# New at Brookhaven National Laboratory: Addressing Wind Energy Integration Challenges *Grid Scale Energy Storage and Grid Modeling*

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BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

# New York State Clean Energy Goals

## Renewable Energy Sources

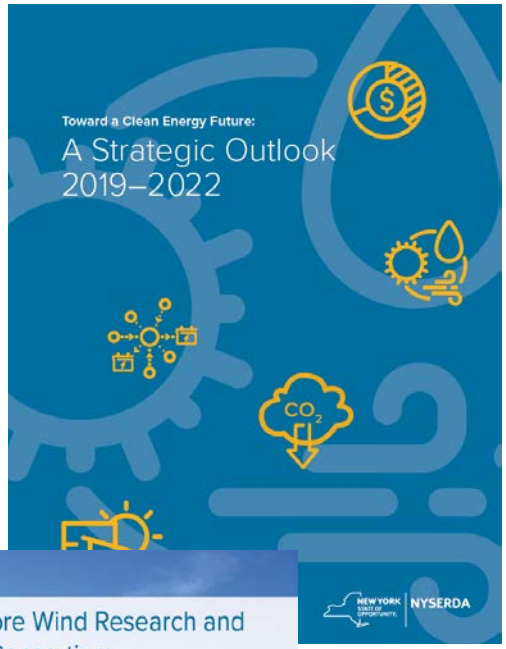
- Wind: 9,000 MW by 2035

## Energy Storage

- 3,000 MW

## National Offshore Wind Center at Stony Brook University

- NYSERDA matches DOE funds 100%
- $41M for Offshore Wind R&D
- Short term 3 pillars
  - Offshore plant
  - Resource and site characterization
  - Installation, operations, and supply chain



