ENABLING TECHNOLOGIES FOR THE
SMART HOME (2013-2)

Research Opportunity Notice

Overall Objective

The objective of this Research Opportunity Notice (RON) is to solicit R&D proposals for disruptive, innovative research and enabling technologies development for the smart home. Proposed R&D may address part or all of the technologies and/or any related technologies which further the goals described in this RON. R&D projects should focus on research or enabling technologies development as opposed to commercial product development.

The research in the above focus area can be applied towards addressing the State's policy goals for greenhouse gases and renewable energy goals. In particular, research into technologies with applications that are smart grid-related or renewable energy integration-related will help with the State's goals.

Background

Advanced Metering Infrastructure (AMI) is being deployed to provide a platform for the next generation of demand-side management applications in California. Dynamic pricing implementations are ramping up to leverage smart meters and home area network (HAN) infrastructure in the future. Limited-scale HAN deployments are taking place to improve understanding of the technical challenges and consumer impacts of HAN technologies. All utilities are actively engaged in shaping industry standards. Other activities include opportunistic exploration into the integration of energy storage, plug-in electric vehicles (PEVs), and other distributed energy resources (DER)[1].

Current AMI deployments are a snapshot of present-day technologies. Enabling technologies research potentially can expand the lifetime of the installed base as technology advances.

California's progressive global climate change and clean energy goals are resulting in changes that will enable customers to actively support the reliable, sustainable, and economic delivery of power to the customer's premise. At the same time, the State's electric distribution system will see a rapid increase in the penetration of distributed generation from renewable energy sources, as well as the need to support new customers' energy service requirements, such as electric vehicles. There is a need in the future for a smart home with capabilities to provide feedback to help customers manage the timing and quantity of their

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[1] California Utility Vision and Roadmap for the Smart Grid 2020, Electric Power Research Institute, CEC-500-2011-34, July 2011.

energy usage; enable third parties, including utilities, to manage energy usage on behalf of customers; and allow customers to adopt environmentally-friendly technologies (e.g., PEVs, solar PV) without sacrificing grid reliability.

Enabling Technologies

Enabling technologies have the potential to mitigate the barriers by making possible new products and applications that result in:

- Better energy efficiency
- Reduced energy and power demands
- Enhanced service reliability
- Accelerated adoption of electric vehicles
- Reduced cost of electricity to rate payers
- Increased lifespan of existing Smart Meter deployments
- Better presentation of energy information to occupants

However, the enabling technologies research must take into account lessons learned from prior and current developments. For example, the integration of smart meter and the HAN have been attempted many times without much success. Lessons learned from those attempts need to be considered.

There are many standards and regulatory organizations working on or funding work on technologies for the smart home; for example how to meter and bill EV charging. Enabling technologies must not be silo'ed; the research must take into account integration with other technologies and as part of a system. Research must not head in a conflicting direction from current standards and regulatory research, to ensure the research will not lead to technologies that are nonstandards compliant, not interoperable or compatible with other technologies, and not able to integrate.

Some Potential Enabling Technologies

1. ***Technologies to facilitate distributed energy storage***
   - For energy shifting, peak shaving, voltage support, or customer backup during outage
   - For modeling, analytics, or optimization
   - At a home or aggregate of homes
   - Improve functional performance
   - Reduce capital, installation, or operation costs
   - For storage media, inverter/power electronics, cooling/ heating systems (where applicable), and overall integration

2. ***Technologies to support DC-direct appliances or DC microgrids***

- For direct current (DC) generated by on-site renewable energy (RE) systems used directly in its DC form to supply DC loads
- For electronics, plug-in Electric Vehicles, and appropriate replacement of AC for typical loads such as lighting and motors.
- For integration of renewables/storage/communication/Building Management System or other controls technologies

3. *Technologies to facilitate demand response.*
   - For smart end-use devices (appliances)
   - For acquisition and dissemination of energy and price information
   - For better presentation of energy information
   - For automatic response to demand response requests
   - For integration and use of local renewable energy resources for demand response (including fail-safe electronics)
   - Intelligent algorithms to integrate the use of local energy storage for demand response and un-interruptible power supply

4. *Technologies for customer energy management.*
   - Intelligent/upgradable protocol bridges to current and future HANs
   - For low-cost gateway or bridge from meter
   - Home area network (HAN) and 2-way communications
   - For smart end-use devices and systems (e.g. appliances, pool pumps, and HVAC)
   - For acquisition and dissemination of energy and price information
   - For energy use automation, control, and optimization (local and remote)
   - Facilitate use of 3rd-party "cloud" services

5. *Technologies to help integrate electric vehicles.*
   - Vehicle-to-Grid 2-way communications
   - Vehicle-to-Grid 2-way electric flow
   - Vehicle-to-Grid 3rd-party business processes (e.g. energy payments and sub-metering)
   - Voltage and frequency regulation capability
   - Integration and coordination with renewable energy resources.

Summary

The purpose of this RON is to solicit proposals for research and development of enabling technologies for the smart home. The outcome of these research and development efforts is not to produce a product but to advance the enabling technology that will contribute to a future smart home that is more energy efficient, better demand responsive, and support the state-wide efforts to develop and deploy a more cost-effective, efficient, and reliable distribution grid.

Candidate research topics are listed in the prior section.   Proposals may address these research topics or other related topics not listed that further the goals described herein.

Acronyms

AMI	Advanced Metering Infrastructure
BMS	Building Management System
DER	Distributed Energy Resources
DR	Demand Response
HVAC	Heating, ventilation, and air conditioning
PEV	Plug-In Electric Vehicle
PV	Photovoltaics
R&D	Research and Development
RON	Research Opportunity Notice

Definitions

Advanced Metering Infrastructure	Advanced Metering Infrastructure refers to systems that measure, collect and analyze energy usage, from advanced devices such as electricity meters, gas meters, and/or water meters, through various communication media on request or on a pre-defined schedule. This infrastructure includes hardware, software, communications, customer associated systems and meter data management software.
Demand Response	Reducing demand in response to a curtailment notification or short term price signal
Distributed Energy Resources	Distributed energy resources are small-scale power generation technologies (typically in the range of 3 to 10,000 kW) located close to where electricity is used (e.g., a home or business) to provide an alternative to or an enhancement of the traditional electric power system
Vehicle-to-Grid	Electric-drive vehicles, whether powered by batteries, fuel cells, or gasoline hybrids, have within them the energy source and power electronics capable of producing the 60 Hz AC electricity that powers our homes and offices. When connections are added to allow this electricity to flow from cars to power lines, we call it "vehicle to grid" power, or V2G. (http://www.udel.edu/V2G/)
Microgrid	A microgrid is a semiautonomous grouping of generating sources and end-use sinks that are placed and operated for the benefit of its members, which may be one utility "customer," a grouping of several sites, or dispersed sites that nonetheless operate in a coordinated fashion. (http://der.lbl.gov/microgrid-concept)