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Docket Number:	12-AFC-02
Project Title:	Huntington Beach Energy Project
TN #:	202637
Document Title:	Unleashing Local Energy
Description:	N/A
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Organization:	Monica Rudman
Submitter Role:	Public
Submission Date:	6/30/2014 2:21:04 PM
Docketed Date:	6/30/2014

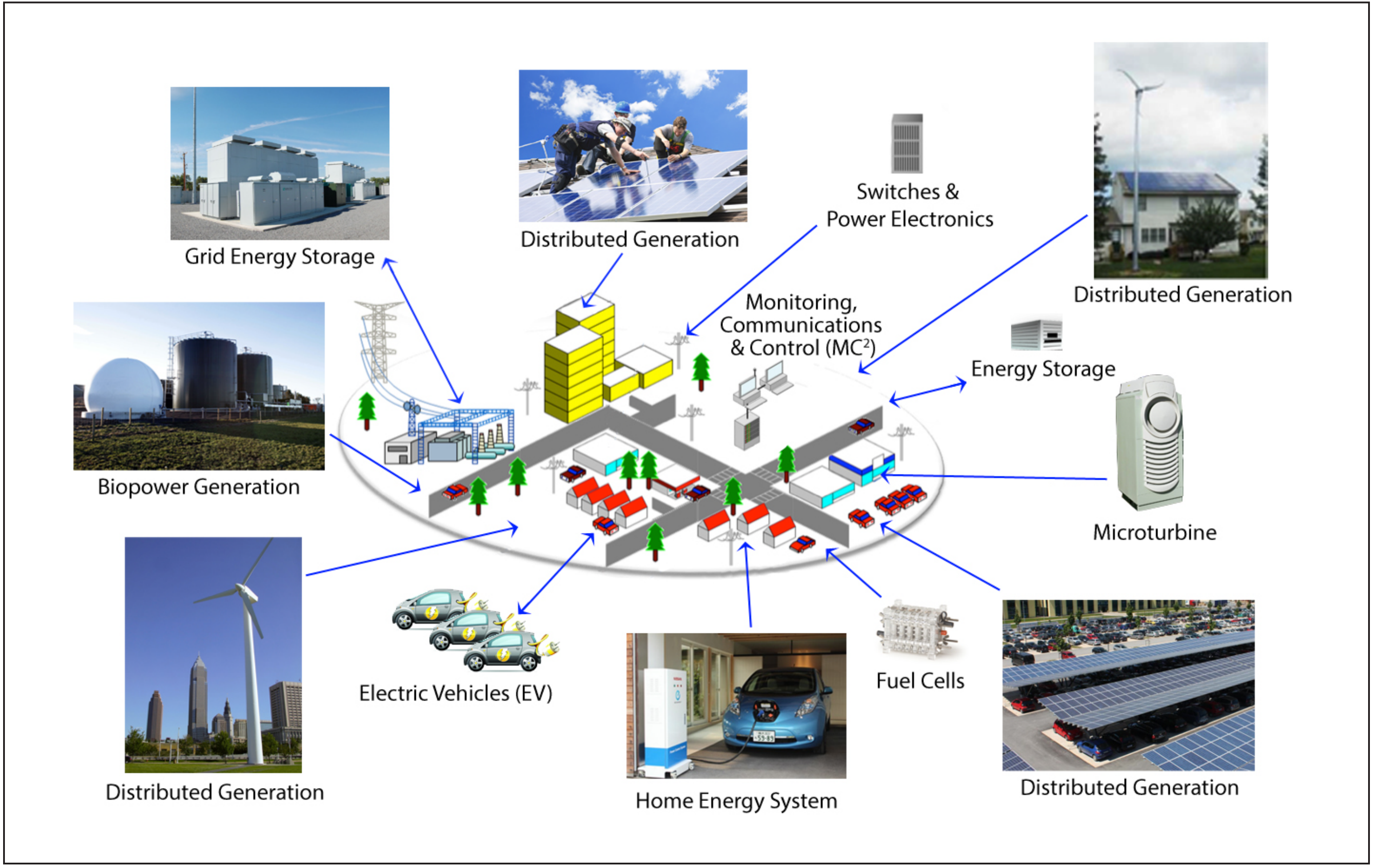
Distributed Generation + Intelligent Grid

America has an opportunity to invest in a 21st century power system capable of keeping the United States competitive in the global economy with clean, safe, and reliable energy. The nation's electric system relies too heavily on centralized generation and long-distance transmission using antiquated infrastructure. This system is too vulnerable to meet modern challenges – a harsh reality recently underscored by Hurricane Sandy.

