

DOE-ID NEPA CX DETERMINATION

Idaho National Laboratory

SECTION A. Project Title: MICROGRID DEMONSTRATION PROJECT

SECTION B. Project Description:

The current state of the United States (U.S.) electric grid is likely incapable of supporting the Department of Energy (DOE) goal of producing 80% of U.S. electricity from clean energy sources by 2035, as stated in the DOE Strategic Plan, May 2011. Supporting such a goal will require increased system flexibility to reliably integrate new, variable, and diverse resources. The energy generation portfolio that exists within the U.S. to date consists mainly of centrally located base load power. Renewable energy integration becomes more difficult as the limits of the existing infrastructure are stretched. The challenge continues to be delivering new technology such as advanced power electronics, controls, communications, and metering, coupled with techniques to better integrate transmission and distribution planning and operation with renewable generation and demand forecasting to enable the needed flexibility across the energy system.

The proposed action would provide a state-of-the-art test bed at the Idaho National Laboratory (INL) for analyzing and dissecting the dynamic, coupled behavior of renewable energy generation, traditional generation, and load. The proposed action would allow direct testing and demonstration of various hardware, electrical, mechanical and controls interactions which may be difficult or impossible to accurately stimulate when fully coupled to a microgrid system. A microgrid system is a localized grouping of electricity generation, energy storage, and loads that normally operates connected to a traditional centralized grid. The purpose is to determine the contribution of variability from renewable generation versus load.

A major research focus of the project would be to construct, analyze, and model the characteristics of common, controllable loads that have the potential to significantly impact (positively or negatively) renewable energy integration. Understanding the scaling and expansion of distributed generation profiles is a significant research effort of the proposed action, and would build on the renewable energy assessment expertise and measurement data sets and techniques developed at INL and other national laboratories over many years. This would be accomplished through the following tasks and objectives:

1. Develop a standard, open-source smartgrid platform, the INL Smartgrid Energy Management System (iSEMS), for systems integration, communications, metering and control of a microgrid, including provisions for island-mode operation and utility grid interaction and support modes.
2. Couple the load characteristics obtained from iSEMS with distributed generation microgrid characteristics as well as regional weather geographical distribution effects on these systems to generate expanded models of larger systems as inputs to economic and system dynamics models utilizing MEGS, Real Time Digital Simulation (RTDS) or other modeling systems to characterize impact potentials and costs.
3. Establish industry collaboration and hardware and software integration and improvement utilizing state-of-the-art power electronics converters and charge controllers and smartgrid energy management/operations/controls systems software platforms.

A secondary purpose of iSEMS is to provide an applied research testbed for testing hardware interactions between components, utilities and control and communication systems. Specifically, this would target equipment such as inverters, charge controllers, two-way charging stations, power converters, protective relaying and reclosing systems, anti-islanding techniques, voltage and frequency control interactions, grid-tie and off-grid inverter designs, phasor measurement unit interactions and placements within areas of large volume distributed generation.

The microgrid platform would include distributed generation hardware and/or inputs, such as fixed solar photovoltaic (PV), tracking PV, distributed Concentrated Solar Power (CSP), Combined Heat and Power (CHP) and/or other fueled generation, small wind, or measured generation signature inputs from existing regional assets where INL collaboration has been or can be established (large wind, hydro, PV, geothermal). The microgrid would also include controllable loads such as thermal or battery storage and interface control of those loads into the microgrid system. Controllable loads would also include programmable and remote controllable load bank for simulations and testing. This project would target power converters and related equipment in the <150kW size range which would keep projects costs manageable while building an easily scalable system for demonstration and research. Also, power electronics equipment is currently more readily available and cost competitive in the 5-150kW size range when considering distributed generation (PV), battery storage and commercial applications. Opportunities for improving standardization and plug and play functionality are also currently more significant in the distributed size range discussed here. Targeted industry hardware/software includes grid-tie and on-grid/off-grid inverters, smart inverters with voltage control, charge controllers and DC management/control systems, microgrid and smartgrid software and controls, Energy Management System software interface/integration, metering products, and grid-tie and off-grid battery systems.

