




FEMP  
FIRST THURSDAY  
**SEMIN@RS**

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# Advanced Metering Requirements and Best Practices

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## Objectives


**After completing this seminar, you will be able to:**

- define advanced metering and discuss the potential benefits.
- determine how to select advanced metering projects.
- discuss advanced metering possibilities in terms of water, air, gas, electricity, and steam.
- explain metering approaches - one time, run time, short term, and long term.
- explain steps in an overall process for approaching advanced metering
- discuss some of the technological considerations when considering advanced metering including communications, data collection and storage, location of hardware, backup systems, and single vs. multiple vendor.
- give examples of advanced metering technologies and selection criteria to consider.
- locate advanced metering resources.

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## Advanced Metering Requirements and Best Practices

Greg Palko  
Certified Energy and Facility Manager  
Oak Ridge National Laboratory

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## What Is Advanced Metering?

- **Advanced meters**
- **Advanced metering systems**
- **Smart meters**



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## Metering includes WAGES

- **Water**
- **Air**
- **Gas**
- **Electricity**
- **Steam**



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## Benefits of Metering

- **Meet legislative and Executive Order requirements –**  
*Which ones apply?*
  - Energy Policy Act of 2005
  - Executive Order 13423
  - Energy Independence and Security Act of 2007
  - Executive Order 13514

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## Benefits of Metering

- **Meters provide data that can be used to**
  - Reduce energy/utility use
  - Reduce energy/utility costs
  - Improve overall building operation
  - Improve equipment operation



## Approaching Advanced Metering



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- What do you want to achieve?
- What data do you need to achieve your goals?
- **WHY????**

Begin with the end in mind!

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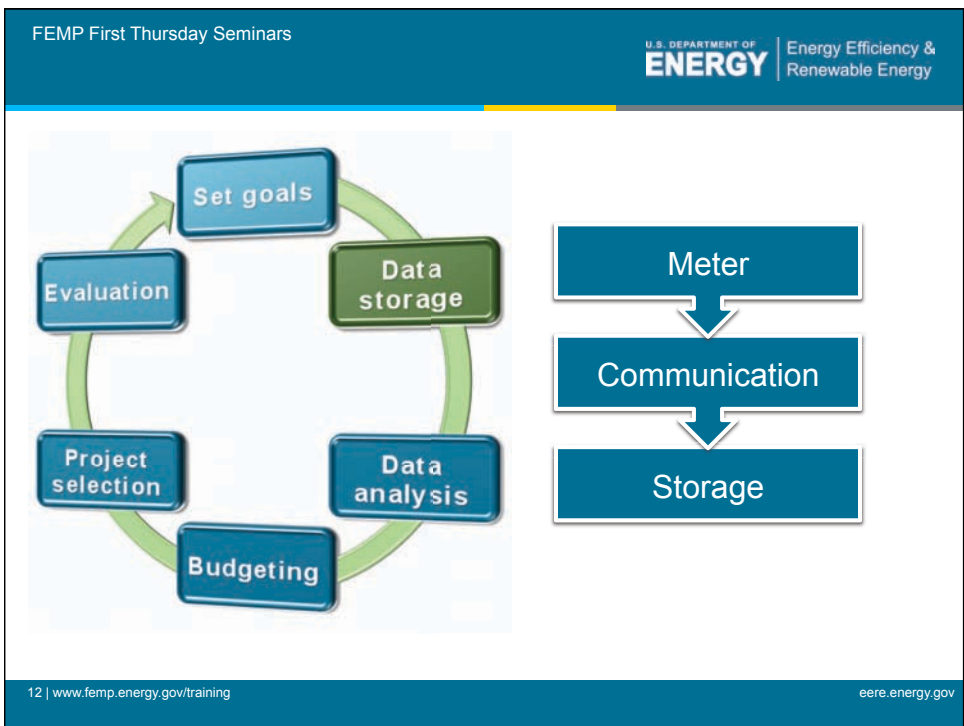
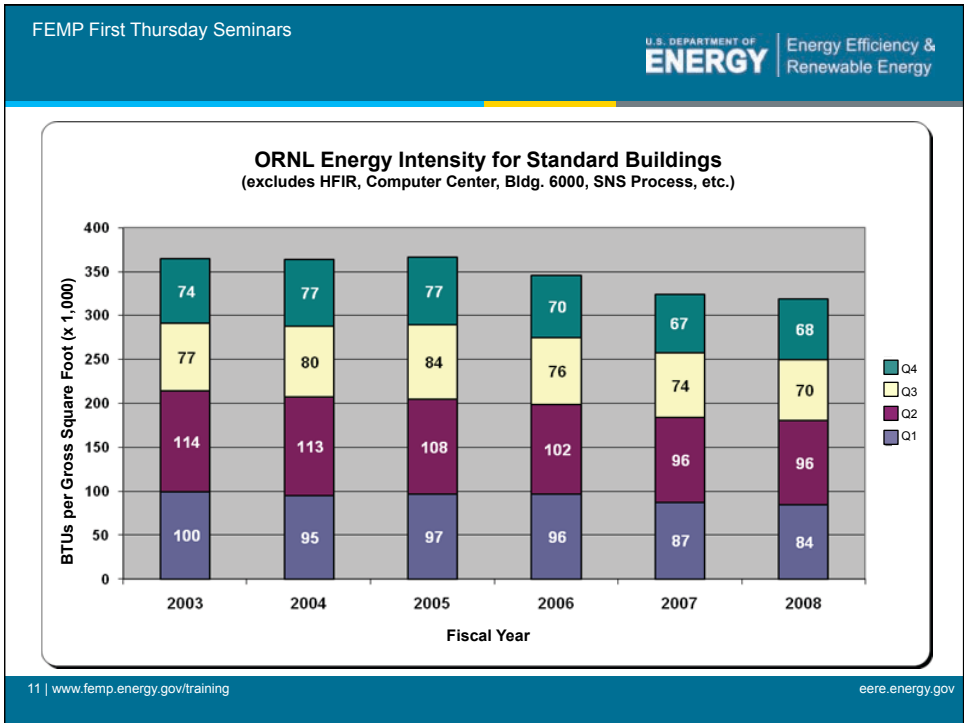
### At ORNL, metering is one element of larger effort

