GM Stokes
Stony Brook University

AEGIS: A VISION FOR COLLABORATIVE RESEARCH

U.S. DEPARTMENT OF ENERGY | Office of Science
BROOKHAVEN NATIONAL LABORATORY

For today

- AEGIS is a proposal for a collaborative research facility serving the Northeast.
- AEGIS is particularly targeted at the emerging challenges facing the electric distribution system.
- The research agenda of AEGIS is intended to meet the joint interests of the region's distribution utilities.
- The facility would be constructed to support missions involving research, training, post-event analysis and the demonstration and testing of new technologies.
- The outcome of this research can be greater resilience and reliability – fast recovery and lower costs.
- AEGIS is a work in progress of which I will describe the status of today.

Historical Context

- In 2010 BNL developed several concepts based on internal discussions and external scanning:
  - BNL chose to focus primarily on utility problems of the Northeast working directly with utilities to identify and solve those problems
  - BNL decided to explore the construction of an analog to the Electricity Infrastructure Operations Center (EIOC) at PNNL, but focused on the distribution system.
  - BNL began to build the infrastructure for the use of the BNL site as an experimental apparatus for studying renewable integration, sensors, and energy storage.

- The concept for a distribution center EIOC analog was christened the Advanced Electric Grid Innovation and Support (AEGIS) Center in April 2010 and work on elements of the design of the equipment and staffing took place throughout the summer of 2010 as did a search for a location.

- Development of a solar research array and its associated micro-grid, the Northeast Solar Energy Research Center, began in FY 11.

These concepts had and continue to have value, impact and importance to DOE

- The electric grid is being transformed by several factors:
  - The infrastructure is aging and vulnerable and needs to be replaced over the next several decades
  - Information technology is transforming the way in which the grid can be managed
  - Renewable energy supplies, valuable yet intermittent, are challenging the existing grid management paradigm
  - Demand is increasing for power of greater reliability and quality
  - New technologies are emerging and need to be integrated effectively into the grid.
  - NY State and the Northeast have fundamentally different grid challenges than other parts of the country and that until recently have been underserved by DOE

Over the past 4 years, BNL has spent a lot of time trying to develop a deeper understanding of the needs and “circumstances” of the distribution utilities of the Northeast.

PATH TO THE CURRENT CONCEPT

What have we learned?

- Our experience with ORU has shaped our view of the importance of model-centric approaches to the distribution (and transmission) system and of the power of high speed (faster than real time) load flow analysis.
- The application of the DEW modeling system to our grid (BNL's microgrid) suggest a broader role for modeling in the microgrid domain.
- Working with LIPA and PSEGLI we learned that the wholesale replacement of current models used for planning and operations is not a short term proposition. Enabling better and broader use of the current tools is important.
- Through a several workshops we discovered that the use of Probabilistic Risk Assessment (PRA) is of growing interest in the utility community
- Through the involvement of the BNL atmospheric sciences staff we learned the the importance of forecasting – not only of weather events but also renewable resource availability.
- An analysis of resilience done in collaboration with ORU suggests very strongly what we have believed all along – the smart grid improvements have benefits far beyond original scope (e.g. distribution automation) – better understanding of these benefits can accelerate adoption.
- The evolving concept of micro-grids and and microgrid-like control strategies suggests that a place where there concepts can be developed and tested is of even more value.

Our view was that the “intelligence” in the smart grid is going to ultimately come from and be reflected in simulation

- The state of Grid Simulation at the time we began our work:
  - One scenario at a time for a given set of load conditions, base network configuration and generation dispatch conditions.
  - Typically, this is limited to running a set of outage conditions for a given scenario. Each condition took much longer than real time!

- Massive computing power (and better algorithms) opens the door
  - One can provide trajectories of load and generation automatically for the tested outage conditions.
  - In addition, several assumed system models can be tested with results compared to actual experience. These are done with iterations in the "sub second" category.

- Our mental model of the future of grid modeling was driven in part by weather forecasting – data driven simulation.

