THE SMART GRID

A WHITE PAPER ON ITS POTENTIAL FOR THE CITY OF FLINT AND GENESEE COUNTY

AltEnergy Inc.

A. What is a "Smart Grid" and how does this affect:

- Flint City Government
- Genesee County Government and other government entities within the County.
- Flint and Genesee County businesses, institutions and residents.
- Consumers Energy

The term "Smart Grid" refers to a modernization of the electricity delivery system so it monitors, protects and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the high-voltage network and distribution system, to industrial users and building automation systems, to energy storage installations and to end-use consumers and their thermostats, electric vehicles, appliances and other household devices, [A definition from the Energy Independence and Security Act of 2007.] The Smart Grid will be characterized by a two-way flow of electricity and information to create an automated, widely distributed energy delivery network. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level.

The greatest benefit from the smart grid will be interoperability that will open up every aspect of the generation, distribution, and use of energy to innovation. Innovation will create change, and change will increase diversity. Diversity is always, and always will be, one of the greatest challenges not only to initial integration, but to maintenance management and to operational integrity of the grid.

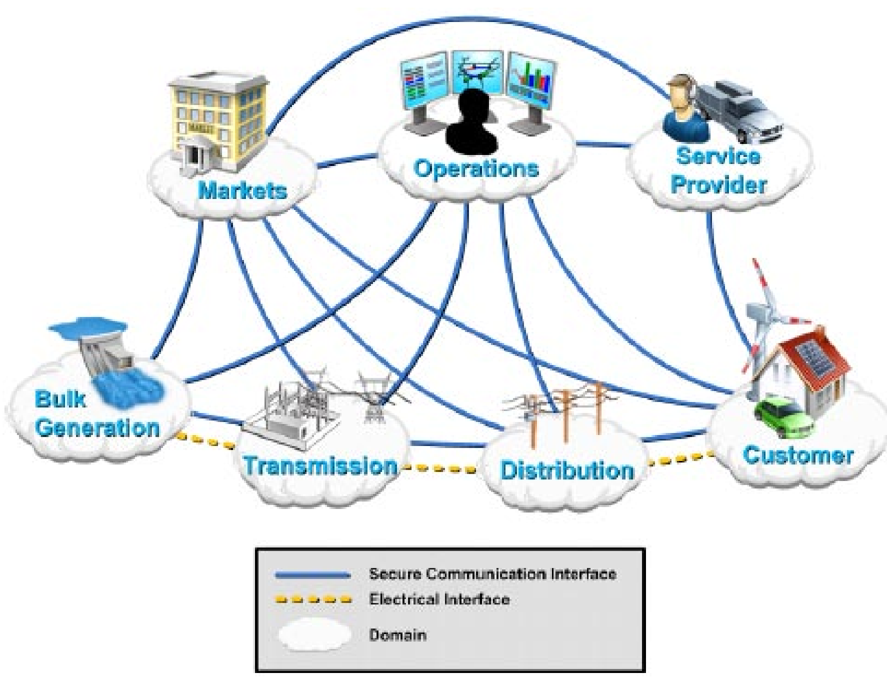

Figure 1. The Smart Grid Architecture.

A.1 Smart Grid Architecture

Although the SM is a fairly recent concept and it will take several years to reach maturity with stables products and markets, there is a fairly well accepted architecture consisting of the following major elements and interconnected as shown in Figure 1:

- **Customers.** The end users of electricity. May also generate, store, and manage the use of energy. Traditionally, three customer types are discussed, each with its own domain: home, commercial/building, and industrial.
- **Markets.** The operators and participants in electricity markets
- **Service Providers.** The organizations providing services to electrical customers and utilities
- **Operations.** The managers of the movement of electricity
- **Bulk Generation.** The generators of electricity in bulk quantities. May also store energy for later distribution.
- **Transmission.** The carriers of bulk electricity over long distances. May also store and generate electricity.
- **Distribution.** The distributors of electricity to and from customers. May also store and generate electricity.

The SM is and will be a very complex system. The focus of this white paper is from the viewpoint of the COF, a local government, is that of a customer. Thus, we will provide only few additional details of the SM as it pertains to the customer constituent component. To begin with, it can be noticed from Figure 1 that the customer component is interconnected to the distribution, markets, operations, and service provider components but not with the bulk generation and transmission components.

Just as the SM is an interconnection of several components, the customer is also an interconnection of several components shown in Fig. 2. Likewise, Figures 3, 4, 5, and 6 shows the corresponding interconnection of components for the distribution, markets, operations, and service provider respectively.

Smart Grid Characteristics: Drivers and Opportunities

The definition of the smart grid builds on the work done in EPRI's IntelliGrid program, in the Modern Grid Initiative (MGI), and in the GridWise Architectural Council (GWAC). These considerable efforts have developed and articulated the vision statements, architectural principles, barriers, benefits, technologies and applications, policies, and frameworks that help define what the Smart Grid is. This section describes some of these widely accepted principle characteristics that will be the basis for the 21st Century grid we are striving to achieve.

Figure 2. Customer major component.

