The Annual **EITC New Energy ** Workshop

(EITC-New Energy 2010)

“Powering Our Future – The Coming Energy Revolution”

James H. Clark Center, Stanford University
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(DRAFT)

We live in a world of cyberspace, biomedical engineering and other mind-boggling technologies. Yet when it comes to energy, our decades-old coal- and oil-based energy systems barely change. Developments around the world are already proving them wrong. However, we may soon witness the most dramatic changes in the world energy economy in a hundred years.

The IP-based smart grid, the power grid of the future, is one of humanity's boldest visions. It turns the current electrical network that has thousands of transmission substations, large substations for distribution, and public and private owners into a shared, interoperable network that communicates intelligently and works efficiently, similar in concept to the way the Internet works today. The smart grid will use new long-distance, extra-high voltage transmission lines (a national "**electric superhighway**") to deliver the bulk of clean power generated by the remote gigantic wind farms on land and offshore, and the enormous solar fields in the deserts and the areas that have an abundance of sun in the years to come. Consumers and companies are installing solar panels and small wind turbines on their roofs or small power plants in their basements. The highly efficient mini power plants (co-generation) provide heat and electricity and also feed back any excess power to the smart grid, providing a profit to the user. Two-way connected IP-based smart meters will be installed in every home. They will be able to measure real-time electricity distribution both inside households and in the power grid. Smart meters use broadband wireless networking (e.g., Wi-Fi, WiMAX, LTE) to shuttle information back and forth between utilities and customers. They are paving the way for tools and services that make the system more responsive to shifts in energy demands.

Power supplies are **likely** to be radically decentralized in the coming decades. A (**futuristic design concept**) network of tens of thousands of decentralized mini power plants (**microgrids and virtual power plants**) will be able to quickly pool resources to produce mass quantities of energy to compensate for fluctuations in other supplies, like wind power if the wind dies down. Energy storage devices (e.g., lithium-ion battery) will be deployed in electric vehicles (EVs) in the future. It will enable electric vehicles to download energy from a plug when plenty is available. And if an electric vehicle isn't in operation and there is a shortage of energy, the electric vehicles will also be capable of feeding electricity back into the smart grid. The smart grid without energy storage is like a computer without a hard drive: severely limited. Energy stored throughout the grid can provide power to address peak power needs, decreasing the use of expensive plants that utilities power up as a last resort when demand spikes, making the network less volatile. In the way that computers and the infrastructure of the Internet have built up around storage as a key component, so will the power grid eventually rely on energy storage technology as a pivotal piece. Energy storage technologies (e.g., compressed air, pumped hydro, molten-salt technology, lithium-ion batteries, fuel cells, etc.) can strengthen grid stability, reduce frequency and duration of operational disruptions, and increase efficiencies.

More intelligent energy consumption will also help to compensate for fluctuations in the power grid. Smart meters will pave the way for real-time pricing, where energy is priced at different rates depending on the time of day and how much demand there is for the electricity. Utilities can use real-time pricing to better manage the loads on the grid, while home owners can use it to cut their monthly energy bills. For example, intelligent appliances are saving energy in our homes: washers, dryers and refrigerators that communicate with each other wash, dry or cool when electricity is cheapest. The dream of a smart grid, where every household appliance is networked (i.e., home area network) and able to communicate with the power grid, and consumers can do things like adjusting their thermostats using a mobile phone, rests on universal Internet connectivity. Decentralized energy-producing units and household appliances would be organized by a central energy management system in each home.

Digital network intelligence is added to the power grid of the future, making electricity more like the Internet. In order to keep the network -- comprised of millions of mini power plants stable -- from collapsing, millions of end-appliances and home management systems will constantly be able to share data or commands. The power grid itself will also be equipped with advanced information technology (i.e., wireless sensor networking technology, software, computing) that will be able to measure demand and production in real time. The deployment of all modern energy technologies will rise or fall based on the construction of a communications network that can deal with mass amounts of real-time data and transport them using Internet Protocols. The smart grid is the backbone of the new infrastructure. The smart grid could promote innovation in energy, just as the Internet did in computing. **The Information Age is arriving at a new level: It's becoming the New Electricity Age.**

Ultimately we need smart grid technology because as the population grows the demand for electricity will only increase, but we need to cut our electricity consumption to fight global warming. The world consumes 14 trillion watts (14 terawatts) of energy every day. In another 50 years, we're going to need 28 terawatts. Where are we going to find another 14? We would have to turn on a new 1,000-megawatt power plant tomorrow, another the next day, and on and on, one a day for the next 40 years to get another 14 terawatts.

In this workshop we will focus on energy systems that tap into inexhaustible, ubiquitous, and clean sources of energy generation, such as **solar**, **wind**, **biomass** (i.e., plant matter such as trees, grasses, agricultural residue, algae, and other biological material), **ocean** (i.e., wave energy, tidal energy, ocean thermal energy conversion), and **geothermal**, but also including non-conventional avenues such as **methane clathrate**, **radiant energy**, **cold nuclear fusion**, **magnet motors**, etc..

This is the website of the EITC New Energy 2010 Workshop to be held in August, 2010. Details will follow later ……

(Drafted by Michael Hwa-Han Wang – 4/27/10)