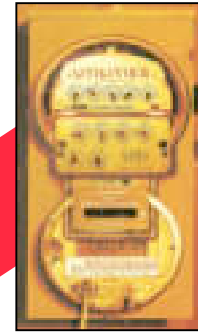

Metering 101



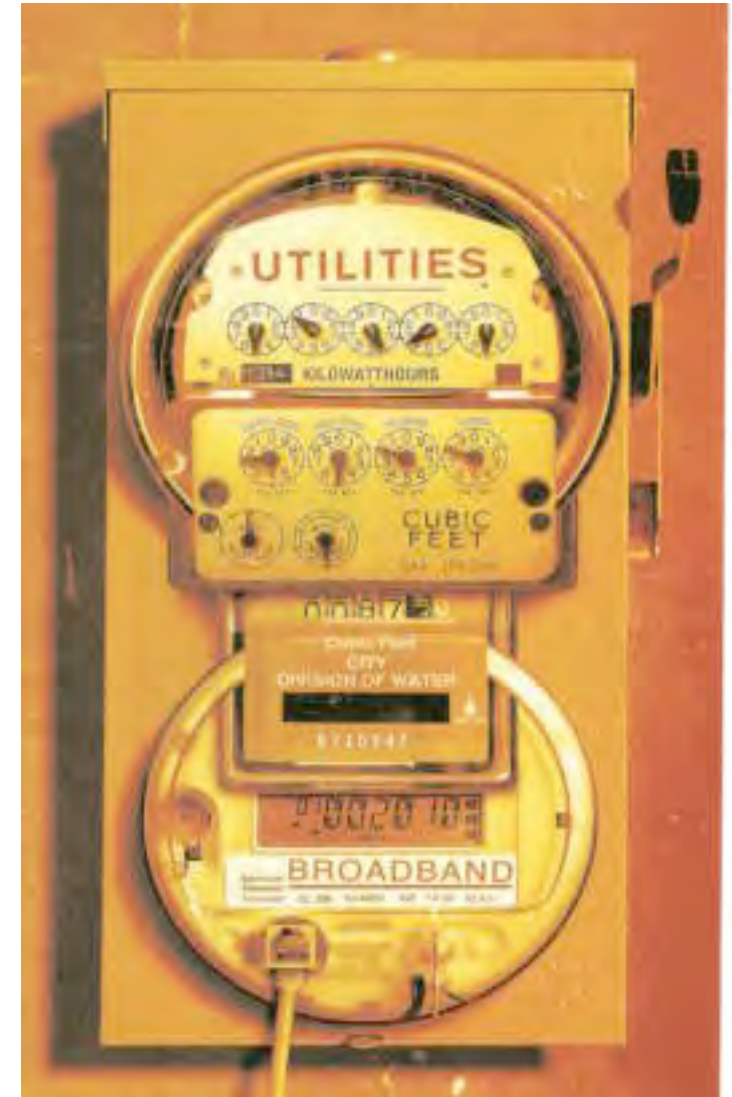
Stephen P. Sain, PE, CEM

Sain Engineering Associates, Inc.



Under the
Hood:
Operations
and
Maintenan
e

- Definitions
- Technologies
- Communications
- Data
- Economics
- Facility Prioritization
- Funding
- DoE Guidelines





Under the
Hood:
Operations
and
Maintenance

Standard Meters:

Electro-mechanical or solid state meters that **cumulatively measure**, record, and store aggregate kWh data.

Advanced Meters:

Solid state meters that have the capability to measure and record **interval data** (at least hourly for electricity), and communicate the data to a remote location (at least daily) in a format that can be easily integrated into an advanced metering system.



Under the
Hood:
Operations
and
Maintenance

Advanced Metering System:

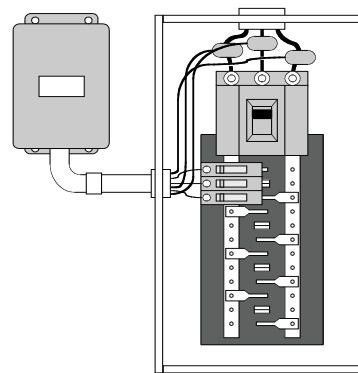
A system that **collects** time-differentiated energy usage from advanced meters via a fixed network system either on an on-request or defined schedule basis.

The system need be capable of providing usage information on at least a daily basis and can support desired features related to energy-use management, system operation, and utility procurement.