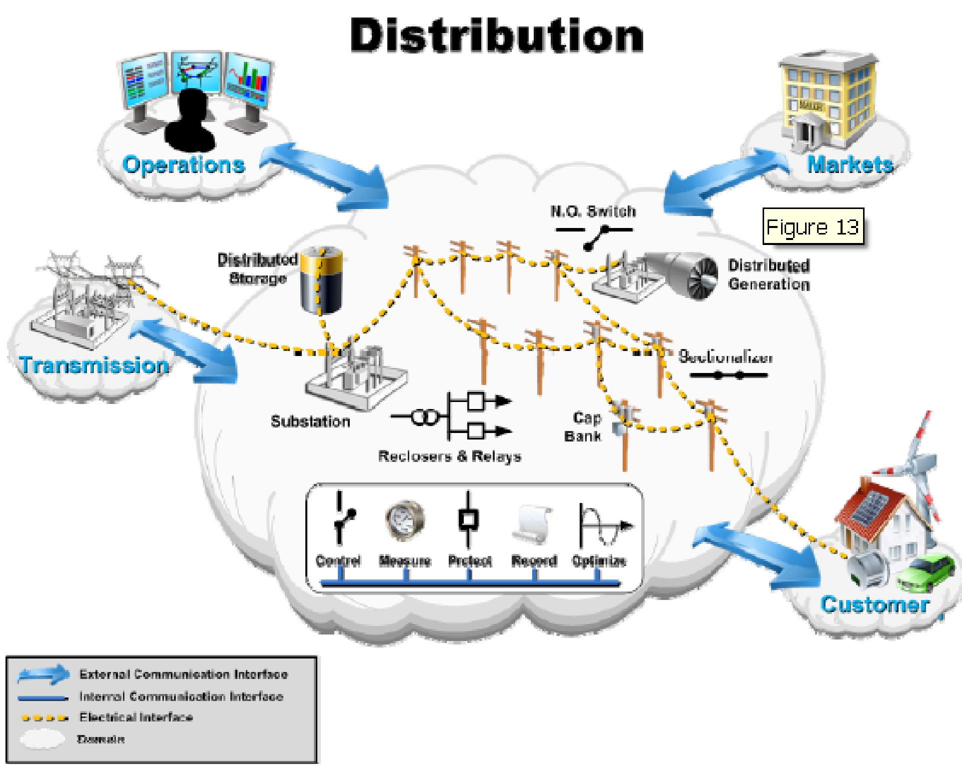

Figure 3. Distribution major component.

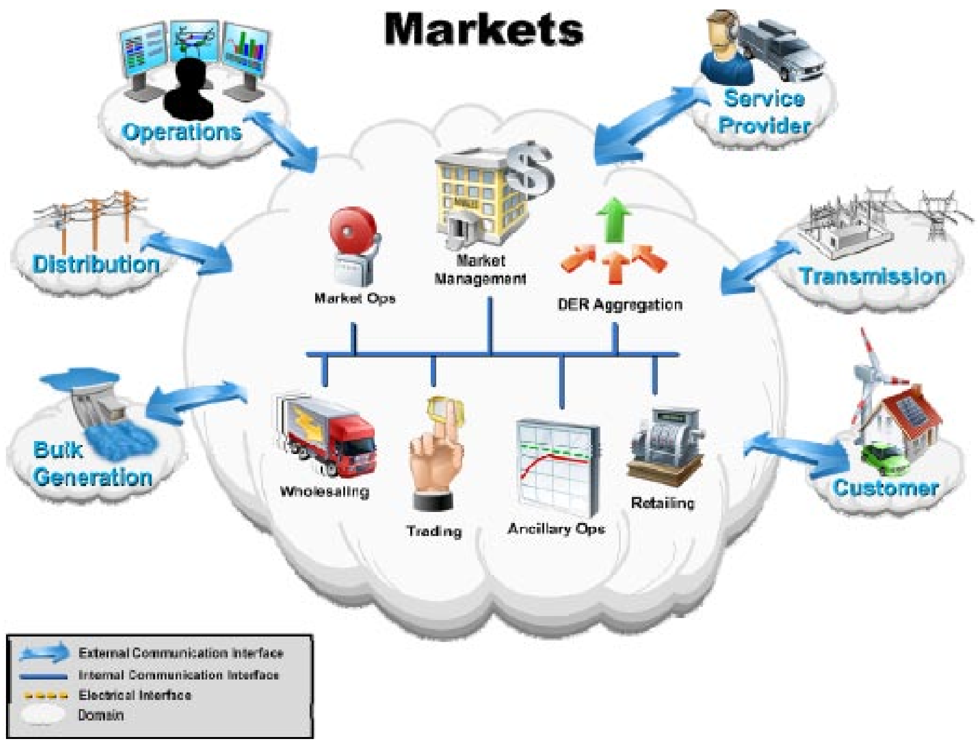

Figure 4. Markets major component.