- 986,000 square feet constructed
- 1,409 new offices
- 181,000 square feet of new laboratories
- 25 buildings use 75% of electricity

Facility	Major	Partial	Complete
Housing			
Attn Valley Campus			
Heston Ridge Campus			
Conference Space			
Conference rooms			
Exhibition space			
Restrooms			
Security			
Storage			
Water			
Waste			


Facility	Major	Partial	Complete
Neutron Scattering			
Operational Neutron Source			
High Flux Isotope Reactor			
Neutron Physics			
Neutron Facility			
Material Sciences and Technology			
Center for Neutron Science			
Materials Science			
Advanced Materials Lab			
High Temperature Materials Lab			
Chemistry & Materials Lab			
Energy Technology			
National Transportation Research Center			
Energy Systems High Bay			
Environmental and Environmental Sciences			
Metallurgy			
Biotechnology			
Field research sites			
Chemistry			
Nuclear Energy			
Radiochemistry			
Materials examination			
Environmental and Sustainability			
Classified work space			
Test and baking site			
Compositional Science and Engineering			
Leadership computing			

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**Data is of no use in and of itself**


**Energy Information Systems (EIS) vary**

- what do you need to know
- who will use what data
- in what form will you use it

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- **No cost options**
- **Appropriations options**
- **Alternative financing**

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## Drop In Replacement Breakers

- Breakers slated for 1505, 6000 and 4500N/S Switchgear
- Many brands already built
- Others can be retro-fitted on-site
- Excellent safety (10 CFR 851)
- Once installed, breakers cannot be opened while energized.
- Immediate Metering (EPAAct 2005)




- **Identifying buildings requiring metering**
- **Determine cost effectiveness of various projects**
- **Select the ones with highest payoff and execute**



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- Consider EPart reporting
- Share success and lessons learned

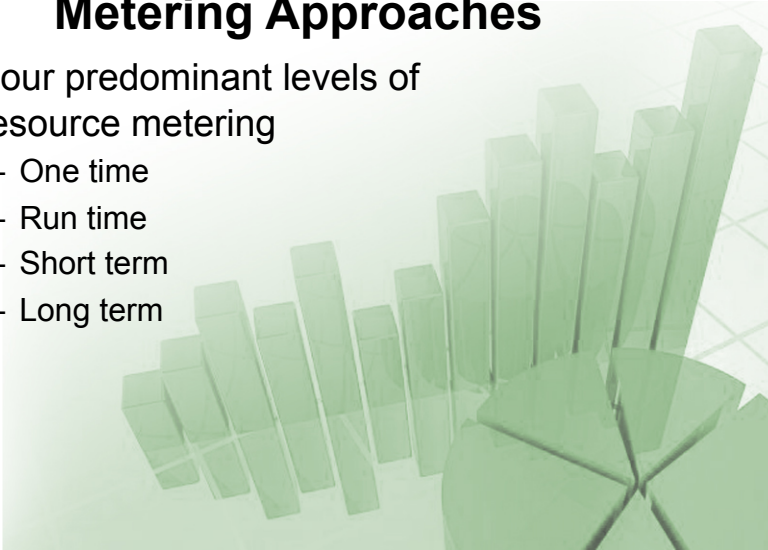
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## Metering Approaches

- Four predominant levels of resource metering
  - One time
  - Run time
  - Short term
  - Long term