Under the
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- **Electro-mechanical** socket meters
- **Electronic** (solid state) socket/non-socket meters
- **Advanced** electronic "smart" meters





Under the
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Utility grade, industry standard, mature technology

Advantages:

- Low cost
- Accurate
- Widely used/available

Disadvantages:

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



Electronic (solid state) Socket/Non-Socket Meters



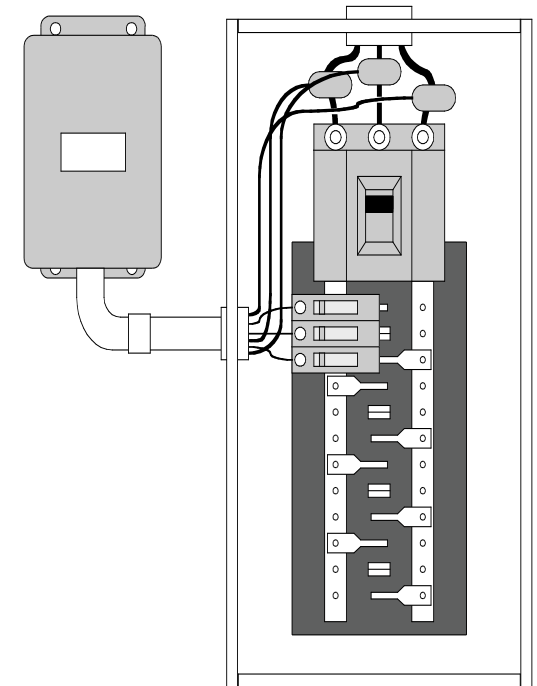
Under the
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Advantages:

- Moderate cost
- Accurate
- Widely available
- Typically have data storage and time-stamp capabilities
- Greater uses for data

Disadvantages:

- More expensive as options and features increase
- More complicated
- Need ancillary systems for data collection and analysis





Under the
Hood:
Operations
and
Maintenance

Advantages:

- Accurate
- Widely available
- Data storage and time-stamp capabilities
- Can accommodate other inputs
- Greater uses for data
- Multiple output/diagnostic capabilities
 - 3-phase diagnostics, voltage imbalance, power quality, reactive diagnostics, max/min readings, etc.
- Two-way communication
- Control/alarm features
- Flexible data intervals and uses





Under the
Hood:
Operations
and
Maintenance

Disadvantages:

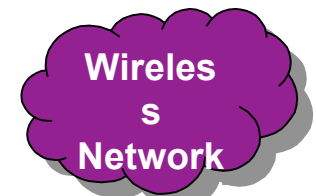
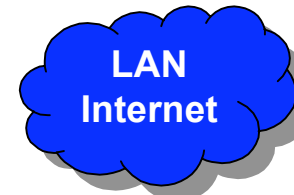
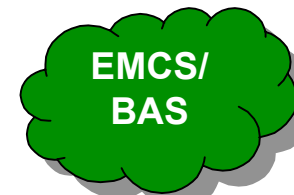
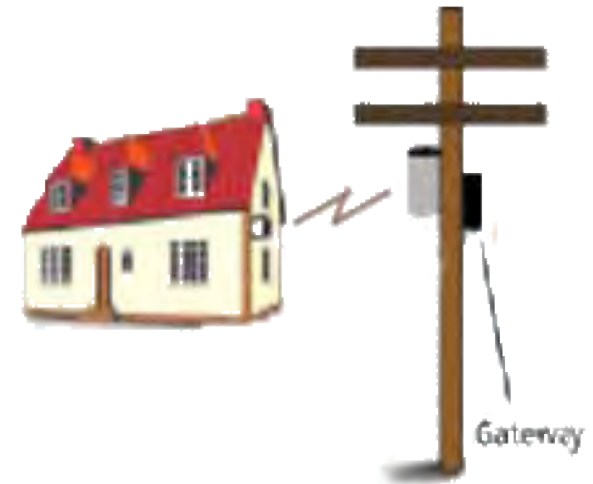
- Moderate/high cost
 - More expensive as options and features increase
- More complicated/more data/staff training suggested
- Need ancillary systems for data collection and analysis





Under the
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Operations
and
Maintenance

