Greener Live Performances

through energy efficiency

Management Guide

Assessing & Purchasing Sub-Metering Systems

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Introduction

Energy costs are frequently the largest variable expense for live performance venues. At the same time, research suggests that up to 40% of the energy consumed in commercial buildings and facilities is needlessly wasted. Monitoring and understanding your energy consumption is the most important step to improving your venue's energy efficiency. General energy meters do not provide you with any information on where, when and why energy is consumed, which makes it difficult to work out how to improve energy efficiency. By sub-metering the energy use of individual areas or appliances your venue could gain a considerably better understanding of where energy is used and where there may be opportunities for energy savings and cost reductions.

This resource introduces the concept and benefits of sub-metering. It also provides you with the information required to assess whether your venue can benefit from sub-metering, and if so, what kind of sub-metering system may be suitable for your venue.

What is Sub-Metering?

Sub-metering is the installation of metering devices to measure the actual energy consumption after the primary utility meter.

A sub-metering system is comprised of hardware including meters and data loggers and software to monitor results. Such devices may be installed temporarily or permanently. They do not report back to your energy provider but are rather an internal mechanism providing a detailed breakdown of power usage by type or area. Sub-meters provide the base for effective energy monitoring and management control, by allowing the measurement of energy consumption for individual tenants, departments, building areas, pieces of equipment or other loads individually.

Why is Sub-Metering Important for Your Venue?

General metering of energy use across your entire venue does not enable you to understand how power is distributed and consumed throughout the building. Data from sub-metering helps you to define baseline energy consumption, detect usage anomalies and identify key areas where energy saving opportunities may be feasibly implemented.

For live performance venues, a break-up of the energy usage across performance spaces is crucial to understand how much power is used for individual performances. Sub-metering enables commercial theatres to make production and touring companies accountable for their performance energy usage. It also allows venues to implement measures such as setting a power limit on the rig. This not only brings down costs for individual performance spaces, but helps to build a culture in your venue and across the industry that encourages people to think differently and integrate energy efficiency considerations into a range of processes and decisions.

What are the Benefits?

The installation of sub-meters provides a variety of benefits to the building owner as well as the tenants. These are summarised below.

Taking Informed Actions

Sub-metering systems can collect, store and provide real-time energy data allowing you to take action before the end of the billing period. It helps you to identify areas and equipment with unusual consumption levels, and take specific and targeted actions to eliminate excess cost. Sub-metering also identifies areas and equipment which have better performance (lower energy consumption), which in turn allows the property manager to potentially replicate that performance throughout the facility.

Accountability for Energy Usage

Sub-metering energy consumption in your venue will allow you to view and compare usage across multiple performance spaces or areas in your venue. If your venue is in a shared building or includes facilities that are managed separately such as a café or bar, sub-metering can help to allocate proportional costs to tenants. If users are billed for their actual energy consumption instead of paying a share of a common building bill, there is more incentive to reduce energy consumption. Research suggests that by promoting accountability for energy use, an average decrease of 10-20% in energy consumption can be achieved.[1]

Monitoring energy health

Most sub-metering systems can monitor a range of parameters such as current and voltage, kW, kWh, power demand (kVA, kVAr) and the Power Factor. This information assists with monitoring energy health including the level of power that is actually converted to outputs, checking whether the voltage is adequate for your equipment and the power distribution in your venue in relation to tariffs, and the overall power demand level.

Power Factor

Sub-metering technologies can provide you with information on the Power Factor in your venue per individual meter. Power Factor is a measure of how efficiently power is being put to use, and is defined as the ratio of 'real' electrical power, which is turned into work and the excess electricity drawn from the grid. Ideally, real and apparent power would be equal. Each state and electricity supplier has its own Power Factor requirements and penalties, and by sub-metering you can check at any time whether your Power Factor falls below the level acceptable for your area to avoid penalties.[2]

Peak Demand

The Power Factor of your venue can also have an enormous impact on your demand charges. Advanced sub-metering systems have integrated functions that alert users when peak demand is reached by measuring the total kVa per sub-meter. Most sub-metering systems can communicate with Building/ Energy Management Systems to provide detailed energy data allowing for even more advanced functions such as load shedding through automated energy demand strategies. Knowing which areas or equipment contribute to peak demand allows you to reschedule non-essential equipment to times when your venue's total energy demand is low, and ensure that redundant equipment is not running during performance times.

1 *If you want to use sub-metering to bill touring companies or tenants, the meters you chose must be covered under the National Measurement Institute (NMI)*

2 *For more information on Peak Demand and how it affects your bill, have a look at our Design Guide on Managing Peak Demand in Venues.*

Multi-tariff Time of Use (TOU) Data

Sub-metering systems can store energy usage data in various formats to accommodate different energy pricing and tariff structures, including fixed-price and time of use (TOU) pricing. By being able to access this data in real-time you can take action by scheduling operations that require large amounts of energy to off-peak times, as off-peak rates are cheaper than shoulder and peak rates.[3]

Building a case for implementing energy efficiency measures

Essentially, sub-metering systems are an energy management and analysis tool providing the data and evidence to build a business case for implementing energy efficiency measures, which may include:

- Implementing no cost recommendations;
- Changing staff behaviour patterns;
- Changing operational procedures; and
- Investing in new technologies.

