Smart Building energy disaggregation Submeter with LEM Split-core CT ATO

Industrial companies, factories, multi-tenant commercial and residential building owners install submetering equipment for the purpose of real-time in-house metering. This allows for accurate allocation of costs, calculation of internal billing and enables the implementation of new energy efficiency measures.

Buildings typically consume energy to provide heat, air conditioning, lighting, display lighting, signage and other electrical appliances. Since the cost of energy is escalating in most parts of the world and governments are enforcing the ISO50001 energy efficiency standard, companies are launching initiatives to understand their energy consumptions and reduce peak demand charges wherever possible. This could result in hundreds of thousands in cost savings annually. In addition, companies with a number factories want to participate in utility company peak-demand saving incentives, which are offered for the purpose of shedding electrical loads at certain times of the day. These incentives also provide a reduction in energy costs, providing that the factories can “off-load” demand for a certain period when required. Companies now require a means to understand the electrical usage within their properties to develop strategies aimed at increasing energy efficiency.

The traditional intrusive method would include the installation of several multi-point or single point submeters, capable of monitoring 1 to 3 phase circuits in each supply closet of the load (Figure 1). Due to the layout of the factory, electrical distribution may be located in several closets throughout the building therefore many submeters would need to be mounted in close proximity. Unfortunately, this method is costly and requires significant installation and maintenance efforts.

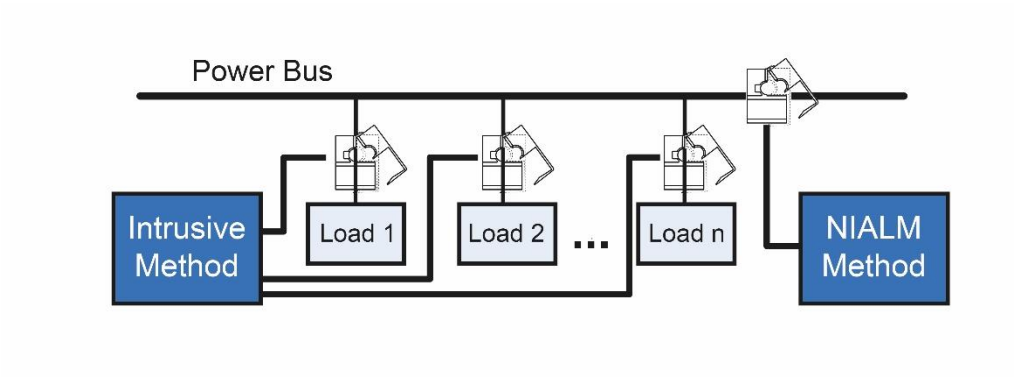

Figure 1

A more innovative way to obtain appliance-specific data is by the disaggregation of total power consumption data acquired at the main breaker level. The Non-Intrusive Appliance Load Monitoring (NIALM) method uses a single point of power measurement (Figure 1), combined with special signal processing techniques. This energy disaggregation technique (Figure 2) refers to a set of statistical approaches for extracting equipment and appliance level data from an aggregate, or whole building energy signal without any plug level sensors.

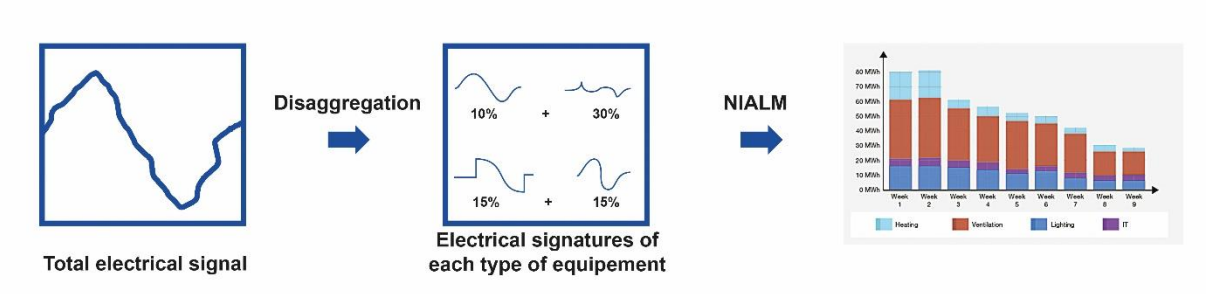

Figure 2

The whole building consumption data was collected using LEM split-core current transformer ATO sensors combined with other hardware (Figure 3). The hardware solution consists of three elements:

- 3 ATO Split-Core CT for the whole building: an electrical device made of Ferrite material with a jaw which opens to allow non-intrusive clamping on an electrical wire installed on the main circuit of the building.
- A NIALM submeter which undertakes the real-time power consumption breakdown and analysis (Figure 2) then transmits energy consumption data to a gateway.
- A gateway that receives the data and sends the energy consumption readings to the cloud based storage so the building manager can identify ways to reduce power consumption by using an energy management application.

