



ZigBee-Based Wireless Energy Management Solution Slashes Industrial Facility's Energy Bill By 37%

Energy Efficiency Becomes Critical Issue

Wasteful energy consumption isn't what it used to be. Once merely an act of inattentiveness that held little consequence, gluttonous energy consumption practices now significantly impact the bottom line of both individuals and businesses. As energy costs continue to skyrocket and environmental concerns move to the fore, running an energy-efficient business becomes a mission-critical practice that not only saves significant money, but also helps create a positive identity that attracts publicity and ongoing business.

Industrial Facility CEO's Dilemma

While all companies are increasingly scrutinized for their energy consumption practices, energy management companies are rightfully held to an even higher standard. In addition to setting the energy consumption pace for companies across all industries, energy management companies have the most to gain and the most to lose when it comes to their efficiency.

The CEO of a Swedish industrial company, recognizing the need for a streamlined solution to reducing energy consumption, decided to outsource the energy management to a specialist firm, setting the straightforward goals: "Room temperature should be adjusted to a suitable and verified living climate, and what is not needed should be shut off." These simple goals resonate with anyone who carefully watches their home thermostat and turns off lights and appliances when not in use. Magnified to encompass a sprawling industrial facility, however, this direct path to energy efficiency took on daunting new complexity. Implementing a building automation system was the clear solution, but achieving that end goal meant overcoming numerous challenges.

BFM AB - Energy Management Specialist

After being selected to manage this project, BFM AB (www.L2W.com) – a Sweden-based innovative energy management company – immediately recognized obstacles to be overcome. Traditional wired building automation strategies contained intrinsic faults that have become synonymous with the wired-networking medium. Commissioning and installation costs are extremely high in existing buildings, while cables, connections, and detailed documentations require resource-draining maintenance, costly and time-consuming field tests, and ongoing updates. Unwilling to settle for a less-than-desirable solution, BFM set out to devise a synergistic solution that better resonated with the streamlined efficiency goals.

Going Wireless

BFM's expert assessment of the energy management industrial facility revealed the need for a solution based on modules interconnected in a wireless network. Such a solution would allow all the benefits of local control functions and remote operation without the associated infrastructure costs. A 1-wire interface was proposed to enable connection of different control signals at a low cost. In order to circumvent complications with the facility's concrete walls, BFM envisioned a self-healing multi-hop mesh network, capable of rerouting a signal if line-of-sight was blocked. Finally, to optimize network performance and stay consistent with the project's energy-efficient goals, BFM proposed battery-operated wireless end-node devices, which would minimize the network's power consumption. ZigBee, a global standard for the wireless sensor networking, based on IEEE 802.15.4, was the only one to meet the above requirements.



IEEE802.15.4/ZigBee Module
with Chip Antenna

Selecting a ZigBee Platform

The next step was to find a ZigBee platform that would enable the proposed design to be implemented cost-efficiently and in a short time frame. While offering low costs, ZigBee chips require time-consuming and costly RF design. Unlike chipsets, ZigBee modules already contain all the RF design with all required circuitry and antenna added. ZigBee modules simply need to be mounted on a PCB — enabling greater flexibility, time and cost savings during the design and prototyping phases. Additionally, no RF expertise is required for ZigBee module implementation. For BFM, ZigBee modules were clearly the way to go. The key selection criteria for the ZigBee modules were RF performance, power consumption and a form factor.

