WHITEPAPER

THERMAL ENERGY METERING:

Regulations and Best Practices for the Canadian Market

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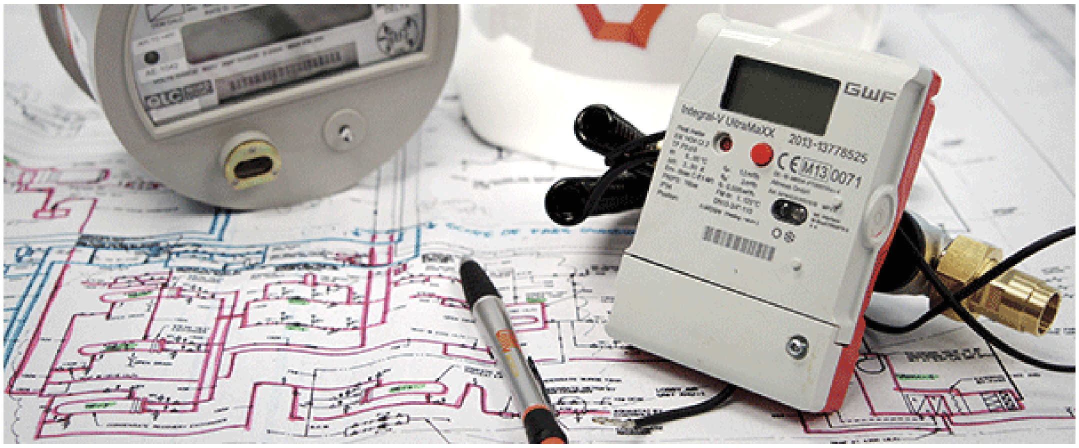
BUILDING INTELLIGENCE WITH SUBMETERING SOLUTIONS



Executive Summary

In Canada, energy conscious communities are expanding their use of Thermal Energy Systems for heating and cooling buildings. One challenge these systems face is the ability to effectively measure and bill thermal energy consumption to end users, such as condominiums, apartments and commercial units.

The Canadian market sees growing demand for submetering thermal energy and appears to be following recommendations from groups such as The Pacific Institute for Climate Solutions who have recommended thermal submetering as a means to achieve energy conservation and cost control.

This paper examines the requirement for and challenges of effectively measuring thermal energy consumption in Canada, whether using submetering or other methodologies. Although the scope of this document is primarily focused on multi-residential properties, it also applies to retail, commercial and mixed use spaces.

Unlike other utilities such as electricity and gas, there are currently no federal regulatory standards in Canada regarding thermal energy measurement. Measurement Canada has indicated it will follow already established European and international thermal metering standards EN1434 and OIML R75 and that it is committed to implementing a standard, as per its Trade Sector Review.

Other international jurisdictions have either developed or are currently developing their standards for thermal energy measurement. The United States and China are basing their regulations off of the well-established and recognized Eurpean and International Standards.

The paper reviews the four main methodologies in Canada for measuring and/or allocating end consumer usage of thermal energy:

a. Thermal Energy Submetering

b. Inferred Measurement or Run Time Measurement

c. Ratio Utility Billing Systems (RUBS)

d. No Metering or Measurement

The costs, strengths and weaknesses of each methodology are reviewed and a supplementary case study examines the significant challenges experienced with inferred measurement in Alberta.

THE ANALYSIS CONCLUDES THAT THERMAL ENERGY SUBMETERING IS THE RECOMMENDED METHODOLOGY FOR THE FOLLOWING REASONS:

- Thermal energy submeters offer the most accurate measurement of the energy consumed
- Thermal energy submetering provides the tenant with the information required to analyze their consumption and control their costs.
- Thermal energy submeters meet all relevant international regulations and best practices and are most likely to comply with future Measurement Canada regulations.

If provided in conjunction with a qualified and experienced submetering provider, thermal energy submetering can deliver accurate, cost effective and regulatory compliant thermal measurement for developers, utilities and end consumers.