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## Selecting a Meter – Electrical

- Whole building or sub-panel
- Specific end use
- Advanced interval meters



## Performance Metrics for Selecting Meters

- Accuracy
- Precision/Repeatability
- Turndown ratio
- Ease of installation
- Ongoing operations
- Installation vs. capital costs



## Advanced Electrical Meters

- **Measure and record** interval data
- **Communicate** that data to a remote location
- **Meet the full intent** of the EPart



## Types of Electrical Meters



**Mechanical**



**Electromechanical**



**Advanced**

## Common Features – Advanced Meters

- Data storage and time-stamp capabilities
- Accommodate other inputs
- Diagnostic
- Two-way communication
- Control/alarm
- Flexible date intervals
- Statistics
- Multiple modes of communication

## Selecting a Meter – Water, Natural Gas and Steam

- **Typically in-line installations**
  - Using positive displacement
  - Insertion turbine
  - Or pressure related techniques
- **Should have digital-output capability**



## Natural Gas Meters

- Positive displacement
- Differential pressure
- Velocity



**Natural Gas  
Diaphragm Meter**

## Natural Gas Meters



**Gas Rotary Flow Meter**



## FEMP Expert

**Ab Ream**

U.S. Department of Energy

Federal Energy  
Management Program

## Steam Meters

- Differential Pressure
- Velocity



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## Meters

**Venturi Meter**

**Orifice Meter**

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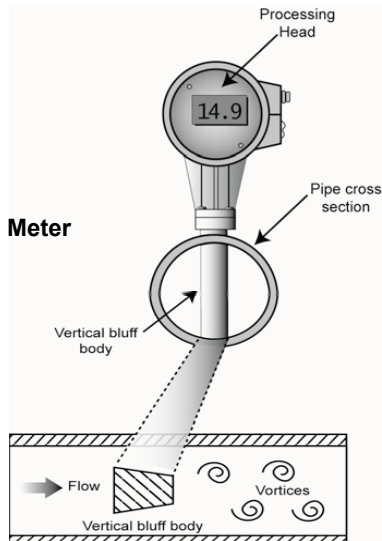
## Meters

**Turbine Meter**

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## Meters

### Vortex Shedding Meter



## Potable and Non-potable Water Meters

- Positive displacement
- Differential pressure
- Velocity






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## High Temperature Hot Water/Chilled Water Meters

- **Common high temperature meters**
  - High temperature hot water distribution/heating systems
  - Metering of condensate return systems
- **Common chilled water meters**
  - Central chilled water meters
  - Packaged chiller systems

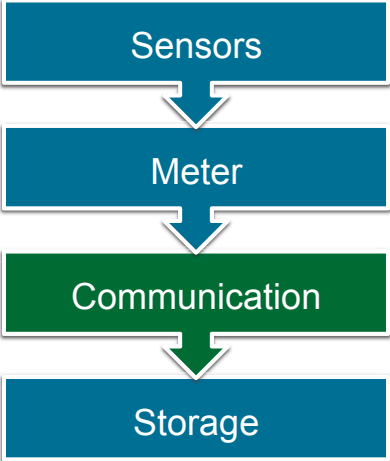


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## Communications



```

graph TD
    A[Sensors] --> B[Meter]
    B --> C[Communication]
    C --> D[Storage]
  
```

- Phone modem
- Local Area Network
- Building Automation System
- Radio Frequency-Wireless Networks
- Phone line carrier

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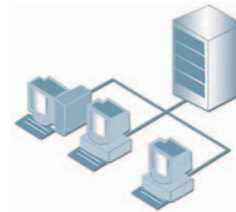
## Communications Options



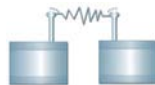
**Modem**



**Building  
Automation  
System**



**Local Area  
Network**



**Wireless**

## Data Storage Software

- **Technical**
  - SQL compliant
  - Allows other application programs to read and access data with passwords
  - Trend data is archived at least daily
  - Time stamps
  - Storage capacity for at least 2 years

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## Data Storage Software

- **Users**
  - Executive
  - Financial and Administrative
  - Facility
  - Utilities

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## Data Storage Hardware

- **Dedicated hardware**
- **Ample processing power and memory**
- **Automated backup function**
- **Consider hosting data with third party**

