Passive House Monitoring Systems

By Carsten Steenberg
CEO PowerWise Systems
Thanks for the support

At this 9th. PH conference:

• Michael Hindle mentioned at the opening speech how important monitoring is!

• More than 10 of the presenters are PowerWise client! .

More than 60% of all Passive House buildings in North America are using PowerWise monitoring solutions
Agenda:
• Background information
• Why monitor Passive House type buildings
• Monitoring Systems available
• The InView Passive Solution
• Energy Monitoring
• Live dashboards
• Monitoring of heat pump technology
• Future Monitoring & Control features
• Q&A
Background information

• The eMonitor - circuit level monitoring.
• The beginning – Peter Schneider/VEIC came with the idea in late 2010.
• Started with eMonitor & the WEL
• Today PowerWise have monitoring systems in more than 60% of certified Passive House buildings in US & Canada.
Why monitor Passive House buildings
You heard it before – "you can’t manage what you don’t measure"

- Feedback for architect, builder, homeowner
- Evaluate and optimized building systems
- Verify performance vs. design
  - Air quality
  - Home comfort
  - Temperature
  - Low energy use appliances, lighting, HVAC
  - HVAC
- Answer the questions – demystifying the technology use in passive houses
Monitoring Systems available

• Many systems can monitor total power or several circuits
• Few systems can add temperature & RH sensors
• Very few, if any have a dedicated system that tying it all together in an online dashboard.
The InView Passive Solution

• Energy management, including renewables
• HVAC performance
  • ERV/HRV energy savings and recovery efficiency
  • ASHP Heat pumps
  • Home comfort conditions
  • Air quality through the year - CO2, VOC, RH
• Water and gas
  • Domestic hot water, solar thermal, HPWS heat pumps
  • Water use, storage, rainfall
• Broad or targeted projects
The InView Passive Solution
- Designed to Answer following questions:

• How much energy is each circuit using?
• How much energy is required to heat and cool the house?
• How uniform is the temperature throughout the house?
• How much energy is saved through the ERV/HRV system and what is the recovery efficiency of the ERV/HRV?
• How much energy does the ventilation system require to run?
• How much energy does the hot water system require? What percent is provided by solar?
• How is the air quality of the house throughout the year (indicated by CO2/VOC ppm)?
• What is the relative humidity level in the home?
Circuit Level Energy Monitoring
Circuit Level Energy Monitoring

The Most Powerful and Versatile Circuit level Monitoring Available
Solutions for residential (single phase) & commercial (3Phase) buildings
More than 3500 units installed since 2010

• **Monitors ALL** energy costs and all energy production
• **Controls HVAC via Thermostats** - the largest cost
• **Proactively alerts** – safety, cost & appliance performance
• **Pinpoints** major cost contributors with granular information
• **Recommends** targeted actions to save money
• **Delivers Cost Savings + Peace-of-Mind**

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Circuit Level Energy Monitoring Overview

**Energy Data**
- Minute-by-minute circuit usage monitoring
- Additional Sensors and Controls
- Integration with commercial Smart Thermostat

**Energy Intelligence**
- Real-time visibility into the commercial buildings electrical & HVAC systems.
- Remote control of heating & cooling
- Intuitive tools and recommendations for savings
- Analysis & Diagnosis of potential issues Working 24x7x365
- Proactive cost, safety & appliance/machinery performance alerts via email & sms text

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Simple, Clean, Cost-Effective Installation

**Wireless** communication - no wires outside the service panel

Eliminates issues with **outdoor panels**

Eliminates issues with **recessed or exposed panels**

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The eMonitor unit alone is an eMonitor 15c or eMonitor4-14

Solutions sold as eMonitor-15c, 25c & 45c or eMonitor4 14, 24 & 44

Channel count can be upgrades in **10 circuit increments** to 45 or 44 circuits with same base unit.