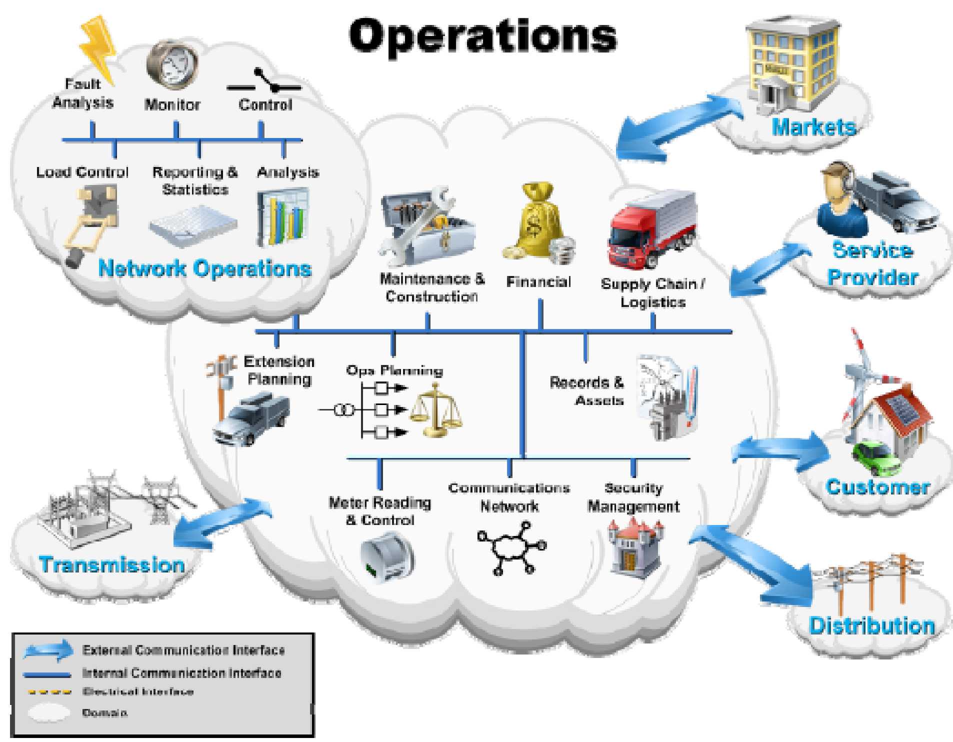

Figure 5. Operations major component.

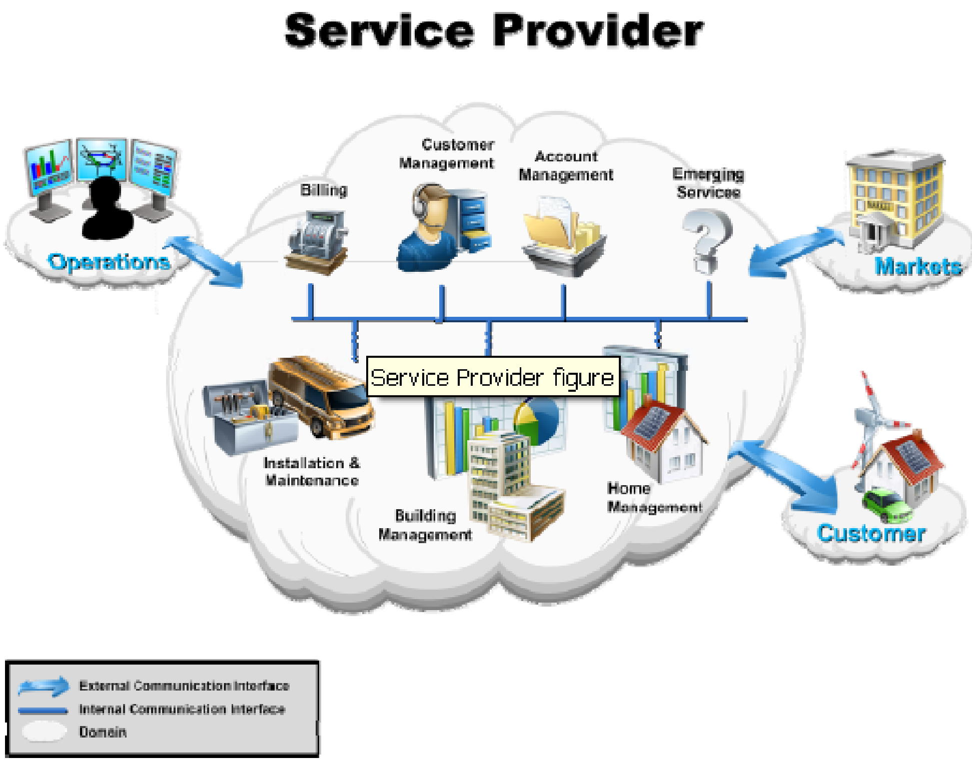

Figure 6. Service provider major component.

A.2 Smart Grid Benefits

Smart Grid benefits can be categorized into 5 types:

- **Power reliability and power quality**. The Smart Grid provides a reliable power supply with fewer and briefer outages, "cleaner" power, and self-healing power systems, through the use of digital information, automated control, and autonomous systems.
- **Safety and cyber security benefits**. The Smart Grid continuously monitors itself to detect unsafe or insecure situations that could detract from its high reliability and safe operation. Higher cyber security is built in to all systems and operations including physical plant monitoring, cyber security, and privacy protection of all users and customers.
- **Energy efficiency benefits.** The Smart Grid is more efficient, providing reduced total energy use, reduced peak demand, reduced energy losses, and the ability to induce end-user use reduction instead of new generation in power system operations.
- **Environmental and conservation benefits**. The Smart Grid is "green". It helps reduce greenhouse gases (GHG) and other pollutants by reducing generation from inefficient energy sources, supports renewable energy sources, and enables the replacement of gasoline-powered vehicles with plug-in electric vehicles.
- **Direct financial benefits**. The Smart Grid offers direct economic benefits. Operations costs are reduced or avoided. Customers have pricing choices and access to energy information. Entrepreneurs accelerate technology introduction into the generation, distribution, storage, and coordination of energy.