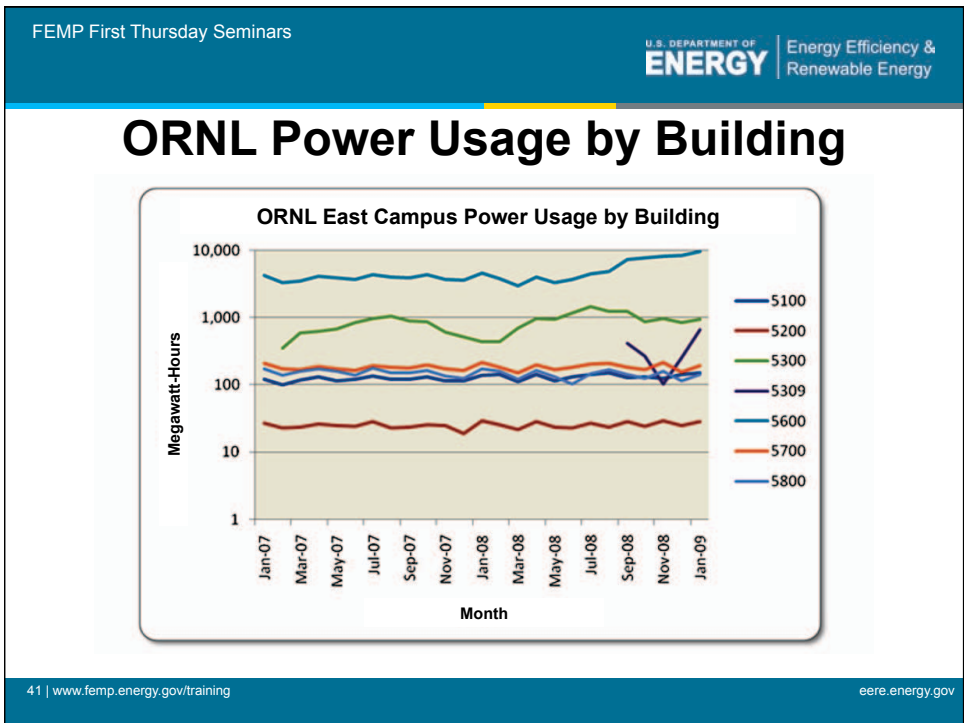
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## Vendor Selection

- **Advantages of**
  - Single vs. Multiple Vendor
  - Price Based
  - Feature Based

## ORNL Power Usage by Building

Facility	Gross Square Feet	Annual MWh	Electric Rate Per MWh	Electrical Energy Cost per Building
5600CC1	18,233	21,672	\$55.90	\$1,211,436
4509	9,160	16,344	\$55.90	\$913,630
7900	66,817	12,528	\$55.90	\$700,315
6000	125,018	12,092	\$55.90	\$675,943
4500s	347,346	11,501	\$55.90	\$642,906



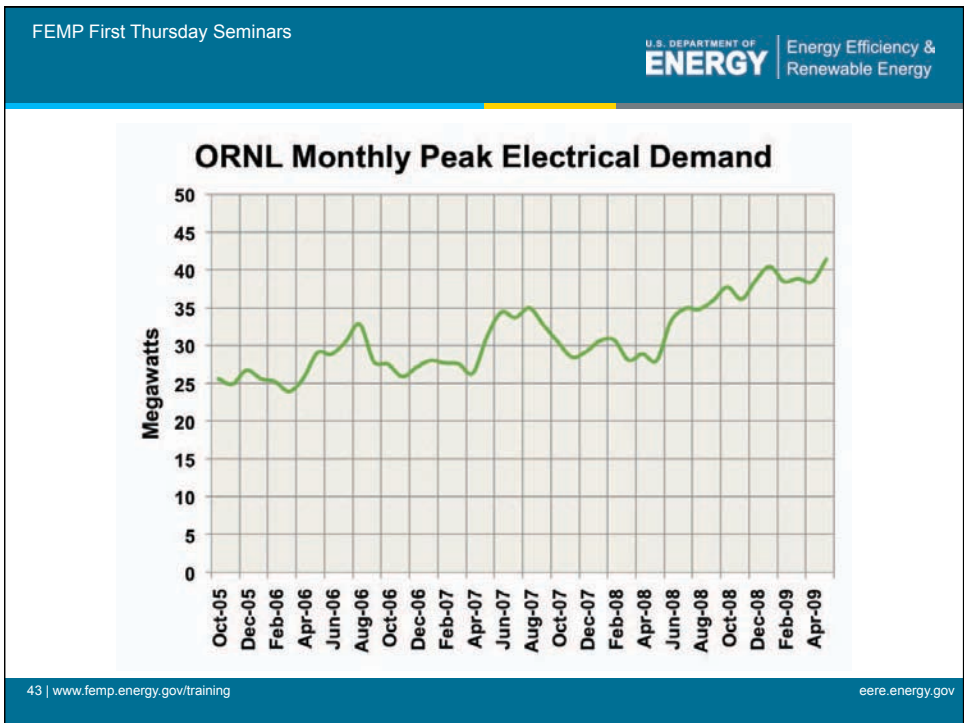
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## ORNL Steam

