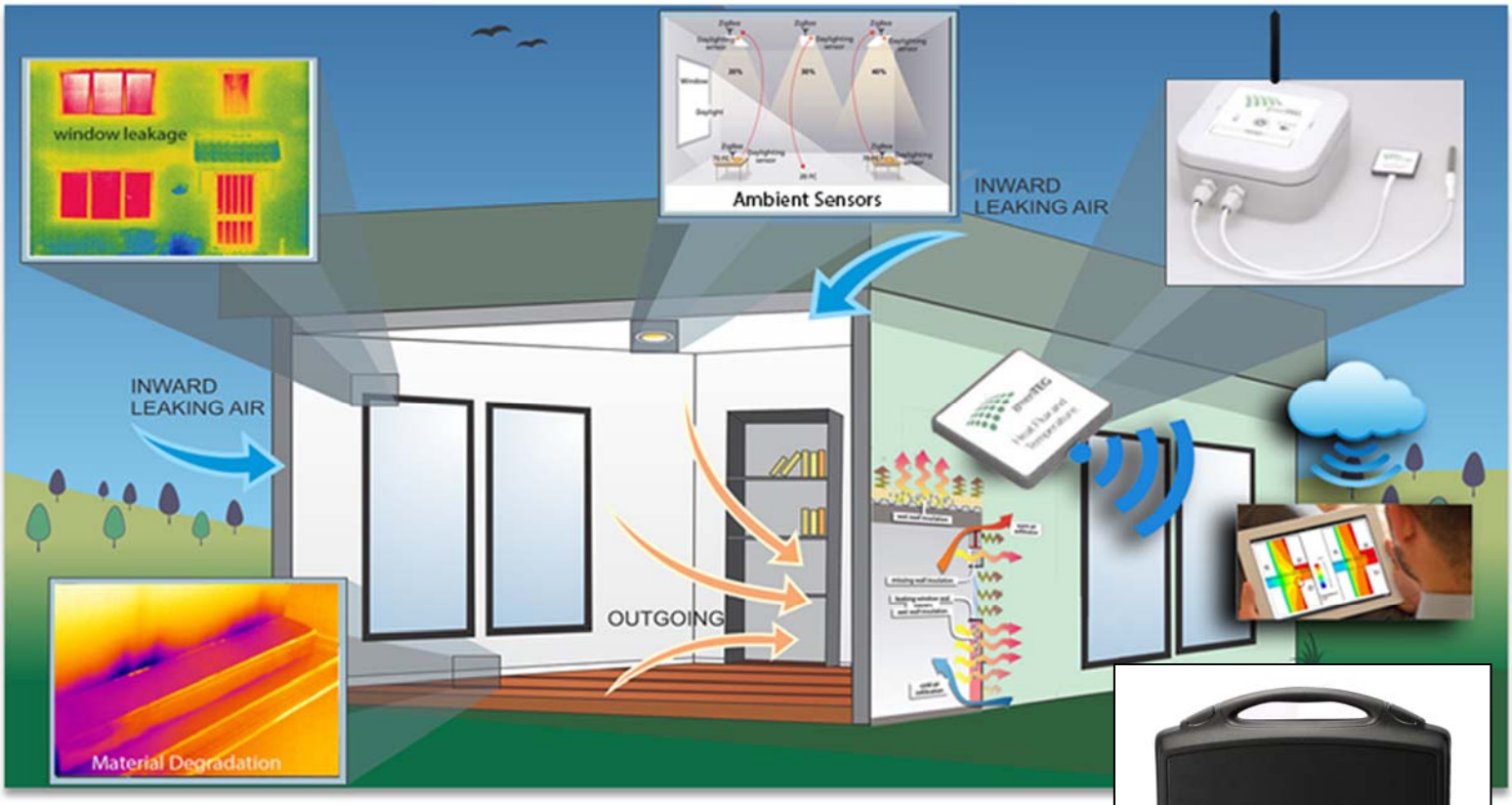

U-VALUE MEASUREMENT KIT TO SPEED ENERGY AUDITS, COST-JUSTIFY SOLUTIONS DEPLOYMENT, MEASURE MATERIAL DEGRADATION & MONITOR ENERGY COSTS IN REAL TIME.