The Emerging AEGIS Scope

- **A secure facility patterned after the PNNL EIOC but designed to solve the problems of the electric grid primarily at the distribution level, with an emphasis on the Northeast.**
- **An analytic capability for studying grid health performance as well as supporting the study of the impact of new technologies and control strategies – using a model-centric approach – and extracting more value and performance out of the existing grid.**
- **An ability to model and understand how micro-grids and associated technology and concepts might impact the distribution system of the future,**
- **Access to the key operational data and models for the Northeast and beyond to support real-time analysis with concurrent modeling generating response scenarios.**
- **Situation room capability for partners to take analysis off-line and to study the results of simulations and scenarios in a private setting – on and off the Brookhaven site (e.g. the AEC at SBU or partners facilities). These off-line analyses can range from the application of PRA to the real-time use of weather data to improve operations.**

- **Interesting – but lower initial interest.**
  - **SCIF capability to support access to classified data, compartmentalized from more general, yet still sensitive, operational data, allowing support of the DHS mission.**
  - **Fully capable of serving as an emergency control center for multiple partners and some concurrently.**

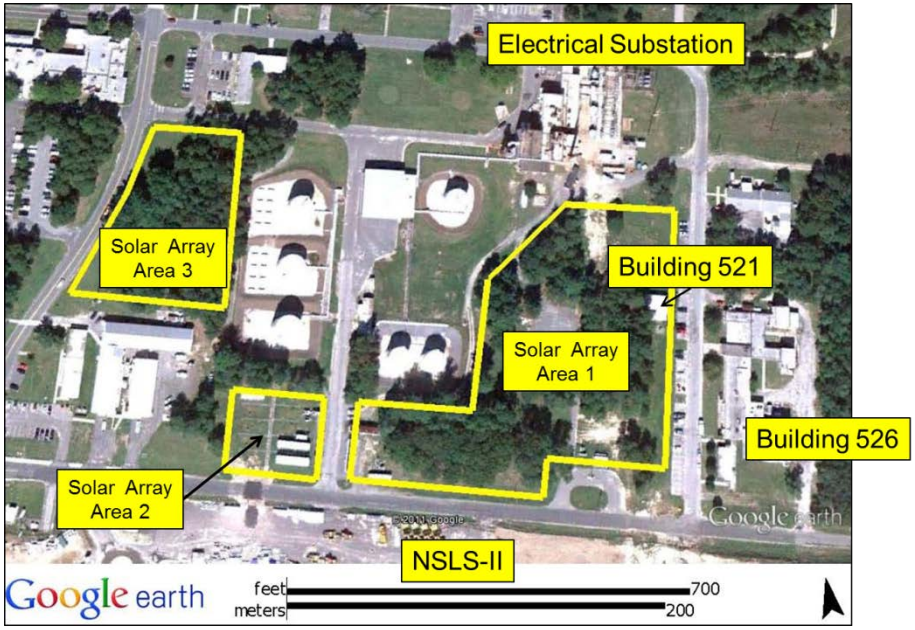
AEGIS IS PART OF A THREE FACILITY STRATEGY

The BNL Microgrid: A unique multi-valued asset

- The BNL micro-grid equipped as a demonstration, test and evaluation center for new grid related technologies. Specific components include:
  - A dedicated solar array integrated into the BNL grid, a federal enclave that can be used for testing integration schemes and to test inverters and related technologies.
  - Pads for the placement of grid scale storage for the purposes of technology demonstration and to test energy management strategies.
  - The ability to place experimental sensors and control devices on the BNL grid.
  - Fully modeled…