The proposed action would construct, analyze, and model the characteristics of common loads that have the potential to impact (positively or negatively) renewable energy integration. The first task, to be completed in year 1, would be to construct a physical load emulator as a modular component in the Energy Systems Laboratory (ESL). This emulator would be reconfigurable to represent any combination of residential, commercial, and industrial behaviors. Of particular interest in terms of renewable power integration are loads connected to thermal, electrical, or chemical storage, such as batteries/chargers, chillers, ice or heat storage (building heating and cooling, hot water), compressors, large capacitors, or dryers. These loads have storage components which make them ideal

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candidates for becoming grid-responsive with the appropriate controllers. In addition, standard resistive, inductive, capacitive, and complex loads such as motors would be included in order to emulate load that may not have added value if controlled in response to unforecasted variability. By the end of year 1, this emulator would demonstrate that it replicates dynamic power consumption profiles from loads that have been monitored on a utility partner's system. These efforts would also include incorporation of several of the distributed renewable energy generation and power electronics and control components, but would not include variability from renewable generation or load management schemes.

By the end of year 2, researchers would demonstrate a fully-emulated islanded system consisting of traditional generation, renewable generation (primarily wind and solar photovoltaic), and variable load. The goal of this demonstration would be to characterize and separate profiles of dynamic load profiles from dynamic renewable generation profiles over multiple time scales.

Year 3 of the research would leverage the findings of the previous years to design a controller that would transform selected loads into dynamically grid-responsive storage resources. Previous work has shown that loads with thermal storage components can provide a large component of dynamic response necessary to integrate high penetrations of variable renewable generation. INL has designed a control algorithm that eliminates these faults by operating in a fully autonomous mode and providing simple calculations of economic value. Validation of the algorithm would require iterative modeling, building, testing, and evaluation of the controller's operation when connected to several of the load emulator's devices.

The proposed action would include the following activities:

1. Install Roxtec wall penetration system on the west side wall of the Energy Systems Laboratory (ESL) high-bay, a 480V three phase 200A fused disconnect switch and weld plug on the outside of the wall, and conduit and wiring from the West side lpack switchgear spare 225A breaker to the disconnect switch. This would allow renewable energy generation equipment (solar array, solar trailer, wind, CSP, battery banks, inverters, control trailer) to be installed outside, and microgrid equipment to be able to interface between outside and inside the highbay depending on the particular research scenario being performed.
2. Equipment and research linkages development in year 1 would include the following:
 - a) 7.56kW (DC rating) of solar photovoltaic (PV) panels (280W per panel). This is an array, approximately 60' x 70', of a portable ballast (1800 lb cement blocks) mounted racking system.
 - b) 1.25kW of solar PV panels for microinverters (6-7microinverters and 5 PV panels and associated cabling).
 - c) Ballast mount racking system for above panels (ballast mount to enable system portability, orientation changes for research, and reduce project costs for ground penetration design and reviews).
 - d) PV system combiner boxes and collector system cabling and hardware.
 - e) One string inverter for 7kW PV panel system.
 - f) One or two 4-quadrant power converters capable of demand response, voltage and frequency support/regulation, battery charging and discharging, EV charging, peak shaving, etc.
 - g) Solar PV trailer (approximately 10' by 20') moved from the Center for Advanced Energy Studies (CAES) to the ESL and connection into microgrid system (trailer includes 3.4kW of PV, two inverters capable of both on-grid and off-grid operation, lead-acid battery system at 24VDC and 1568 Ah of capacity, and room for other new distribution panels and transformer(s)).
 - h) Ground rods (and associated subsurface investigation), equipment grounding conductor and associated hardware, etc.
 - i) Unistrut, bang-boards, fused disconnect switches, three phase plugs/connectors, SO cable (multiple sizes depending on each load and NEC-based design), cable ramp/raceway protection, etc.
 - j) One to two 25kW transformers, 480-240/120V single/split phase.
 - k) One 480V three phase distribution panel with 200A main breaker and sub breaker sizes that would be determined during system design. Two 240/120V single phase distribution panels, 100A mains, one for load trailer and one for bang board distribution to be located in solar trailer.
 - l) Portable load trailer that would be located inside or outside the highbay depending on research scenario. The trailer would include heat pump water heating/storage system, electric forced-air heating system, IceBear air conditioning system with ice storage, portable programmable load bank (with communications , control and auto-operation capabilities) sized at 100-300kW (would include both resistive and reactive load), micro/smartgrid control system and hardware components (i.e., microcomputers/PLCs, load control via inverter or controller or circuit contactors, etc.) including displays showing power flows and energy storage levels. Other controllable loads may be added in year 2 such as pump systems, typical appliance loads, etc.
 - m) A 2005 Honda ES 6500 Generator mounted on the portable trailer and used approximately 100 hours or less per year.
 - n) Metering and control of microgrid loads and generation. Communications systems both within the microgrid and for connections to other projects would be determined and designed as the project progresses (continuing into years 2 and 3), to enable multiple uses of the data both in real-time and historical applications, within Hybrid Energy Systems (HES)/cross-cutting, RTDS, National Homeland Security (NHS), Instrumentation Control and Intelligent Systems (ICIS), battery group, Human Factors control room display/use, etc.
 - Some existing meters may be available from ICIS project and from our renewable energy group equipment. If the ICIS meters are available, research linkages would be further developed with that project and its related projects and industry partners.
 - o) Additional small-scale battery storage would be considered for the microgrid system, most likely a commercially-advanced off-the-shelf system such as Li-ion types from Corvus/Dow Kokam, Panasonic, Saft, GE, Valence, hybrid from IndyPower, or other.