A.3 Stakeholder Benefits

The benefits from the Smart Grid can be categorized by the four primary stakeholder groups:

Consumers. Consumers can balance their energy consumption with the real time supply of energy. Variable pricing will provide consumer incentives to install their own infrastructure that supports the Smart Grid. Smart grid information infrastructure will support additional services not available today.

Utilities. Utilities can provide more reliable energy, particularly during challenging emergency conditions, while managing their costs more effectively through efficiency and information.

Business enterprises. These are enterprises other than utilities, e.g., vendors and integrators. These will benefit from business and product opportunities around Smart Grid components and systems.

Society. Society benefits from more reliable power for governmental services, businesses, and consumers sensitive to power outage. Renewable energy, increased efficiencies, and PHEV support will reduce environmental costs, including carbon footprint.

A benefit to any one of these stakeholders can in turn benefit the others. Those benefits that reduce costs for utilities lower prices, or prevent price increases, to customers. Lower costs and decreased infrastructure requirements ameliorate social justice concerns around energy to society. Reduced costs increase economic activity which benefits society. Societal benefits of the Smart Grid can be indirect and hard to quantify, but cannot be overlooked.

Other stakeholders also benefit from the Smart Grid. Regulators can benefit from the transparency and audit-ability of Smart Grid information.

A.4 Modern Grid Initiative Smart Grid Characteristics

For the context of this section, characteristics are prominent attributes, behaviors, or features that help distinguish the grid as "smart". The modern grid initiative (MGI) developed a list of seven behaviors that define the Smart Grid. Those working in each area of the Smart Grid can evaluate their work by reference to these behaviors. These behaviors match those defined by similar initiatives and workgroups.

The behaviors of the Smart Grid as defined by MGI are:

1. **Enable Active Participation by Consumers.** The Smart Grid motivates and includes customers, who are an integral part of the electric power system. The smart grid consumer is informed, modifying the way they use and purchase electricity. They have choices, incentives, and disincentives to modify their purchasing patterns and behavior. These choices help drive new technologies and markets.
2. **Accommodate All Generation and Storage Options.** The Smart Grid accommodates all generation and storage options. It supports large, centralized power plants as well as Distributed Energy Resources (DER). DER may include system aggregators with an array of generation systems or a farmer with a windmill and some solar panels. The Smart Grid supports *all* generation options. The same is true of storage, and as storage technologies mature, they will be an integral part of the overall Smart Grid solution set.
3. **Enable New Products, Services, and Markets.** The Smart Grid enables a market system that provides cost-benefit tradeoffs to consumers by creating opportunities to bid for competing services. As much as possible, regulators, aggregators and operators, and consumers can modify the rules of business to create opportunity against market conditions. A flexible, rugged

market infrastructure exists to ensure continuous electric service and reliability, while also providing profit or cost reduction opportunities for market participants. Innovative products and services provide 3rd party vendors opportunities to create market penetration opportunities and consumers with choices and clever tools for managing their electricity costs and usage.

4. Provide Power Quality for the Digital Economy. The Smart Grid provides reliable power that is relatively interruption-free. The power is "clean" and disturbances are minimal. Our global competitiveness demands relatively fault-free operation of the digital devices that power the productivity of our 21st century economy.

5. Optimize Asset Utilization and Operate Efficiently. The Smart Grid optimizes assets and operates efficiently. It applies current technologies to ensure the best use of assets. Assets operate and integrate well with other assets to maximize operational efficiency and reduce costs. Routine maintenance and self-health regulating abilities allow assets to operate longer with less human interaction.

6. **Anticipate and Respond to System Disturbances (Self-heal).** The Smart Grid independently identifies and reacts to system disturbances and performs mitigation efforts to correct them. It incorporates an engineering design that enables problems to be isolated, analyzed, and restored with little or no human interaction. It performs continuous predictive analysis to detect existing and future problems and initiate corrective actions. It will react quickly to electricity losses and optimize restoration exercises.

7. **Operate Resiliently to Attack and Natural Disaster.** The Smart Grid resists attacks on both the physical infrastructure (substations, poles, transformers, etc.) and the cyber-structure (markets, systems, software, communications). Sensors, cameras, automated switches, and intelligence are built into the infrastructure to observe, react, and alert when threats are recognized within the system. The system is resilient and incorporates self-healing technologies to resist and react to natural disasters. Constant monitoring and self-testing are conducted against the system to mitigate malware and hackers.