The creation of a reliable power system through increased distributed generation (DG) integrated with intelligent grid (IG) solutions is vital for powering America's increasingly electricity-reliant economy. Intelligent grid solutions enable high levels of local renewable energy, improve power quality, and enhance system resilience. The core DG+IG solutions are distributed generation, demand response, forecasting & curtailment, advanced inverters, energy storage, and monitoring, communications & control (MC2) systems.

This document summarizes the key considerations for modernizing the electric system and spans the following topics:

- Challenges
- Opportunities
- Vision of the DG+IG Future
- Core DG+IG Solutions
- Policy Recommendations



Challenges

Given that our outdated, unsafe electric system is incapable of addressing current challenges, there is no reason for energy consumers to continue investing billions of dollars in its business-as-usual expansion.

Outdated, Unsafe System: Energy consumers pay massive, unnecessary costs for an aging and antiquated power system. A 2010 natural gas pipeline explosion in San Bruno, California killed 8 people and may cost Pacific Gas & Electric more than $2 billion in penalties. Relying on fossil fuel burning power plants and long-distance transmission made sense when a lack of clean energy technologies made local generation undesirable. Now, technological innovation allows for the local production of clean energy and enhanced resilience through intelligent grid solutions.

An energy system too reliant on centralized generation and transmission is inherently susceptible to massive failures.

Unprepared for Transformation: The existing electric system cannot accommodate the high levels of renewable energy and the electrification of transportation necessary to slow down climate change. Nor is it resilient enough to adapt to the increasing frequency and severity of storms, fires, and other natural disasters. An energy system too reliant on centralized generation and long-distance transmission is inherently susceptible to massive failures. Hurricane Sandy and the 2011 San Diego blackout highlight the vulnerability of our existing system to widespread outages, which cost Americans up to $188 billion annually. The nation's power system will remain prone to widespread failures – caused by accidents, weather, or intentional attacks – as long as there are critical dependencies on centralized power plants and associated transmission. There is currently too much risk with over 280,000 miles of active electric transmission lines in the U.S.

Opportunities

Americans have an opportunity to invest in a modern power system that takes advantage of the latest technologies for providing cleaner, more affordable, and more reliable energy.

Clean Energy: A modern power system, capable of integrating significant amounts of renewable distributed generation will enable the rapid transition to a clean energy future. Local renewable projects can be deployed within communities – such as on rooftops and parking lots – avoiding the long delays and high costs associated with building new transmission lines, while preserving pristine ecosystems. Since clean local energy projects can come online within months, they can quickly reduce harmful pollutants from fossil fuels that endanger human health and security.

Affordable Energy: Local energy systems ensure ongoing access to affordable, domestic power. Full cost and value accounting – which includes consideration of transmission costs and inefficiencies, escalating fossil fuel costs, local economic realities, and environmental impacts – must guide energy procurement decisions. Historically, electricity procurement and planning decisions have focused solely on the contract price of

The cost of transmitting energy long distances is exorbitantly expensive. Up to $80 billion will be spent on transmission infrastructure in the U.S. between 2011 and 2015, with the entire cost paid by energy consumers through electricity rates.

decisions have focused solely on the contract price of energy at the point of interconnection to the grid. This misleading "sticker price" approach fails to account for factors that significantly impact electricity rates. For example, a comprehensive approach shows that avoiding long-distance transmission results in tremendous savings. Edison Electric Institute found that its members invested over $11 billion in electric transmission infrastructure in 2011 alone. Furthermore, the Galvin Electricity Institute estimates that the annual cost of power outages is more than double the cost of preventative intelligent grid investments.

Reliable Power for the Economy: The power system must be modernized to ensure reliable power for the nation's economic well-being. Distributed generation strengthens local economies by creating local jobs and giving individuals, farmers, small businesses, and organizations the opportunity to transform unproductive spaces and agricultural wastes into new sources of revenue. Distributed generation also keeps energy spending local, which has a multiplier effect in stimulating local economies.