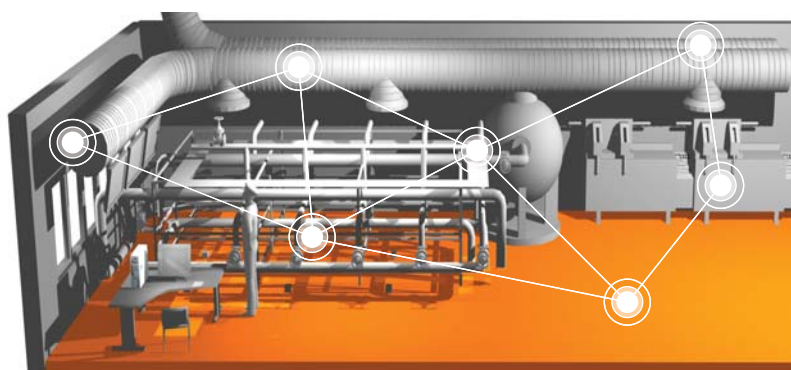
Having done extensive online research, BFM narrowed their search to a handful of ZigBee module vendors. MeshNetics' ZigBit modules topped the list. Boasting over 1,000m of unamplified line-of-sight range, 6 µA of current consumption in sleep mode, and only a half square inch of footprint, MeshNetics ZigBit modules fully met all BFM's technology requirements. The fact that ZigBit modules come bundled with the MeshNetics' own ZigBee networking stack software, along with support for both hardware and software, further boosted BFM's confidence in this choice.

Implementation

In order to create a complete building automation system using the Internet as an operators' platform, BFM used the following basic components:

- **NetControl** – Web server
- **XNet-Coordinator** – ZigBit-based Wireless Sensor Network (WSN) coordinator unit that uses RS-232 interface for communication and a 24V AC power supply
- **XNet-Local Controller** – ZigBit-based WSN controller unit that uses 1-wire analog interface and 24V AC power supply
- **XNet-Endnode** – ZigBit-based WSN end device that has 1-wire analog interface and is 3V battery-powered

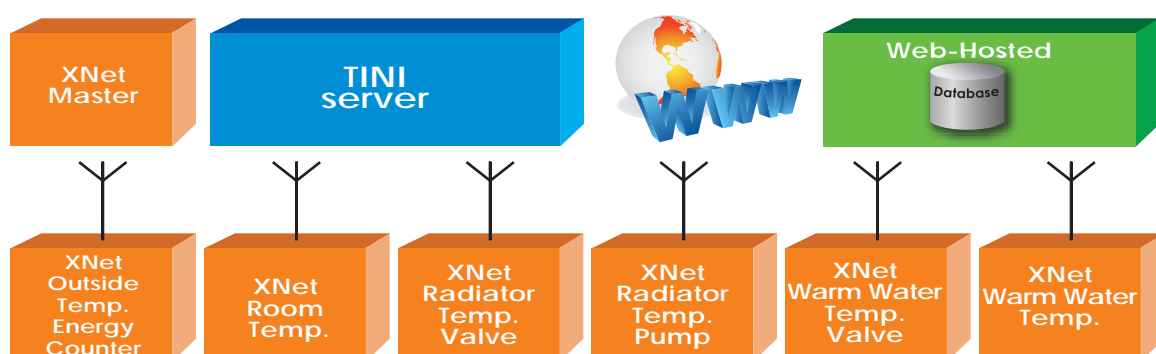
With these components, a complete over-the-internet energy management system for a district heating installation or an air handling unit can be implemented for US\$ 3,000. The system was named "Link2Web".



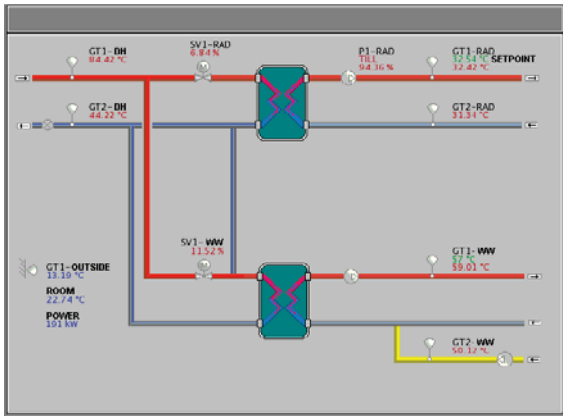
Wireless Sensor Network Deployment Site



ZigBit-Based XNet Wireless Module



Link2Web Energy Management System's Components



Operation Diagram



WEB-Based Interface

Next, BFM implemented ZigBit module-based control and sensor devices based on ZigBee ultra-low-power wireless networking technology with an embedded mesh networking stack software – forming a self-organizing, self-healing sensor and control network. This embedded wireless communications approach achieves a high-quality, cost-effective system that’s applicable to virtually any commercial building or industrial facility, all while reducing start-up and commissioning costs to nearly nothing.