NSERC takes advantage of the federal enclave status of BNL

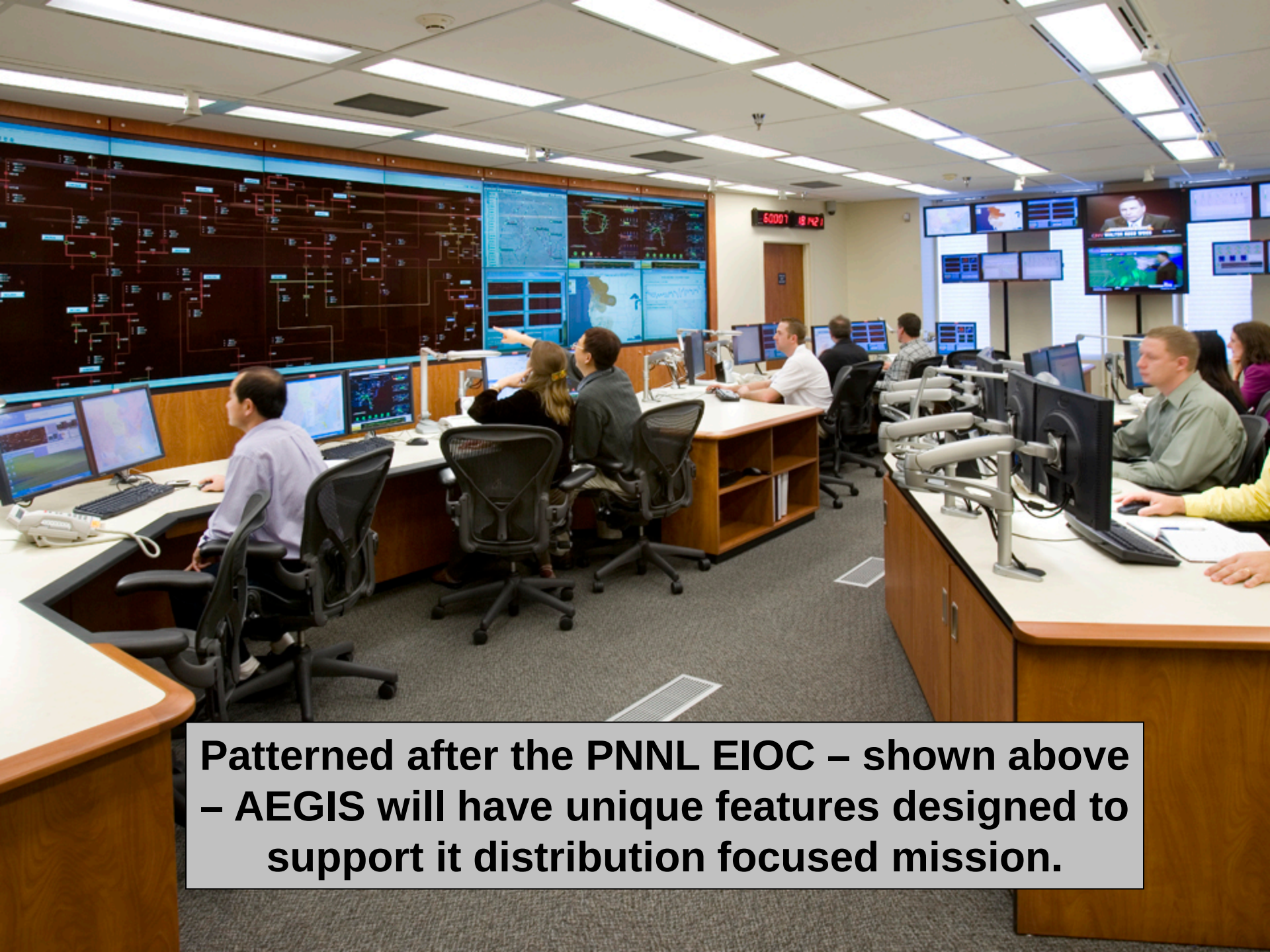
- Fills important gap for pre-commercial research for smart grid & renewable energy technologies
  - Enables research in microgrid design and control w/demand response
  - Reconfigurable Solar Array
    - Variable solar generation/penetration levels
    - Different energy harvesting topologies
- A unique "plug and play" for testing advanced technologies
  - Microgrid controls
  - Inverter testing from utility-scale to string level and micro inverters
  - Storage systems
  - Solar module testing (reliability and degradation)
  - Demand response
- Capability of broad interest to utilities, businesses. universities across NYS & NE



LIPA Long Island Power Authority
EPRI Electric Power Research Institute
Orange & Rockland
Urban Electric Power
United Technologies Research Center
AutomatedLogic
PVMC
BlueStream
Stony Brook University
Clarkson University

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY



Patterned after the PNNL EIOC – shown above – AEGIS will have unique features designed to support it distribution focused mission.

AEGIS is made up of specialized facilities

- Control room
  - Basic need: Working with utilities requires a familiar setting. PNNL uses this kind of setting for display of data; testing display technologies; training; post-mortem analyses; getting operator input on analysis products; and, demonstrations.

- Distributed Asset Management facility
  - A place for developing microgrid management systems and perhaps operating them.
  - The BNL micro-grid will be monitored and perhaps managed from the facility.
  - A place for testing ideas about dynamic micro-gridding, recovery strategies and off-line modeling support.
  - Connected to main control room to simulate and test the protocols for communication between a main control room and satellite control facilities

- Situation room
  - Rooms designed for analysis in support of operations
  - Some rooms will be isolated, but some will have observation ability of a control room(s) [including microgrid versions] and the ability to interact with them.
  - Could be replicated at a remote site for training and collaborative interactions.