This paper will not detail the technical aspects of thermal submetering applications. It serves as an informative and educational document to help steer major industry stakeholders to provide thermal submetering transparency, sustainability and accountability.

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Background

The use of Thermal Energy Systems (inclusive of District Energy Utilities, Hydronic Systems, Geothermal and Combined Heat and Power) for heating and cooling buildings is increasing in Canada. These use a central heating or cooling system to distribute energy throughout a property or community. Energy is extracted through a heat exchanger and consumed by condominiums, apartments, commercial units, etc. These systems can provide efficient heating and cooling with reduced ongoing utility costs and with less carbon emissions than other technologies.

One challenge with thermal energy in Canada is the accurate measurement of its distribution, and ultimately, how to accurately account for individual consumption and usage based billing.

Within district energy systems, there is widespread use of thermal energy metering (AKA "BTU metering" or "heat metering") to measure the energy consumption of entire buildings. See further details on thermal metering on page 8.

However, in Canada there are currently no set regulations for measuring the thermal energy used by end consumers (condominiums, apartments, office or retail units) This is unlike electricity, water and gas, which have regulated measurement (metering) practices in place to ensure fair measurement for both suppliers and consumers. Without accurate measurement systems installed, thermal energy systems will not be able to allocate costs effectively. This may result in lower returns on investments for suppliers, increased end-user consumption (waste), or unfair bills to end consumers.

THERE ARE CURRENTLY FOUR MAIN METHODOLOGIES IN CANADA FOR MEASURING OR ALLOCATING END CONSUMER USAGE OF THERMAL ENERGY:

a. Thermal Energy Submetering
b. Inferred Measurement or Run Time Measurement
c. Ratio Utility Billing Systems (RUBS)
d. No Metering or Measurement

This paper will review the strengths and weaknesses of each of these options in order to determine the best measurement investment for real estate developers, property owners and managers, district energy utilities, and end consumers.

To do this, this paper will explore the technologies and processes behind each option, as well as best practices from other jurisdictions internationally. First, the current and future thermal energy regulatory environment within Canada must also be reviewed to ensure any methodology used will be compliant.

The Regulatory Environment in Canada

Regulation of thermal energy measurement will likely follow the path of other utilities such as electricity, water and gas. In the Canadian market, electricity and gas fall under the Federal Weights and Measures Act and are regulated by Measurement Canada. Although water is not federally regulated, municipal regulations, building codes and well established standards apply.

All of these utilities' regulations insist upon using an in-line metering device as their measurement standard. These meters must always meet a high standard of accuracy and reliability. This would signify that any thermal measurement should be done with an in-line metering device.

> Measurement Canada indicated it will follow already established European and international thermal metering standards EN1434 and OIML R75 when it enters the space of thermal meter regulation.

Thermal energy measurement is not currently regulated in Canada. However, Measurement Canada has significantly contributed to the conversation. Measurement Canada conducted a Trade Sector Review on the Thermal Metering Industry in Canada (2010) and has since released recommendations, decisions and an implementation update.

Measurement Canada indicated it will follow already established European and international thermal metering standards EN1434 and OIML R75 when it enters the space of thermal meter regulation. Measurement Canada also stated it remains committed to implementing the recommendations of the Trade Sector Review. Based on these statements, utilizing technologies compliant with the above standards would be the best way to ensure long-term regulatory compliance in Canada for any measurement system.

The Canadian Standards Association (CSA) has also contributed by adopting EN1434 in its CSA-C900 standard. However, reference to this standard is infrequent and coincides with little enforcement capacity.

On a Provincial level, the only province to regulate thermal energy measurement is Alberta. Its government was prompted to regulate the industry after thousands of multi-residential units were billed using unproven, run-time measurement equipment. They enacted the Energy Marketing and Residential Heat Submetering Regulation which prohibits anyone to charge for consumed thermal energy based on measurement without the use of a Measurement Canada approved meter.

British Columbia regulates thermal energy rates via the BC Utilities Commission, but does not have any jurisdiction over measurement technology.

