FEMP Metering Training Course
Session 1: Metering Overview
February 28, 2007

Course Introduction – slide 3

- Help Federal agencies meet EPAct 2005 metering requirements
- Three-part program
  - Metering Overview (2/28/2007)
  - Metering Technologies, Communications, and Data Storage (3/14/2007)
  - Metering Planning, Financing, Data Usage, and Case Studies (4/4/2007)

Session #1 Objectives – slide 4

- High-level overview of
  - EPAct 2005 metering requirements
  - Metering concepts
    - Technologies
    - Data uses
    - Planning and financing

Other FEMP Metering Support – slide 5

- FEMP metering website:
  http://www.eere.energy.gov/femp/technologies/om_advmetering.cfm
- Energy 2007 – August 5-8, 2007
  http://www.govenergy.com
- Metering Best Practices Guide – summer 2007:
  - Methods and approaches
  - Technologies and applications
  - Communications and data storage
  - Program planning
  - Data applications
  - Case studies

Session #1 Topics – slide 6

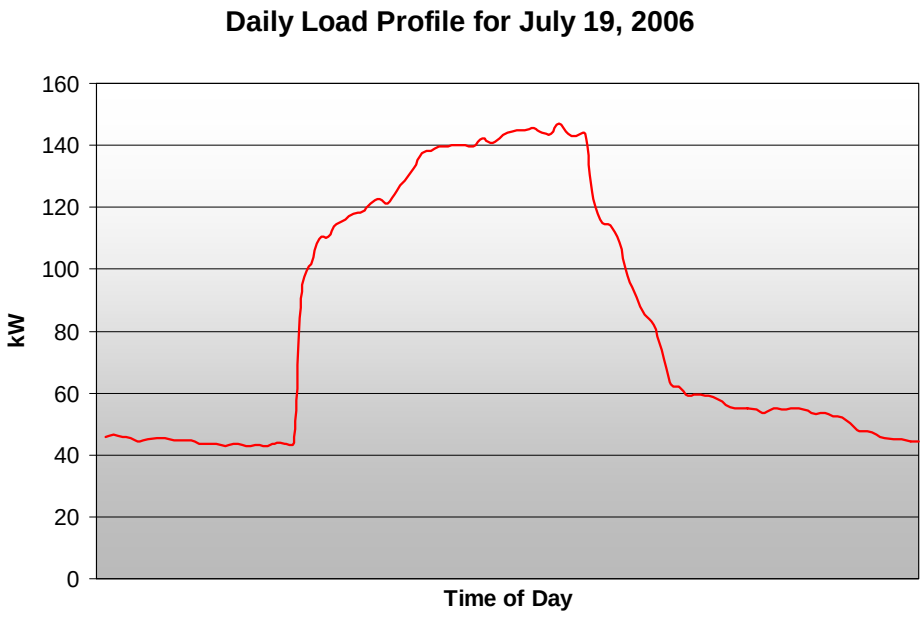
- ❑ Federal metering overview/EPAct 2005
- ❑ Metering technologies
- ❑ Communications and data storage
- ❑ Data uses
- ❑ Planning and financing