The infrastructure is scaled to the support the facilities

- Computing power:
  - To support modeling and large scale data manipulation
  - Proprietary software installation will be required
  - BNL computing resources will be accessible.

- Data storage
  - Storage for modeling results
  - Storage of utility data (security issues – not insurmountable)

- Communication
  - High speed for normal data transfer
  - Will meet appropriate security requirements

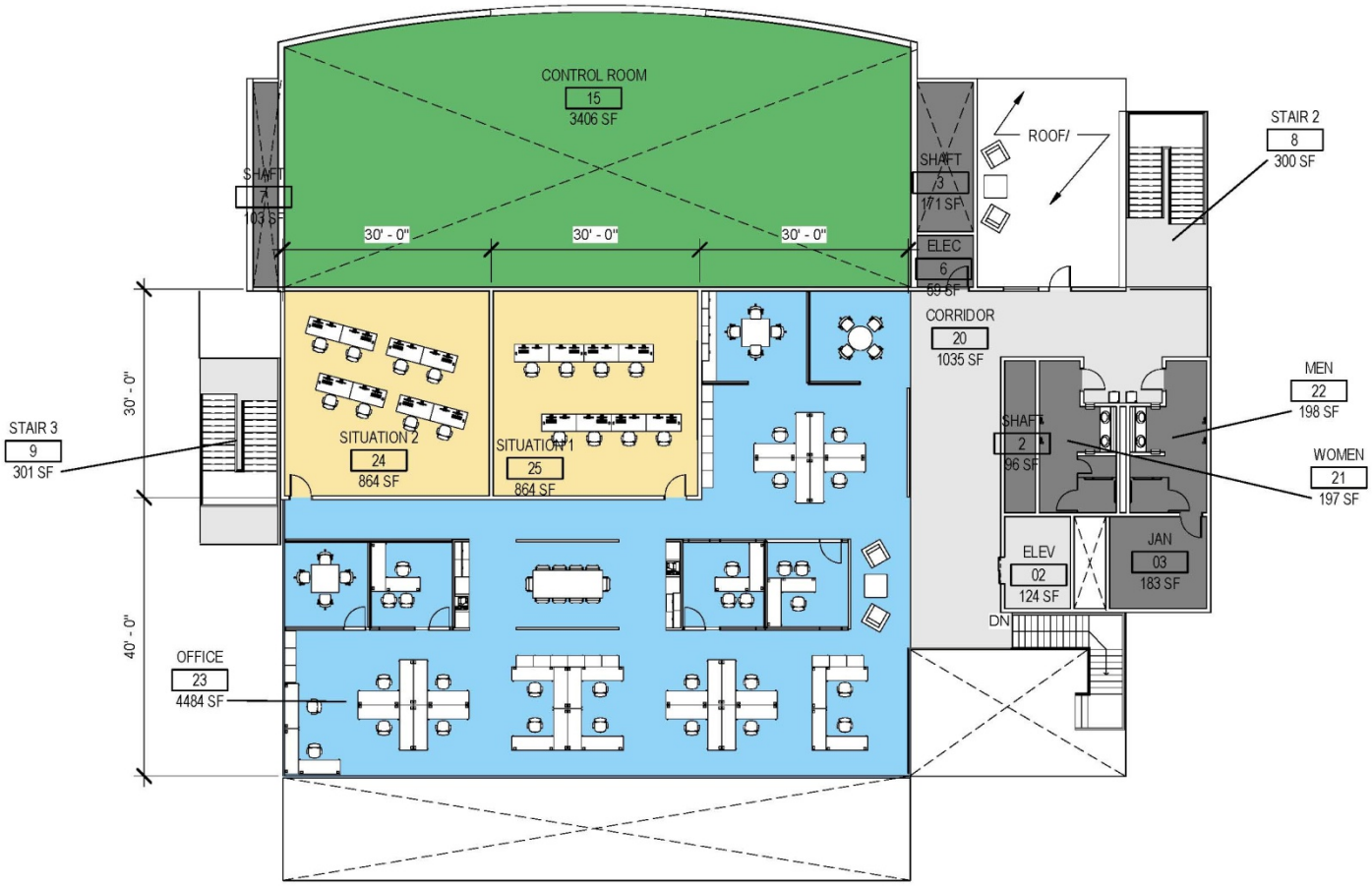
- Security
  - Physical infrastructure and data security all depend on scope of the work