The Gateway architecture in place to support PowerWise Temp and RH sensors, flow meters and Zigbee & Z-Wave radios

U-Snap module supports Z-Wave and Zigbee radios

3 analog + 3 digital wired ports
HVAC/Thermostat Control

Current Thermostat Settings (Tuesday, November 19, 2013, 4:10 PM)

Mode: Heating Off
Fan: Auto On

Outdoor Temp: 41°F
Workday Away Setting: 66°F Hold

Heating Schedule for Today

Sleep: 62°F 10:20p - 6:00a
Wake: 66°F 6:00a - 10:30a
Away: 66°F 10:30a - 6:30p
Home: 62°F 6:30p - 10:20p

Drag the bars horizontally to change the time periods; vertically to change today's temperature settings.
In & outdoor environment Monitoring
Temperature, Relative Humidity, CO₂ & VOC levels
Mini split Heat Pumps – Short Cycling

Check a box to show/hide today or yesterday. Drag your mouse horizontally (across time) to zoom into minute by minute detail. This chart updates every minute. If you are zoomed in, you may be "kicked out" to the 24-hour view.
Temperature Variation with Point Source Heating & Heat Pump Energy Usage (135 kWh)
Electricity Use and Renewable Power
Solar Hot Water Monitoring

inView Passive™
Passive House Dashboard

Good time to use hot water

1200 kJ/m²

View Data and Graphs

COLD IN
101° Solar Storage Tank
4.46 gal/min

HOT OUT
Existing Domestic Hot Water
4.46 gal/min

101°
97°

99°
116°

Today: 472 btus produced

Today: 4720 btus produced

By The Numbers

Saved Today $1.64
Last 7 Days $9.64
Last 30 Days $57.64
Solar HW Supplied 1,292 BTU
Makeup Hot Water 4,925 BTU
Efficiency Last Week 63%
Efficiency Last Month 71%

Today:
772 Solar BTUs
22 gal @ 120°

Today:
3,806 Domestic BTUs
22 gal @ 120°

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Solar Hot Water Monitoring

Current SHW Usage: 12 W

Too cold to use hot water

Today (Upper): 34980 Solar BTUs 297 gal @ 15°

Today (Lower): 10043 Solar BTUs 182 gal @ 7°

Today: 6 Radiant BTUs 0.91 gal @ 1°

Current SHW Storage Tank Temperatures:
- Upper: 78°, Lower: 79°
- Upper: 79°, Lower: 83°

Current Radiant Floor Usage: 0 W
Solar Hot Water Monitoring

<table>
<thead>
<tr>
<th>Data</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
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<tr>
<td>Radiant Heat Supply Loop Temperature</td>
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<td>Solar Tank - Lower Right Temperature</td>
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<td>84</td>
<td>70</td>
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<tr>
<td>Solar Tank - Upper Right Temperature</td>
<td>60</td>
<td>80</td>
<td>66</td>
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<tr>
<td>Solar Tank - Lower Left Temperature</td>
<td>65</td>
<td>80</td>
<td>69</td>
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<tr>
<td>Solar Thermal Return to Panels - Lower System Temperature</td>
<td>56</td>
<td>94</td>
<td>65</td>
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<tr>
<td>Solar Tank - Upper Left Temperature</td>
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<td>80</td>
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<td>Solar Thermal Return to Panels - Upper System Temperature</td>
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<td>89</td>
<td>64</td>
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<tr>
<td>Radiant Heat Return - Upper Tanks Temperature</td>
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<td>67</td>
<td>60</td>
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<td>Solar Thermal Feed from Panels - Lower System Temperature</td>
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<td>103</td>
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<tr>
<td>Radiant Heat Return Loop Temperature</td>
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<td>Solar Thermal Feed from Panels - Upper System Temperature</td>
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<td>105</td>
<td>66</td>
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<td>Radiant Heat Return - Lower Tanks Temperature</td>
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<td>Radiant Circulators Flow</td>
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<td>Upper Solar Thermal Pump Flow</td>
<td>0</td>
<td>2.25</td>
<td>0.15</td>
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<tr>
<td>Lower Solar Thermal Pump Flow</td>
<td>0</td>
<td>1.13</td>
<td>0.1</td>
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</tbody>
</table>
Solar Hot Water Monitoring