Having real-time energy data broken down into individual areas and for specific equipment encourages people to think differently about energy usage and helps to establish a culture of continuous monitoring and improvement through gradual change.

For example, retrieving data on your venue's Power Factor and peak demand might help you in identifying the need for a Power Factor correction unit. Sub-metering of individual equipment or systems such as lighting, HVAC, and motors or pump systems can be of great value when trying to build a case for an LED retrofit, upgrading equipment of your HVAC system, and selecting a VSD (variable speed drive) motor or pump to improve efficiency.

Compliance with green building initiatives

"Going Green" can comprise a variety of programs and initiatives to reduce energy and support environmental sustainability. Sub-metering is essentially a green product as it promotes energy awareness and energy conservation for building owners as well as energy users. Sub-metering helps you to control and measure energy conservation programs and depending on the system, it can translate real-time energy consumption into carbon emission information.

Accurate knowledge of where energy is being used is the first step to create an energy savings program, while constant monitoring allows the user to observe the ongoing effectiveness of the building's energy savings programs.

3 *For further information regarding off-peak, shoulder and peak times and tariffs please access: http://www.ausgrid.com.au/Common/Our-network/Metering/Time-of-use-pricing.aspx#.U8ikSfmSxZs*

What Options are Available?

There are a range of fixed, temporary and portable solutions measuring energy consumption by area (e.g. performance space), circuit or system/ equipment level (e.g. HVAC system). Typically sub-meters collect data at every half hour interval.

Temporary and portable sub-metering solutions

Portable devices may be a first step to inform the design of a more permanent sub-metering system. Portable metering solutions do not require any instalment and usually come as a clip-on device or other flexible options. Such portable solutions can be used as a survey that can be carried out at any time and at any desired point on the electricity system ranging from the incoming energy supply down to individual areas, circuits or equipment. Temporary metering and logging tools can be a costly investment and it may be advisable to hire such tools for a period of time to carry out a temporary energy survey. This may help you in determining whether investment in a fixed sub-metering system would be worthwhile for your venue.

Fixed sub-metering solutions

Fixed sub-metering options are permanent and require professional installation of hardware and software by technicians or electricians. The sub-meters usually report to a common interface (Modbus), which is linked to a computer or web- based portal that will display the desired measures (i.e. real-time data). Fixed sub- metering systems are more complex in their functionality and monitor multiple circuits at a time rather than providing snapshot data for one circuit at a time. Depending on the system, more complex physical energy data can be obtained that helps you to assess the “health” of your electricity supply and enables you to take corrective action (see section above on monitoring energy health).

There is a big difference in the level of investment, accuracy and functionality between and amongst fixed and portable sub-metering solutions. Choosing the suitable system for your venue essentially depends on the scale, scope and metrics you want to measure and the purpose and results you are hoping to achieve.

If your aim is to bill tenants or production and touring companies for their respective energy usage, you should look at fixed sub-metering solutions that are covered under the National Measurement Institute (NMI) rules.

If your aim is to solve a specific issue such as identifying equipment with excessive energy consumption or finding ways to decrease peak demand charges, a more flexible metering solution may be appropriate. For example, portable meters could be used to find out what equipment and/ or area is a major contributor to peak demand. By testing multiple areas and equipment across your venue, you can identify where and when energy demand peaks are caused and take responsive actions.

How Do I Know Which Option Best Suits My Needs?

There is no standard 'off-the-shelf' sub-metering solution that suits the needs of every venue. Each venue will contain intricacies that require a customized approach to meet current infrastructure and future requirements.

When considering a sub-metering strategy, break down the site into end uses of energy. This might be by area (for example, front of house, individual performance spaces, backstage, dressing or technical control rooms), by system (heating, cooling or lighting) or both.

Monitoring every end-use in a venue may not be cost-effective. To determine whether and how many sub-meters would be cost-effective for your venue you should consider conducting a Return on Investment (ROI) Assessment.[4] While it is not possible to predict the amount of savings associated with sub-metering you should consider the value of the data that sub-metering will yield. To do this, it is recommended you compare the cost of the meter, its instalment and the resources required to monitor the metering results (e.g. the software and staff) against the impact the area or equipment has on your venue's overall energy use.

Conducting an energy survey through a temporary portable sub-metering solution may be a suitable approach to identify whether your venue would benefit from sub-metering and if so, how complex the system needs to be.

The table below describes the different sub-metering methods and technologies in terms of flexibility, measurement approaches, the level of investment and the accuracy and scope of the methods.