Why Should You Meter? – slide 7

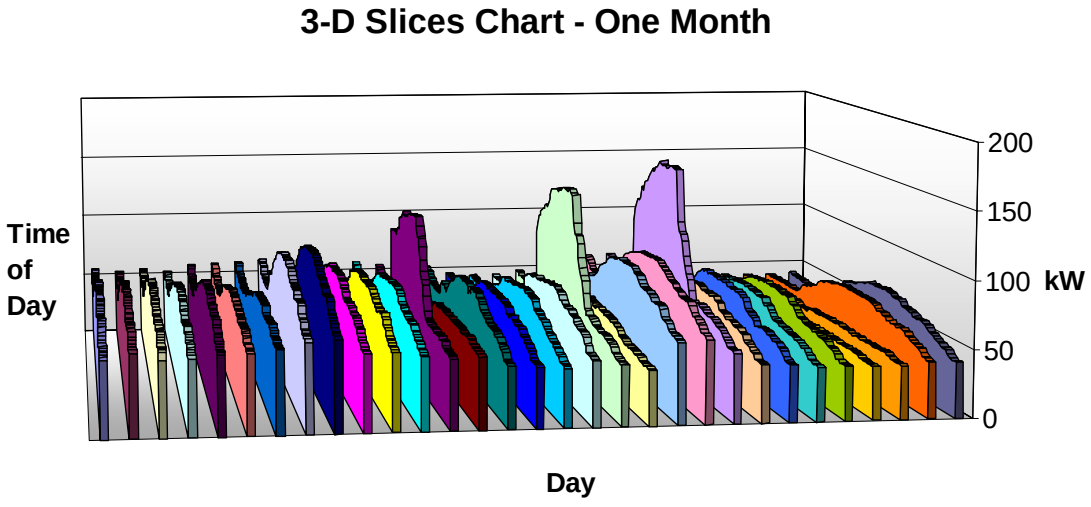
- EPAct 2005 Section 103 requires it
- Good management practice
  - Manage energy use and cost

- Verify equipment operations
- Support decisions
- Benchmark facilities
- Verify utility bills
- Allocate costs
- and more

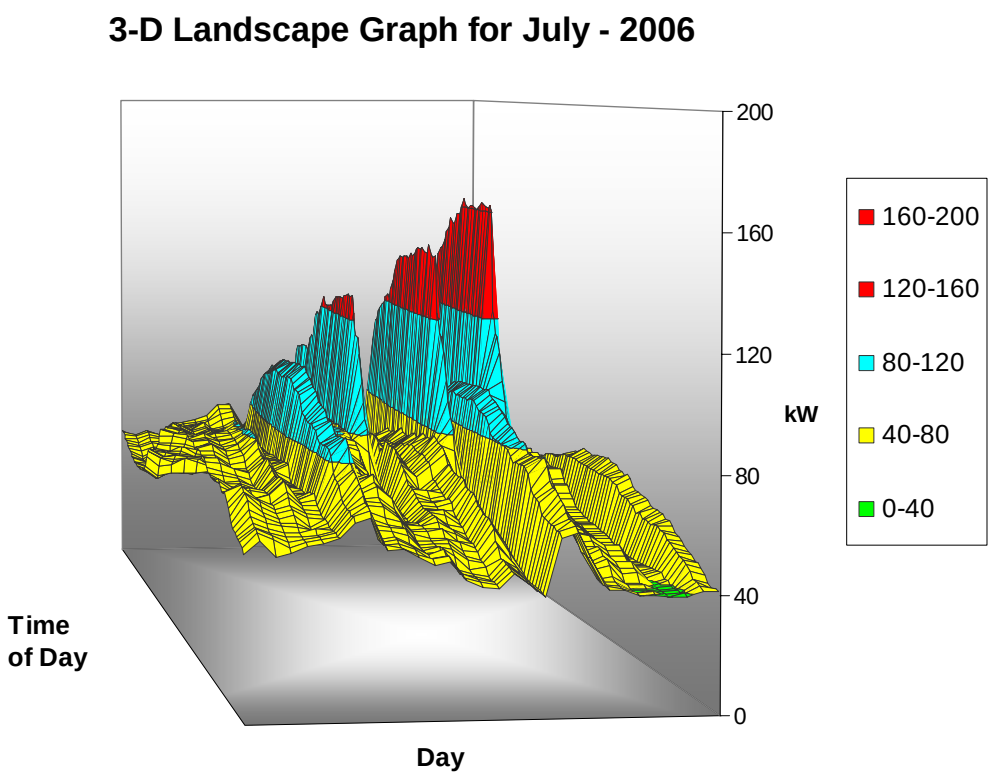
Daily Load Profile – slide 8



Interval 3-D Landscape – slide 9



Interval 3-D Landscape – slide 10



What to Meter – slide 11

- Electricity
- Other energy uses
- Meet 2012 needs

EPAct Metering Requirements – slide 12

- October 1, 2012
- All Federal buildings
- Efficient energy use and cost reduction
- Meter electricity
- Advanced meters
- Make data available

