevention is better than cure, the system must be protected so that the fault can be reduced to a great extend. Protective equipment-relays-is designed to respond to system abnormalities (faults) such as short circuits. When faults occur, the relays must signal the appropriate circuit breakers to trip and isolate the faulted equipment. The protection systems not only protect the faulty equipment from more serious damage, they also protect the power system from the consequences of having faults remain on the system for too long. In modern high-voltage systems, the potential for damage to the power system-rather than to the individual equipment- is often far more serious and power system security considerations dictate the design of the protective system.

In 2007, Hadley et al [8] introduced the concept of plug in hybrid vehicles. The main advantages are optimize engine and battery operations for efficient operation and were the best methods to improve gasoline mileage, by using a combination of a gasoline engine and batteries to provide vehicle power. It too had few disadvantages like Local distribution grids will see a change in their utilization pattern, and some lines or substations may become overloaded sooner than expected. The conclusions of the research were: These areas can be explored further for more energy utilization. The impact of alternative vehicle operation schemes, Transmission and distribution impacts from PHEV, *Options for utilities to modify customer behavior and *PHEV manufacturers could improve the vehicle.

In order to conserve energy a method was implemented in 2007. Plug-in hybrid vehicles (PHEVs) are being developed around the world; much work is going on to optimize engine and battery operations for efficient operation, both during discharge and when grid electricity is available for recharging. However, there has generally been the expectation that the grid will not be greatly affected by the use of the vehicles, because the recharging would only occur during off peak hours, or the number of vehicles will grow slowly enough that capacity planning will respond adequately. But this expectation does not incorporate that end users will have control of the time of recharging and the inclination for people will be to plug in when convenient for them, rather than when utilities would prefer.

PHEV penetration of the vehicle market will create a substantial change on the electric grid. By evaluating these issues early, DOE will be able to help utilities, manufacturers, and regulators to understand the issues involved and suggest ideas that will better optimize the combined system. Using ORNL staff that have expertise in transportation technologies, battery operation, and electric systems, new ideas and options can be explored that better prepare for a PHEV world. These areas can be explored further for more energy utilization:- The impact of alternative vehicle operation schemes (longer distance batteries, partial charging, employer-provided daytime charging, vehicle to grid generation).

- Expansion of the analysis to areas besides the VACAR region
- Transmission and distribution impacts from PHEV
- Options for utilities to modify customer behavior
- Options for utilities and PHEV manufacturers to improve the vehicle/grid system
- Options for utilities to take advantage of PHEV characteristics to improve grid reliability

In 2009, Mohammad Abdullah et al[9] presented highlights the importance of Electronic Design Automation tools and system level design methodology e.g., Model-Based Design (MBD) for the Cyber-Physical Energy Systems (CPES) to tackle the heterogeneous design complexity coming from multiple domains including power-flow dynamics, market conditions, weather, infrastructure, control, communication, consumer demand responses, etc. In addition to discussing the importance of EDA tools and its associated research challenges, this paper also showcases an exemplary EDA tool developed by the author and his group that may perform a cyber-physical co-simulation of a residential micro grid as well as potentially expedite the design of various control algorithms efficiently and interactively. Furthermore, this paper proposes a novel way of abstracting a CPES model by means of a functional abstraction level that is coded through a Functional Basis language. Finally, a discussion on how high level synthesis algorithms and EDA tools may be developed to generate high fidelity simulation models quickly and efficiently is presented.

The state electricity profile of U S in 2010 [10] was also analyzed. The State Electricity Profiles 2010 presents a summary of State statistics. This report was prepared by the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the United States Government. The views in this report therefore should not be construed as representing those of the U.S. Department of Energy or other Federal agencies. The objective of the publication is to provide industry decision makers, government policymakers, analysts, and the general public with historical data that may be used in understanding U.S. electricity markets. The State Electricity Profiles is prepared by the Electric Power Systems and Reliability Team; Office of Electricity, Renewable, and Uranium Statistics; U.S. Energy Information Administration (EIA); U.S. Department of Energy. Data in this report can be used in analytic studies to evaluate new legislation and are used by analysts, researchers, statisticians, and other professionals with regulatory, policy, and program responsibilities for Federal, State, and local governments.

