Virtual Tour of the Pacific Northwest National Laboratory

KIM FOWLER
ENERGY & ENVIRONMENT DIRECTORATE
PACIFIC NORTHWEST NATIONAL LABORATORY

Federal Utility Partnership Working Group, Fall Seminar
November 3, 2016
The National Laboratory system
PNNL: FY2016 at a Glance

- $920 million budget
- 4,400 staff
- 104 patents
- 1,058 peer-reviewed publications
PNNL’s Distinctive Science Vision

EARTH

ENERGY

SECURITY

Understand, Predict and Control Complex Adaptive Systems
Energy for National Security Capabilities

ASSESS
- Comprehensive Energy and Water Evaluations
- Renewable Energy Assessments
- Grid Analytics
- Water Balance and Efficiency Analysis

MEASURE
- Metered Data Analysis
- Building & Installation Automation and Control Systems

IMPLEMENTATION
- Distribution Systems & Demand Response

PNNL Capabilities

POLICY
- Transmission Reliability
- Smart Grid
- Energy/Energy Modeling

TRAINING
- Energy Storage
- Renewable Energy and Water Evaluations
- Grid Analytics
- Water Balance and Efficiency Analysis

TECHNOLOGY
- Solid State Lighting Technology
- Energy Storage
- Renewable Energy and Water Evaluations
- Grid Analytics
- Water Balance and Efficiency Analysis

INSTITUTIONAL CHANGE
- Energy, Water & Sustainability Reporting
- Cybersecurity & Interoperability
- Climate Resiliency
- Sustainable Design & Operations
Comprehensive Energy and Water Evaluations (CEWE)

- EISA compliant audits resulting in life-cycle cost effective energy and water conservation measures in project-ready format
Renewable Energy Assessment Types

10% design if resource availability, economics, and other project considerations show good potential based on detailed data collected during a site visit.

Detailed Assessment
- Tangible products that move a specific project closer to development (e.g., detailed resource data collection, RFI, 1391, proposal reviews).

Project Development Support
- Resource availability and economic analysis of site-specific projects to show what should be further investigated using data provided by the site.

Screening
- Resource availability and economic analysis of prototype projects for comparison across multiple sites using data provided by the client.

Preliminary Assessment
PNNL Developed Cybersecurity Products for OEI REGF:

- Cybersecurity Risk Assessment of Proposed REGF Implementations
- Cybersecurity Protections in support of REGF Procurements
- Cybersecurity Training and Briefings
# Buildings Cybersecurity Capability Maturity Model (C2M2)

## Model Domains
- Logical groupings of cybersecurity practices
- **10 Model Domains**: 
  - Risk Management
  - Asset Change and Configuration Management
  - Identity and Access Management
  - Threat and Vulnerability Management
  - Situational Awareness
  - Information Sharing and Communications
  - Event and Incident Response, Continuity of Operations
  - Supply Chain and External Dependencies Management
  - Workforce Management
  - Cybersecurity Program Management

## Maturity Indicator Levels
- 0: Not Performed
- 1: Initiated
- 2: Performed
- 3: Managed

## 4 Maturity Indicator Levels: Defined progressions of practices
- Each cell contains the defining practices for the domain at that maturity indicator level

---

Proudly Operated by Battelle Since 1945
Energy Data Analysis Roadmap

Building Inventory
- Building ID/#
- Building type
- Square footage
- Energy/water sources
- Energy generation
- Occupancy level
- Hours of operation

Document Buildings
Develop an inventory list

Data Analysis
Metered data analysis to inform resource efficiency related decisions

Status Quo
Building Level Analysis
- 1 Building
- # of Meters

Utility Services
Identify & document which utility services are metered

Follow Metering Guidance
Develop a list of meters and install/connect appropriate meters

Enterprise Energy Analysis
Determine what type of analysis is needed to answer a specific question

Data Collected?
Cost, Information Assurance, Time, Data Storage, Other?

Why?

Communication Protocol
Data collected at a central location?

Why?

Where?
- MDMMS
- UMCS
- BOCC/BAS
- Other?