Requirements – Guidance & Planning – slide 13

- Guidance for Electric Metering in Federal Buildings (2/3/06): http://www1.eere.energy.gov/femp/pdfs/adv_metering.pdf
- Agency metering plans
  - Meet EPAct requirements
  - Designate primary personnel
  - Documentation of impracticability

Definition – Advanced Meters – slide 14

- Capability to measure and record interval data – at least hourly
- Communicate data – at least daily
  - To a remote location
  - Format compatible into advanced metering system

Definition – Advanced Metering System – slide 15

- Collects time-differentiated data from advanced meters
  - Via network system
  - On-request or defined schedule
- Can provide usage information on at least a daily basis
- Supports desired features and functionality

Definition – Standard Meter – slide 16

- Electromechanical or solid state meter
- Cumulatively measures, records and stores aggregated kWh data
- Data periodically retrieved
- Not an advanced meter

Advanced vs. Standard Meters – slide 17

- Interval data vs. cumulative data
- Data communications and retrieval: daily or more vs. scheduled
- Data analysis: system functionality vs. limited analysis

Practicability – slide 18

- Definition: *Feasible or usable*
- Factors to consider
  - Value of data
  - Costs to meter
- Agency/site definitions

Practicability – Value of Data – slide 19

Action	**Observed Savings**
Installation of meters	0-2% (the "Hawthorne Effect")
Bill allocation only	2 ½ to 5% (improved awareness)
Building tune-up	5 to 15% (improved awareness, and identification of simple O&M improvement)
On-going commissioning	15 to 45% (improved awareness, ID simple O&M improvements, project accomplishment, and continuing management attention)

Practicability – Costs to Meter – slide 20

- Metering systems hardware and software
- Labor to install
- Recurring costs
  - Monthly fees – communications and Application Service Provider
  - Data collection and storage
  - Data analysis
  - Operations and maintenance

Practicability – Cost Effectiveness – slide 21

$$\frac{\left[\left(\frac{\text{Installed Cost}}{\text{Desired Simple Payback}}\right)+\text{Annual Cost}\right]}{\%\ \text{Annual Savings}} = \text{Minimum Annual Electric Bill}$$

Sample Calculation – slide 22

Assumptions:

- Annual energy savings: 2%
- Equipment capital cost: $5,000
- Required payback: 10 years
- Recurring fees for maintenance and data collection/processing: $25/month

Cost Effectiveness – Sample –slide 23

$$\frac{\left[\left(\frac{\$5{,}000}{10\text{ years}}\right)+\$25/\text{month}*12\text{ months}\right]}{2\,\%\,\text{Annual Savings}}=\$40{,}000$$

Result: $40,000

Thus, cost effective to meter buildings with > $40,000 in annual electric cost

Session #1 Topics – slide 24

- ✓ Federal metering overview/EPAct 2005
- ❑ Metering technologies
- ❑ Communications and data storage
- ❑ Data uses
- ❑ Planning and financing

Metering Technologies – slide 25

- The basics:
  - Measure of current: ***amperage (amps)***
  - Measure of voltage: ***volts***
  - Current (amps) times Voltage (volts) = **Power** (Watts or Kilowatts)
  - Power over time (kilowatt-hours) = **Energy**
  - We pay for "Energy" …$/kWh
  - We may also pay for "Power" …$/kW

Safety First! – slide 26

- Prior to interaction with electrical meters, panels, connections, or wiring - a full safety inspection needs to take place

- Only trained and certified personnel should interact with electrical components

- All actions need to comply with the National Electric Code (NFPA 70)