Vision of the DG+IG Future

Germany and other European countries have already begun to reap the benefits of modern electric systems. Now is the time for the U.S. to modernize its grid to enable high levels of renewable generation, improve power quality, and enhance system resilience.

Clean Energy: DG+IG makes it possible to integrate high levels of renewable energy, and eventually transition to a 100% renewable energy portfolio. Many renewable technologies, such as wind and solar, have intermittent output that is dependent on weather conditions. However, decentralized power systems with geographically and technologically diverse energy resources minimize the impact of intermittency on system reliability. In addition, intelligent grid solutions enable high levels of renewable generation by balancing energy supply and demand – and voltage and frequency too – without requiring any form of fossil fuel generation.

Higher Quality Power: Many companies need high quality power to protect manufacturing and information technology equipment. A modern energy system balances energy supply and demand locally without disruptions in voltage or frequency. Intelligent grid solutions are extremely versatile at balancing energy, voltage, and frequency and are capable of significantly increasing power quality in a cost-effective manner. Hence, DG+IG is primed for improving power quality by eliminating disruptions caused by the imbalances in energy, voltage, and frequency that too

Overview of Core DG+IG Solutions

Solutions	Features	Benefits
Distributed Generation	• Generates energy close to load using technologically and geographically diverse resources	• Increases power system reliability • Avoids long-distance transmission • Keeps energy dollars close to home
Demand Response	• Incentivizes customers to reduce or shift power consumption as needed to avoid dirty and expensive peaker plants	• Reduces or shifts load at times of highest demand and insufficient supply in order to balance supply and demand of energy • Eliminates need for fossil fuel peaker plants
Forecasting & Curtailment	• Forecasts output from intermittent renewables and reduces supply as needed to facilitate smooth ramping	• Uses forecasting and proactive curtailment of intermittent renewables to balance supply and demand of energy • Eliminates need for new natural gas power plants and dirty/wasteful/expensive spinning reserves
Advanced Inverters	• Provisions fast and flexible reactive power to/from the grid (close to loads where it is needed and efficiently delivered when associated with DG) • Provides fault ride-through	• Provisions free voltage support to/from the grid • Provides critical fault ride-through for stable, efficient, and safe operation of the grid • Facilitates twice the penetration level of intermittent renewables
Energy Storage	• Provides instantaneous generation, load, reactive power, and frequency regulation for smooth grid operations – in the exact form needed	• Provides power and the full gamut of grid services needed for stable and efficient operation of the grid • Provides backup power and grid resilience when other power sources are unavailable and/or if the transmission grid fails
Monitoring, Communications & Control (MC^2)	• Links resources for coordinated and optimized grid operations	• Monitors instantaneous grid performance and communicates relevant data and control signals between grid resources and appropriate decision processing nodes • Enables local grid reliability and resilience

commonly occur in the antiquated electric systems that exist in the U.S. today.

Resilient System: Americans need a resilient electric system that has the ability to ride through potential disruptions, maintain critical services in the event of disruptions, and rapidly recover from unavoidable blackouts. Local energy production makes communities less vulnerable to grid failures – the loss of several small generators has much less impact on the grid than the failure of a single central station power plant or transmission line. Intelligent grid solutions enhance the ability of the grid to ride through potential disruptions by preventing imbalances in energy requirements and associated voltage and frequency levels. Distributed renewable generation leverages secure domestic resources and delivers electricity through the security of local systems – avoiding critical infrastructure risks and vulnerabilities. Modern electric systems provide the foundation for local grids that can "island" to provide continuous power for essential services during widespread grid failures. Several universities and research facilities successfully relied on campus microgrids to "island" their critical power needs during Hurricane Sandy's widespread and prolonged outages. DG+IG solutions can also facilitate rapid grid recovery from blackouts by providing granular control of all major grid elements and loads as power is restored to the grid.

Core DG+ IG Solutions

1

Distributed generation provides geographic and technology diversity, which greatly decreases the impacts of intermittency on system reliability and enables renewables to become the primary source of energy. Greater geographic diversity also decreases the effects of weather on system reliability. For example, passing clouds will have much less impact on the aggregate output of solar panels spread across multiple locations than solar panels grouped together. Similarly, technological diversity makes it possible for renewable resources to serve demand during more hours during the course of a day. Renewable resources that deliver power in the evening, such as wind, can complement renewable resources that deliver power during daylight hours, such as solar. Generating energy close to load avoids the long-distance transmission of energy, while keeping energy dollars close to home.