Industry stakeholders should recognize that regulations and standards are on available now and Federal Regulation is on the horizon.

Thermal Energy Metering: Success in Other Markets

When making its recommendations for thermal measurement, Measurement Canada utilized European standards. Europe has the most established thermal energy systems and has decades of experience in the measurement and billing of these systems through metering. Europe follows standards set out by the European Committee for Standardization (EN) and is harmonized under the European Union's Measuring Instruments Directive (MID). The standard specifies in-line thermal submetering technology and is the basis for thermal energy measurement in Europe.

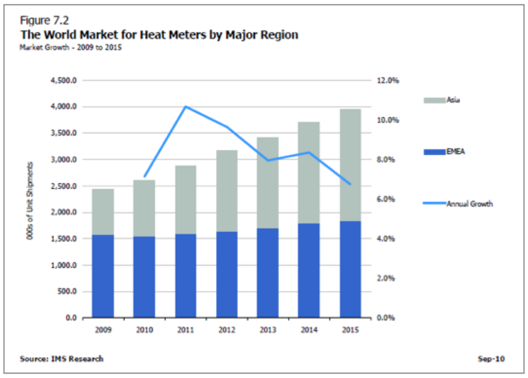
Recognizing the meticulous detail and success of existing European standards, China, the fastest growing thermal submetering market in the world, has adopted the same standards set out in EN1434.

In the United States, the Environmental Protection Agency by way of the American Society for Testing and Materials (ASTM) is in the final stages of releasing a draft of thermal metering standards. The American market has both realized the necessity of standardization but also its regulated use through state governments. The standard is essentially a preproduction of the OIML R75 international thermal metering standard, inclusive of American deviations.

See graph below for breakdown of international thermal (heat) meter sales.

Technology acceptance and growth

This year 4,000,000 thermal meters will be deployed worldwide. This is a testament to the acceptance of thermal metering technology.



Optional Thermal Energy Measurement Methodologies

The following sections provide a description of each of the thermal energy measurement options currently utilized in Canada. Their strengths and weaknesses are discussed.

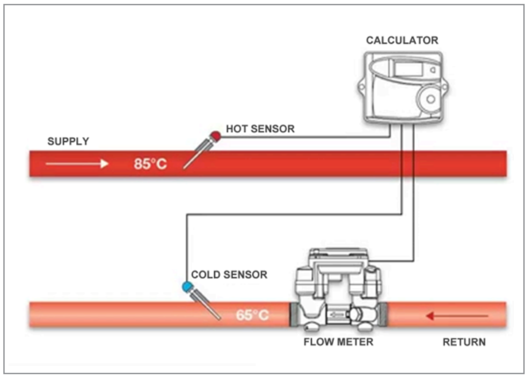
Option A – Thermal Energy Submetering

Similar to a utility level thermal energy meter, a thermal energy submeter is comprised of the following components:

- A flow meter
- Supply and return temperature sensors
- A BTU calculator

Standard Thermal Meter System:

The meter calculates energy (BTUs or ekWh) by multiplying the flow (volume) by change in temperature [E=V * (Ts-Tr) * k]. "K" factors are small variables that can affect the energy value, such as glycol content percentage.



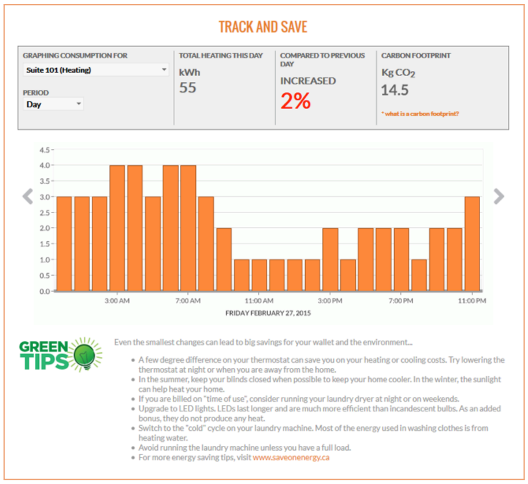
A properly designed and implemented submetering architecture has the following benefits:

- Proper measurement of consumption and cost to the user. If tenants are confident in the accuracy of the consumption data, they will be more confident in the costs reflected on the bill.
- Confidence through regulation: Compliance with thermal meter regulations, such as EN1434, will lead to increased confidence in measuring equipment and resulting data.
- Data traceability: multiple forms of data traceability are possible. For example, the tenant/owner can read the register of the meter, often displaying consumption in kWh equivalent. Moving beyond that, newer communications protocols allow for the real time data reporting from the meter to accessible web based tenant engagement portals.
- Technology acceptance and growth: This year nearly 4 000 000 meters will be deployed worldwide. A testament to the strength in the proper use of thermal metering technology.
- Tenant engagement: thermal energy submeters provide accurate data and communications options to enable tenant engagement. This is critical for conservation efforts supported by a utility, municipality or private submetering provider. See sample web-based tenant engagement tool below:

Web-based tenant engagement software allows tenants to access their energy consumption profiles, billing history and tips for conserving

Tenants Engagement Software

Web-based tenant engagement software allows tenants to access their energy consumption profiles, billing history and tips for conserving



Previously seen as too expensive, thermal submetering is now more affordable than ever in the Canadian market. As well, financing and long-term strategic contract options with qualified submetering companies can help reduce financial deterrents.

Option B - Inferred Thermal Energy Measurement or Run Time Measurement

Inferred thermal energy measurement (also called run time measurement) uses a combination of measurements, assumptions and hardware performance factors indicated by manufacturers. These methodologies are not always consistent and vary between suppliers; however, they share two main principles:

- The system will measure or assume temperature at one or several locations for the entire building.
- The system will assume flow characteristics based on a combination of inputs such as hardware performance factors, run time and valve positions. (Please refer to the Case Study for a detailed example)

Although this type of measurement may have a lower initial cost than submetering and will enable billing of an end-user's consumption in a fairer manner than not measuring at all, it does have several challenges:

1. Inferred measurement is not as accurate as true submetering. Assumptions are made in key areas in the process to calculate consumption. These assumptions can include some or all of the following;
    - Time on or off — in some instances inferred measurement uses the time the thermal system is on as an input. This assumes that when your system is on it is operating at full capacity. Certainly this assumption is not always valid.
    - Consistent temperature of the heating and cooling fluid throughout the building.
    - All equipment, such as fan coils, is operating efficiently and identically in each suite.
    - The factory settings and performance of system hardware are as stated by the manufacturer and will continue to be the same for the lifetime of equipment. This is particularly highlighted when making assumptions on flow, as the flow of the medium (ex. water) is equally as significant as the temperature readings
2. Traceability is a major concern in utility measurement; the lack of traceability makes it difficult to explain and justify energy usage to a customer.
    - Utility consumption traceability: it is more difficult for a utility or metering company to prove to the tenant that their invoice reflects what they consumed if there is no actual meter data but a combination of measurements and assumptions.
    - Hardware traceability: it is more difficult to track the history of equipment calibration or manufacturer when multiple components, often from multiple manufacturers, are used to create a reading. As well, there are no relevant standards to reference when building a proprietary system.
3. The measuring equipment in inferred measurement does not follow any available or recognized standards.
4. Inferred measurement systems are proprietary. Utilizing an inferred measurement system will tie a condominium corporation or building owner to the supplier indefinitely for services and maintenance.

5. Tenant engagement with meter data is not possible in these types of systems. Allowing a tenant or owner to view consumption data at the meter or online is not possible. Providing consumption data through submetering has proven to significantly improve the credibility of the metering system in the eyes of the tenants.

The challenges faced by Inferred Measurement are illustrated in the case study on Thermal Energy Measurement in Alberta, located at the end of this document.

> User pays systems also help building owners decrease the risks associated with escalating energy costs.