Metering Fundamentals – Basic Meter Functions – slide 27

- Current measurements
- Voltage measurements

Metering Fundamentals – Meter Outputs (minimums) – slide 28

- Power (kW)
- Energy (kWh)
- Considerations:
  - Power quality
  - Power factor

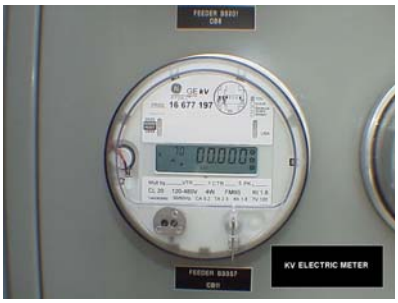
Metering Fundamentals – Measurement Frequency – slide 29

- The "Interval"
  - EPAct requirement
  - Flexibility is key
  - Functional suggestions

Metering Approaches – slide 30

- Long-Term Measurements
- Short-Term Measurements
- Run-Time Measurements
- One-Time/Spot Measurements

Metering Approaches – Long-Term Measurements – slide 31



- Permanent/fixed equipment installations
- Whole building focus
- Data applications include:
  - Billing
  - Load profiling
  - High-level operational verification

Metering Approaches – Short-Term Measurements – slide 32

- Portable equipment installations
- Panel/sub-panel to end-use focus
- Data applications include:
  - Trending
  - Measurement and Verification (M&V)

Metering Approaches – Run-Time Measurements – slide 33

- Portable equipment installations
- End-use focus
- Data applications include:
  - M&V
  - Equipment diagnostics
  - Controls verification

Metering Approaches – One-Time/Spot Measurements – slide 34

- Portable equipment installations
- End-use focus
- Data applications include:
  - M&V of scheduled loads
  - Equipment diagnostics

The Metering Process Hierarchy – slide 35

- Whole Building
- Panel/Sub-Panel Level
- Circuit-Level
- End-Use/Equipment Level

Whole-Building Metering Technologies – slide 36

- Electro-mechanical socket meters
  - Retrofit option
- Electronic (solid state) socket/non-socket meters
- Advanced electronic "smart" meters

Electro-Mechanical Socket Meters – slide 37

Advantages:

- Low cost
- Fairly accurate
- Widely used/available

Challenges:

- Manually read – most read infrequently
- No time-based recording
- Limited use for readings

Meets EPAct? NO!

Retrofit Electro-Mechanical Socket Meters – slide 38

Advantages:

- Low/moderate cost
- Fairly accurate
- Can be automated for data recall

Challenges:

- Retrofit solution
- May not have time-based recording
- Added cost

Meets EPAct? Possible, but…

Electronic Socket/Non-Socket Meters – slide 39

Advantages:

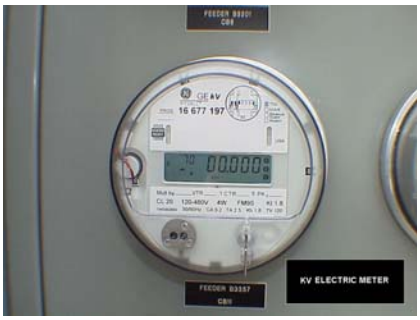
- Moderate cost
- Very accurate
- Typically have data storage and time-stamp capabilities
- Greater uses for data

Challenges:

- More expensive
- More complicated
- Need ancillary systems for data transfer and use

Meets EPAct? Yes!

Advanced Electronic "Smart" Meters – slide 40



Advantages:

- Accurate
- Data storage and time-stamp capabilities
- Can accommodate other inputs
- Multiple output/diagnostic capabilities
- Two-way communication
- Control/alarm features
- Flexible data intervals and uses

Advanced Electronic "Smart" Meters – slide 41

Challenges:

- Moderate/high cost
  - More expensive as options and features increase
- More complicated/more data/staff training suggested
- Need ancillary systems for data transfer and use

Meets EPAct? Yes!