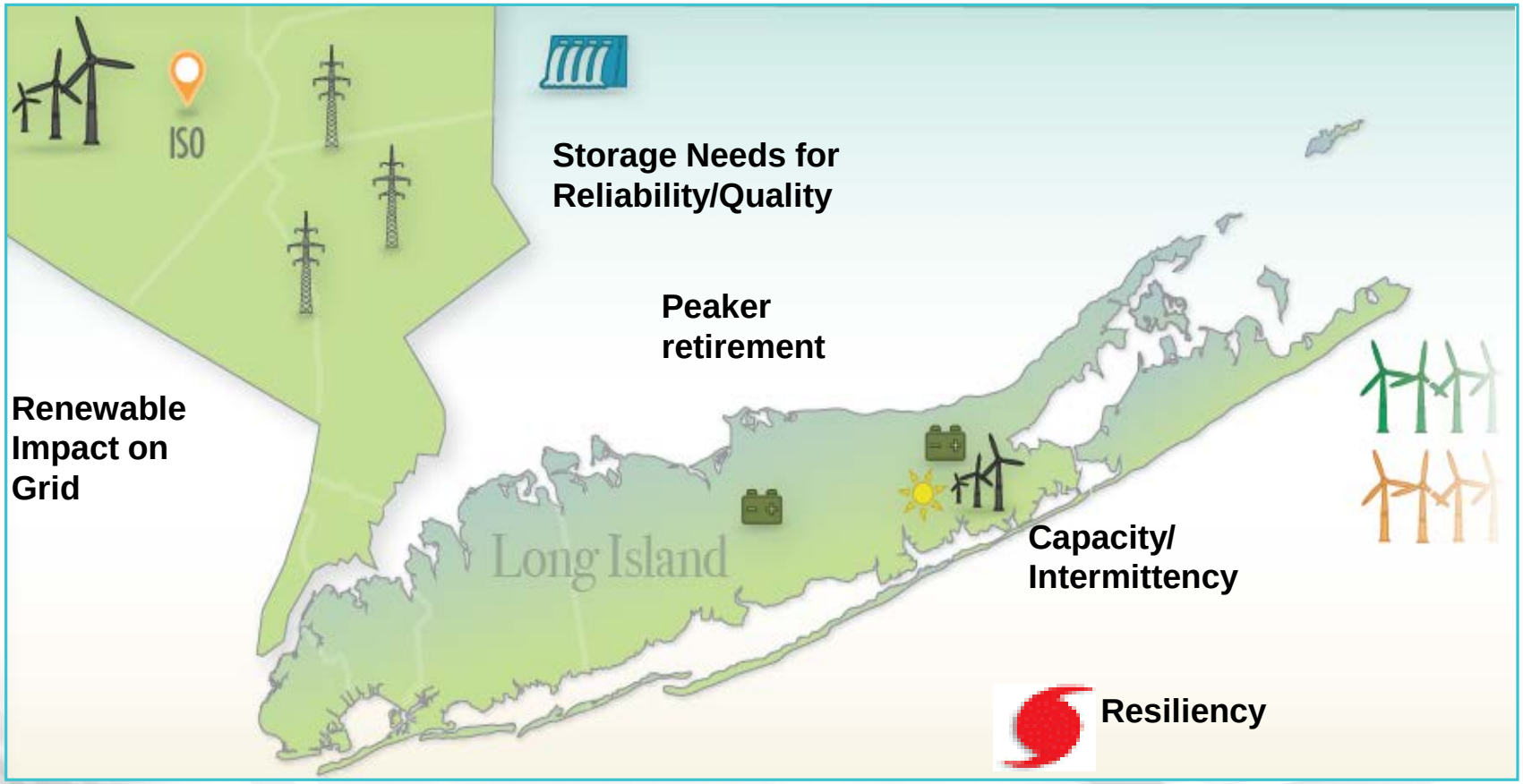


***Long term challenge: Integration of 9 GW of wind on Long Island***

# Offshore Wind Opportunities and Challenges

Integration Challenges:

- *PART 1: Grid scale electrical energy storage (GSEES)*
- *PART 2: Electric grid integration (Center for Grid Innovation-CGI)*



# The Current Challenges for Grid Scale Energy Storage

Safety

Environmental Impact; Ability to Recycle

Scaling

Lifetime

Cost

The needs are unique, distinct from vehicle and other applications

| | Vehicle Technology | Grid Scale Storage |
|---|---|---|
| Gravimetric power density | Critical | Less important |
| Volumetric power density | Very important: 500 Wh/L needed for 500 km range on a single charge | Importance dependent on deployment location |
| Gravimetric energy density | Critical | Less important |
| Volumetric energy density | Important | Importance depends on location |
| Fast charging requirements | Important: 80% state of charge within 20 minutes | Less important |
| Inherent thermal stability (safety) | Critical, but a limited quantify of energy exists in the vehicle | Critical; however, magnitude of impacts resulting from a failure are significant |
| Cost | Important | Critical |
| Lifetime | Important | Critical |

# BNL Energy Storage

Goal: Leverage BNL's facilities and expertise to understand, predict, and control the mechanisms of electrochemically active materials for energy storage

Approach: Exploit world-leading capabilities in electron microscopy and NSLS-II

## BES EFRC: Mesoscale Transport (m2M)

Build the scientific knowledge to enable creation of **scalable** energy storage systems.

Demonstrated 3D electrode architecture with continuous ion and electron transport pathways.

*ACS Energy Lett.,* **2019,** *4(1),* 271.

Stony Brook University

TEXAS
The University of Texas at Austin

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Cornell University

Drexel UNIVERSITY

BERKELEY LAB
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Georgia Institute of Technology

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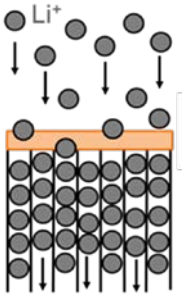
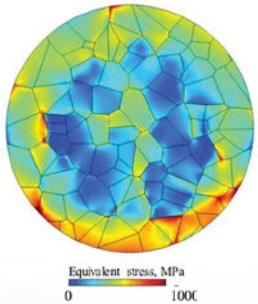
## EERE Funded Programs - Fast Charge




Surface treat electrode to affect overpotential

## EERE Funded Programs- Battery500




Identified strain, heterogeneity, and micro-cracks in particles of a battery material.