The State Electricity Profiles presents a summary of key State statistics for 2000, and 2004 through 2010. Data published in the State Electricity Profiles are compiled from five forms filed annually by electric utilities and other electric power producers. With the survey of electricity profile of U.S, 2010 analytic studies to evaluate new legislation could be made possible. It clearly shows energy and its efficient utilization.

Electrification in the early 20th century dramatically improved productivity and increased the well-being of the industrialized world. No longer has a luxury now necessity electricity powered the machinery, the computers, the health-care systems, and the entertainment of modern society. Given its benefits, electricity is inexpensive, and its price continues to slowly decline. Electric power distribution is the portion of the power delivery infrastructure that takes the electricity from the highly meshed, high-voltage transmission circuits and delivers it to customers. Primary distribution lines are "medium-voltage" circuits, normally thought of as 600 V to 35 kV.

At a distribution substation, a substation transformer takes the incoming transmission-level voltage (35 to 230 kV) and steps it down to several distribution primary circuits, which fan out from the substation. Close to each end user, a distribution transformer takes the primary-distribution voltage and steps it down to a low-voltage secondary circuit. From the distribution transformer, the secondary distribution circuits connect to the end user where the connection is made at the service entrance functionally, distribution circuits are those that feed customers. The distribution infrastructure is extensive; after all, electricity has to be delivered to customers concentrated in cities, customers in the suburbs, and customers in very remote regions; few places in the industrialized world do not have electricity from a distribution system readily available. Distribution circuits are found along most secondary roads and streets. Urban construction is mainly underground; rural construction is mainly overhead. Suburban structures are a mix, with a good deal of new construction going underground.

In 2013, Mohammad Abdullah Al Faruque et al [11] designed on EDA, system-level design methodology and CPES model and came to certain conclusions that it could tackle the heterogeneous design complexity coming from multiple domains. It has more reliability, flexibility, efficiency and cost effectiveness and offers security of the future electric grid. The semiconductor industry has been driven by Moore's law for more than 40 years. These dramatic improvements came as a direct result of large amounts of R&D investments by the government agencies, e.g. NSF, DoD, DOE, etc. and key industry players such as Intel, IBM, TSMC and many others. Electronic System Level (ESL) design methodology and various Electronic Design Automation (EDA) tools (including high level synthesis, logic synthesis, etc.) have been successfully used to revolutionize the semiconductor industry thanks in part to their combined ability to tackle both the increasing complexity that comes with smaller and more efficient semiconductor designs, as well as to meet the short deadlines that exist due to the quick time-to-market pressure.

EDA tools and algorithms are based on rigorous analysis and optimization algorithms that are the results of many decades of work, and they are well-trusted by the industry due to them being frequently compared to existing published benchmarks. However, with the rise of new technologies and issues ranging across different fields the development and design-work of energy grid systems will require more optimization work with data cross disciplinary fields as well as more participation by the consumers.

A smart grid is a modernized electrical grid that uses analogue or digital information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. A smarter grid applies technologies, tools and techniques available now to make the grid work far more efficiently. The main advantages are: it ensures its reliability to degrees never before possible. It maintains its affordability. It also helps in fully accommodating renewable and traditional energy Sources, potentially reducing our carbon footprint, introducing advancements and efficiencies yet to be envisioned.

As technology evolved so did the energy measurement system. A modern energy management system is characterized with:

- The dispatch operation has been replaced with the fully digital Automatic Generation Control (AGC). The AGC integrates the dispatch function with the load frequency control, power interchange control problem, and varying degree of power system optimization functions.
- System security functions (monitoring and control) have been integrated in a hierarchical control scheme.
- Advanced economy scheduling functions are an integral part of the system, including access to the power markets, if available.