A. 5 Government drivers: Planning Assumptions

The Smart Grid is vital component of President Obama's comprehensive energy plan, which aims to reduce U.S. dependence on foreign oil, create jobs, and help U.S. industry lead in the global race to develop and apply clean energy technology. The President has set ambitious short and long-term goals, necessitating quick action and sustained progress in implementing the components, systems, and networks that will make up the Smart Grid. For example, the President's energy policies are intended to double renewable energy generating capacity, to 10 percent, by 2012—an increase in capacity that is enough to power 6 million American homes. By 2025, renewable energy sources are expected to account for 25 percent of the nation's electric power consumption.

The American Recovery and Investment Act includes $11 billion in investments to "jump start the transformation to a bigger, better, smarter grid." These investments and associated actions to modernize the nation's electricity grid will result, for example, in more than 3,000 miles of new or modernized transmission lines and 40 million "smart meters" in American homes. In addition, progress toward realization of the Smart Grid will contribute to accomplishing the President's goal of putting one million plug-in hybrid vehicles on the road by 2015. Over the long term, the integration of the power grid with the nation's transportation system has the potential to yield huge energy savings and other important benefits.

A Department of Energy study found that the idle capacity of today's electric power grid could supply 70 percent of the energy needs of today's cars and light trucks without adding to generation or transmission capacity—*if the vehicles charged during off-peak times.* Estimates of associated potential benefits include:

- Displacement of about half net oil imports;
- Reduction in U.S. carbon dioxide emissions by about 25 percent; and
- Reductions in emissions of urban air pollutants of 40 percent to 90 percent.

While the transition to the Smart Grid may unfold of over many years, incremental progress along the way can yield significant benefits. In the United States, electric-power generation accounts for about 40 percent of human-caused emissions of carbon dioxide, the primary greenhouse gas. If the current power grid were just 5 percent more efficient, the resultant energy savings would be equivalent to permanently eliminating the fuel consumption and greenhouse gas emissions from 53 million cars.

President Obama has called for a national effort to reduce, by 2020, the nation's greenhouse gas emissions to 14 percent below the 2005 level and to about 83 percent below the 2005 level by 2050. Reaching these targets will require an ever more capable Smart Grid with end-to-end interoperability.

Progress in developing the Smart Grid will strongly and broadly support the Administration's policies to advance energy and climate cyber security, while promoting economic recovery efforts. Specifically, steps toward realizing of the Smart Grid will help to:

- Create new jobs in a "clean energy economy" by spurring development of new green manufacturing opportunities,
- Promote U.S. competitiveness in the global economy,
- Enable and foster innovation in next-generation energy technologies;
- Break U.S. dependence on oil by promoting development of the next generation of cars and trucks and the alternative fuels that will power them;
- Enhance U.S. energy supplies through responsible development of domestic renewable energy, fossil fuels, advanced biofuels and nuclear energy;
- Promote energy efficiency and reduce energy costs in the transportation, electricity, industrial, building and agricultural sectors; and.
- Develop an economy-wide emissions reduction program to reduce greenhouse gas emissions and secure the greatest benefits at the lowest cost for families and businesses.

The SG is concept that will affect all stakeholders and many constituents but not in the same way. In the following, its impact for the COF and Genesee county will be described.

A.6 How does the Smart Grid affect Flint City Government?

The main impact for the COF will be economic, the SG could save the COF a significant portion of its energy consumption. leveraging the aid from the state and Federal governments
A second impact will be efficiency.
Yet another impact will be environmental.
Still another impact is working in partnership with the state and Federal governments.
A final impact is on the working in partnership with local businesses and institutions to further the development.

1. **Financial impact.** There are two main mechanisms that the Smart Grid could have an financial impact on the FCG. The first one is the leveraging of 11 billion dollars in the American Recovery and Investment Act (ARRA) set specifically to "jump start the transformation to a bigger, better, smarter grid." This investment from the Federal government from various departments such as the Department of Labor, Department of Energy, Department of Defense, Department of Homeland Security, etc. and in many forms such as SBIR/STTR, Grants with cost sharing or no cost sharing, loans, energy tax credits, etc. The COF could finance many energy related projects and improve the industrial landscape of Flint and Genesee county by leveraging a large pot of money set specifically for the Smart Grid. The second financial impact is the savings on energy costs as a result of using less energy through the application of Smart Grid principles. It is argued that it costs money to actually use less energy because of the new technology that needs to be put in place. While this is true, we are assuming that for the immediate future the savings will only happen if ARRA money is used for the Smart Grid infrastructure in the Flint area.

2. **Energy efficiency impact**. As noted above, one of the behaviors of the Smart Grid is its ability to Optimize Asset Utilization and Operate Efficiently. Thus by participating in the Smart Grid concept, the COF has the opportunity to optimize its energy assets and operate them efficiently serving as an example to other local governments.

3. **Environmental impact**. By participating in the Smart Grid concept, the COF has the opportunity to obtain the environmental benefits associated with it and serve as an example to the rest of society.

4. **Partnership with the State and Federal Governments impact**. By participating in the Smart Grid concept, the FCG has an excellent opportunity to develop a great partnership with the State and Federal Governments because they are the catalysts for SG developments.

5. **Partnership with local Institutions impact**. It is very likely that many other institutions (e.g., Universities) in the Flint are will actively participate in the Smart Grid.

A.7 How does the Smart Grid affect Genesee County Government and other government entities within the County?