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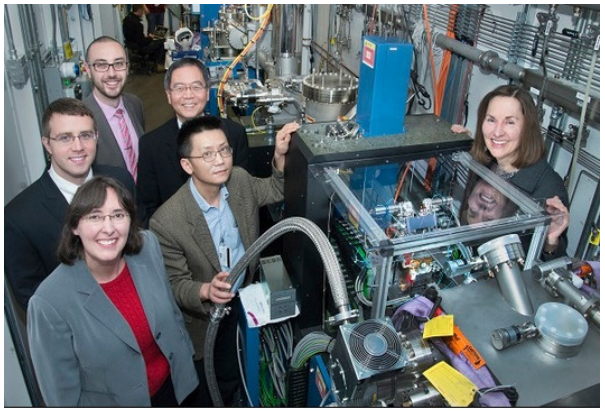
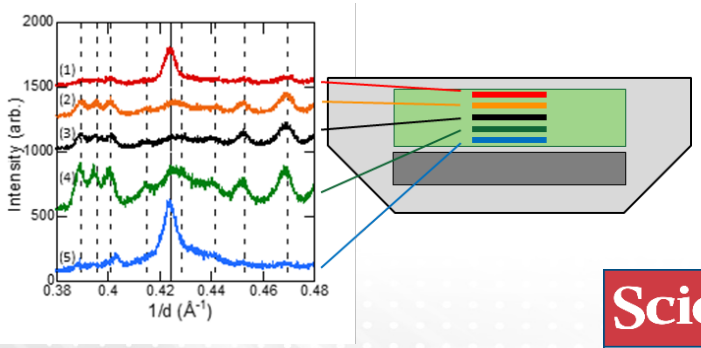
# Leverage NSLS-II/CFN
# Operando studies of active batteries

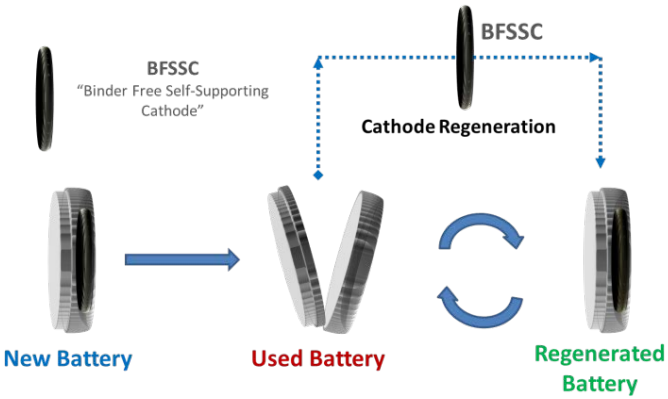
EDXRD tomographic mapping provides non-destructive 3D image.

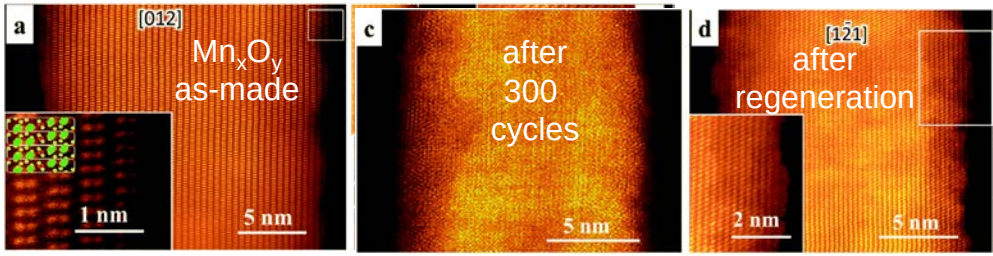


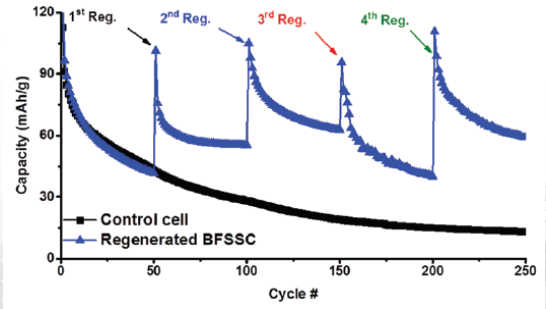



*Science*, **2015,** *347(6218)*, 149-54.