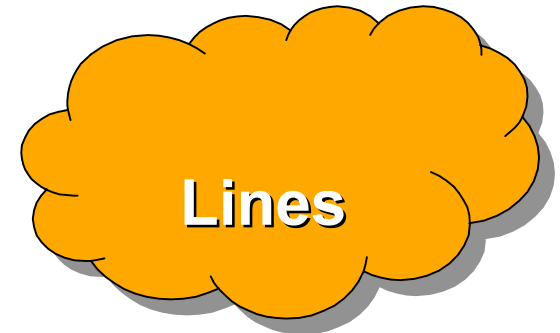
- Increasing options, lower cost, and more flexible
- Search for the path of least resistance
- Make sure decisions keep the future "open"
- Considerations/questions:
 - EMCS/BAS – existing infrastructure
 - Ethernet/LAN – existing infrastructure
 - MODBUS/RS 485
 - Phone lines (dedicated wired, cell, etc.)
 - Wireless





Under the
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- Meters (with modem) connected to existing phone network (wired or cell)
- Communication initiated at the meter or at the collection point

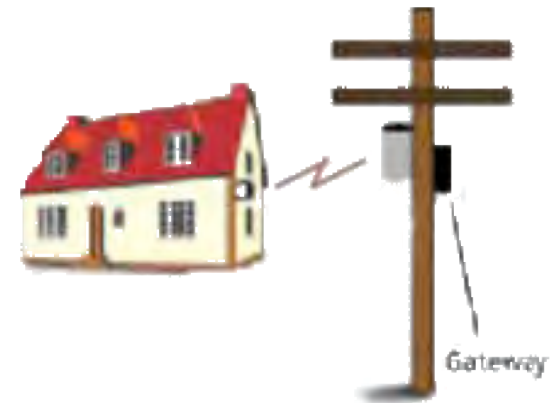


Advantages:

- Usually available
- Proven technology

Disadvantages:

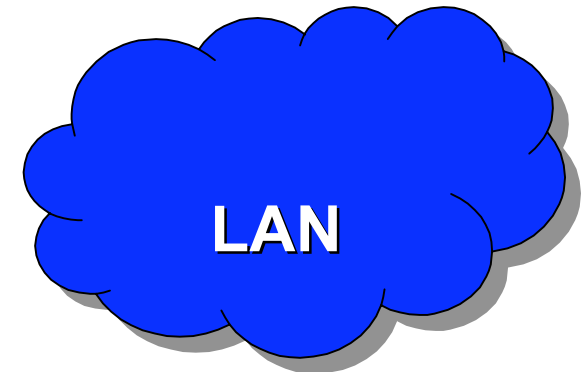
- Can be expensive
- Wired installation – except cellular
- Difficult to view real time data





Under the
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and
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- Meters direct-connect to area network
- Communication initiated at the meter or at the collection point

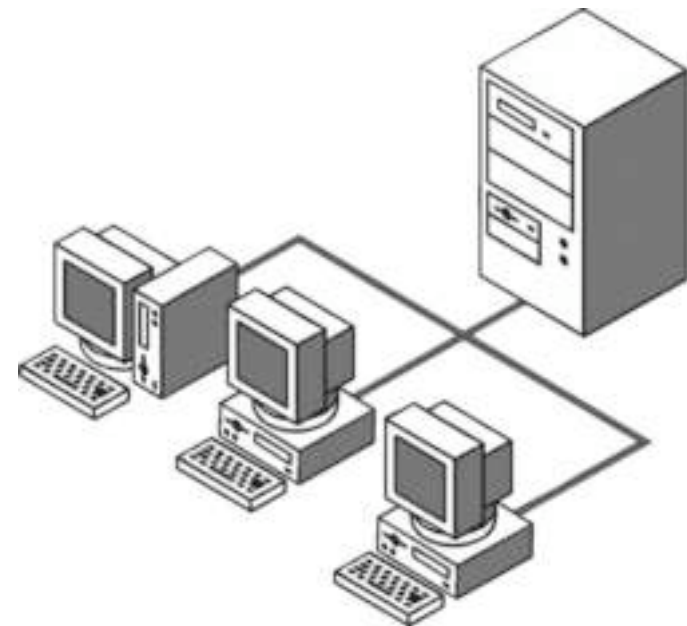


Advantages:

- Usually available
- Proven technology
- Fast communication
- Always connected
- Data sharing

Disadvantages:

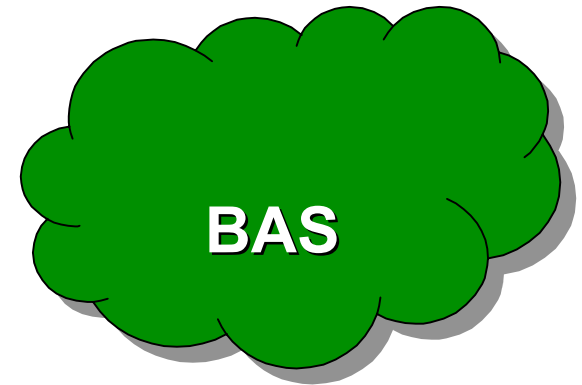
- Network/IT concerns
- Wired installation





Under the
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and
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e

- Meters direct-connect to existing BAS
- Communication initiated at the meter or at the collection point



Advantages:

- Usually available
- Fast communication
- Always connected

Disadvantages:

- Potential system compatibility issues
- Potential data availability issues





Under the
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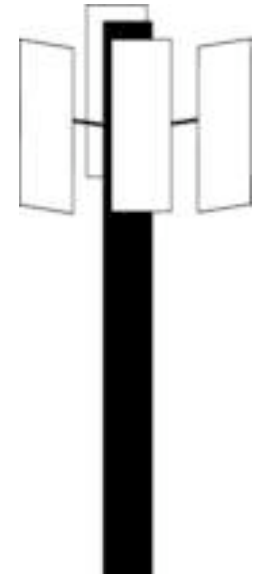
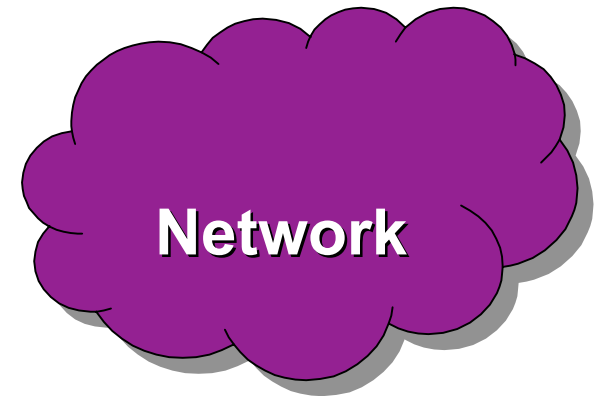
- Meters wirelessly communicate
- Communication initiated at the meter or at the collection point

Advantages:

- No wiring
- Fast communication
- Always connected

Disadvantages:

- System cost
- Perceived RF interference issues
- New system/infrastructure

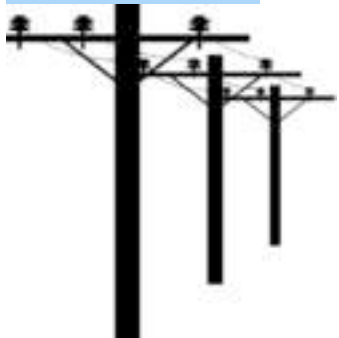




Under the Hood:
Operations
and
Maintenance

Others...

- Sneaker-net (*manual read*)
- Windshield-net (*drive-by read*)
- Power Line Carrier