Percent of Steam Allocated to Bldg	Steam Plant Cost	Steam Fuel Cost	Steam Fuel Cost for Bldg	Total Bldg Utility Cost
5600CC1				\$1,211,456
4509	0.0169%	10,042.746	\$10,739	\$962,112
7900	1.4060%	10,042.746	\$141,200	\$993,726
6000	1.592%	10,042.746	\$196,071	\$898,704
4500S	14.054%	10,042.746	\$1,411,432	\$2,182,693

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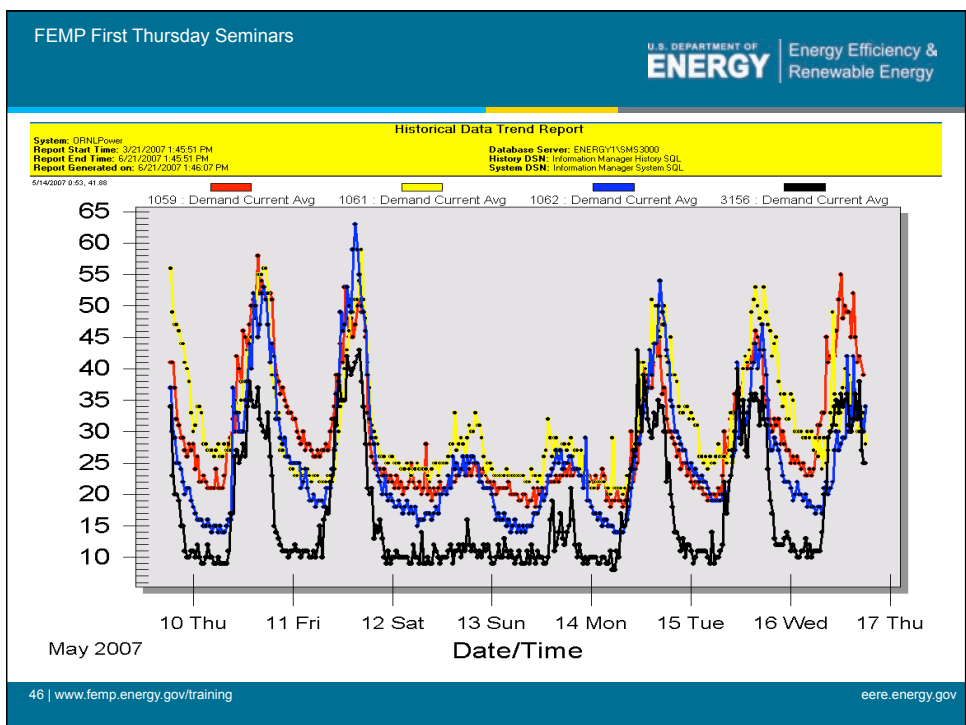
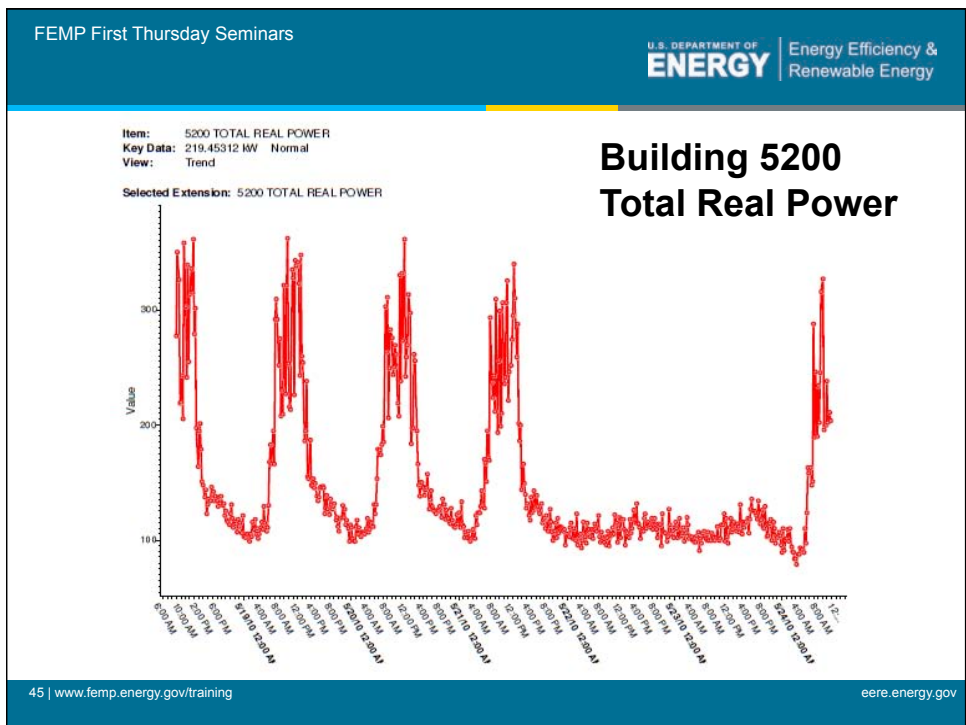
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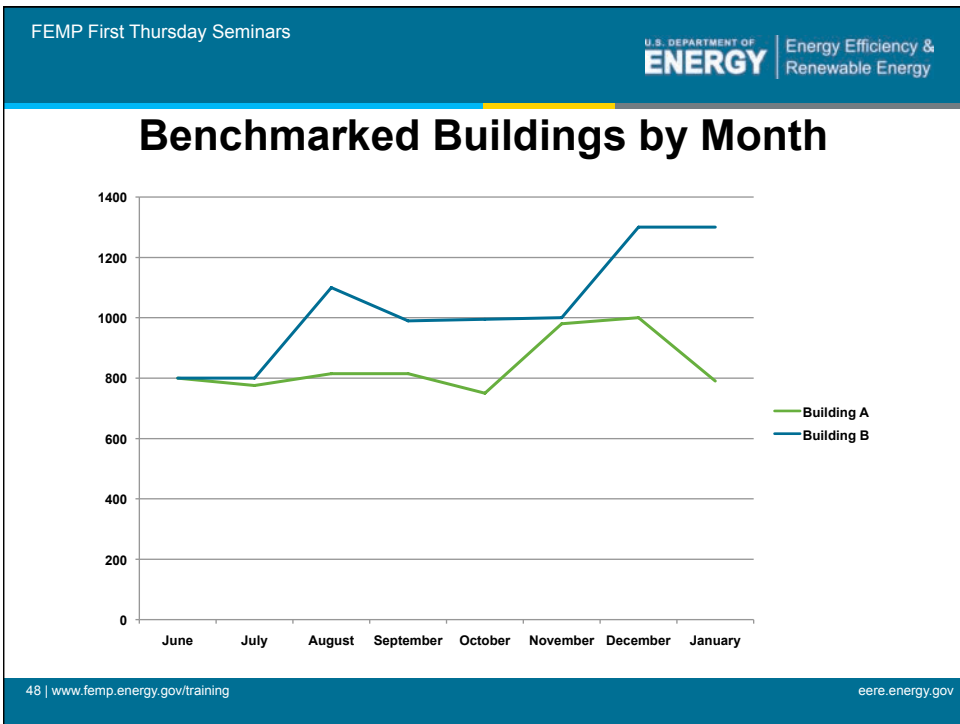
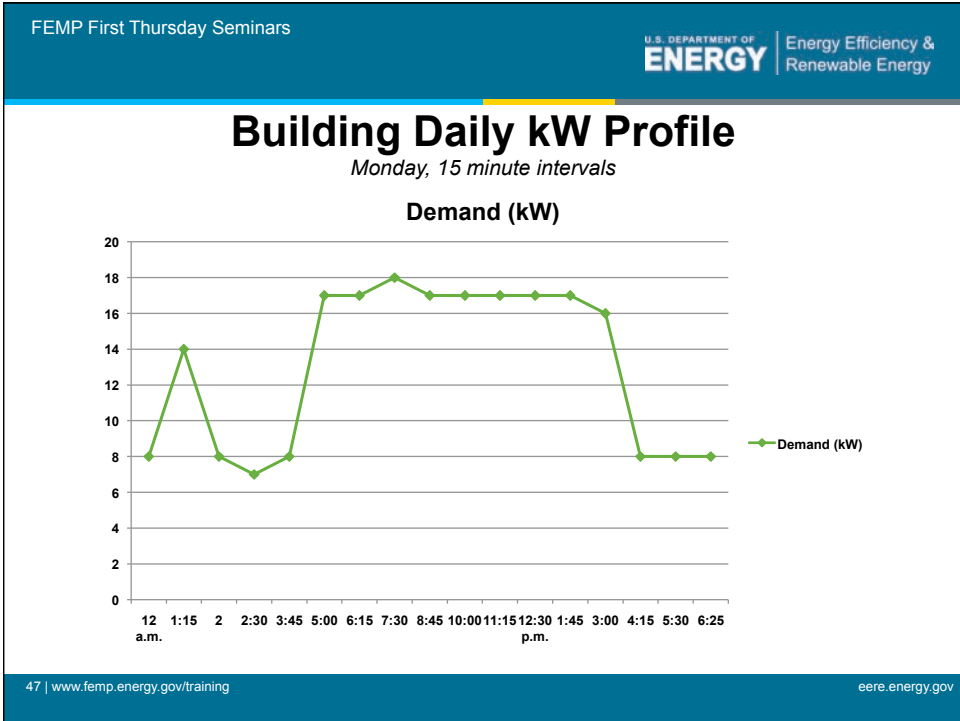
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### Building 5200 Power Meter A

