Whole House Energy Monitoring
Why It Saves Money, and How to Install One

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Think of your house as a large engine with very poor fuel efficiency
Top Ten Steps to Cut Your Residential Energy Costs in Half

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Ten Steps to Cut Your Energy Costs in Half

Opportunity Space: Electricity

- Pool pumps
- Heating & cooling
- Microwave, blow dryers
- Lighting, electronics, TV, oven
- Refrigerators
- Dishwasher
- Night time lighting
- Computers, ‘phantom’ load

Last 36 hours

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Opportunity Space: Natural Gas

Monthly Natural Gas Cost Since Year 2006

Month

Jan-06 Apr-06 Jul-06 Oct-06 Jan-07 Apr-07 Jul-07 Oct-07 Jan-08 Apr-08 Jul-08 Oct-08 Jan-09 Apr-09 Jul-09 Oct-09 Jan-10 Apr-10 Jul-10

Monthly Cost

Furnace

Pool

Hot water, stove, clothes dryer, outside grill

Actual 12 Mo Rolling Avg

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<table>
<thead>
<tr>
<th>Step</th>
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<td>2.</td>
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**Summary**

- **No cost, or low cost; small effort**
  - Steps 1, 2, 3, 4, 5

- **Higher cost; larger effort**
  - Steps 6, 7, 8, 9, 10
Ten Steps to Cut Your Energy Costs in Half

Summary of Mission: Continuously Reduce Costs

Bottom Line So Far = 57% reduction in 3 years

Monthly Electricity & Natural Gas Costs Total Since Year 2006

2006 Annual Cost = $8080  
2009 Annual Cost = $3479

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Ten Steps to Cut Your Energy Costs in Half

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Summary

No cost, or low cost; small effort

Higher cost; larger effort
Step 5: Understand Actual Energy Consumptions

✓ Purchase / borrow a Kill A Watt meter

Put in whole house energy monitoring capability:

• The Energy Detective (TED) (electricity only)

✓ Web Energy Logger (WEL) (a lot more than electricity)

http://www.p3international.com

http://www.welserver.com
Whole House Energy Monitoring
Why It Saves Money, and How to Install One
Energy Monitoring - Why?

Reduce costs:
- **Lower operating costs:**
  a. Instant visualization tool - stimulates usage reduction (i.e., adjust tstats, turn off lights/appliances) – raises consciousness of being more energy frugal.
  b. Provides information needed to adjust maintenance settings.
- **Lower maintenance costs** - Anticipate repair needs in advance of more catastrophic expenses.

Increase satisfaction:
- Confirm improvements, enhancements, corrective actions were effective.
- Verify advertised equipment performance
- Ensure results occur, surprises don’t happen, promised savings materialize.

Enhance decision making:
- Optimize decisions by providing quantitative feedback:
  a. Provides ‘base line’ to compare future actions to.
  b. Identifies what to work on next – facilitates pareto analysis.
  c. Offers data for informational and analysis purposes – perform ROI analysis.
- Enables questioning of unusual anomalies to identify more opportunities.

Speed up repairs / problem solving:
- Fix specific problems quicker / more accurately.
Energy Monitoring Benefits

Example - Reducing Operating Costs
(Visualization tool to stimulate usage reduction)

Last 36 hours

Electronics, TV, cooking, lights

11 PM 6 AM 9 AM

Night time lighting

Refrigerators

Computers, ‘phantom loads’

Dishwasher

Pool pumps

Heating & cooling

Microwave, blow dryers

Lighting, electronics, oven

Last 36 hours
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Energy Monitoring Benefits
Example - Reducing Operating Costs
(Visualization tool to stimulate usage reduction)
Energy Monitoring Benefits

Example – Reducing Maintenance Costs
(Anticipate repair needs in advance of catastrophic expenses – i.e. heat pump coil replacement)
Example – Reducing Maintenance Costs

(Anticipate repair needs – i.e. heat pump coil replacement (again!))