Session #1 Topics – slide 42

- ✓ Federal metering overview/EPAct 2005
- ✓ Metering technologies
- ❑ Communications and data storage
- ❑ Data uses

- ❑ Planning and financing

Metering Communications – Considerations – slide 43

- Existing infrastructure
- Non-proprietary protocols
- Need for multiple solutions

Metering Communications – Options – slide 44

- Phone lines
  - Cellular options
- Ethernet/LAN
- Building Automation System (BAS)
- Wireless/Radio Frequency (RF)
- Power-line Carrier

Data Acquisition/Storage – slide 45

Considerations:

- Data Acquisition
  - Metering system software
- Data Storage
  - IT Department engagement
- Contracted Services
  - Application Service Providers

Metering Costs – slide 46

- Actual costs depend on technology, communications, and scope
- Average meter cost: $500 - $3,000
- Installation: $500 - $2,000
- Communications: $500 - $2,000
- Back-office/reporting: $20 - $50/month
- O&M: $5/month
- Average cost range: $1,800 - $7,000/meter
- *Best Estimate:* *$4,000 - $6,000/meter*

Metering Resources – slide 47

- Automatic Meter Reading Association:
  - http://www.amra-intl.org/
- Advanced Utility Metering report:
  - http://www1.eere.energy.gov/femp/pdfs/33539.pdf
- PECI report:
  - http://www.energystar.gov/ia/business/datalog.pdf
- FEMP:
  - http://www1.eere.energy.gov/femp/

Session # 1 Topics – slide 48

- ✓ Federal metering overview/EPAct 2005
- ✓ Metering technologies
- ✓ Communications and data storage
- ❑ Data uses
- ❑ Planning and financing

Data Uses – slide 49

- What makes sense for your application?
  - Energy savings opportunities
  - Cost savings opportunities
  - Best chances to succeed
    - Now
    - 10 years from now

Data Uses – Cost Allocation – slide 50

- Use when segregating use among multiple tenants, programs, or buildings
- Encourages energy use management

Data Uses – Electric Rate Selection – slide 51

- Includes time-of-use (TOU), real-time pricing (RTP), and/or interruptible rates
- Select rate based on
  - Demand (and energy) usage profile
  - Willingness to manage load
  - Ability to manage load
- Periodically reassess rate tariffs
- Companion to Electric Load Management

Data Uses – Electric Load Management – slide 52

- Use with time-based rates
- Requires
  - Planning and (near) real-time monitoring
  - Ability to control loads
- Planning should involve affected parties

Data Uses – ESPC Measurement & Verification (M&V) – slide 53

- Option C (Whole Building)
- Data collection requirements defined by contract
  - Appropriate M&V option
  - Cost to contract