The impact on Genesee County Government and other government entities within the County will be similar to that on the COF but to a lesser degree because the County Governments are smaller than the COF with less resources and thus, for example the potential for leveraging opportunities from the State and Federal governments is less.

A.8 How does the Smart Grid affect Flint and Genesee County Businesses, Institutions and Residents?

In general, and Genesee County Businesses, Institutions and Residents will be affected differently depending upon their role in the Smart Grid arena, that is, whether they are a customer, service provider, operations provider, market support, or generation or transmission or distribution provider.

For businesses, it is very likely that its role could be as customers, service providers, operations, markets, and distribution. Although unlikely, it could include bulk generation and transmission. Thus, the effect on business could be huge or minor depending upon whether the businesses get involve in some aspect of the SG depending upon its role. One example could involve a local business developing SG data management technology to support buildings and manufacturing plants. Another example involves a local business developing and manufacturing components for distributed generation, an important component of the Smart Grid.

For Institutions, it depends on their nature. For the most part the effect will be economical, efficiency, and a contribution to lower the carbon footprint.

For Residents, the impact will be similar to that for Institutions but to a lesser degree because residents do not generally have the means to make large investments in new equipment and/services unless they are subsidized or incorporated into a plan by the service providers.

A.9 How does the Smart Grid affect Consumers Energy?

Consumers Energy will be affected in two major ways. The first way will be that new players will come into the picture and Consumers Energy must work in a new playground that includes: markets, operations, service providers, bulk generation, transmission, distribution, and customers. The second way that Consumers Energy will be affected is that the nature of its customers will change considerably by the capability of generating energy and selling it back to Consumers Energy and the capability of customers to have control on the time and conditions energy is purchased from Consumers Energy or sold to Consumers Energy. Thus Consumers Energy has no choice but to participate in the new Smart Grid playground.

B. Categorize and catalogue potential Smart Grid components and activities.

The Smart Grid is in its beginning stages and it will take several years before it takes a recognizable shape. Thus, it is currently difficult to list and categorize with detail all of its components as it is likely that there will be a large number and some important components may not be envisioned yet. Nevertheless, by looking at the conceptual models of the major Smart Grid components depicted in Figures 2 through 6, one can list many components that will play important roles. Because of the model depicted in Figure 1, a good way to categorize the components of the Smart Grid is by the following categories: customer, markets, operations, service provider, generation, transmission, and distribution. In the following we list some typical components in each category.

- **Customer Category components**. Building automation, supervisory control and data acquisition (SCADA), building area network (BAN), distributed generation (DG), advanced meters, energy efficient industrial automation, home energy management system (EMS), smart appliances, plug-in-electric vehicle (PEV), home area networking (HAN), energy storage, , intelligent energy distributor (IED), energy optimization software.

- **Markets Category components.** Market operations, market management, distributed energy resource (DER) aggregation, wholesaling, trading, ancilliary operations, retailing.

- **Operations Category components**. Maintenance and construction, supply chain/logistics, extension planning, operations planning, records & assets, meter reading & control, communication network, security management.
- **Service Provider Category components**. Billing, customer management, account management, engineering services, installation and maintenance, building management, home management.
- **Generation Category components**. Gas plant, coal plant, nuclear plant, pump storage plant, geothermal plant, biomass plant, hydro plant, wind plant, solar plant, distributed control system (DCS), generation management system (GMS).
- **Transmission Category components.** Substation, distributed storage, SCADA, transmission management system (TMS).
- **Distribution Category components.** Substation, distributed storage, reclosers & relays, capacitor bank, power control switch, SCADA, intelligent energy distributor (IED), , SCADA, distribution management system (DMS).

C. Estimate costs for implementation of Smart Grid components and activities.

Just as it is currently difficult to list and categorize the Smart Grid components, it is also difficult to estimate implementation costs. Nevertheless, by comparison to similar components or activities we can estimate costs for some. Thus the following are best estimates only for a price range. These costs are estimates for commercial units. If a component or activity is developed for the first time or it is re-designed, there are other development costs that are actually much higher than the commercial costs.

Component/Activity	Cost	Component/Activity	Cost
Home EMS	2,000	Advanced meter (building)	3,000
Building EMS	25,000	Intelligent energy distributor (home)	5,000
Distributed generation (Home)	10,000	Intelligent energy distributor (building)	25,000
Distributed generation (Building)	100,000	Energy optimization software	2,000
Energy storage (home)	5,000	SCADA (building)	50,000
Energy storage (building)	30,000	SCADA (distribution)	150,000
Home area network	800	SCADA (transmission)	250,000
Advanced meter (home)	2000	DCS (Generation)	1 Million

D**. What are some studies, analyses of current and projected opportunities for Green Jobs with implementation of a Smart Grid. (Flint, Region, State, National)**

There are a large number of preliminary and initial studies and analysis of current and projected opportunities for Green jobs related to the implementation of the Smart Grid, perhaps too numerous to list them comprehensively. A great deal of the publications are from the Department of Energy, particularly the National Renewable Energy Laboratory. The publications can be classified by the government agency (e.g., DOE, DOD, etc.), by technology (e.g., solar, wind, geothermal, etc), by applications (e.g., PEVs, energy efficiency, remote metering , etc.)