Compression Refrigerant (R410A) Highest Discharge Temperature:

July 8th
Evaporator coil replaced (September) before compressor burnout

Oct 8th
Energy Monitoring Benefits

Example – Increase Satisfaction
(Confirm improvements, etc result in real savings - i.e. CFL replacement of incandescent bulbs)

12 kWh/day @ $0.10/kWh = $1.20/day = $36/mo = $440/year savings
Energy Monitoring Benefits

Example – Increase Satisfaction

(Confirm improvements, etc. result in real savings - i.e. geothermal HVAC replacement)
Energy Monitoring Benefits

Example – Increase Satisfaction

(Confirm corrective actions, etc. result in real savings - i.e. aggressive electricity rate management)

kWh Rates Since Year 2006

Avg rate last 12 months = $0.104/kWh

Cost per KWh

Avg rate last 12 months = $0.102/kWh

Now
Energy Monitoring Benefits

Example – Increase Satisfaction
(Verify advertised equipment performance)

Heat pump #1 heating at about 2 tons
Heat pump #2 heating at about 3 tons
Heat pump #1 cooling at about 2 tons
Heat pump #2 cooling at about 3 tons

Example – Increase Satisfaction
(Verify advertised equipment performance)
Energy Monitoring Benefits

Example – Increase Satisfaction
(Ensure results occur, surprises don’t happen - i.e. confirmation of joining ‘half way club’)
Energy Monitoring Benefits

Example – Enhance Decision Making
(Baseline to compare future actions to - i.e., annual geothermal loop water temperature cycle)
Energy Monitoring Benefits

Example – Enhance Decision Making
(What to work on next – i.e. pool pumps)

Electricity Consumption Distribution
(12 mo. Rolling Averages)

HVAC = 26%

Now focus here

74%
Energy Monitoring Benefits

Example – Enhance Decision Making
(Perform ROI analysis – i.e. solar PV system)

Approx $22/mo net savings this year (positive cash flow)
Focus of Highlighted Energy Monitoring Products:

- For people to build their own monitoring systems without requiring a lot of detailed technical knowledge
- Average user needs to:
  - Be somewhat technical
  - Have an eagerness to learn more about their energy usage

Alternatives (a few of the many):

- Agilewaves
- eZEsys
Electricity bill are rising. Now you can cut down on costs and find out what appliances are actually worth keeping plugged in. Simply connect these appliances to the Kill A Watt™, and it will assess how efficient they really are.

Large LCD display will count consumption by the Killowatt-hour, same as your local utility. You can calculate your electrical expenses by the day, week, month, even an entire year.

Now you´ll know if it is time for a new refrigerator or if that old air conditioner is still saving you money. With the amazing Kill A Watt™ you´ll know “Watts” killing you.
TED (The Energy Detective) is a simple, yet extremely accurate, home energy monitor that allows you to see electricity usage in real-time. You no longer have to wait for the 'electricity bill surprise'! TED will accurately tell you what your bill is going to be long before the electric bill arrives.

Meanwhile, you will learn more about conserving energy, saving money, and helping save the environment.

With its patented solution to home energy management, TED quantifies electricity and displays the results on its easy-to-read LCD screen and/or a local or remote computer.

...TED is a simple, intuitive and affordable way to monitor and manage your entire home's energy consumption. Think of it as your home's speedometer.
eGauge Energy Monitoring Solutions

eGauge Systems LLC is a leading provider of affordable whole-house and renewable energy monitoring solutions.

• Optimize your carbon footprint
• Lower your peak demand
• Monitor your system health remotely
• Measure individual appliances

Supports Google PowerMeter.
WEB ENERGY LOGGER (WEL)

… the Web Energy Logger (or WEL) is the most economical way to monitor lots of temperature sensors, plus a host of other energy related devices in your home or office.

It's ideal to verify the performance of a solar thermal system, or to calculate the efficiency of a geothermal installation, or even to prove that your home really is Net Zero.

Not only does the WEL give you a window into your energy environment, but it also provides a live snapshot of your system, and a range of trend charts that you can share on the WEB in real-time.