## *Bake and Reuse*

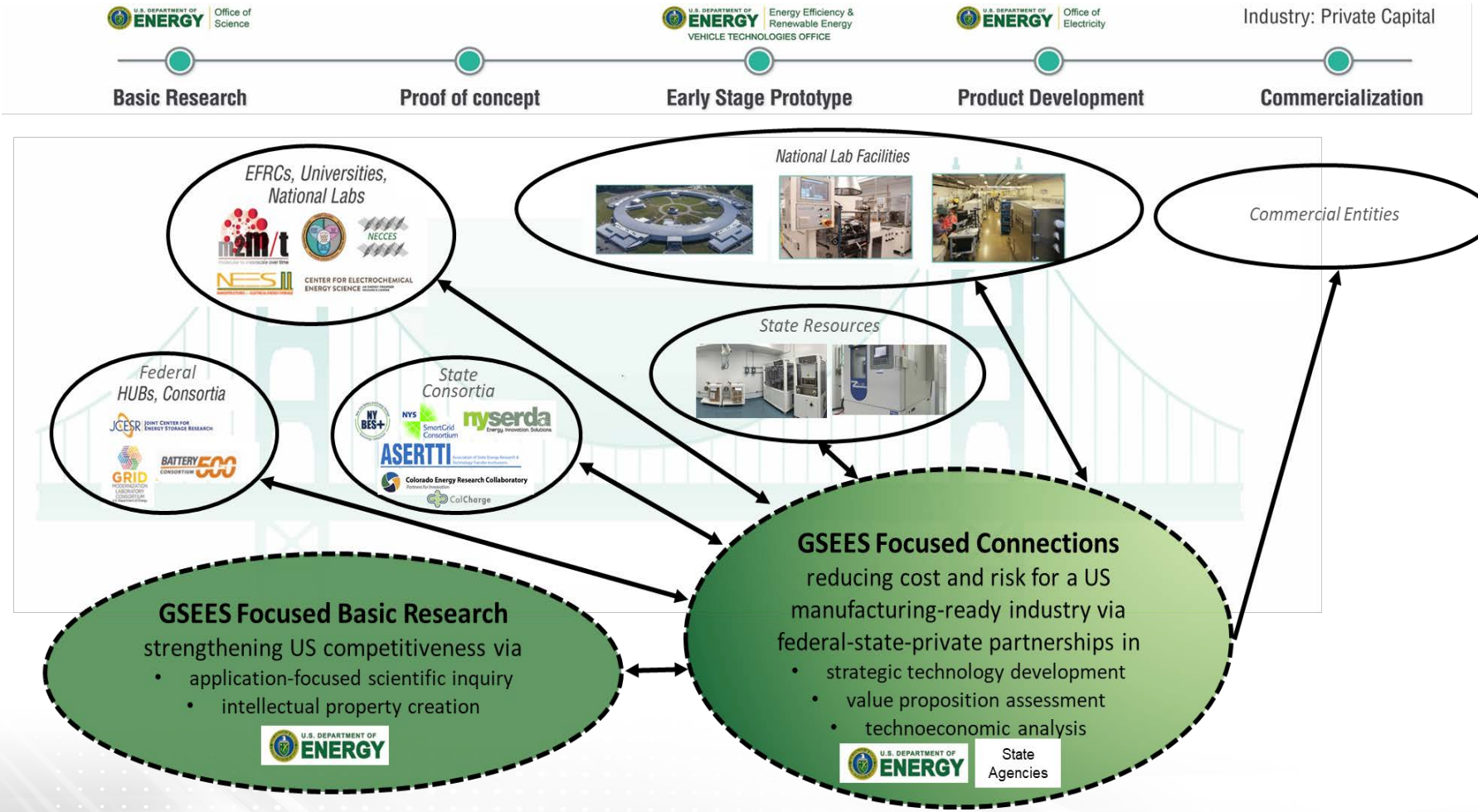


# Connecting Energy Storage Assets

## NYSERDA/BNL Vision to Accelerate Grid Energy Storage




GOAL: Reducing Cost and Risk in GSEES Development

# PART 2: Electric grid integration

## Challenges

- Large-scale integration of renewables to assure reliable grid operations
- Reliability of grid operations in future Distribution System Platform (DSP)

## Approach: Three Key Quesions

- How much storage do you need for reliable large scale wind integration?
- Where do you put it in the system?
- Grid operational concerns: Reliability, Resilience, Security