PRESENTING A MODEL FOR

VALUING ENERGY EFFICIENCY

By Thomas E. Simon

GreenPortal

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EXECUTIVE SUMMARY

The purpose of this document is to engage a demonstration of a *first-in-the-world* low cost system to measure and monitor real-time energy waste in commercial and residential buildings. The system was developed by greenTEG, a spin-off from the Swiss Federal Institute of Technology (ETH), that manufactures, and markets thermal sensors for heat flux and laser power/position measurements for OEMs as well as scientists in corporate and university labs around the world.

The GreenTEG system addresses[1] the problem of building-envelope energy waste, estimated at almost $600 Billion per year[2] , which also equates to almost 24 billion pounds of GHG wasted each year. Providing customers with an easy way to accurately measure energy waste in real-time.

What makes the greenTEG gO system unique in the world is its patented thermopile sensors, designed for scientific accuracy, that are integrated into a system providing real-time quantitative insulation data (i.e. U-value) of complete buildings and building components. Currently these values exist as invalidated specifications for individual building materials that degrade over time. The absence of real-time U-values for complete building profiles makes it harder to cost-justify investments that will reduce energy waste over time.

Our product includes a Portal Platform that can integrate into existing facility management software to provide decision support dashboards with models to accurately detail costs in wasted energy. These models help cost-justify solutions and can even cross-reference specific products and services including methods to optimize financing and access to rebates, subsidies and other incentives.

HOW WE CAN WORK WITH YOU

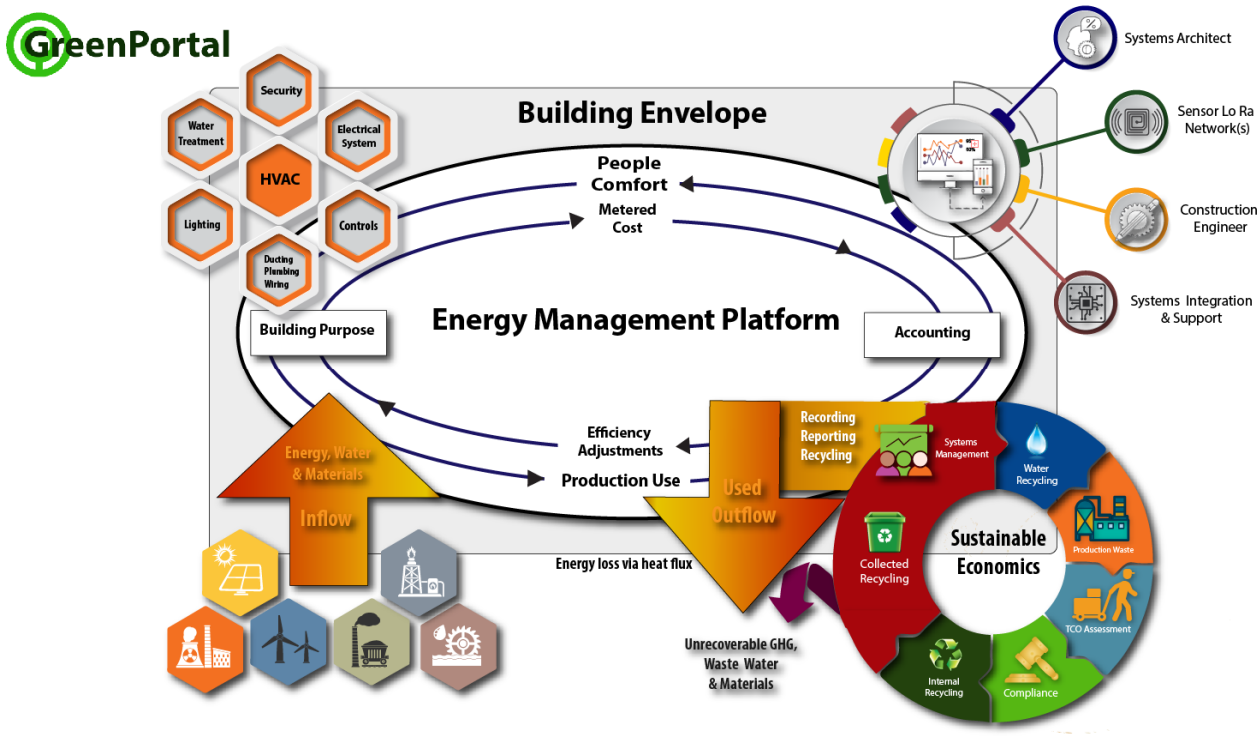
Our proposal is to first demonstrate and then introduce significant advancements in speed and accuracy for precise measurement of energy loss along with real time analytics that simplify existing methods to cost justify and implement energy saving improvements. We can work directly with your sustainability and facility management to implement the world's most advanced U-Value measurement technology that is uniquely standardized around ISO 9869, ASTM C1046 and ASTM C1155 protocol.