PROGRAM

- CIRCULATION
- CONTROL ROOM
- DISTRIBUTION ASSET MANAGEMENT
- KITCHENETTE
- OFFICE
- SITUATION ROOM
- SUPPORT
- SYMPOSIUM/LOBBY

ENERGY | Office of Science

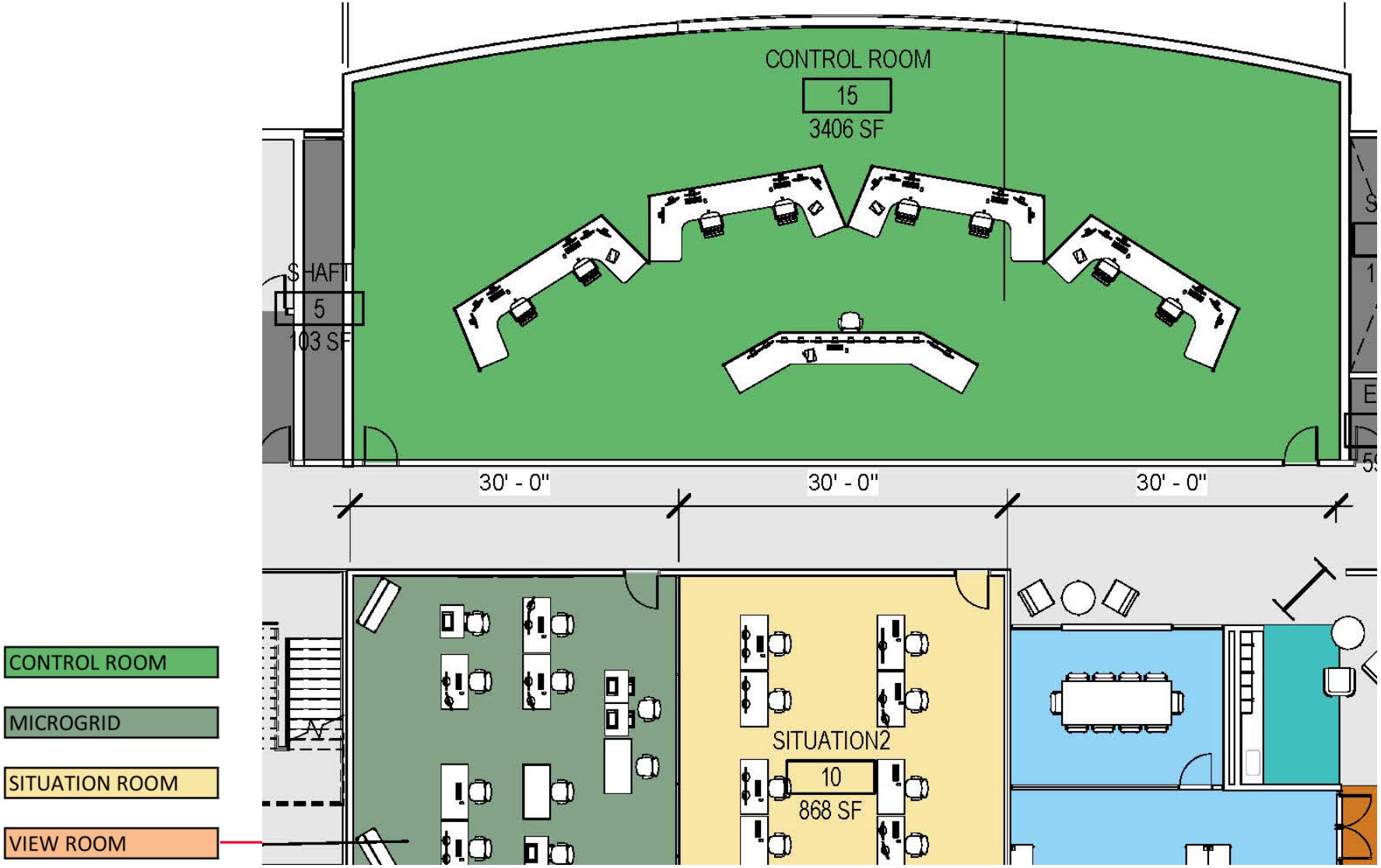
BROOKHAVEN NATIONAL LABORATORY

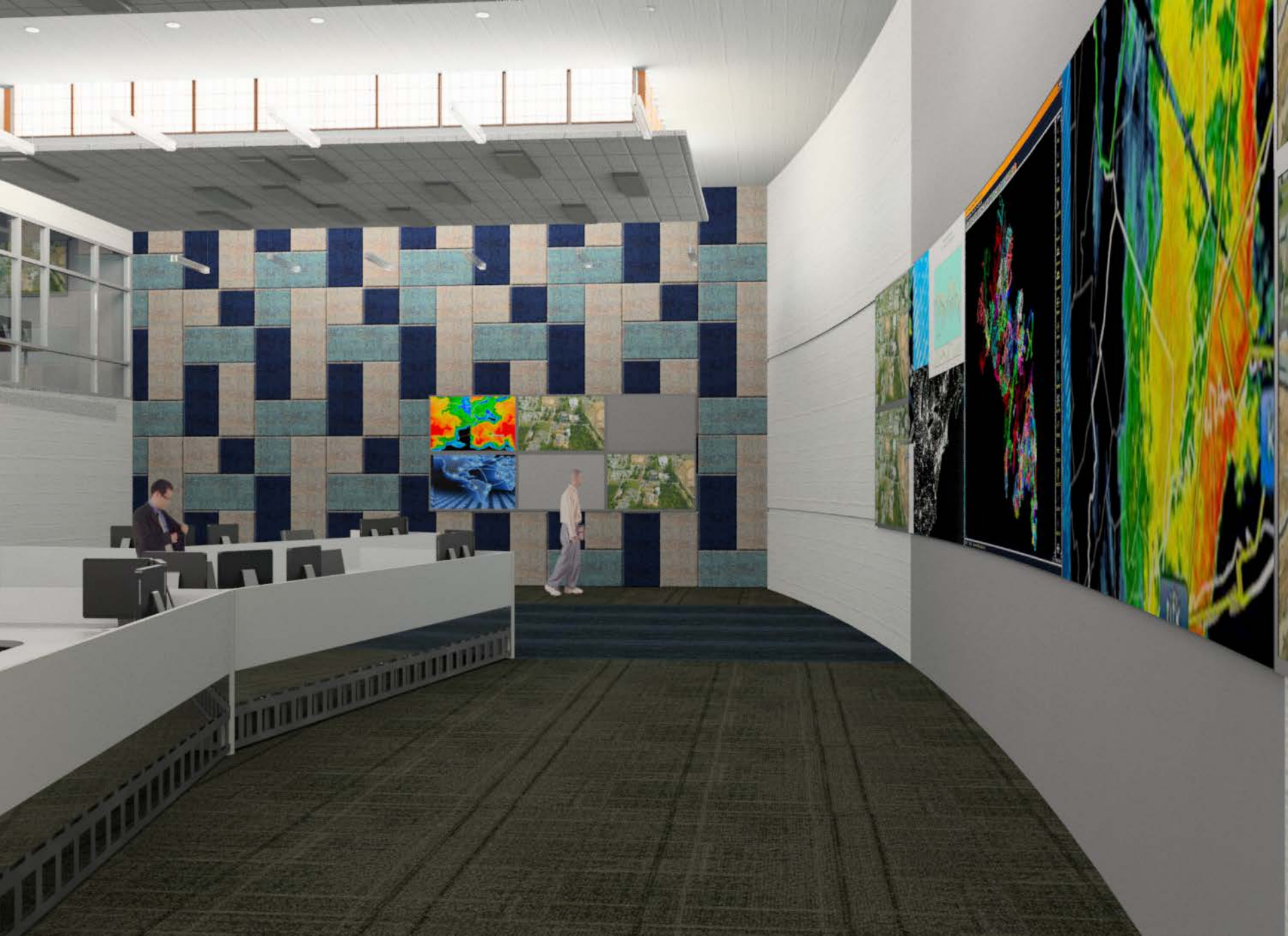


PROGRAM

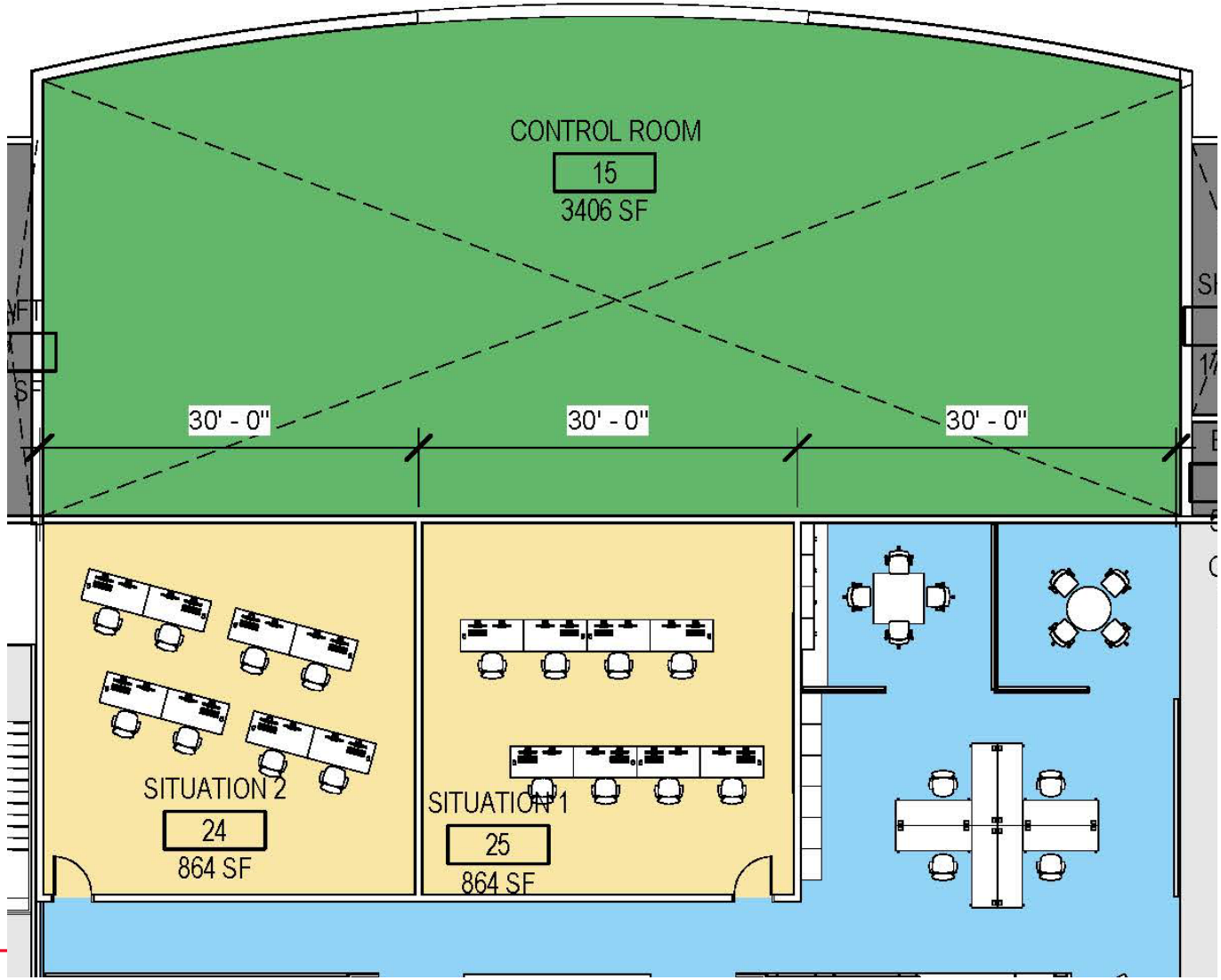
- CIRCULATION
- CONTROL ROOM
- OFFICE
- SITUATION ROOM
- SUPPORT

Control room Level I





Control room Level II



CONTROL ROOM

MICROGRID

SITUATION ROOM

VIEW ROOM

HAVEN
BORATORY

VEN
ATORY

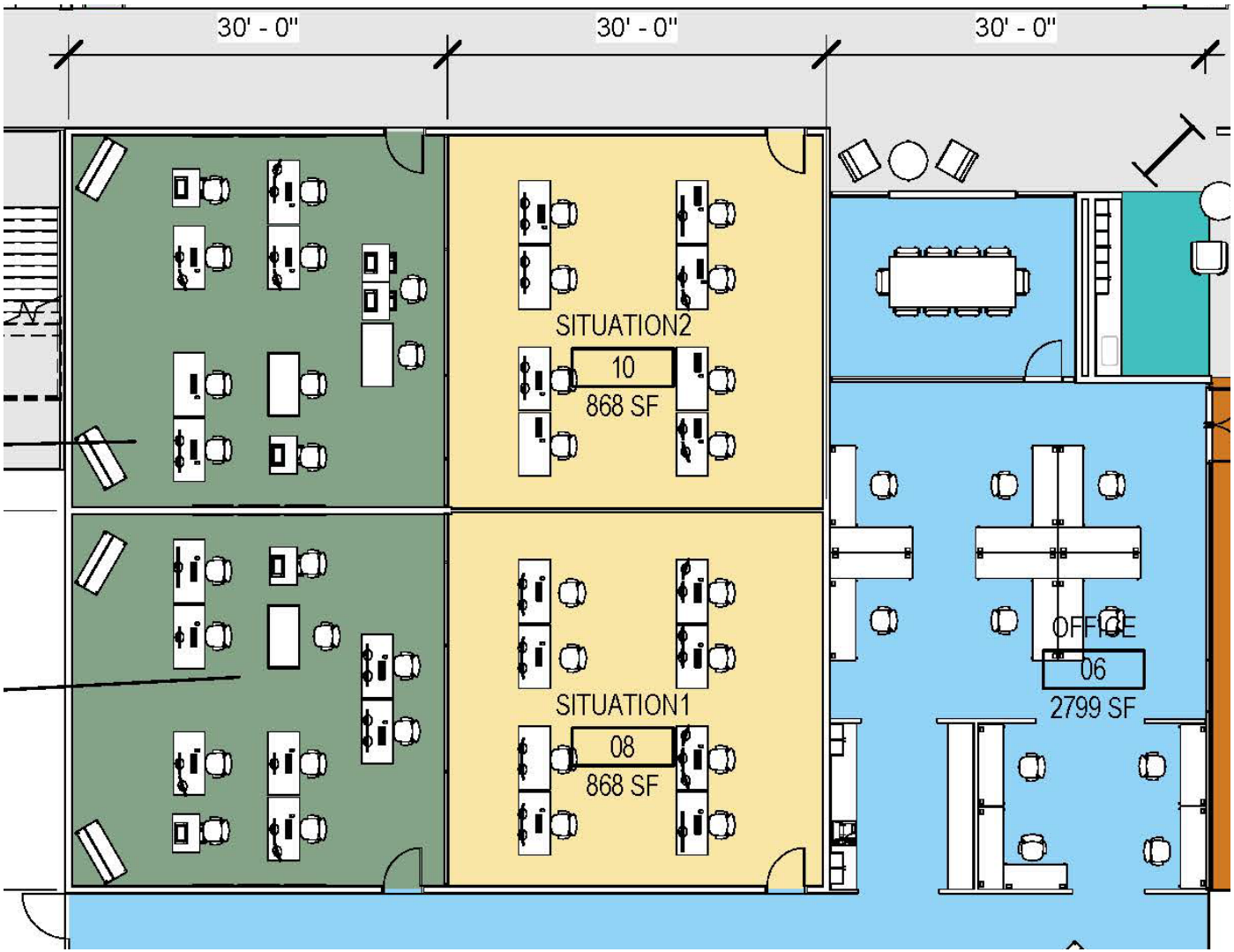
Microgrid Configuration

CONTROL ROOM

MICROGRID

