Title of the Invention: **Energy reporting unit**

Abstract Title: **Energy Reporting Unit Comprising a Split Toroid Transformer**

An energy reporting unit can comprise a split toroid transformer 2, a microprocessor and a wireless data transmission means 5. The energy reporting unit can further comprise of a passive infra red sensor (pir, figure 3). The reporting unit can be configured such that it is normally switched off, switching on only when a voltage change is detected, or alternatively switched on intermittently for a predetermined amount of time which is shorter than the period of time it is switched off. Also disclosed is a method for monitoring power usage utilizing the energy reporting unit which involves using the energy reporting unit during a fault free operating cycle, storing the energy usage signature thereof, monitoring subsequent operating cycles, and comparing the stored signature of the fault free operating cycle with the signature of each subsequent operating cycle. Exemplary uses include household or office power meters, electrical distribution boards, power outlets or light switches.
1. Self Powered Radio Power Measurement Circuit

Fig. 2
2. Self Powered Radio Power Measurement Circuit, with Local/Remote Switching Control

Fig. 3
Machine Energy Profile

Fig. 4
Energy Reporting Unit

The present disclosure relates to an energy reporting unit. Preferably, it further relates to an automated energy monitoring system comprising one or more energy reporting units and at least one data collector.

With increased fuel costs, and a heightened awareness of the environmental impact of the inefficient use of resources, there is an increasing need for effective energy monitoring, which monitoring allows wastage to be identified and minimised.

The present invention arose in a bid to provide an improved apparatus for monitoring energy usage.

According to the present invention, in a first aspect, there is provided an energy reporting unit comprising a transformer, a microprocessor and a wireless data transmission means.

The energy reporting unit is preferably adapted such that, in use, it may be fitted around a wire to be monitored. The transformer preferably comprises a split toroid. The energy reporting unit preferably comprises a housing within which the energy reporting unit is entirely self contained. The housing is preferably provided in two parts that are pivotally or detachably connected to one another such that the housing may be opened to receive a wire to be monitored, and closed around the wire.

According to the present invention in a further aspect, there is provided a power outlet, a light switch or an electrical distribution board comprising an energy reporting unit.

According to the present invention in a further aspect, there is provided an energy monitoring system comprising one or more energy reporting units and one or more external data collectors that are adapted to receive data wirelessly from the one or more energy reporting units.
According to the present invention in a further aspect, there is provided a method for monitoring the power usage of a machine comprising the steps of: using an energy reporting unit to monitor the energy usage of a machine during a fault free operating cycle of the machine and recording the energy usage signature of the fault free operating cycle, monitoring one or more subsequent operating cycles and recording the energy usage signature for the or each subsequent operating cycle, and comparing the signature of the or each subsequent operating cycle to the fault free operating cycle.

Non-limiting embodiments will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows, schematically, an exemplary energy reporting unit according to the present invention;

Figure 2 shows a circuit diagram for an exemplary energy reporting unit according to a first embodiment;

Figure 3 shows a circuit diagram for an exemplary energy reporting unit according to a second embodiment; and

Figure 4 shows an exemplary machine energy profile as recorded by an automated energy monitoring system utilizing an energy reporting unit.

According to a first arrangement, as seen schematically in Figure 1, there is provided an energy reporting unit 1 comprising a split core toroidal transformer 2, herein referred to as a split core toroid, a power supply 3, which preferably comprises a super capacitor, a microprocessor and wireless radio 5. The data processed by the microprocessor may be sent by the wireless radio to an external data collector 6, which may comprise a personal computer or otherwise. The split core toroid is adapted such that, in use, it may be fitted around an electrical supply to be monitored, as shown. Here the electrical supply comprises a wire.

All of the components that combine to form the energy reporting unit are housed in a self contained housing (not shown) that is suitable for mounting in any area in which it is
desired to monitor energy usage. The housing most preferably comprises a split ring arrangement, comprising two halves that may be clipped together around a wire to be monitored (with each half of the split ring housing a half of the split toroid). The halves may be pivotably or detachably connected to one another.

The wire, around which the energy reporting unit is fixed, may comprise, for example, a wire from the back of an electrical socket or plug, a wire from the back of a light switch, or a wire from a feeder circuit. The energy reporting unit may form an integral component of any of these items and may be integrated into new items or retrofitted to existing items. Numerous alternatives will, however, be readily appreciated by those skilled in the art.

The split core toroid will be selected on the basis of the electrical supply to be monitored, with the smallest size possible selected. The toroid may have a diameter of 20mm or less. As detailed, the toroid supplies voltage for the operation of the microprocessor and for measurement. By varying the toroid selected the energy reporting unit may be scalable from 1A to 100A or higher. The toroid outputs voltage versus current draw of the electrical supply.

The power supply (super capacitor) is configured to retain the power generated by the toroid for the processor when the supply is switched off and is charged by the current flowing in the electrical supply.

The energy reporting unit is configured as an ultra-low power device. The microprocessor is configured such that the energy reporting unit is normally switched off. Under control of the microprocessor, the energy reporting unit will switch on (“wake”) intermittently and for a predetermined period of time that is shorter than the intermittent period during which it is switched off. The energy reporting unit may, for example switch on and remain on for up to 5 milliseconds per second, preferably for 2 to 3 milliseconds per second. The energy reporting unit will power on and remain on when a change of state is
detected, however. The energy reporting unit will transmit a wireless signal only when it is switched on, transmit (Tx) mode.