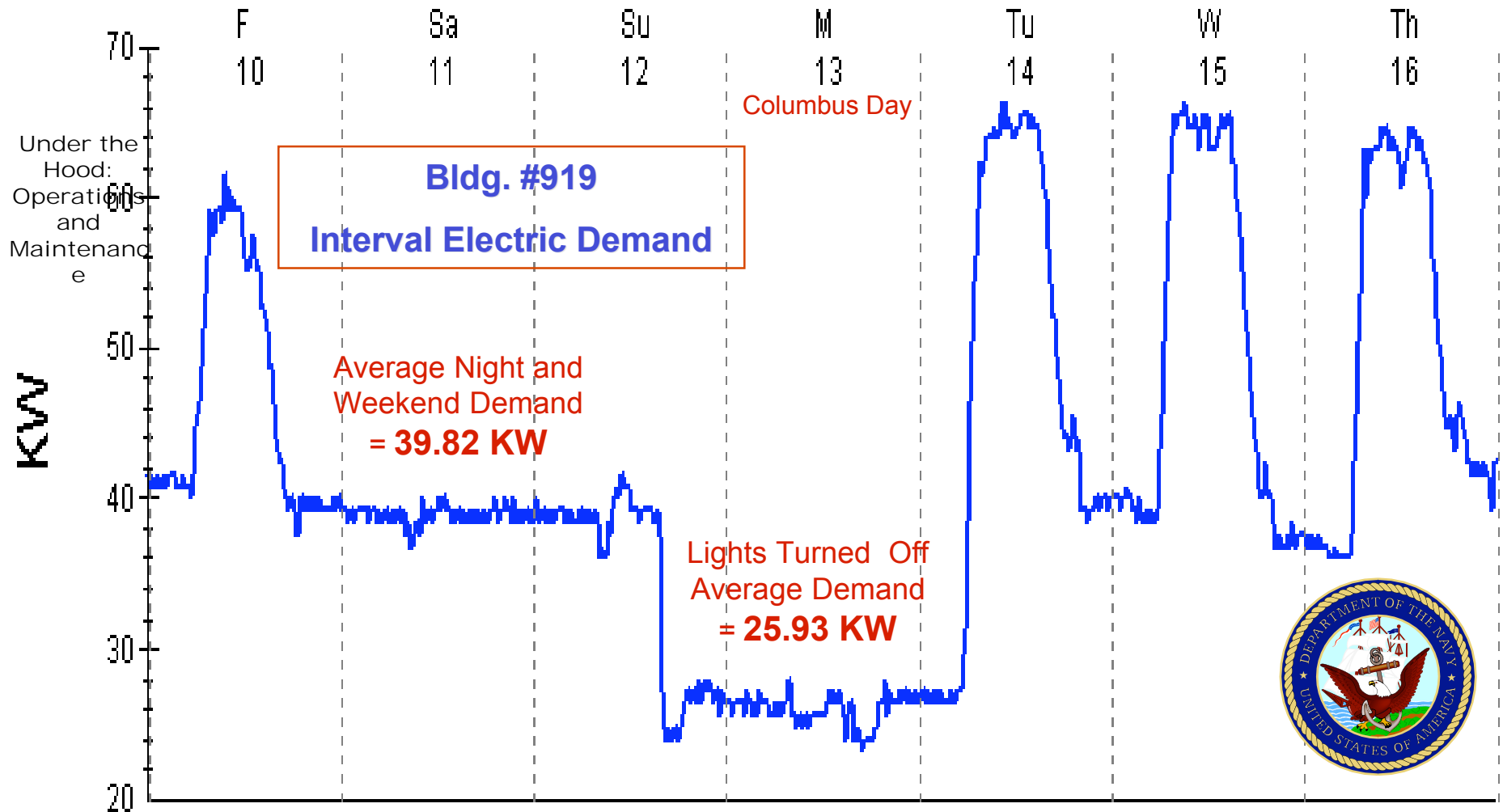




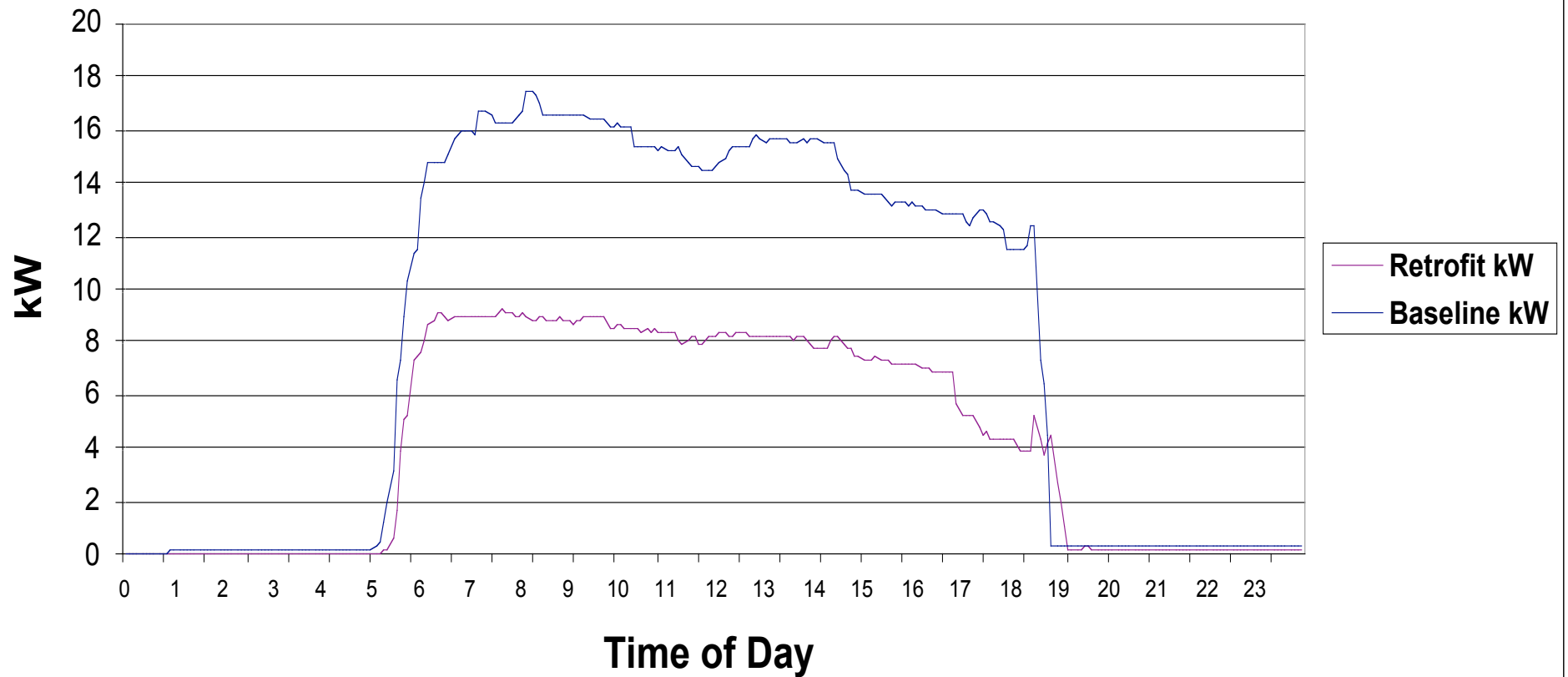
Under the
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Operations
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Maintenance

- Reimbursable Billing
- Identify Conservation Opportunities
- Identify Peak Shaving Opportunities (demand response)
- Identify Night-Time Shutdown (verify control strategies)
- Measurement & Verification
- Energy Use Diagnostics
- Benchmarking
- Energy Awareness
- Utility interaction (time-of-use metering/real-time pricing/load aggregation)
- Planning & Reporting