SITUATION ROOM

VIEW ROOM



U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

AEGIS OPERATING MODEL

Services provided

- **Research** – collaborative and sponsored; near term and longer term
- **Workshops** – holding workshops on key topics of interests to a larger group of stakeholders
- **Model building and analysis** – Developing the right models necessary to perform Smart Grid planning and cost-benefit analysis
- **Cost benefit analyses** – performing cost-benefit analysis to support specific implementations under different scenarios
- Case studies -
- **Post-mortem analysis** – performing post-mortem analysis of key events
- **Training (operators, planners and others)** – create and deliver training programs to utilities and others based on real-world situations.
- Early stage technology demos (NSERC)
- Product testing and analysis
- Standard testing and evaluation
- Best practices and modeling …
- GIS on steroids (in boot camp) and connection to the modeling

Modes of Interaction

- Collaborative efforts (among utilities and others)
- Fee for service – analysis
- Fee for service - technology
  - Technology demos (NSERC)
  - Technology evaluation
- Sponsored research (DOE and others)
- Joint competitive projects (e.g. NYSERDA, DOE)

AEGIS status

- Through support from the State of New York, we are in the midst of a pre-conceptual design.
- We have interacted with utilities and other stake holders during this development and will continue to do so.
- Phase 1 of the solar research array is up and running.
- The BNL micro-grid is being modeled and new sensors added.
- We believe that the REV process now in progress in New York under the auspices of the Public Services Commission is laying down a future vision that AEGIS can help fulfill – not only in New York, but for other regional utilities as they go down the same path.