Finally, the WEL records all your sensor data in monthly log files that are easy to download and import into programs like Excel.

It's compact, versatile, and extremely configurable
Energy Monitoring System Using the WEL - Key Features

1. **Low cost** – no monthly fees; includes web site and off-site data logging.
2. **Easy/quick to install** - doesn’t require on-site computing equipment or s/w installations – data logged to off-site WEL server.
3. **Ultra reliable** and very low power consumption.
4. **Accurate** - 6 decimal point digits maintained internally.
5. **Real time** - **no processing time delays**.
6. **Supports a lot of sensors:**
   - Up to approximately **150 sensors**.
   - Virtually all subject areas accommodated: temperature, humidity, electricity, weather (dew point, wind speed), water/gas flow, gas pressure, voltage/current, etc.
   - Five sensor technologies supported: 1-wire, switch closure, pulse producing, 4-20 ma, custom sensors that have XML produced content to Ethernet (i.e., TED, eGuage power sensors).
7. **Everything** (real time data/results, charts, logged data) **accessible anywhere via Web:**
   - Screens operate quickly, with normal Internet response times, without delay.
   - No Java processes (and associated delays) required for screen display.
8. Advanced monitoring capabilities - real time data/results displayable in custom pictorial form.

9. Advanced analysis capabilities:
   • Powerful charting capabilities.
   • Historical data logging at 60 sec. sample rate.

10. ‘Off-to-the-side’ summaries/charts rarely needed - significant built-in processing capabilities (not just a data logger):
    • Arithmetic computation - plus, minus, multiply, divide, averaging, highs/lows, Boolean logic.
    • Arithmetic integration – computation of flows/volumes (kWh, gallons, MCF, solar insolation, run times, KBTU).
    • Sample & hold – significantly cleans up non-continuous data.

11. Alarm output capability – a value/result can trigger an automated email or text message.

12. Remote administration / configuration / firmware update capable (including with security).
Energy Monitoring System Using the WEL - Architecture

Web Energy Logger (WEL)

- 1-Wire Interface
- 4-20mA Analog In
- Watt-Meter Interface
- Pressure, DC voltage/current transducers
- Local Run Monitor
- On/off switches/relays
- Temperature, humidity sensors
- Power transducers, flow sensors

Real-Time Clock

- User Config Web Server
- Sensor Polling
- Scaling and Filtering
- User Name Assignment
- HTTP WEB Post

RS-232 Serial Log

LED STATUS

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Energy Monitoring System Using the WEL – Components Sourcing


Transducers and sensors:

- **1-wire:**
  - Temperature - [http://www.welserver.com/store.htm](http://www.welserver.com/store.htm)

- **On/Off (contact closure):**
  - Presence of 120 VAC (or higher) current - [http://www.welserver.com/store.htm](http://www.welserver.com/store.htm)
  - Presence of 24 VAC (i.e. HVAC thermostat) voltage - [http://www.welserver.com/store.htm](http://www.welserver.com/store.htm)

- **Pulse counting:**
  - Water Flow - Clark

- **4-20ma analog:**
  - Pressure – Omega
  - Voltage, Current – CR Magnetics
COMPONENT PRICING

WEL:
- Unit (including enclosure, power transformer) - $385
- Temperature sensors - $15
- Current (on/off) sensors - $23

Hobby Boards:
- Humidity sensor - $60
- Dual counter (pulse to 1-wire interface – 2 channels) - $32
- Some kind of enclosure for dual counters - $10 (approx)

Continental Controls:
- WattNode power transducers - $216 (includes high freq capability)
- Current transformers:
  - Solid core - $38 ea.
  - Split core - $66 ea.