Temperature vs. Flow

- Radiant Hea (°F)
- Solar Tank (°F)
- Solar Therm (°F)
- Radiant Hea (°F)
- Radiant Cir (GPM)
- Upper Solar (GPM)
- Lower Solar (GPM)

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Environment Monitoring Hardware

- **PowerWise Building environment Metering -Temp, RH, CO2 & VOC**
- **inDAQ Sensor Controller**
  - 1-Wire support of 15 Temp + 5 RH/Temp or Multi Sensors
  - 4 x Pulse Input Counters, 4 Analog & 4 Digital Inputs
  - RS485 Modbus input/output RS232 Serial input/output
  - Optional Wire-less connect to Gateway
- **Environment Sensors**
  - All sensors 1-Wire (normally using existing CAT 3 or 4 phone/Ether)
  - Compact & easily wall mountable
  - Measure Temperature, Relative Humidity, Volatile Organic Compounds (VOC) & CO₂
  - Wireless version planned for Q4 2014
Environment Monitoring Hardware

- PowerWise Water, Gas & other liquid flow Metering
  - Support of many pipe diameters from 2”-1/2”
Detailed Weather Monitoring

- PowerWise Local Weather data- Via professional grade weather stations
  - Wireless sensor assembly, Wind speed & direction, RH, Temp, Rainfall, Barometric pressure.
  - Accurate real-time weather data from a professional grade weather station by RainWise - the preferred station by Weather Underground and the Weather Channel
  - If no weather station is supplied PowerWise can supply weather data from Weather Underground.
Custom Dashboard Portal design
### Advantix Details

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Geotube CFM</td>
<td>248 CFM</td>
</tr>
<tr>
<td>Geotube Temp in</td>
<td>87°F</td>
</tr>
<tr>
<td>Geotube Temp out</td>
<td>54°F</td>
</tr>
<tr>
<td>Advantix Processing Chamber – Supply to Risers: Temp/CFM/RH</td>
<td>64°F/14 CFM/87% RH</td>
</tr>
<tr>
<td>Advantix Regen Chamber Exhaust Air into Chamber: Temp/CFM/RH &amp; Out to discharge Temp/RH</td>
<td>64°F/14 CFMM/87% RH</td>
</tr>
<tr>
<td>Advantix Cold Water Usage in &amp; Out: Gal/Temp</td>
<td>64°F/73°F OUT</td>
</tr>
<tr>
<td>Advantix Hot Water Usage in &amp; Out: Gal/Temp</td>
<td>98°F/122°F OUT</td>
</tr>
<tr>
<td>Air Pressure Sensors readings in both Supply Risers</td>
<td>18.6 PSI Riser 1, 19.4 PSI Riser 2</td>
</tr>
</tbody>
</table>

**Diagram**

- **Regeneration Section**
- **Process Section**

**Water Connections**

- Cold water connections
- Hot water connections
Future Monitoring & Control features
• Alert functions for all parameters
  • Temperature deviation
  • RH, CO2, VOC levels
• Deeper integration with ERV/HRV systems
• Add additional control features
  • ASHP Mini-Split
  • Lighting
  • Outlets
  • Blinds
Monitoring & Control possibilities beyond electricity
Near future announcements

inSense™
Sensor Network
1-Wire • Analog
Pulse • Digital
RS485 Modbus
RS232 Serial

inDACP™
Data Acquisition
& Control

PowerWise
inServe™ Server with
Advanced Analytics

inSense™
Wireless Sensors
& Controls

Wide Range
of Smart Wireless
Thermostats

inControl™
Wireless Smart Devices

Lighting & Fan Switches, Smart Outlets, Lighting
Dimmers, Door Locks, Garage Door Openers,
Motion Sensors, Shade Controls

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Mini-Split HVAC control (coming soon)
Monitoring & Control possibilities beyond electricity
Near future announcements
Thank you

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