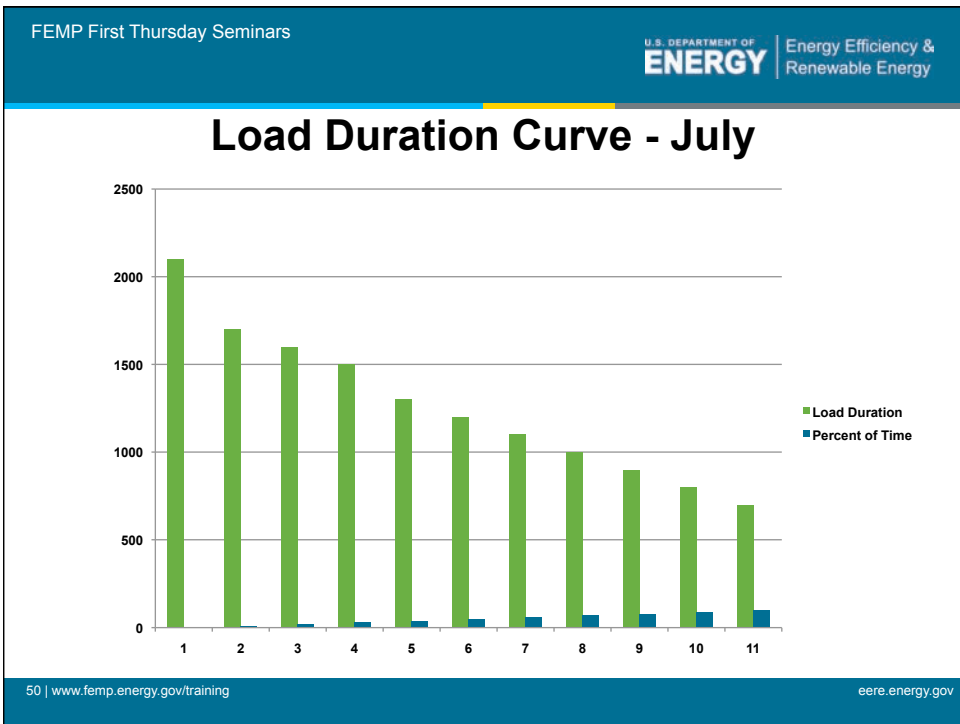
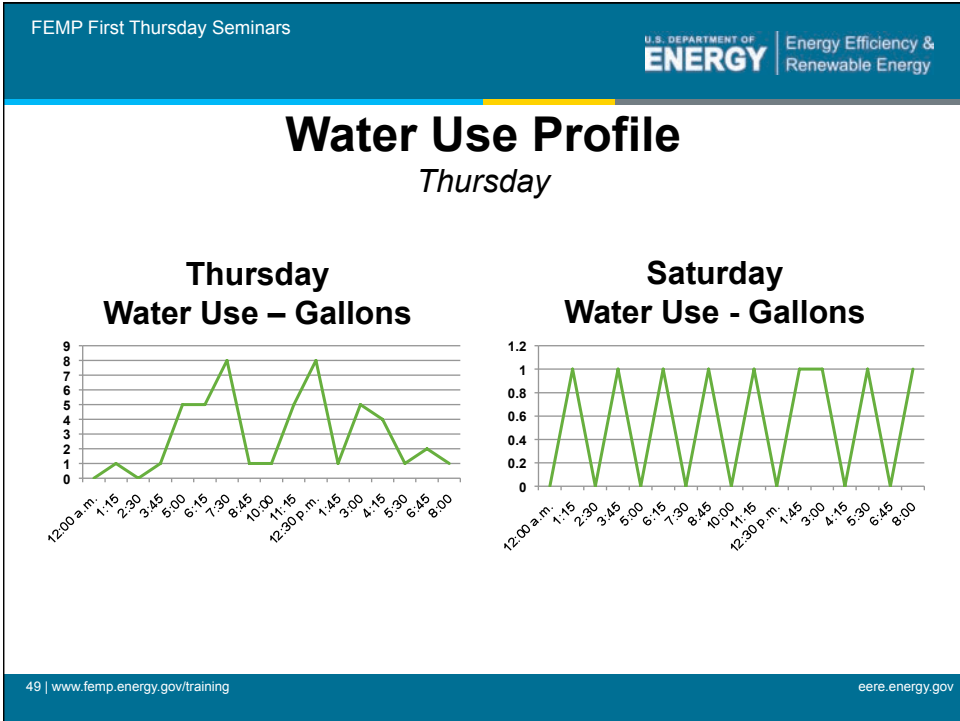
ENERGY CONSUMPTION		VOLTAGE		RESET	
Consumption	1,553,320.0	Voltage A to B	479.0 V	Reset kWh	No
<b>POWER</b>		Voltage B to C	480.0 V	Reset Min/Max/Avg	No
Apparent Power	169.0 kVA	Voltage A to C	487.0 V		
Reactive Power	76.0 kVAR	Voltage A to Neutral	278.0 V		
PF Total	0.99	Voltage B to Neutral	275.0 V		
Power Factor A	0.9	Voltage C to Neutral	279.0 V		
Power Factor B	0.92	Voltage Line To Line	474.0 V		
Power Factor C	0.86	<b>CURRENT</b>			
Real Power	152.0 kW	Average Current	203.0 A		
Real Power A	49.0 kW	Current Phase A	197.0 A		
Real Power B	51.0 kW	Current Phase B	206.0 A		
Real Power C	49.0 kW	Current Phase C	206.0 A		
Avg. Real Power	166.0 kW				
Min. Real Power	0.0 kW				
Max. Real Power	296.0 kW				