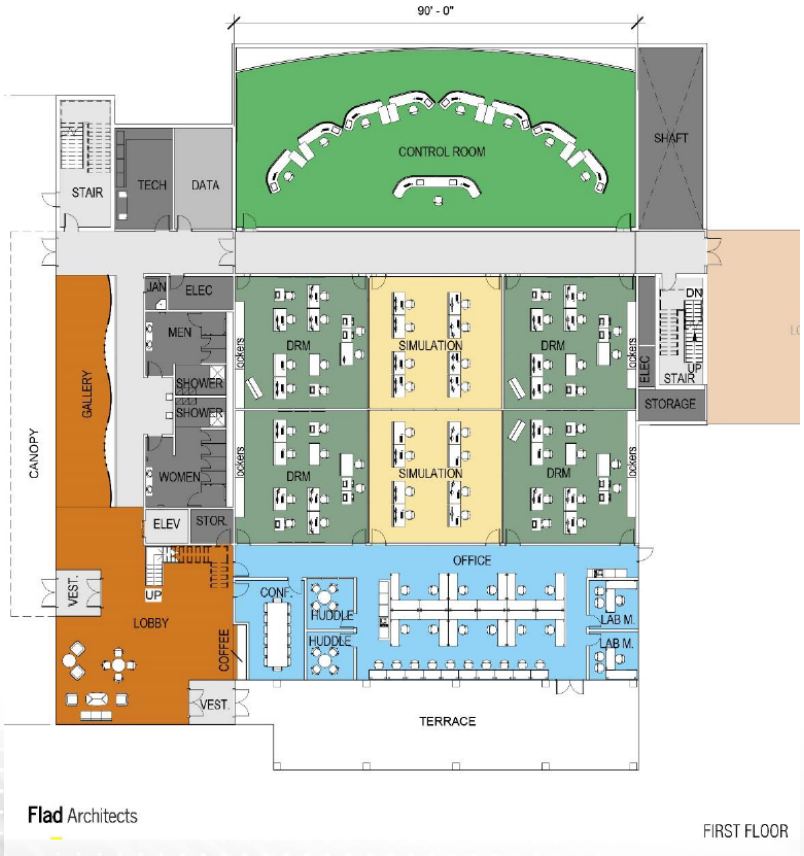
## Opportunities

- Innovations in large-scale modeling and simulation
- Center for Grid Innovation (CGI) – an advanced grid laboratory focused on NYS grid modernization (REV)

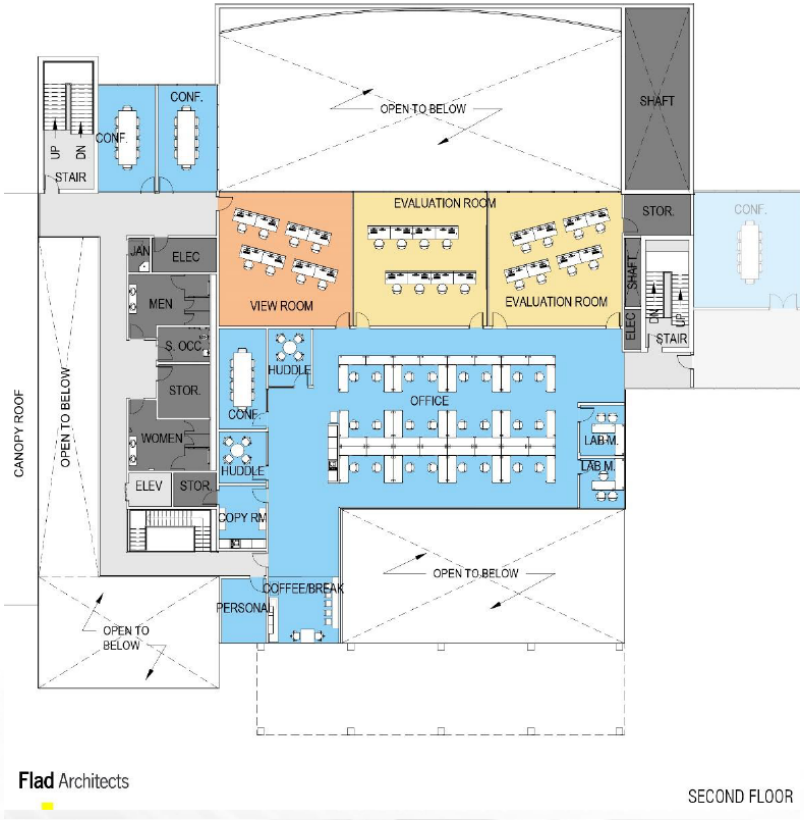
# Center for Grid Innovation (CGI) Vision

- A simulation laboratory dedicated to the distribution system challenges
- Features: distribution system control room, data and simulation support