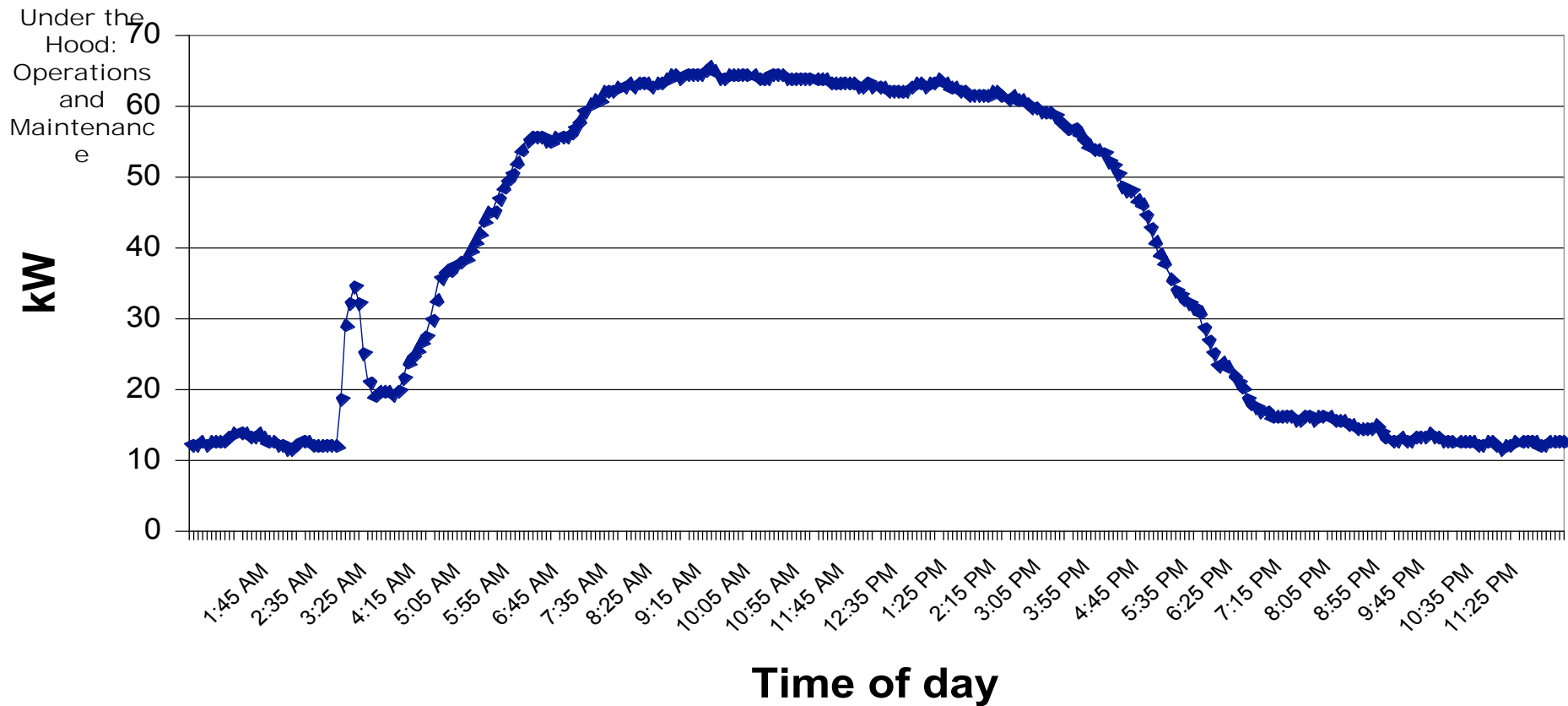




Scotopic Light Demonstration Aggregate Daily Lighting Profile



Lighting kW 10/14/05
Note the "spike"





Under the
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e

Ask not what a meter costs...



... But what it costs NOT to meter!



Under the
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Maintenance

*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: \$50/month
- O&M: \$5/month



Average cost range: \$2,000 - \$7,000/meter

Best Estimate: \$4,000 - \$6,000/meter



Under the
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<u>Action</u>	<u>Observed Savings</u>
Installation of meters	0-2% (the "Hawthorne Effect")
Bill allocation only	2 _ to 5% (improved awareness)
Building tune-up	5 to 15% (improved awareness, and identification of simple O&M improvement)
Continuous Commissioning	15 to 45% (improved awareness, ID simple O&M improvements, project accomplishment, and continuing mgmt. attention)



Under the
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assumptions:

- Simple metering and cost allocation/tracking can save 2% - 5% of annual energy bills
- Estimated building level metering cost: \$5K/building
- Plus: \$25 monthly cost per meter including maintenance, data collection, storage and analysis
- Desired simple payback: 10 years



Under the
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calculations:

Investment: $\$5,000 / (2\% \times 10 \text{ years}) = \$25,000$

O&M: $(\$25/\text{mo.} \times 12 \text{ mos./year}) / 2\% = \$15,000$

Result:

Any building with an annual elect bill $> \$40,000$



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- Prioritize buildings based on energy use/potential for savings
 - At some point metering is not cost effective
 - These buildings need be documented

- Chicken and egg conundrum...
 - Needed to know energy use to determine which to meter
 - Need a meter to know energy use





Under the
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Non-metered building methodologies

- Square footage based estimate
 - Quick, simple, inaccurate
- Energy Use Intensity (EUI) based estimate
 - kWh/ft²/yr by facility type and climatic region
 - Commercial Buildings Energy Consumption survey (CBECS) data
 - Need fit building types/size, fuel types, prevalent equipment, climate zone, occupancy
 - Site-specific EUI data available?
 - Not-so-quick, not-so-simple, more accurate



Under the
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Non-metered building methodologies

- Computer modeling
 - Facility Energy Decision System (FEDS) analysis
 - Other single building simulation (DOE 2, BLAST, Energy Plus, etc.)
- Short-term metering/data logging