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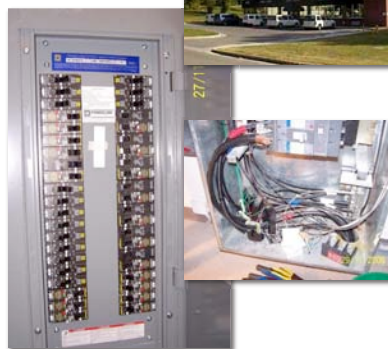
## Lessons Learned

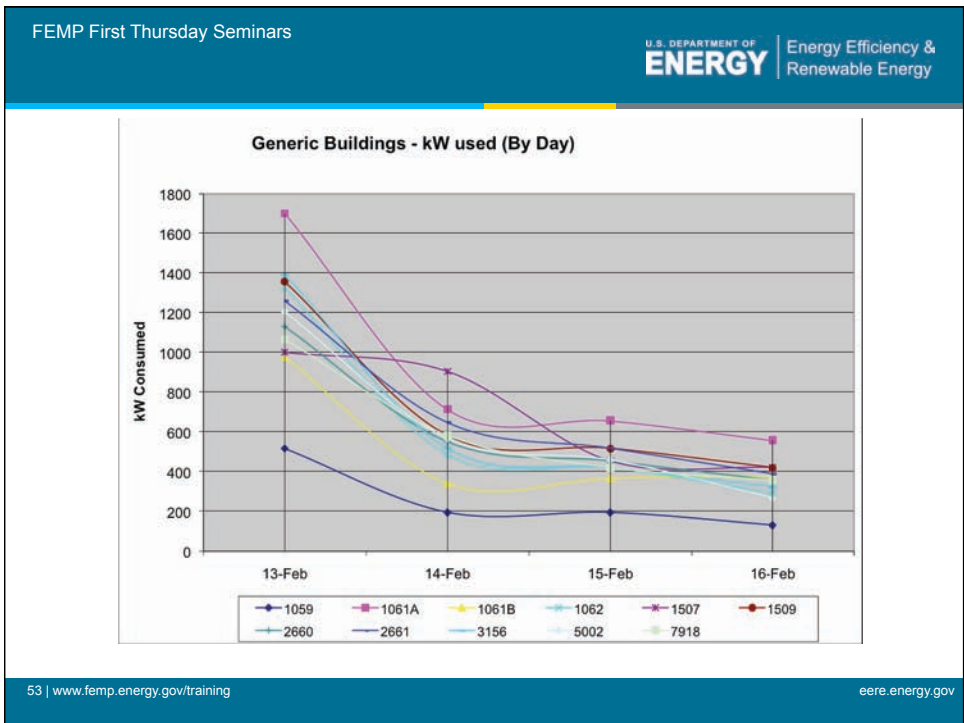
- **Utilities**
- **Assessment**
  - Platform
  - Communication's System
    - Wiring
    - Power Relays
  - Revenue meters vs. power quality



## Generic Office Building Controls

- One ENERGY STAR® Building to Model
- Switch-rated, Motor-controlled Breakers
- Occupancy Sensors
- Combined 70K ft<sup>2</sup>
- Potential of multiple ENERGY STAR® buildings once implemented
- Scalable to Larger Facilities





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## Lessons Learned

- **Dashboard development**
  - Utilities
  - Facility Managers
  - Executives
- **Vendor Check**
- **SmartGrid**

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## The Future of Metering

- **Executive Order 13514 will further increase need for Advanced Metering**



## Key Resources

- **FEMP Web site:**  
[www.femp.energy.gov](http://www.femp.energy.gov)
- **Learner Guide:**  
[www.femp.energy.gov](http://www.femp.energy.gov)  
follow the link to the  
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**Advanced Metering Requirements  
and Best Practices  
Seminar Evaluation  
and the Open Book Quiz**

*Almost done . . .*

The link below will take you to the brief  
open-book Quiz and Evaluation.  
*Earn a Certificate of Completion for your records!*

<http://apps1.eere.energy.gov/femp/training/quiz/metering.cfm>