Option C - Ratio Utility Billing Systems (RUBS)

RUBS is a billing practice where the property owner recovers utility costs by apportioning fees based on an arbitrary set of energy related variables, such as number of tenants, square footage, number of fan coil units, etc. RUBS assumes constant consumption behaviors by all tenants.

RUBS is a very simple and low cost way of measuring and allocating thermal energy costs. Unfortunately, since it does not account for any variation among end-users, it is completely inaccurate and provides no financial incentive for an end-user to conserve (similar to Option D).

Option D - No Metering or Measurement

This option has been the most widely used form of thermal energy allocation in the past. The most common approach is to divide the total utility bill by the total amount of square feet in a property and then apportion the bill based on respective suite sizes. Square footage utility allocation comes with relatively no cost to the developer or building operator and is easy to manage. There is no measurement of actual consumption at the tenant level. This option does little to promote conservation efforts and does not contribute to popular conservation efforts, such as Vancouver's "Greenest City by 2020 Action Plan."

Utility costs are most often lumped into the general operating costs of a building and then accounted for in rising condominium fees (CAM fees for commercial properties). The optics of high fees is certainly a concern for developers and members of the real estate industry. Since invoicing individual users for their utility consumption will lower condominium fees, properties that do not measure and bill end-users for energy will be at a disadvantage.

Certainly markets with rising real estate and leasing prices would benefit from this – Vancouver and Toronto, in Canada, in particular. User pays systems also help building owners decrease the risks associated with escalating energy costs.

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Options for tenant billing of thermal energy through submetering:

METHOD	BENEFITS	RISKS
THERMAL ENERGY SUBMETERING		
• Install heating/cooling submeters, which measure the incoming and outgoing temperature as well as the volume of heating/ cooling fluid. • Heating and Cooling is measured precisely.	• Measurement of an actual medium • Data traceability • Hardware traceability • Tenant engagement with utility consumption data and visible meter hardware • Conformity to Regulations and Standards	• Typically more expensive; market may have assumptions that the solution is too expensive • If mediums except for water are used, there may require calculation of "k" factors on a monthly or annual basis • Can be difficult to retrofit in existing buildings
INFERRED MEASUREMENT / RUN TIME MEASUREMENT / COST ALLOCATION		
• Infer heating/cooling energy usage from a meter or temperature. Use a sensor and engineering coefficient to calculate the expected energy output from the heating/cooling source.	• Lower cost • May be more equitable than square footage allocation	• Accuracy inconsistent & dependent on assumptions • No available standards or industry best practices • Does not conform to already established standards EN1434 and OIML R75 • Assumes all equipment is operating efficiently and in an identical manner • Inability to measure energy intensity • No traceability - no way to confirm measurement devices are accurate • Tenant cannot view their meter and determine how much energy they are consuming

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METHOD	BENEFITS	RISKS
INFERRED MEASUREMENT / RUN TIME MEASUREMENT / COST ALLOCATION (CONT'D)		
		• Difficult to explain and justify energy usage calculations to tenant • Data subject to manipulation by billing company • Proprietary solution will tie property manager to the service provider indefinitely • Risk to loss of investment if inferred measurement banned, as in Alberta example
RATIO UTILITY BILLING SYSTEMS (RUBS)		
• Apportion utility consumption based on a number of factors such as, number of fan coil units, suite occupants, etc.	• Low cost • No capital investment	• Inconsistent fairness to tenants as it assumes similar usage pattern of all tenants • Complicated process • Subjective billing practices
NO METERING OR MEASUREMENT		
• Allocated Costs on a square footage basis or per unit	• No cost • Easy to manage	• Inconsistent fairness to tenants • Does not promote conservation • Condominium fees are potentially higher

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Conclusions and Recommendations

The adoption of thermal energy systems will continue to grow in Canada since it offers considerable cost efficiency and conservation benefits to all stakeholders. As with the other utilities, thermal energy will need to move towards a measurement standard that will enable equitable cost allocation and billing practices for a user pays system.