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- p) Small wind turbine could be added to the system. The turbine would be approximately 70' tall, with the overall tip height of less than 98'. A pier-type concrete foundation may be needed and would be addressed (including possible revision of this environmental checklist) if installation occurs. The Federal Aviation Administration (FAA) requires wind turbines that are 200' or taller to be filed and those 100' or taller to be lighted. The proposed wind tower is below the height that would trigger FAA requirements for filing and lighting and would be similar in height to buildings, structures, and vegetation in the vicinity. Additionally, the tower would not be located in an approach or circling zone for the Idaho Falls Regional Airport. Turbine zoning would follow City of Idaho Falls planning and zoning process, and if that process determines a separate need to file with the FAA or state, project personnel would follow that guidance.
- q) An electrical vehicle (EV) charging system would be added to the smartgrid system and integrated with vehicle battery group. This equipment, and occasionally EV(s) or other battery systems, would be located in the highbay. Future connections to larger grid-connected or secondary-use vehicle battery storage systems would be considered and program-developed with the battery group as the project progresses and information is obtained. The microgrid and battery equipment would be located inside the highbay, close to the west end. As other HES hardware system implementations develop needs for space on the thicker concrete floor on the west side of the highbay, project personnel would analyze methods or modifications (adding cabling, overhead cable trays and/or other routing methods or facility modifications) to relocate equipment to other areas of the highbay.

3. Years 1 and 2 would include work control planning and development, facilities integration and other planning and labor to get the equipment and research plans in place and connected.

4. Year 2 would include further micro/smartgrid control programming and development, applied research and collaborative developments with university/student/INL research and potential industry partners, and communication and linkage developments to other projects. Research and demonstration tests would be developed, planned and executed, and may continue into year 3. Development/collection of other renewable energy generation signatures for larger off-site systems would be started, and arrangements developed with partners (utilities, independent power producers, Department of Defense, renewable projects, etc.). This data would be used to assist in the development of larger scale modeling systems and linkages with other INL projects.

5. Other equipment and/or related research elements being considered for addition to the system, some dependent upon other proposals (both external and internal):

- a) Stirling multi-fuel genset system (linking to INL's Biofuel programs)
- b) Stirling Dish CSP system (both solar heat operated and/or multi-fuel model options). A pier-type concrete foundation may be needed and would be addressed (including possible revision to this environmental checklist) if installation occurs.
- c) 20-50kW small wind turbine system and associated floating foundation and linkages to offshore power research
- d) Fuel cell or microturbine generator systems
- e) Smart PV inverters/testing
- f) Diesel or propane genset systems (most likely leased), and other distribution system voltage regulation equipment.