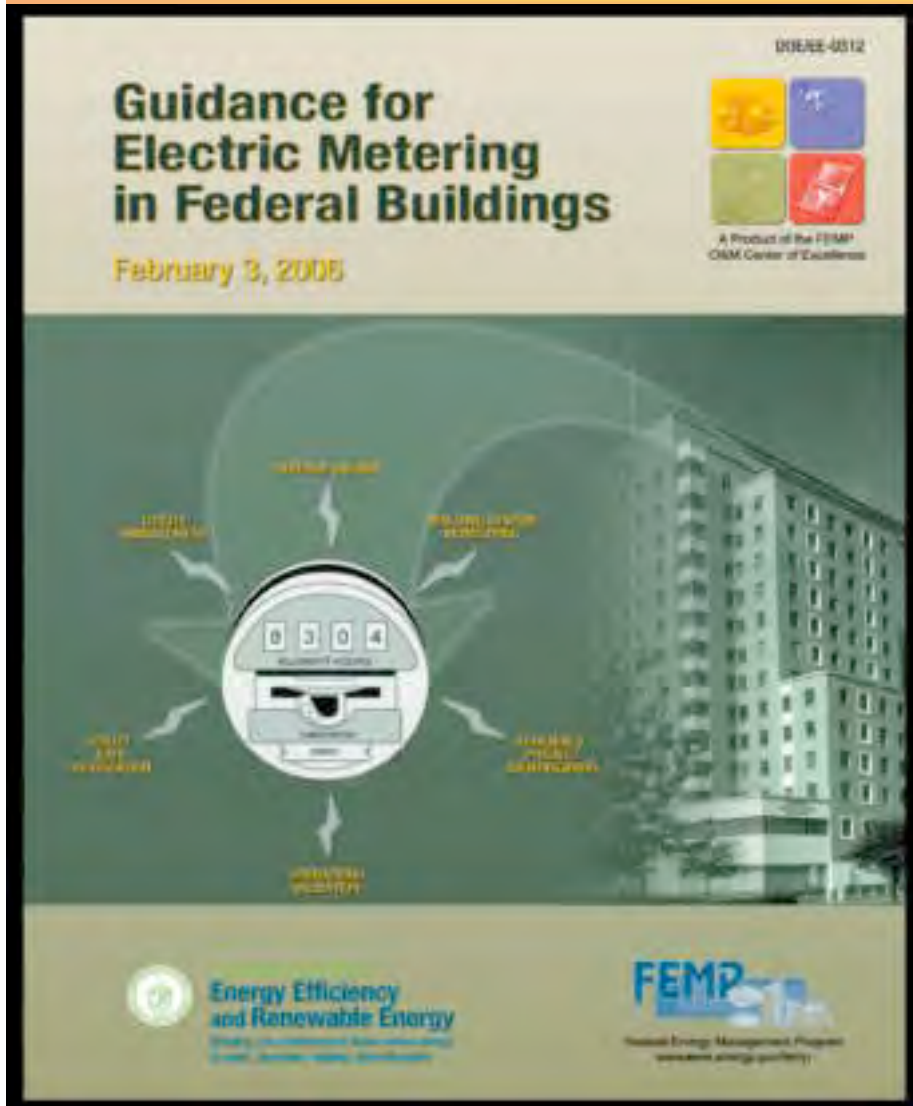




Under the
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- Appropriations
- ESPC
- UESC
- ECIP
- Specified with construction/renovation
- Sub-meter/reimbursable fees
- Leased opportunities
- O&M budgets





- “Advanced Metering” Definition
- Uses of Metered Data
- Metering Approaches and Technologies
- Metering Cost-Effectiveness
- Methods for Prioritizing Buildings
- Methods of Financing
- Template for an Agency Metering Plan
- Performance Measures
- Special Considerations
- EPCa ‘05 Metering Text

http://www.eere.energy.gov/femp/pdfs/adv_metering.pdf





Questions?



Under the
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Under the
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- Extras



Under the
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■ Current:

- Amps measured with ammeter or current transformer (CT)
 - Current draw proportional to magnetic field developed
 - CT detects field and develops output in proportion to field/current
 - CTs need be sized/installed properly





Under the
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■ Voltage:

- Volts measured with voltmeter as “potential” referenced to known voltage/ground
 - Voltage measured in parallel with circuit using potential transformer (PT)
 - Challenging part of installation – installed on “hot” line
 - PTs need be sized/installed properly





Under the
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■ Power:

- Current x Voltage
 - Most power meters record “true” power measurements
 - Real and reactive power taken into account
 - kW is billed on peak
 - kvar is billed when have poor power factor



Under the
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■ Time:

- Afford ability to track power over time
- Intervals selectable – typically, 15 min or 1 hour.



Under the
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and
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Retrofit pulse initiator (optical encoder)

Advantages:

- Low/moderate cost
- Accurate
- Widely used/available
- Can be automated for data recall

Disadvantages:

- Typically a retrofit solution
 - Not long-term solution
- No time-based recording
- Added cost
- Limited use for data