4 *The "Building a Business Case for your Board or Sponsors" Management Guide includes a template for an ROI assessment – while the savings are hard to predict, the template may give you some guidance on how to approach an ROI.*

Fixed Sub-Metering Solutions

Type/ Method	Flexibility/ Ease of Instalment	Measurement	Level of investment	Accuracy	Scope
Direct sub- metering	Direct sub-metering means creating multiple accounts through your energy provider, which requires fixed meters to be installed and integrated with the main metering system.	Direct-sub metering can measure every end use on site (subject to location and amount of meters installed). Such a metering approach is only relevant if you share your building with multiple tenants and you want separate billing accounts. This is the only sub-metering approach that involves your energy provider.	High	High	Area
Fixed sub- metering	Fixed sub-metering is designed for installation in a fixed area and can be installed by any qualified electrician.	Such systems are highly accurate and are usually covered under NMI rules (always check before you make a decision). They enable multi-circuit energy reading reporting back to a data storage device collecting a range of data (energy health, power demand, etc.) that is transferred to a computer for real-time display and analysis. Such a system can usually incorporate as many sub-meters as desired and additional meters can be added at any time.	High/ Medium	High	Area, Circuit, Equipment
Indirect Metering	Requires one fixed sub-meter to be installed.	This approach takes information from a fixed sub-meter combined with other physical measurements to estimate energy consumption. An example would be measuring hot water consumption – by installing a water meter measuring the amount of cold water going into the water heater, hot water consumption can be calculated by incorporating measurements of water temperatures (before and after) and heater efficiency.	Medium/ Low	Medium/ Low	Equipment/ System
Constant Load Metering	Requires an hour meter to be installed on equipment operating at a constant, known load. Installation is relatively simple.	An hour meter is a relatively simple device that logs the running time of equipment (e.g. fan or motor). The amount of hours of operation can then be multiplied by the known load (in kW) and load factor to estimate the actual consumption (kWh).	Low	Low	Equipment

Portable / Temporary Sub-Metering Solutions

Type/ Method	Flexibility/ Ease of Instalment	Measurement	Level of investment	Accuracy	Scope
Portable sub-metering solutions	There are two options with portable metering solutions. Equipment can either be purchased or hired from suppliers together with technical staff to conduct a temporary energy audit.	Portable equipment can be used around the building to measure specific areas, circuits or equipment. Most portable systems can only meter one circuit at a time and provide snapshot data rather than data trends or comparisons to other areas at the same time.	Medium/ Low	Medium	Area, Circuit, Equipment
Clip-on ultrasonic meters	Attached to pipe – can be installed or moved to other locations by non-technical staff. May be part of a portable solution as above.	Measures the flow of water or gas - the flow rate can then be used to calculate the volume of gas or water being used. The device can be attached at any point between the incoming supply to a building to an area or to a machine or appliance.	Medium/ Low	Medium	Area, Circuit, Equipment
Electricity Clip-on meter	Sensors to detect electromagnetic field to measure flow – can be installed or moved to other locations by non-technical staff. May be part of a portable solution as above.	Measures the flow and subsequent usage of electricity. The device can be attached at any point between the incoming supply to a building to an area or to a machine or appliance.	Medium/ Low	Medium	Area, Circuit, Equipment

Sub-Metering & Energy Efficiency

Installing sub-metering alone will not make your venue operations more energy efficient.

In order for sub-metering to be successful and achieve the desired outcomes, the following key elements are required:

1. Commission an Energy Audit to obtain professional advice to define where the major gains may be achieved and which equipment is required to identify those gains.

2. Establish an Energy Management Program. Whether simple or comprehensive, the program must have support from management and dedicated champion to ensure the program's objectives are implemented. If you do not have a program in place yet, the LPA Management Guide on writing an Energy Policy provides you with the information required to get started.

3. Ensure the metering and sub-meter installations collect and store data and communicate with a centralised system that enables the champion or energy consultant to evaluate consumption patterns, detect anomalies or inefficiencies and make data-driven improvement recommendations.

4. Use data driven improvement recommendations as the quantitative foundation to build energy efficiency business cases.

5. Ensure all successful energy efficiency initiatives or projects are communicated to internal and external stakeholders to drive cultural and behavioural shifts towards an energy efficiency mindset.

Useful Tips

Energy Performance Contracting

Energy Performance Contracting is a payment scheme that uses cost savings from reduced energy consumption to repay the cost of installing energy conservation measures. Many larger suppliers (e.g. Philips, Siemens or Honeywell) offer such flexible payment options allowing you to invest in energy efficient solutions without major capital investment. Electrical engineering companies propose and quantify energy efficiency measures they could implement to reduce energy use over a set period of time and project the expected savings/reductions. Depending on the scheme, contracts can include regular payments based on the projected savings over a timeframe of 3-7 years.

Where to look for more information?

- The **Australasian Energy Performance Contracting Association** Inc. (AEPCA) Energy Performance has developed a set of standard contractual agreements to foster the development of the Energy Performance Contracting. A Best Practice Guide to Energy Performance Contracts is available at: www.eec.org.au

- Have a look at the **Energy Efficiency Council** website. It includes information on Energy Performance Contracting and a products and services directory.

  - Energy Performance Contracting
  - Products and Services Directory – Metering and Monitoring Services

- The Carbon Trust has published a comprehensive guide to **Metering - Introducing the techniques and technology for energy data management**, which is available at: www.carbontrust.com

References

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