According to the US Government, the job expectations for ARRA funding is the following:

$92,000 of government spending creates 1 job-year (i.e. 1 job for 1 yr)
64% of the job-years represent direct and indirect effects
36% of the job-years are induced effects

It is still too early to have detailed studies on the number of green jobs as a result of the investments from the Federal Government on the Smart Grid. However, using the above rules, the projected number of job-years, assuming a fairly even distribution of Federal financing for the State, Region, and Flint is shown next.

Smart Grid	**National**	**State of Michigan**	**Genesee County**	**Flint**
Investment	11 Billion	600 Million	20 Million	5 Million
No. Job-years	119,565	6521	217	87

Source: http://www.washington.edu/research/gca/recovery/pdfdocs/CEA_RecoveryActJobs.pdf

E**. Identify some programs and funding available (new and/or leveraged) for implementation of a Smart Grid.**

The number of programs and funding available for the implementation of a Smart Grid is really large and it is expected to continue for the next few years. The following are the major sources of funding:

- Department of Energy: *www.**energy**.gov/*
- Department of Defense: *www.**defense**link.mil/*
- SBIR/STTR: *www.zyn.com/**sbir***
- Government grants
- Energy tax credits: http://www.irs.gov/irb/
- Investment credits: http://www.irs.gov/irb/

F**. What partnerships are available or could be constructed to encourage the creation and development of a Smart Grid**.
The FCG can develop partnerships with the following institutions both to encourage the creation and development of a Smart Grid and to leverage funding opportunities:

- Consumers Energy
- Local businesses
- Local Institutions
- Local Universities
- Other local governments

G. **What are the existing barriers and/or any impediments to the creation of a Flint and Genesee County Smart Grid.**
The Smart Grid barriers has been documented by a number of studies and are summarized below. The any impediments to the creation of a Flint and Genesee County Smart Grid are related to these barriers and are listed below together with a recommendation to overcome these barriers. The Smart Grid poses many procedural and technical challenges as we migrate from the current grid with its one-way power flows from central generation to dispersed loads, toward a new grid with two-way power flows, two-way and peer to peer customer interactions,

and distributed generation. These challenges cannot be taken lightly – the Smart Grid will entail a fundamentally different paradigm for energy generation, delivery, and use.

G.1 Procedural Challenges

The procedural challenges to the migration to a smart grid are enormous, and all need to be met as the Smart Grid evolves:

1. Broad Set of Stakeholders. The Smart Grid will affect every person and every business in the United States. Although not every person will participate directly in the development of the Smart Grid, the need to understand and address the requirements of all these stakeholders will require significant efforts.

Recommendation: Establish interest groups at The Flint Chamber of Commerce and Genesee

2. Complexity of the Smart Grid. The Smart Grid is a vastly complex machine, with some parts racing at the speed of light. Some aspects of the Smart Grid will be sensitive to human response and interaction, while others need instantaneous, automated responses. The smart grid will be driven by forces ranging from financial pressures to environmental requirements.

Recommendation: Plan in coordination with local educational institutions to have a series of lectures, workshops, and educational materials on the Smart Grid. Encourage and support (through credits?) that local institutions have educational and training programs related to the SM.

3. Transition to Smart Grid. The transition to the Smart Grid will be lengthy. It is impossible (and unwise) to advocate that all the existing equipment and systems to be ripped out and replaced at once. The smart grid supports gradual transition and long coexistence of diverse technologies, not only as we transition from the legacy systems
and equipment of today, but as we move to those of tomorrow. We must design to avoid unnecessary expenses and unwarranted decreases in reliability, safety, or cyber security.

Recommendation: Develop a SG long term plan.

4. **Ensuring Cyber Security of Systems.** Every aspect of the Smart Grid must be secure. Cyber security technologies are not enough to achieve secure operations without policies, on-going risk assessment, and training. The development of these human-focused procedures takes time—and needs to take time—to ensure that they are done correctly.

Recommendation: No specific recommendation since this barrier is addressed by other stakeholders.

5. **Consensus on Standards.** Standards are built on the consensus of many stakeholders over time; mandating technologies can appear to be an adequate short cut. Consensus-based standards deliver better results over.

Recommendation: No specific recommendation since this barrier is addressed by other stakeholders.

6. **Development and Support of Standards.** The open process of developing a standard benefits from the expertise and insights of a broad constituency. The work is challenging and time consuming but yields results more reflective of a broad group of stakeholders, rather than

the narrow interests of a particular stakeholder group. Ongoing engagement by user groups and other organizations enables standards to meet broader evolving needs beyond those of industry stakeholders. Both activities are essential to the development of strong standards.

Recommendation: No specific recommendation since this barrier is addressed by other stakeholders.

7. **Research and Development.** The smart grid is an evolving goal; we cannot know all that the Smart Grid is or can do. The smart grid will demand continuing R&D to assess the evolving benefits and costs, and to anticipate the evolving requirements.
Recommendation: No specific recommendation since this barrier is addressed by other stakeholders.

G.2 Technical Challenges to Achieving the Smart Grid

Technical challenges are listed below. No specific recommendations are listed since these barriers are addressed by other stakeholders.