Process Data
Manage data collection errors and prepare data for analysis

Total Energy Consumption
Identify highest energy use regardless of building size

Annual EUI
Identify which buildings are more/less efficient than others

Monthly EUI
Examine energy usage for a specific building over temp changes
Compare baseline energy usage to peak energy usage

Weekly Load Profiles
Compare daily energy use patterns to building use

Daily Load Profiles
Compare base load to peak energy use
Night and weekend setbacks

- Identified by a change in consumption patterns between night, weekday, and weekend hours

![Graphs showing energy consumption patterns in April and May with highlighted periods for night and weekend setbacks.](image)
Decision Support for Operations & Maintenance (DSOM)

- Building-level controls integration
- Central plant optimization
  - Boilers, chillers, cogeneration

http://www.pnl.gov/DSOM/
Re-tuning is a systematic process to identify and implement low-/no-cost energy efficient solutions to building operational problems (primarily through control system changes). The PNNL approach includes:

- Training of building operations staff with the goal of embedding re-tuning into daily operations.
- Identifying control system, operations and maintenance, and additional energy efficiency opportunities that may require investment.
- Calculating the potential savings of the proposed control system recommendations, followed by measurement of the actual savings.

![Diagram](Typical commercial building behavior over time with periodic and continuous re-tuning to maximize persistence.)
Supporting Federal Participation in DOE Lighting Campaigns

### Exterior Lighting

**LEEP Campaign –** [www.leepcampaign.org](http://www.leepcampaign.org)

**Overview:**
- Recognition and guidance program supporting adoption of high efficiency parking lighting
- Sponsored by DOE Commercial Buildings, BOMA, IFMA, Green Parking Council
- *For Federal Users* page on the web site
- Free technical assistance to federal sites

**Results:**
- Documented energy savings of up to 90% (LED with controls)
- Simple paybacks of 2-4 years not uncommon
- 30 LEEP Award winners saving nearly 30 million kilowatt-hours and $3 million per year
  - 5 federal sites received awards to date; no Air Force sites

### Interior Lighting

**Interior Lighting Campaign –** [www.interiorlightingcampaign.org](http://www.interiorlightingcampaign.org)

**Overview:**
- Recognition and guidance program supporting adoption of high efficiency troffer lighting
- Sponsored by DOE Commercial Buildings, BOMA, IFMA, IES, and possibly GSA
- Free technical assistance to federal sites
- FEMP-developed resources on wireless occupancy sensors (September 2015)

**Anticipated Results:**
- Savings of 60% on one-for-one replacement basis; up to 75% with the use of controls.
- Awards – Summer 2016

### Suggested Next Steps
- Define technical assistance needs of the Air Force
- Identify ways to get Air Force sites to join DOE lighting campaigns
Smart Grids and Microgrids

DoD - Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS)
- Phase 1: Joint Base Pearl Harbor Hickam
- Phase 2: Ft. Carson
- Phase 3: Camp Smith

DOE – Smart and Micro-grids as a Resiliency Resource
- Modeling and analysis with Grid-LabD
- Local Resource
- Community Resource
- Black Start Resource
Regulatory Analysis

**Program Impact (2005 to 2016)**

- 11 Quads of Energy Savings
- Saves Consumers $35B
- 355 million tons of avoided CO$_2$

**Program Impact (1992 to 2014)**

- 28 Quads of Energy Savings
- Saves consumers $170B
- 1.8 billion tons of avoided CO$_2$
Solid State Lighting Program

Impact Goal: Drive LED market penetration, reducing energy consumed for lighting by more than 30%

- Measurements, technical reports have changed the SSL industry – better products!
- Organized development of most major SSL industry standards and test methods
- L Prize led to market introduction of most advanced bulb
- Creating market pull for new products: the SSL Municipal Consortium is the most influential lighting organization for streetlights
- Providing information that creates consumer confidence in purchasing decisions
Buildings-Grid Integration

**Impact Goal:** Improve building energy efficiency by 20%-30% through enhanced control and enable low-cost building-grid integration.

**Significant Accomplishments:**

- Development of cost-effective automated diagnostic and control technologies, many of which are now embedded in commercial products
- Pioneered “re-tuning” for commercial buildings with BAS’s
- Application of our tools saved PNNL $400K in FY13

**We Are Leading The DOE Transactive Energy Program, The Cornerstone Of Buildings-Grid Integration**
Contact:

Kim M. Fowler
Chief Research Engineer
Electricity Infrastructure & Buildings Division
Pacific Northwest National Laboratory
509-372-4233
kim.fowler@pnnl.gov