> TO MINIMIZE POTENTIAL RISK IN INVESTMENTS, THERE ARE FOUR CRITICAL FACTORS DEVELOPERS AND OTHER STAKEHOLDERS MUST CONSIDER WHEN SELECTING A MEASUREMENT OPTION FOR THEIR PROJECT:
>
> 1. Will the measurement methodology selected meet current and future regulations within Canada?
> 2. Is the methodology utilized by more mature thermal energy markets, such as Europe?
> 3. Can the methodology stand up to scrutiny if an end-user (tenant) disputes their bill? What international standards or hardware can you direct them to ease their concerns?
> 4. Will the methodology be delivered by an appropriate provider who will correctly specify, deploy, manage and bill from the system in the long-run?

Consideration of these factors and analysis of the measurement options presented it is clear that thermal energy submetering has more benefits and far fewer risks than the other methodologies. While more costly to implement, it offers long-term regulatory compliance within Canada and meets the best practices of more mature thermal energy markets. Tenant disputes can be alleviated with referral to metered data and international standards, and tenant engagement can be utilized to help reduce utility costs.

Many developers in Canada have already taken steps to benefit from thermal submetering in their multi residential or mixed-use buildings. Professionally trained experts in thermal metering are available in Canada and can help organizations develop a successful thermal energy submetering system.

Case Study #1

Heat Meters in Alberta

In 2007, a submetering company began installing heat 'meters' in Alberta for landlords planning to have the cost of heating suites billed to the building residents. The premise of "conservation enabled by metering" was the impetus for the drive to help reduce building costs. Over the next two years the company installed over 3000 heat meters in numerous multi-residential building in Alberta.

As the billing of residents began, it became apparent that there were many inconsistencies in billing between customers that were not easily explained. Residents would get bills with almost no consumption but would still have to pay the administration and meter fees charged by the submetering company. Others were getting extremely high monthly bills, which were very different from their neighbours. Both the landlords and the submetering company were receiving complaints over the residents' bills.

The Utilities Consumer Advocate in Alberta began receiving complaints from building residents for what they felt were unrealistic bills. The department held a number of fact-finding sessions with the metering industry along with consumer advocates to understand the issues. In the end the Alberta Regulation 72/2012 Fair Trading Act, Energy Marketing and Residential Heat Submetering was instituted, which banned heat metering unless the meters were Measurement Canada approved.

The so called 'meters' utilized were actually inferred measurement devices and not actually thermal energy meters. The devices calculated the BTU's used in a suite by measuring the temperature of the heat registers at a specific location, multiplying that by an assumed flow rate in the pipe along with a number of other factors to totalize the BTU's generated in a specific time period. The theory was based on factors and tables developed by American Society of Heating and Refrigeration and Air-Conditioning Engineers. The problem with these tables were they were developed assuming the ideal condition of heating registers and not aged heating systems that may not have been well maintained.

There were other factors that led to criticism of these meters. First is that to be able to accurately calculate the heat given off by the radiator you must know the rate of flow through the pipes. Where the measuring device used an assumed flow rate it could not compensate for partially open shutoff valves or any other restriction of fluid flow. This meant that where a pipe had calcium buildup or a partially opened zone or shutoff valve the meter would register higher heat usage than was actually produced, thereby causing inaccurate overbilling. Another factor which caused inaccuracy was that should the radiator fins be dirty or loose or should the radiators airflow be blocked by curtains or furniture, the heat given off by the radiator will not make it into the room, meaning the thermostat must remain on longer than necessary to heat the room.

As customer complaints began to appear and the absence of true flow rate became apparent the submetering company stopped calling their device a meter and began calling it a "heat allocation device."

The submetering company decided to abandon the heat allocation program and in so doing had to write off hundreds of thousands of dollars of capital assets. In addition, property owners and landlords saw a complete loss of investment with no ability to account for tenant billing in the future.

This case study demonstrates that financial and regulatory repercussions can result from inadequate measurement methodologies and devices. It highlights the importance of using true metering devices with internationally accepted technology to properly measure and allocate thermal energy consumption.

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