2

Demand response programs incentivize customers to reduce power consumption during high demand periods as an alternative to increasing supply with dirty and expensive peaker plants. A modern electric system will enable utilities' widespread use of this affordable tool to accommodate increasing levels of intermittent renewable generation.

3

Forecasting & curtailment allows for cost-effective balancing of supply and demand by forecasting output from intermittent generators and curtailing output when supply is greater than demand. This eliminates the need for new natural gas power plants and expensive spinning reserves.

4

Advanced inverters can provision fast, flexible reactive power to manage local voltage issues and provide critical fault ride-through for stable, efficient, and safe operation of the grid. Taking advantage of advanced inverter features is cheaper than building new facilities to provide these services and will allow utilities to defer grid upgrade investments. Installing advanced inverters will enable twice the penetration level of intermittent renewables.

5

Energy storage can provide many benefits to the grid, including instantaneous generation, voltage support, frequency regulation, and smoothing out variability of renewable output. Electric vehicles can act as a combination of distributed energy storage and demand response – responding to real-time pricing signals to charge during hours of low demand or high supply and dispatching energy to the grid when desirable to address high demand.

6

Monitoring, Communications & Control (MC^2) links resources for coordinated and optimized grid operations. Distribution-level data visibility and sufficient granular control enable successful management of a 21st century grid. Eventually, system operators will be able to use MC2 to provide power for critical services during outages.

Policy Recommendations

The Clean Coalition recommends implementing the following paradigm-shifting policy changes to achieve a timely and cost-effective transition to a modern electric system.

1. Integrate Grid Planning: Policymakers should ensure that energy policies developed in different forums and proceedings collectively work together to support an integrated plan for a DG+IG future. Transparent and public distribution planning processes should guide all electricity policy decisions, and utilities should be accountable for adhering to these plans. Transmission grid planning processes should proactively evaluate DG+IG alternatives to new transmission investments. Integrated grid planning will make it possible for states to meet both near-term and long-term renewable energy goals, as well as local generation goals. This approach will also ensure that grid investments are cost-effective for ratepayers in the long-term by accounting for shifts in demand due to climate change and electric vehicles, preventing unnecessary expenditures on soon-to-be obsolete infrastructure, and enhancing the resilience of the electric system.

2. Implement Full Cost & Value Accounting: Policy decisions should reflect the full cost and value of each type of generation, preventing biases against distributed generation. To protect the interests of ratepayers and communities, electric system investments should reflect the full spectrum of impacts on electric rates, economic growth, health, safety, and environmental sustainability.

3. Develop Markets for DG+IG Services: Policies should create and expand markets for grid services provided by DG+IG, including grid resilience, power quality, distribution level visibility and control, and resource adequacy requirements that ensure sufficient capacity to meet peak load. Opening grid services markets to competition from DG+IG will benefit ratepayers. Currently, many DG+IG developers cannot obtain financing because they cannot monetize any or all of the grid services that can be provided by such solutions. For example, energy storage currently does not qualify for resource adequacy compensation in California even though energy storage can provide an unparalleled resource adequacy service. In addition, many grid services markets are structured in a manner that prevents utilities from tapping the economic benefits of owning and operating DG+IG systems.

4. Prioritize DG+IG Development in High Value Locations: Policies should prioritize DG+IG development in locations with higher value for ratepayers. This approach will incentivize market participants to develop projects at the most cost-effective locations and will make it easier for these projects to succeed. Utilities and system operators should be required to pre-identify preferred locations on the grid based on criteria selected by policymakers, such as enhanced resilience or low interconnection costs. Next, policymakers should set "Local Portfolio Standard" targets for DG+IG deployment and streamline interconnection and contracts for these zones.

5. Update Technical Standards: National technical standards that are governed by the Institute of Electrical and Electronics Engineers (IEEE) and Underwriters Laboratories (UL) must be updated to allow DG+IG to provide the vast range of grid services that such technologies are capable of providing. Since most state policies simply reference these national standards, updating these standards is the most effective pathway for policy innovation.