# Hawaii Renewable Energy Development Venture
## Technology Assessment
# "Smart Grid" Technologies

## 1. Overview

The electric power system has undergone extensive changes over the past several years and has become substantially more complex, dynamic, and uncertain as new market rules, business practices, regulatory policies, and new grid technologies (generation resources, transmission and distribution, energy storage, and end use technologies) have been adopted. And, as our society moves from an analog to a digital age, the requirements for high-end power quality will increase. The means to utilize more information and to better stabilize the system have not kept up with these changes.

Various definitions of what is meant by a "Smart Grid" have been presented over the recent years and are part of a significant solicitation as part of the current national administration's stimulus package. The consensus on what is a true "smart grid" has yet to emerge. That said, there are a number of attributes and systems that will belong in a "smart grid" and are enumerated here.

One reason for having a "smart grid" is to address the substantive increase in distributed energy resources (DER), most of which are renewable energy resources, on the grid. Some of these needs are covered in other parts of the HREDV technology assessments and will not be covered here. These include improvements to renewable energy systems, energy storage systems, and integration of the transportation and electricity sector through the commercialization of plug-in hybrid vehicles. Thus, this assessment focuses on other parts of "smart grid" systems: wide area monitoring and control, substation automation, distribution automation, advanced metering infrastructure, and advanced communication, control, and information systems.

These technologies, coupled with those discussed in other assessments, should serve to address the functions of a new "smart grid." These are:

1. Enabling the informed participation of end users;
2. Accommodating all generation and energy storage options;
3. Enabling new products, services, and markets that are beneficial to the overall economic well-being of the state;
4. Providing power quality consistent with the emergence of the digital society;
5. Optimize electric utility asset utilization and allow for efficient operation of these facilities;
6. Address disturbances to the grid (the concept of the self-healing grid) by using automated prevention, containment, and restoration; and

7. Be resilient in the face of potential physical or cyber attacks as well as being more resilient to natural disasters.

## 2. Status of Commercial Readiness

The pace of technology development is extremely rapid in this area. The current technology assessment will most certainly be outmoded in as little as six months. Any technology developer and provider responding to HREDV solicitations should – first of all – be involved in discussions with end users of these technologies. This will most certainly include the state utilities. Other collaborators should include the end user community that would be defined by the nature of the technology being proposed. While it is clear that the pace of development is rapid, there are five technology areas that can be considered in this overall technology space. A brief description follows for each.

Advancement of integrated communications will be a key for any "smart grid." These technologies will be connecting components to open architectural systems for real-time information and control. These technologies will allow every part of the grid to both "talk" and "listen."

The development and deployment of sensing and measurement technologies is also critical. The concepts of resiliency and power quality, to name just two of the points in the preceding section, cannot be brought to fruition without these systems. Sensing and measurement technologies are required to support faster and more accurate responses for such needs as remote monitoring, time-of-use pricing, demand side management, and demand response (peak demand reduction).

Materials research and development activities will also be important. Advanced engineered components that can be placed on the grid can take advantage of new developments in areas such as superconductivity, energy storage (covered in a different assessment), power electronics, and power diagnostics.

The development and deployment of advanced control systems, with related operational methodologies, is also important to the "smart grid." Control systems are needed to monitor critical components, enable rapid diagnosis of systemic problems, and develop precise solutions appropriate to any event. This can be important to Hawaii as the electricity grid operates on margins of error much smaller than mainland systems, owing to the relative small size of our systems.

All of these fundamental technologies must rely on improved interfaces and on rapid and accurate decision support systems. Given the rapidity of decision-making needs on the grid, it is necessary to find technological approaches to improve human decision-making. This can allow for the improved operation of the grid by utility system operators and their management.

All of these technologies must be considered in the context of incorporating other technologies into the overall grid. The intent will be to demonstrate and deploy these systems that, to the extent possible, will be integrated with one another at early stages of the deployment. Simply placing one new technology on the grid does not make the grid any "smarter," if these technologies operate in isolation.

### 3. Appropriateness to Hawaii

These technologies must lend themselves to meeting state of Hawaii goals for clean energy as presented under the Hawaii Clean Energy Initiative (HCEI). The goal of HCEI is to have a reduction of 30% of projected growth in electricity use as a result of accelerated end use energy efficiency and demand side management by 2030. HCEI goals also required that 40% of delivered electricity come from renewable energy resources by 2030. These are certainly stretch goals and will not be achieved without substantive increased deployment in various "smart grid" technologies between now and 2030.

The deployment of these technologies will need to incorporate changes in regulations such as the development of:

1. Dynamic pricing or time-of-use pricing;
2. Changes in DER interconnection rules;
3. Development and enhancement of feed-in tariffs;
4. Rules that will benefit electric vehicles; and
5. Data sharing.

Hawaii is currently ready to address these issues. Thus, the deployment of these technologies is appropriate considering the rule changes being developed and/or considered.

In addition, technology providers in this area will need to work with the state utilities in order to capitalize on the most efficacious way to use these technologies. This would include, in addition to areas described in the preceding paragraph, uses such as:

1. Load participation;
2. Development of microgrids;
3. Optimal incorporation of distributed energy resources and energy storage;
4. Optimize grid-responsive load;
5. Improve transmission and distribution reliability and automation;
6. Optimize use of advanced meters and sensors;
7. Develop and deploy better technologies for dynamic line rating;
8. Address cyber security and physical surety issues; and
9. Improve power quality.

The means for addressing new technologies must provide solutions that will optimize the operation of the grid in these areas. Since Hawaii is embarking on a significant effort to stop using oil and use more distributed resources for generation – and that these are indigenous renewable resources – this technology area is appropriate for development as part of this project.

## 4. Considerations Related to this Technology Area

This is an area ripe for deployment of new technologies. These systems are ones that may have been developed for exogenous uses other than for an electricity grid. Deployment of these technologies in a correct manner will almost certainly lead to an increased amount of end use energy efficiency and utilization of indigenous renewable energy resources.

The key will be to allow for the training of both the utility system operators and the end use customers. In the case of the utility system operators, an observation has been made that it may be difficult to link IT (information technology) to electrical engineering. For end users, in the long run a sufficient percentage of end users must be involved in order to make this whole effort worthwhile. Thus, the final consideration is to enable the informed participation of the consumer. This will require – over a period of time – that:

1. A significant percentage of customers will be capable of receiving information from the grid;
2. A significant percentage of customers will either opt to make decisions with this information or notify the utility that they delegate this decision-making back to the utility or to a third party;
3. A sufficient number of communications-enable devices are on the customer side of the meter;
4. A sufficient number of customer-side metering devices will be sending and receiving signals from the grid;
5. The amount of load managed in this way will be large enough to have an impact on overall electricity use; and
6. The end result will lead to energy and financial savings by end users, while still allowing the company a reasonable rate of return.

If these conditions are met, this is an appropriate area of funding under this new project activity. The insertion of these technologies is a key component of the overall needs of a future “smart grid.” The deployment of these technologies can be done initially with relatively small amounts of funding for proof of concept. Larger amounts of funding can flow from successful pilots. These in turn are consistent with how the state of Hawaii wishes to proceed under HCEI.