[1]In 2010, commercial buildings consumed 22 quadrillion BTU "quads" of energy, and residential buildings consumed 18 quads. Residences lost 7.37 quads in heating and 2.37 quads in cooling. Commercial buildings lost 5.07 quads in heating and .74 quads in cooling. Total energy lost in heating and cooling residential and commercial buildings in 2010 was 15 quads, 39% of the total energy consumed by those buildings (40 quads)." Source: DOE Emerging Technologies Roadmap 2015

[2] 15 quad/BTU per kWh X .12 per kWh.

ABOUT GREENPORTAL

WORKING TO IMPLEMENT A SYSTEMS ARCHITECTURE BUILT AROUND RELIABLE DATA



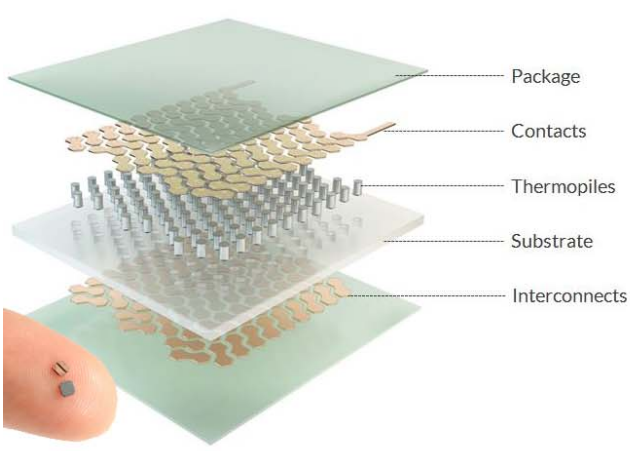
GreenPortal is an organization founded by Tom Simon, for research and development of innovations in sustainable energy management. For several decades, Simon has spearheaded projects with Iowa State University, the State of Iowa, UPS, Xerox, H-P, IBM, Litton Industries, and others that have been on the leading edge of advanced technology solutions built around sustainability. Websites include: MyTown.Center, Greenportal.org, MyiOffice.com.

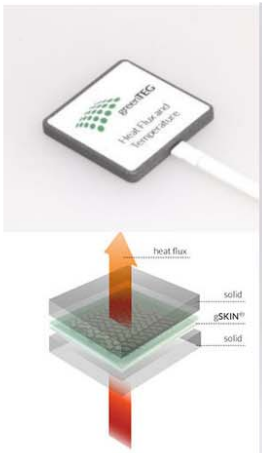
Simon has also worked in academia to build student teams around energy management innovations. Because of these efforts he developed a model for measuring energy transmittance using infrared thermopile sensors integrated into a wi fi mesh network to transmit energy data to a cloud based analytics platform. It was while researching manufacturing partners to build his system that Simon was introduced to greenTEG. Recognizing greenTEG's scientific credentials, existing technology and manufacturing expertise, Simon sought to build a partnering relationship for mutual benefit.

The greenTEG system described in this document represents the pinnacle of global sophistication in heat flux sensor technology. GreenPortal's role as a systems architect, project lead and supplier providing customers with a single point of contact to bring the most advanced technology in building envelope U-Value Measurement to accurately measure energy performance of building components in real time. Then provide accurate data for decision support to cost-justify energy efficiency solutions.