In 2013, an R&D program was organized by SERC [12] and it explained about smart energy distribution system. The Science and Engineering Research Council (SERC) of the Agency for Science, Technology and Research announce a call for research proposals in the area of Smart Energy Distribution Systems. Electricity transmission and distribution systems are among the most important technologies serving the world today, bringing clean and useful energy to meet the demand of end users in many parts of the world. However, in the light of concerns on energy security and access, environmental impacts of energy use (especially the threat of climate change) and depletion and rising costs of non-renewable energy resources, these existing energy distribution systems (built primarily around large, centralized power generation plants) have begun to show signs of age, inflexibility, vulnerability, high costs and inefficiencies. Much has to be done to address these challenges facing centralized and large scale power transmission and distribution.

At the same time, distributed energy resources (including renewable energy systems, distributed power generation, and integrated energy systems) are becoming increasingly widespread and important, and entail the development and use of new and innovative approaches and technologies in energy supply and distribution. Distributed energy resources are smaller in capacity and output (and therefore much greater in numbers) compared to existing centralized power and energy conversion systems. They are based on a variety of different alternative and renewable energy resources with different technical and economic characteristics (including intermittency in output in the case of many forms of renewable energy resources). The design, control, management and optimization of these new distributed energy resources and technologies, and their integration into existing energy transmission and distribution networks, pose significant technological challenges to ensure their reliability and safety, and to improve and maximize their efficiency and cost competitiveness.

Micro grids and other smaller scale power networks can make important contributions to the wider application of distributed energy resources. They enable distributed energy technologies to be safely and reliably integrated with centralized networks (where they exist), or to operate on their own (in islanded mode) in remote locations not served by centralized power grids. They offer opportunities to improve energy efficiency and can ease the strain on, and cost of developing centralized power grid infrastructure. By embedding the necessary “intelligence” into energy distribution systems and optimize diverse energy resources, and provide reliable, cost competitive, and environmentally sustainable energy and power to residential, commercial, industrial, and transportation needs.

Such “intelligence” will enable flexible and interactive exchange of energy and power between distributed systems and centralized energy systems. They will enable price awareness and price sensitivity to be shared with energy suppliers and users across time and space dimensions, creating a sophisticated real time energy marketplace that is robust, adaptive, interconnected and interactive. A*STAR’s initiative in Smart Energy Distribution Systems therefore targets the research and development of sensor and communication technologies, power control and distribution devices, advanced software for energy management and the integration of various energy technologies at a system and “system of systems” level.

In 2014, Sani at el [13] researched on the application of VLSI EDA on power distribution system. Energy distribution networks delivers power to homes and business for efficient products. But to the contrary significant amounts of energy are being wasted simply due to inefficiencies in this network. With the technological advancements, this domain is rapidly changing with new types of loads such as electric vehicles or the spread of new types of energy sources such as photo-voltaic and wind. A comprehensive design automation capability for energy distribution networks leading to much more flexible yet effective system is being demonstrated. The new system’s capabilities include power load distribution and transfers, equipment upgrading, geospatial-aware network optimization, outage identification, contingency planning and loss analysis/ reduction. These features are enabled by advanced simulation, analysis and optimization engines that are adapted from those available in the traditional VLSI design automation area.

The main algorithm used is Comprehensive Design automation capability. It also includes power load distribution and transfers, load balancing, contingency planning and network optimization. It made the system more flexible and effective. It could make energy distribution market more dynamic and the usage of advanced simulation, analysis and optimization made the system more perfect. The algorithm focused on loss analysis and loss reduction. One drawback of this algorithm is that wastage of energy is still being continued after the implementation of this algorithm. Thus it can be concluded that Energy grid Optimization is an important problem that can generate significant benefits for society. Another one is addressing problems such as the reaction to outages, monitoring/adjusting power quality, and equipment management is focused. With the tight integration of geographical, societal and weather models into energy distribution system was practicable.

Currently in the power systems industry, there is a paradigm shift from the traditional, non-interactive, manually controlled, power grid to the tight integration of both cyber information and proper physical representations (the flow of electricity governed by the laws of physics continuous dynamics) at all scales and levels of the power grid network. This new grid which features this cyber and physical combination is termed as Cyber-Physical Energy Systems (CPES), and it is expected to improve the reliability, flexibility, efficiency, cost-effectiveness, and security of the future electric grid. However, the introduction of Distributed Energy Resources (DERs) which include renewable and new types of loads (specifically Electric Vehicles(EVs)) in the residential distribution grid presents the challenge of multi-level monitoring and control for supply and demand management to an already complex and heterogeneous grid.