1. Smart equipment. Smart equipment refers to all field equipment which is computer-based or microprocessor-based, including controllers, remote terminal units (RTUs), intelligent electronic devices (IEDs). It includes the actual power equipment, such as switches, capacitor banks, or breakers. It also refers to the equipment inside homes, buildings and industrial facilities. This embedded computing equipment must be robust to handle future applications for many years without being replaced.

2. Communication systems. Communication systems refer to the media and to the developing communication protocols. These technologies are in various stages of maturity. The smart grid must be robust enough to accommodate new media as they emerge from the communications industries and while preserving interoperable, secured systems.

3. Data management. Data management refers to all aspects of collecting, analyzing, storing, and providing data to users and applications, including the issues of data identification, validation, accuracy, updating, time-tagging, consistency across databases, etc. Data management methods which work well for small amounts of data often fail or become too burdensome for large amounts of data—and distribution automation and customer information generate lots of data. Data management is among the most time-consuming and difficult task in many of the functions and must be addressed in a way that will scale to immense size.

4. Cyber Security. Cyber security addresses the prevention of damage to, unauthorized use of, exploitation of, and, if needed, the restoration of electronic information and communications systems and services (and the information contained therein) to ensure confidentiality, integrity, and availability.

- **Information/data privacy.** The protection and stewardship of privacy is a significant concern in a widely interconnected system of systems that is represented by the Smart Grid. Additionally, care must be taken to ensure that access to information is not an all or nothing at all choice since various stakeholders will have differing rights to information from the Smart Grid.
- **Software applications**. Software applications refer to programs, algorithms, calculations, and data analysis. Applications range from low level control algorithms to

massive transaction processing. Application requirements are becoming more sophisticated to solve increasingly complex problems, are demanding ever more accurate and timely data, and must deliver results more quickly and accurately. Software engineering at this scale and rigor is still emerging as a discipline. Software applications are at the core of every function and node of the Smart Grid.

SUMMARY

The Smart Grid is a modernization of the electricity delivery system so it monitors, protects and automatically optimizes the operation of its interconnected elements. It is a fairly new, ambitious, and complex system that will take several years for its full implementation. Nevertheless, due to massive investments by the Federal Government, it is full of opportunities for all stakeholders. More specifically, the FCG can take advantage of these opportunities to significantly contribute to the speedy implementation of the Smart Grid. The opportunities are countless, limited only by the innovative mind and local resources. The COF could work with the State of MI to be a leader in Smart Grid. Flint has a great tradition in transportation and manufacturing and both of these industries have declined significantly. There is an opportunity for the COF and Genesee County to convert the transportation and manufacturing experience and resources and develop a great Smart Grid workforce. In general there are too many other opportunities in the SG area for COF and Genesee county. The COF should start small according to its available resources, assets, and capabilities and gradually increment its effort as leveraged resources is obtained from other companies, institutions, the State, and the Federal Government. There is also an opportunity for innovation and partnerships. The COF should partner with Kettering University on innovation as this school is actively involved in innovation through several initiatives such as the “Entrepreneurship across the curriculum”. It is recommended that the COF hire one employee to monitor, identify opportunities, and advocate SM for COF and Genesee County.

RESUME OF DR. JUAN R. PIMENTEL

President & CEO, AltEnergy Inc.

EDUCATION:

Ph.D., Electrical Engineering, University of Virginia, 1980.
M.S. Electrical , Engineering, University of Virginia, 1978.
B.S., Electrical Engineering, National University of Engineering, Lima, Peru, 1975.

CURRENT POSITION AND RESEARCH:

Dr. Juan R. Pimentel founded AltEnergy Inc. in 2007 is acting as the current President & CEO. He is also a full Professor at Kettering University, Flint, Michigan. He has extensive research experience in the areas of control systems, dependable communication networks, automotive electronics, distributed energy, the Smart Grid, renewable energy, and hybrid electric vehicles. In 2007 he received the "Distinguished Researcher Award" from Kettering University for significant research involving hybrid electric vehicles, power electronics, distributed embedded systems, industrial communications, and safety critical systems. Dr. Pimentel is the developer of FlexCAN, an industrial communication network for safety-critical applications with high reliability, availability, and survivability requirements. FlexCAN has been successfully used in various prototypes and demonstration projects. At Kettering University, with the support of several industrial partners, he developed the Distributed Embedded Systems laboratory.

RELEVANT EXPERIENCE:

Dr. Pimentel is an experienced business executive, entrepreneur, and engineering Professor with over 10 years in start-up companies, and over 25 years in teaching and research & development. He has founded three other companies in the areas of industrial systems, multimedia systems, and industrial communications. Dr. Pimentel is a recognized international expert in the area of industrial communication networks with high reliability, safety, availability, and survivability requirements. He has performed extensive research at well known institutions such as INRIA-LORIA, Nancy, France, Fraunhofer Institute, Germany, University of Padova, Italy, Universidad Politecnica de Madrid, Spain, Universidad Carlos III de Madrid, Spain, and Universidad de los Andes, Bogota, Colombia. He has written three books on *Communication Networks for Manufacturing*, *Multimedia Systems*, and *Safety-Critical Automotive Systems*. Throughout his career, Dr. Pimentel has refined his expertise in the start-up business environment including small business administration, operations, team building, fund-raising, and strategic business development.