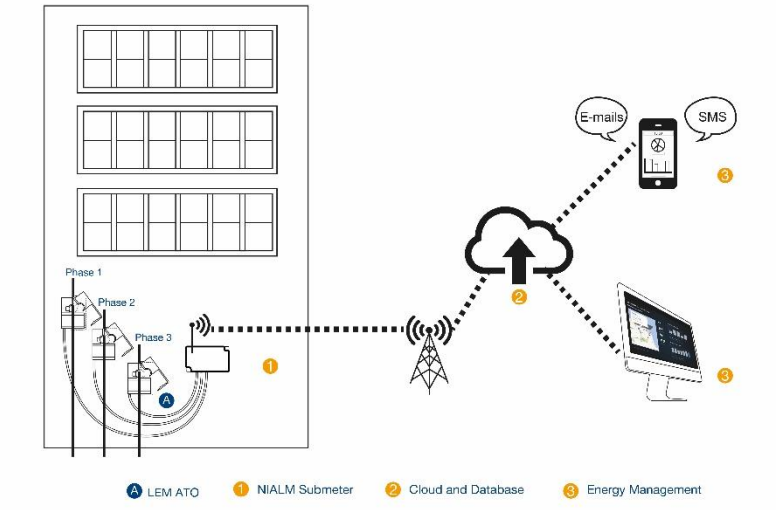

Figure 3

Although ferrite materials for current transformer sensors have been well known for years, their poor performance in terms of saturation level and magnetic permeability did not allow their use at frequencies as low as 50/60Hz. However, recent developments have revolutionized the characteristics of ferrite at these frequencies, bringing many advantages to a wide range of power monitoring applications.

The new types of ferrite have significantly improved permeability and can be implemented in 50/60 Hz current transformers as a substitute for FeSi or FeNi cores, despite the low magnetic saturation level. Split core current transformers implementing the new types of ferrite can perform accurate measurement of AC signals in an extended frequency range that includes the 50/60 Hz application domain. They take advantage of the intrinsic ferrite qualities, providing high accuracy and excellent linearity even at very low current levels. They also feature particularly low phase-shift between input and output currents, which is essential for accurate measurement of true active power or energy. The hard, dense core allows air gaps to be minimized and is virtually immune to ageing and temperature changes in contrast to other materials like FeSi or FeNi.

Last but not least, all the ferrite qualities are available at a lower cost, which puts the high performance of LEM ATO split core current transformers on the market at a very attractive price with innovative features (Figure 4).

ATO key value added features:

- Insulation 600V, Cat III
- Class 1 and 3 (IEC 61869-2)
- Phase displacement respected
- Output mA, 225mV, 333mV
- No interruption of electricity
- 5 Year warranty

Figure 4

The ATO is the only split-core CT certified to IEC 61869-2 standard with an adapted voltage output of 333 mV and 225 mV at I_{Pr} (rated nominal current) less demanding in energy consumption. It is also rated Accuracy Class 1 & 3 and fully validated by characterization tests requiring both ratio error and phase displacement accuracy. For example, Figure 5 is representing what is required by IEC 61869-2 standard in terms of accuracy and phase shift versus the percentage of measured rated nominal current: in this example,1% and 3% accuracy are required for a 75A waveform nominal current when being respectively at 120% and 5% of I_{Pr} (rated nominal current). And this is what ATO models provide!

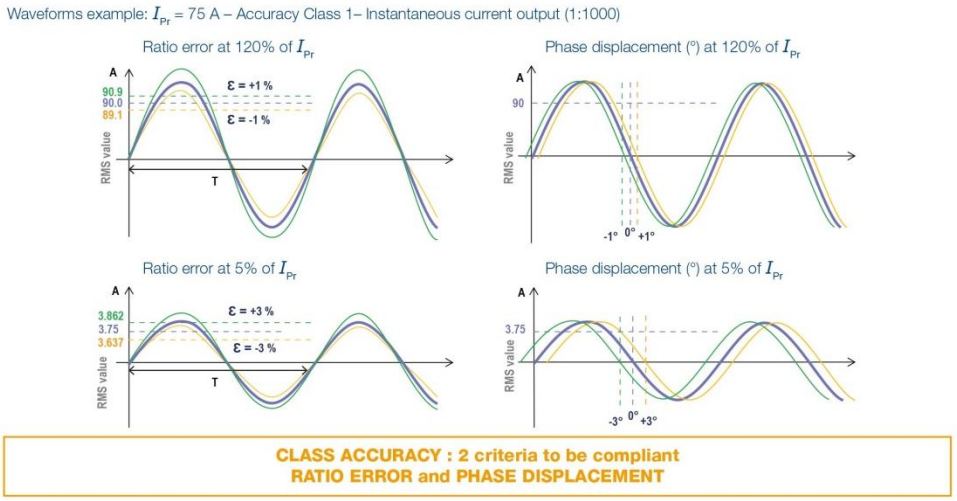

Figure 5

Today, the overall signal percentage of correctly reconstructed appliance with NIALM algorithm based submetering solution is around 80-90% and keeps improving. At a lower cost, real-time energy information and energy disaggregation based solutions using LEM ATO sensors can influence consumer behavior to increase savings and drive engagement. In addition, energy disaggregation can also perform remote energy audits, measure and validate utility demand-response programs, and resolve high bill disputes between the utility and the building owner.