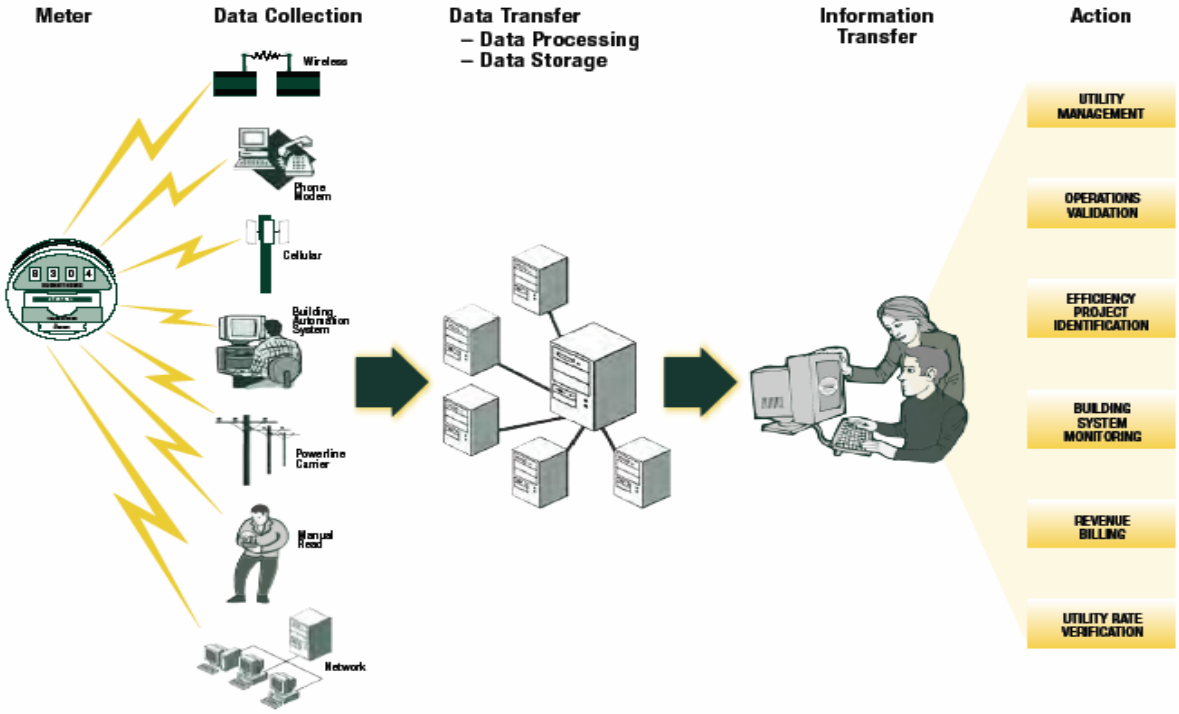
Data Uses – Planning & Reporting – slide 54

- Includes using data in support of
  - Annual and periodic reporting
  - Developing electricity budgets
  - Site master planning efforts

Data Uses – Other – slide 55

- Billing verification
- Emergency response
- Leak detection (non-electric)

Metering System Path to Action – slide 56



Session # 1 Topics – slide 57

- ✓ Federal metering overview/EPAct 2005
- ✓ Metering technologies
- ✓ Communications and data storage
- ✓ Data uses
- ❑ Planning and financing

Developing a Metering Plan – Steps – slide 58

- Identify your metering program objective
- Survey existing meters
- Assess financing options
- Design
- Install
- Operate

Developing a Metering Plan – Identify Program Objectives – slide 59

- Considerations:
  - Site occupancy
  - Annual electric costs
  - Electric rate structure
  - Site management
  - "Practicability"
- Think opportunity!

Developing a Metering Plan – Survey Existing Meter Infrastructure – slide 60

- Individually metered buildings?
- Electricity? Other?
- Advanced or standard meters
- Communications system
- Data storage
- Data use
- Results of current system

Developing a Metering Plan – Assess Financing Options – slide 61

- Consult agency policy/guidance
- Estimate cost

Developing a Metering Plan – Design – slide 62

- Satisfy functional requirements
- Determine system architecture
- Develop equipment specifications
- Refine cost estimate
  - Verify practicability/impracticability

Developing a Metering Plan – October 1, 2012 – slide 63

Install by October 1, 2012

- Installation plan
  - Phase installation
  - Prioritize applications

- Commission
- Train staff

Developing a Metering Plan – Operate and Maintain – slide 64

- Identify and program required resources
- Collect and analyze data
- **Initiate actions!**
- Periodically review program results

Financing Options – slide 65

- No funding appropriated in EPAct
- No one-size-fits-all approach
- Many options

Financing Options – Primary – slide 66

- Appropriations
- Energy savings performance contracts
- Utilities

Financing Options – Policy – slide 67

- Require in construction
- Tenant sub-metering fees
- Retained energy savings

Session # 1 Topics – slide 68

- ✓ Federal metering overview/EPAct 2005
- ✓ Metering technologies
- ✓ Communications and data storage
- ✓ Data uses
- ✓ Planning and financing

Live Q&A

Our Next Session – slide 70

- Metering Technologies, Communications and Data Storage
- Wednesday March 14, 2007 at 1:00 ET/ 10:00 PT