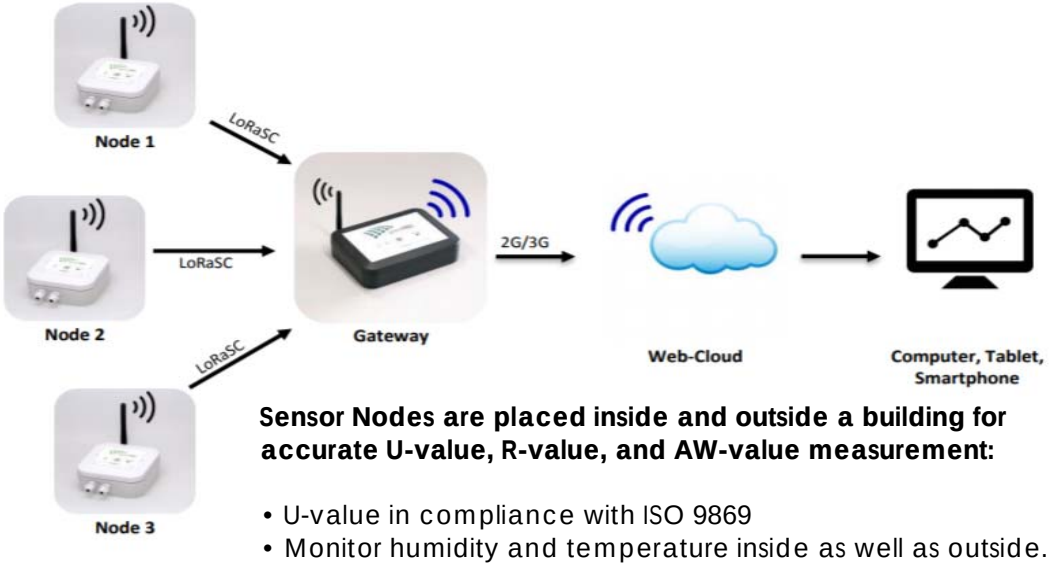
DEMONSTRATION SYSTEM

Components of the U-Value demonstration kit





Patented micro thermopiles form the core for U-Value measurement. The demonstration kit uses a **heat flux sensor** along with **temperature and humidity sensors** as standardized in ISO 9869, ASTM C1046 and ASTM C1155. *This is the only method which delivers reliable quantitative in-situ information about a building envelope*. It is conveniently packaged to speed energy audits and provide reliable data to cost-justify solution investments.



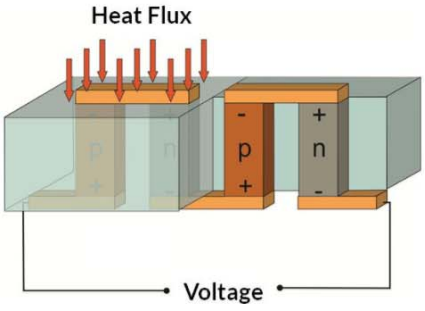
Sensor Nodes are placed inside and outside a building for accurate U-value, R-value, and AW-value measurement:

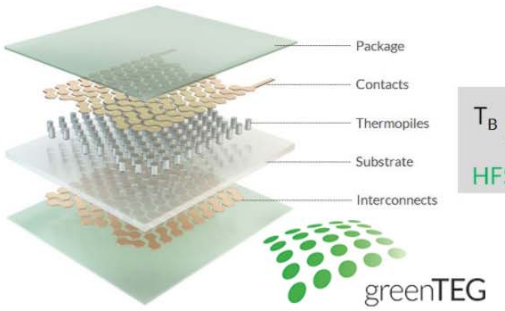
- U-value in compliance with ISO 9869
- Monitor humidity and temperature inside as well as outside.
- Building moisture measurements
- Dew point monitoring on wall surface (AW-value)
- Real time data monitoring via cloud application
- All data is presented in a structured report
- Simple data management and cost control
- Highest data security can integrate with analytic portals
- Works with any internet-ready device

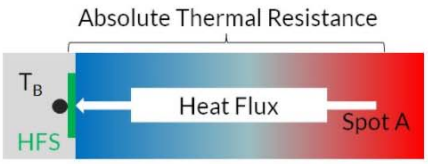
DEMONSTRATION DETAILS

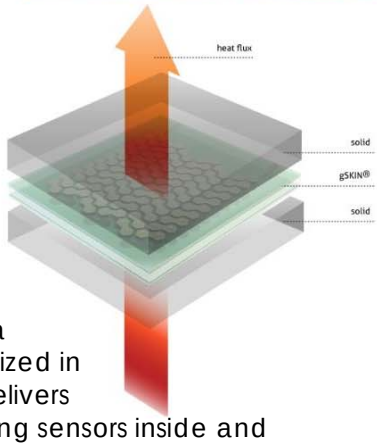
Heat Flux Principle & Method to Accurately Measure U-Value

Heat Flux Sensors are based on the Seebeck effect. When heat passes through the sensor, the sensor generates a voltage signal. This voltage signal is proportional to the heat passing through the sensor. greenTEG Heat Flux Sensors can resolve heat fluxes < 0.01 W/m2.