Resulting Savings

The entire Link2Web system was installed in an Industrial building with a total heated area of 3,600 square meters holding one oil-fired boiler and nine Air Handling Units (AHUs) with air heaters and recycling air control:

Oil-fired boiler (1 unit)	Air Handling (9 units)
XNet-Controller 1 Boiler	XNet-Controller 1 Air heating valve
XNet-Controller 2 Heating water system	XNet-Controller 2 Recycling damper
XNet-Controller 3 Warm water system	XNet-Controller 3 AHU
XNet-Controller 4 Outside air temperature/ Oil meter	XNet-Controller 4 Outside air temperature
XNet-Controller 5 Heating water meter	XNet-Controller 5 Return air
XNet-Controller 6 Return heating water	XNet-Controller 6 Exhaust air
XNet-Controller 7 Return warm water	
XNet-Controller 8 Return boiler	

With the wireless sensor network in place, a webserver called TINI was employed to oversee the facility’s energy usage. Every ten minutes, all values collected by the ZigBit modules are sent to the TINI web server, which in turn channels the values over the internet to a SQL database. Operators connect to the database to read and change values. Each time the TINI webserver connects to the database, changed values are read and sent back to the local ZigBit-based controllers. In the industrial energy management facility, ZigBit uses this information – including data referencing both outside temperature and inside temperature – to precisely control the radiator temperature in a way that effectively realizes the CEO’s initial vision: “Room temperature should be adjusted to a suitable and verified living climate, and what is not needed should be shut off.”

Leveraging in-depth, real-time temperature and energy usage data, the BFM-designed ZigBee wireless sensor network optimized energy management – achieving a dramatic improvement in efficiency that translated to significant bottom-line gains. For a total installation cost of \$45,000 USD, the Link2Web energy management system returned annual energy savings in the amount of \$34,974 – nearly paying off itself over the course of a single year.

The energy savings achieved over the year are recorded in the table below:

Annual Energy Savings

Month	Energy Consumption, MWh		Savings, %	Savings, US\$
	BEFORE Link2Web Installation	AFTER Link2Web Installation		
January	205	118	42%	5 592
February	192	153	20%	2 532
March	179	149	17%	1 945
April	129	59	55%	4 548
May	78	59	25%	3 143
June	52	4	93%	3 127
July	27	-	100%	1 913
August	40	-	100%	2 834
September	65	32	50%	2 108
October	116	71	38%	2 877
November	144	110	24%	2 198
December	156	123	21%	2 157
Year	1383	877	27%	\$34 974

The complete system cost in US Dollars was as follows:

Link2Web System	\$38,000
Installation	\$4,000
Commissioning	\$3,000
Total:	\$45,000

Now BFM offers an even easier alternative. An industrial facility or a commercial building can start using the Link2Web Energy Management System with \$0 prepayment. They can simply rent it for a fixed monthly fee and BFM will install and maintain the system for an agreed period of time.

The rental costs in US Dollars are as follows:

Initial payment:	\$0
Monthly maintenance fee by L2W:	\$1650
Total (per year):	\$19,800



In the case above, the value of the reduced energy consumption was \$34,974. With the annual rental cost of \$19800 it would produce the immediate annual saving of \$15,174.

In the words of BFM AB

“Energy management wireless sensor networks such as the ZigBit module-based solution implemented by us give an indication of the tremendous value these networks offer in terms of energy conservation and bottom-line benefits for building owners across any and all industries,” said Richard Hänsel, CEO of BFM AB. “Working with MeshNetics allowed us to stay focused on our core competency, while reaping all the benefits of ZigBee wireless technology. We look forward to continuing to use MeshNetics high-performance RF modules in our future solutions.”

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