First Floor




Second Floor

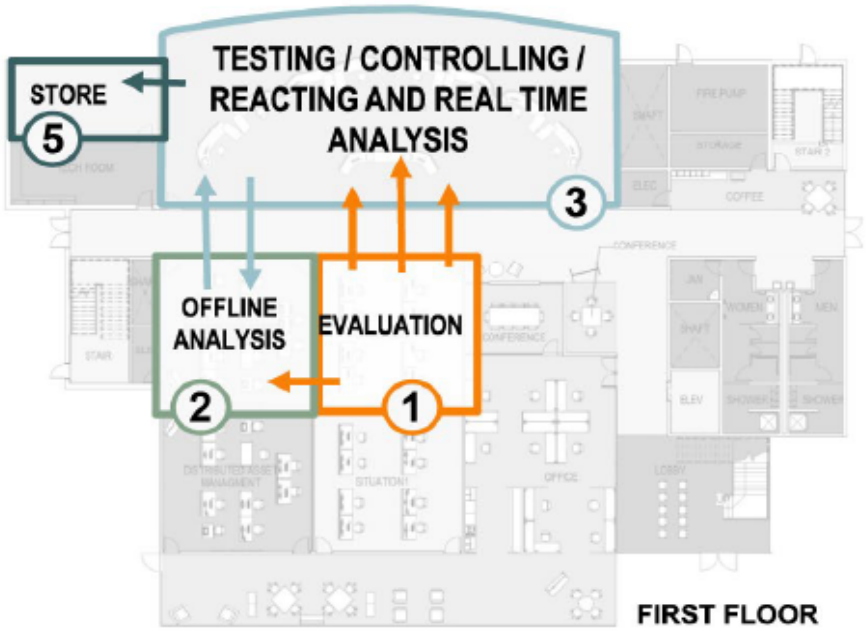


# Use Case- **Cyber and Physical Security**

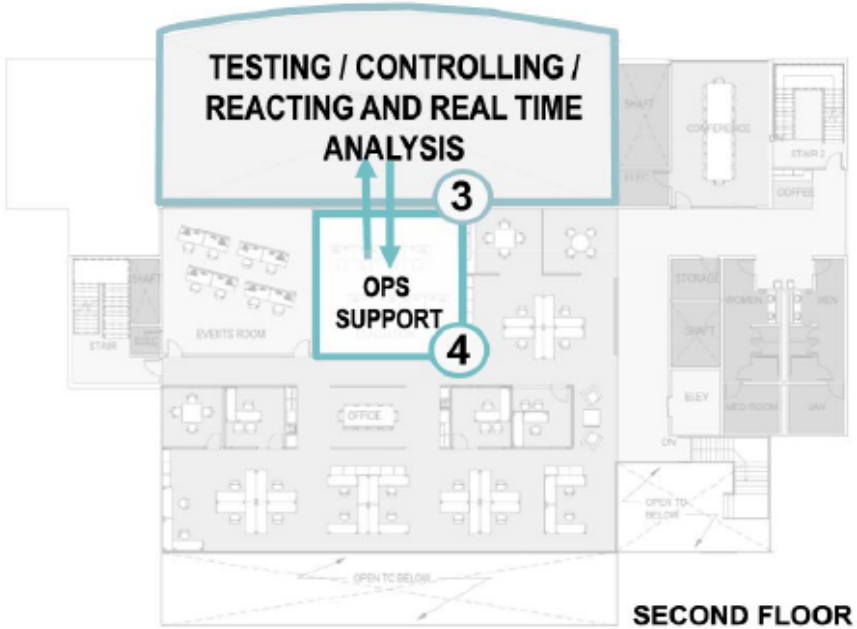
**Description of Use Case:** Used to test detection and response strategies associated with physical and cyber-attack.

1. Situation Room 1- Generate, Manage and Evaluate Attack.
2. DAM Room: Offline Analysis & Communication Center. Support Control room. Evaluated by Situation Room on 1st floor.
3. Control Room: Testing detection and response in real time.
4. Evaluation room :Testing detection and response in real time.
5. Data Room- Data is stored effectively for ease of retrieval .

**Primary Outcome:** The Development of definitive and integrated detection strategy for physical and cyber attacks that will reduce the system's vulnerability.




FIRST FLOOR




SECOND FLOOR

# Center for Grid Innovation (CGI)

**Partnership is key, developing a New York State based set of potential sponsors, users, collaborators**

- Empire State Development: Provided funds to develop conceptual plan, blueprints, engineering
- Discussions
  - NYSERDA
  - Con Edison
  - National Grid

***Brookhaven Partnerships are Key to our Future***

***University***

Columbia University
Stony Brook University
CSH
Rutgers The State University of New Jersey
Yale
Illinois

***National Lab***

Argonne National Laboratory
Pacific Northwest National Laboratory
INL Idaho National Laboratory
SLAC National Accelerator Laboratory
Oak Ridge National Laboratory
Managed by UT-Battelle for the Department of Energy

***Industry***

GM
DOW
Toyota
GE
N.E. Chemcat
Proton
The Leader in On Site Gas Generation

***New York State***

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