In the field of building physics, U-Value is the term used to describe the heat transfer coefficient of a building element (e.g. wall or window). U-Value describes the insulation quality of a building. The unit of the U-Value is W/(m²K). The smaller the U-Value, the better the insulation quality of the building element.

How to measure U-value? The greenTEG measurement-approach uses a heat flux sensor and two temperature sensors. This approach is standardized in ISO 9869, ASTM C1046 and ASTM C1155. This is the only method which delivers reliable quantitative in-situ information about a building envelope. Placing sensors inside and outside of a building, transmitting the data to nodes connected to the internet via a secure gateway and then performing analytic calculations to convert to energy billing costs will provide a convenient way for building owners to cost-justify investments that will reduce energy waste.

Why Is This an Advantage?

Energy audits that provide accurate information on ways to reduce waste are required to validate subsidies, rebates and financing of energy saving improvements. Currently the time and expense required, as well as personnel, certifications and equipment needed to conduct reliable audits limits the number of audits that can be completed. Furthermore, the methods now being used do not provide reliable real-time data. For example:

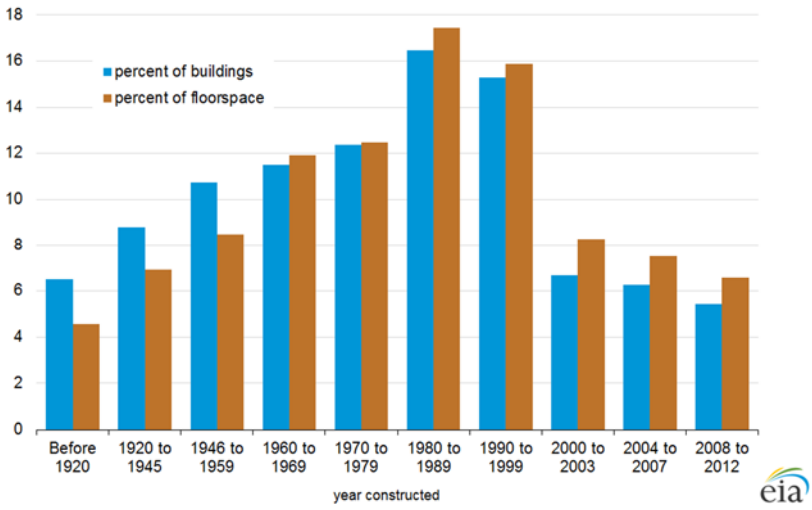
1. Thermography (i.e. infrared imaging) shows thermal radiation of an object as an image showing spots with higher and lower radiation. Thermography helps to understand overall quality of a building envelope and identify thermal bridges and sections with inadequate insulation. However, it does not produce quantitative data (e.g. U-value in W/m2K) that can be used to interpret energy loss. Therefore, this method can only be used to roughly approximate the U-value.

2. Multiple temperature measurements - By synchronizing three or more temperature sensors inside and outside of a building element, it is possible to calculate the heat flux indirectly, and from this information, derive the U-value of a building element. While this method generates quantitative data, it is not usable for in-situ measurements. To apply this method, a minimum temperature difference of 10 °C between the inside and outside temperature is required. Such temperature differences do not occur very often in most regions, and are most likely not achieved continuously throughout the year. Moreover, both the inside and outside conditions must be constant during the measurement period and no solar radiation is allowed. These requirements make it very hard to obtain reliable data.

BUSINESS CASE

We are suggesting a way for even a non-technical person to walk into a room, unpack the Demonstration Kit, place sensors as required, turn on nodes and gateway, then with a tablet or even a smart phone see visually U-Value, and associated energy waste, costs, as well as cost-justified solutions.

Figure 3. About half of all commercial buildings were constructed before 1980



Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey

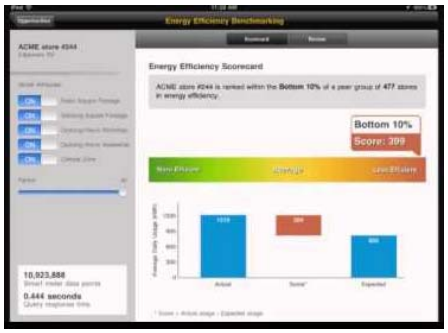
U-Value Measurement Kits

The initial market is to provide U-Value Measurement Kits to energy auditors and others who deliver energy management solutions for commercial, educational, municipal, and residential customers.