Balance of System parts: Power strip, CAT 5 (or equiv) cable, CAT 3 cable, low voltage wire nuts
WEL Installation - Step 1
Getting Started

• Mount unit to wall
• Connect WEL to active LAN
• Apply power to WEL
• Use any Web Browser (on the LAN) to configure WEL
• String one long twisted cable and run it from the WEL past all sensors.
• Connected ‘1-wire technology’ cable to WEL
• Attach temp sensors
• Attach on/off (contact closure) sensors
WEL Installation - Step 2 continued
Connect Sensors

Examples

Outside air temperature

Inside humidity

Leaving (supply) air temperature
WEL Installation - Step 2 continued
Connect Sensors - WattNodes

- Install current transformers into circuit breaker panel
- Connect current transformers to WattNode
- Connect WattNode pulse output to WEL (CAT3 cable)
- Connect WattNode power to a circuit breaker
WEL Installation - Step 3

Configure WEL

- Display live data
- Name sensors
- Calibrate sensors with Scale and Offset values
- Add arithmetic computations (if any)
WEL Installation - Step 4
Owner Website Setup

- Define data to log to central server every minute
- Define graphs (charts)
- Define live data

### WEL9999 Log Order

**LogOrder:** Enter each sensor name you want logged into the box below.

Date, Time, Zone1, Zone2, Zone3, Zone4, AirTemp, Net, Net_D, Net_H

[Save Changes]

### WEL9999 Image Text

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<table>
<thead>
<tr>
<th>Posted Name</th>
<th>X,Y Pos</th>
<th>Color</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>eg: T1</td>
<td>100,150</td>
<td>255,0,0</td>
<td>Bedroom = [3.1]°F</td>
</tr>
<tr>
<td>Date</td>
<td>20,40</td>
<td>255,0,0</td>
<td>[text]</td>
</tr>
<tr>
<td>Time</td>
<td>20,55</td>
<td>0,255,0</td>
<td>[text]</td>
</tr>
<tr>
<td>AirTemp</td>
<td>20,100</td>
<td>0,0,255</td>
<td>Temp [3.1]°F</td>
</tr>
<tr>
<td>Zone1</td>
<td>20,120</td>
<td>128,125,0</td>
<td>Zone1 [ON]</td>
</tr>
<tr>
<td>Zone2</td>
<td>20,140</td>
<td>0,0,0</td>
<td>Zone2 [ON]</td>
</tr>
</tbody>
</table>

[Save Changes]

### WEL9999 Graphs

See the **Tips** section below for configuration help.

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<table>
<thead>
<tr>
<th>Graph Name</th>
<th>Size W,H</th>
<th>TimeSpan</th>
<th>Lines</th>
<th>Units</th>
<th>Caption</th>
</tr>
</thead>
<tbody>
<tr>
<td>AirTemp</td>
<td>400,200</td>
<td>24 Hours</td>
<td>T1/Red T2/Blue</td>
<td>°F</td>
<td>Zones: Red=Bedroom, Blue=Office</td>
</tr>
<tr>
<td>AirTemp</td>
<td>900,400</td>
<td>7 Hours</td>
<td>AirTemp/Green</td>
<td>°F</td>
<td>Air Temp: Green</td>
</tr>
<tr>
<td>Zones</td>
<td>900,400</td>
<td>7 Hours</td>
<td>Zone1/Red Zone2/Green</td>
<td>On</td>
<td>Zone1:Red Zone2:Green</td>
</tr>
</tbody>
</table>

[Save Changes]
WEL Installation - Step 4 continued
Owner Website Setup

• Draw summary diagram (if desired)
WEL Installation - Step 4 continued
Owner Website Setup

Summary Diagram – Another Example
WEL Installation - Step 4 continued
Owner Website Setup

Summary Diagram – Another Example

Time: 02:13:03 EST
Date: 12/11/2010

- Solar Run Today: 0.0 Hrs
- Solar Run Month: 8.2 Hrs
- Radiant Today: 0.0 Hrs
- Radiant Month: 26.1 Hrs
- Solar Temp Rise: -5.7°F
- Collection Rate: 0 BTUH
- Heat Today: 0 BTU
- Heat Month: 45079 BTU
- Thermostat: On
- Gas Heat: Off

27.3°F
22.2°F
48.0°F
45.3°F
42.3°F

750 Gal Tank

FAFCO
SOLAR WATER HEATING

www.FiveAcesBreeding.com

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Questions?

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