6. Year 3 would include additional systems testing and development, research modeling linkages, and model scaling to larger systems. Year 3 would also include system controller design efforts and industry collaboration development, as far as funding allows. Grid/electrical and economic modeling software will also be utilized for this project.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions: Portable gas and/or diesel generators, < 100 kw, with operation limited to short testing/research scenarios (< 100 hrs/yr) would be used. The office building simulator would have an A/C cooling unit (Ice Bear, < 5 ton). All other loads and generation are standard electrical equipment, including solar PV, wind turbine, lead acid or Li-ion batteries, and typical electrical loads such as heaters, water heater, etc. The Solar CSP system may also use a stirling generator that could be heated with other fuel sources besides solar (such as propane or biofuel).

There is a potential for construction activities to generate fugitive dust. All reasonable precautions would be taken to prevent particulate from becoming airborne. If dust control methods are required, the date, time, location, and amount/type of suppressant used must be recorded in the project records. These records are used to demonstrate compliance with the INL Title V Air Permit. Personnel are responsible for working with the PEL to determine if any permitting requirements apply to generators and other equipment and, if necessary, obtaining the permit and maintaining a file of the documentation. This requirement does not apply to mobile equipment (an engine that is connected to a drive train to propel a vehicle). Prior to purchase or lease of fossil fuel generators, a review by the Program Environmental Lead (PEL) would be performed to identify the applicable environmental requirements. Such review may result in a revision or modification to this EC.

Disturbing Cultural or Biological Resources: Construction of a wind turbine could impact migratory birds and bats. If dead birds are found under the wind turbine, project personnel must notify Jen Nordstrom (526-8119), the BEA Technical Point of Contact (TPOC) for migratory bird support for guidance regarding management of carcasses in compliance with the DOE-ID Migratory Bird Treaty Act Special Purpose Permit. If dead bats occur in the vicinity of the wind turbine, project personnel must contact Jericho Whiting (525-9358 ext. 130) at Gonzales-Stoller Surveillance (GSS) for guidance on managing the carcasses.

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Generating and Managing Waste: All waste generated from this activity would be managed in accordance with laboratory procedures. Pollution prevention/waste minimization would be implemented where economically practicable to reduce the volume and/or toxicity of waste generated. All waste generated would be transferred to Waste Generator Services (WGS) for appropriate disposition.

Releasing Contaminants: Because this project would use petroleum products and possibly other potentially hazardous industrial chemicals, there is the potential for release of small amounts of contaminants into the air, water or soil.

To minimize the potential impact of contaminant release, project personnel would use non-hazardous chemical substitutes in the place of hazardous chemicals as long as the non-hazardous substitutes meet the requirements/specifications of the requester. Project personnel would apply spill prevention/minimization measures during chemical use and storage and will reference Affirmative Procurement (Management Control Procedure [MCP]-592) as guidance to procure appropriate chemicals.

Using, Reusing, and Conserving Natural Resources: All materials would be reused and/or recycled where economically practicable and as accepted by the customer. All applicable waste would be diverted from disposal in the landfill where conditions allow. New equipment would meet either the Energy Star or Significant New Alternatives Policy (SNAP) requirements as appropriate (see <http://www.sftool.gov/GreenProcurement/ProductCategory/14>). In addition, the project would practice sustainable acquisition, as appropriate and practicable, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting, have recycled content, or are non-toxic or less-toxic alternatives.

<p>SECTION D. Determine the Recommended Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.</p>
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For Categorical Exclusions (CSx) the proposed action must not: 1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of DOE or Executive Orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: 10 CFR 1021, Appendix B to subpart D, item B5.15 "Small-scale renewable energy research and development and pilot projects."

Justification: Project activities described in this EC are consistent with 10 CFR 1021, Appendix B to Subpart D, item B 5.15, "small scale renewable energy research and development projects and small-scale pilot projects, provided that the projects are located within a previously disturbed or developed area. Covered actions would be in accordance with applicable requirements (such as local land use and zoning requirements) in the proposed project area and would incorporate appropriate control technologies and best management practices."

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) Yes No

Approved by Jack Depperschmidt, DOE-ID NEPA Compliance Officer on: 03/24/2014