A consequence of the rapid addition of these DERs would be that traditional power system design methodologies become more time-consuming to perform and that the ability to preempt grid problems would be more difficult. Various research challenges have been already identified in the 2009 NSF Workshop "Research Recommendations for Future Energy Cyber-Physical Systems", of which various funding and research efforts from the past few years have been performed towards meeting these challenges. It is the author's understanding that now would be a good time to further identify research challenges of interest in the area of CPES due to the introduction of more heterogeneity in the grid, such as through the addition of DERs. Energy systems is an integral part of the overall Utility service package that is necessary for the consumer and industrial demand sector to continue thriving, and the work done towards researching and building the models and tools that drive CPES to meet the aforementioned challenges will have a positive impact towards both improving the overall system design and to meeting these important consumer end-goals.

The main advantage of power system modeling is accelerated developments and managed risk. System modelling is an essential technology for managing the interactions that occur across the CCS chin. It allows not only detailed analysis of individual components such as capture plant operation, but quantification of the interactions that occur up and down the chain and eventually across networks. The key benefit is the potential to reduce technology and commercial risk, and rapidly screen and rank options and tradeoffs, thereby accelerating deployment.

3. Comparative Analysis

Table 3.1: Various Energy Conservation techniques

Author	*Year*	*Method*	*Merits*	*Demerits*	*Results*
Sani et al	2014	1) 1)Comprehensive 2) Design automation capability 3) power load distribution and transfers 4) load balancing 5) contingency planning 6) geospatial-aware network optimization	1) more flexible and effective systems 2) made energy distribution market more dynamic 3) advanced simulation, 4) analysis and optimization made the system more perfect 5) Loss analysis and loss reduction.	1) Wastage of energy due to inefficiencies of network	1) Energy grid Optimization can generate benefits for society. 2) There are significant research opportunities arising in this area.
Gi-Joon Nam et al	2010	1) 1) Distribution Network System Optimization using grids.	1) efficient 2) reliability 3) affordability 4) reduces carbon footprint		Usage of grid increases the energy efficiency as traditional energy sources
Mohammad et al	2009	Electronic Design Automation (EDA)	1) widely used 2) Faster than traditional sources.		One of the best algorithms adopted for energy management.
Stanton W. Hadley	2007	1)Plug in hybrid vehicles	1) optimize engine and battery operations for efficient operation 2) Best methods to improve gasoline mileage, by using a	1) Local distribution grids will see a change in their utilization pattern	These areas can be explored further for more energy utilization.

			combination of gasoline engine and batteries to provide vehicle power.	2) Some lines or substations may become overloaded sooner than expected.	
Melville et al	1993	1) Artificial Parameter Homotopy Methods	1) remains valid even with strong nonlinearity	1) Solving nonlinear problems is inherently difficult	new analytic method for Nonlinear problems homotopy analysis
Bjornson et al	1986	Electric Power Distribution for Industrial Plants	1)flexibility	1)energy wastage	1)one of the energy conservation technique
Swamy et al	1980	1)Linear time invariant networks	1) more accuracy 2) does not fluctuate with time		
Chen et al	1974	1) Power system modeling 2) EMS concept	1) Accelerated developments and managed risk. 2) commercial risk		

4. Conclusion

Various kinds of energy distribution systems are being compared in this paper and include details of Plug-in Hybrid Electric vehicles, Power system modeling, artificial parameter homotopy methods, LU Factorization in Network Sensitivity Computations and Power Distribution Planning. State Electricity Profiles of U.S is analyzed for the betterment and progression of our country. Thus came to a conclusion that by applying VLSI EDA to energy distribution system the energy can be conserved and could be useful for future.

There is no doubt that energy grid optimization is an important problem that can generate significant benefits for society. However, most current research appears to be focused on operational management addressing problems such as the reaction to outages, adjusting power quality, and equipment management. At the other end of spectrum, a whole new research opportunity crops up in the design planning realm. With the tight integration of geographical, societal and weather models into energy distribution system, believe that there are significant new research opportunities arising in this area.

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