Energy waste from existing buildings, especially those built before 1980, is the largest cost both to owners and the environment. Kits can be purchased, leased, or rented.

Future Vision

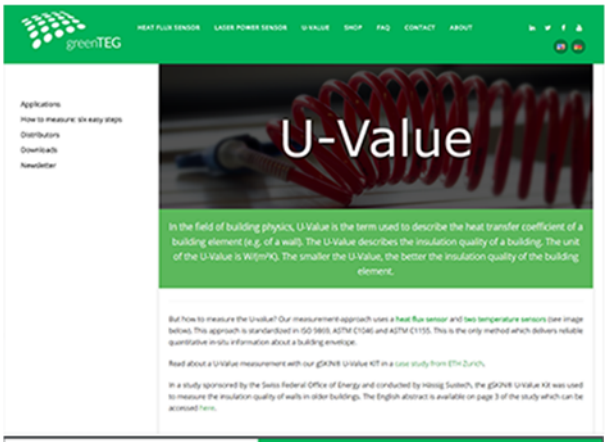
The market for a reliable U-Value Measurement System is substantial in just meeting the needs of existing Energy Auditing and Facility Management contractors, alliance partners and customers. But the long-term opportunity is to introduce an affordable permanent system providing real time energy-use data that integrates with your facility management and accounting systems.



Imagine online digital smart meters that send real-time messaging alerts referencing performance anomalies with links to options for improvements that are cross-referenced with solution options along with models and incentives for financing. We are dedicated to this mission.

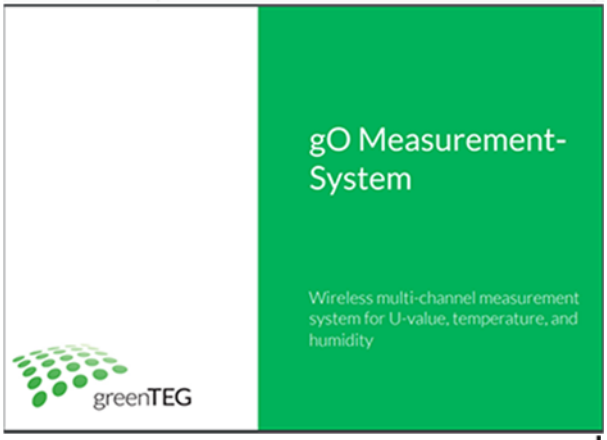
To start, all that is needed is to arrange an effective demonstration date, time, and venue. Then engage senior decision makers to participate in a way that can forward the vision presented in this document. To do that we need to coordinate people, purpose and timing.

greenTEG Literature

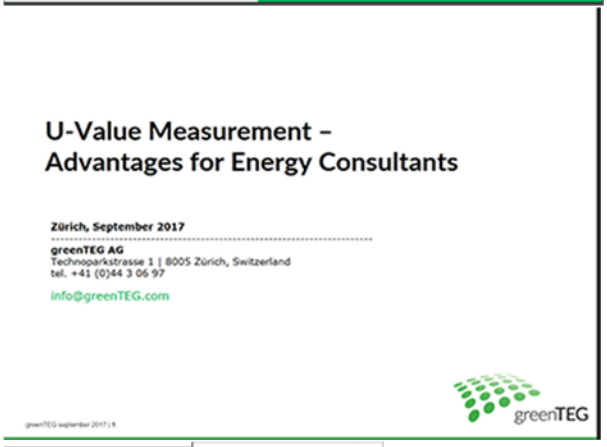


greenTEG's website has significant resources and links to published scientific papers and case studies.

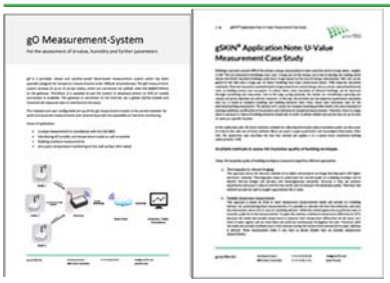
Click images for links



Product and applications brochure for the proposed wireless multi-channel measurement system for U-value, temperature, and humidity.



Slideshow presented September 2017 by Dr. Holger Hendrichs to European energy management consultants.



Two papers: The gO System data sheet and a case study created during initial system testing in Switzerland.

Click images for links

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