The energy reporting unit of the present invention is self-powered, drawing power from the wire around which it is fixed in use. The super capacitor is configured to provide power to the microprocessor when there is no current flowing in the electrical supply. By the above control, with the energy reporting unit ordinarily off, power stored in the super capacitor is effectively conserved.

When switched on, the processor of the energy reporting unit will process the output of the toroid to measured units. The microprocessor calculates and transmits power usage through the wireless radio processor.

Any number of the energy reporting units may be provided which are operatively linked to one or more of the data collectors, which are provided to receive and process data received from the energy reporting units, and which together with the energy reporting units may be considered to form an automated energy usage monitoring system.

The energy reporting units are each preferably linked to one of the data collectors by the wireless radio through a low power wireless network (iLan), which preferably operates in the ISM bands. Most preferably, each energy reporting unit provides communication at a frequency of 315, 433, 868 or 915 MHz. It will be appreciated by those skilled in the art that numerous suitable wireless radios exist.

Data that is received by the or each data collector may be distributed locally or through the Internet to a remote location.

With reference to Figures 2 and 3, there are shown exemplary circuit layouts for energy reporting units according to the present invention. The arrangement of Figure 3 introducing local/remote switching control to the arrangement of Figure 2.
Circuit 1 (Figure 2):

Exemplary uses of the depicted configuration include but are not limited to:

1) A low power (13A, for example) household or office power meter. Can be used, for example, to detect a laptop or an individual appliance (for example, a washer/dryer or a television) powered up and the corresponding energy use.

Such energy monitoring units may, in particular, be located within/mounted behind individual power outlets.

2) A medium power (32A, for example) power meter, situated, for example in an office distribution board, to detect energy use and efficiency of separate parts of an office complex (different cost centres, for example).

3) A high power (100A, for example) industrial machinery power meter, which can be used to detect energy use and efficiency of an individual machine and/or can be used to record the energy cycle signature of an individual machine, which signature can be used as a comparison for subsequent machine cycles to detect defects.

Figure 4 illustrates a sample machine energy profile, wherein each cycle of the machine has a signature of power use. The signatures of four machine cycles A, B, C and D are shown. As shown the profiles of cycles B to D exhibit differences.

For each machine a fault free machine cycle signature can be stored by the microprocessor within the energy monitoring unit or by a data collector associated with the energy monitoring unit. The signatures of subsequent cycles can be compared against the stored signature, wherein increased energy usage, for example, may be indicative of a fault with the machine; and wherein inefficiencies may be identified. Moreover, machine cycles can be counted with intervention into the control system of the machine a possibility.
Circuit 2 (Figure 3):

Circuit 2 is shown to include, in addition to the components of the first circuit, a PIR (passive infrared sensor) and a dimmer/power switch, which here comprises a MOSFET (metal-oxide-semiconductor field-effect transistor) or a TRIAC (Triode for Alternating Current). As mentioned, these components introduce additional capabilities, including local/remote switching control.

With the PIR the presence of people may be monitored by the energy monitoring unit, which allows for the correlation of occupancy and power usage data together and control based upon occupancy. All data being sent together wirelessly to a data collector and/or to a controller, which may be at a remote location.

Exemplary uses of the depicted configuration include but are not limited to:

1) A low power (13A, for example) household or office power meter, which can be used, for example, to detect a laptop powered up and the corresponding energy use, and furthermore to remotely switch on/off power for valid use.

Such energy monitoring units may, in particular, be located within/mounted behind individual power outlets.

2) A low power (13A, for example) household or office lighting power meter, which can be used to detect lighting circuit power usage and on/off status, wherein power can be remotely switched on and off for valid use, or locally on/off via the PIR or MOSFET.

Such energy monitoring units may, in particular, be located within individual lighting switches or mounted behind switch plates.
Claims

1. An energy reporting unit comprising a transformer, a microprocessor and a wireless data transmission means.

2. An energy reporting unit as claimed in Claim 1, wherein the transformer comprises a split toroid.

3. An energy reporting unit as claimed in any preceding claim, wherein the energy reporting unit is adapted such that, in use, it may be fitted around a wire to be monitored.

4. An energy reporting unit as claimed in any preceding claim, wherein the energy reporting unit comprises a housing and the energy reporting unit is entirely self contained within the housing.

5. An energy reporting unit as claimed in any preceding claim, wherein the housing is provided in two parts that are pivotally or detachably connected to one another such that the housing may be opened to receive a wire to be monitored and closed around the wire.

6. An energy reporting unit as claimed in any preceding claim further comprising a power supply for providing auxiliary power to the energy reporting unit.

7. An energy reporting unit as claimed in Claim 6, wherein the power supply comprises a super capacitor.

8. An energy reporting unit as claimed in any of Claims 2 to 7, wherein the toroid has a diameter of 20mm or less.

9. A sensing device as claimed in any preceding claim comprising a microprocessor, which is arranged to run a software package for controlling the operation of the energy reporting unit.
10. An energy reporting unit as claimed in any preceding claim, wherein the energy reporting unit is configured such that it is ordinarily switched off, switching on when a voltage change is detected by the processor and/or switching on intermittently for a predetermined period of time, which is shorter than the intermittent period during which it is switched off, to monitor the voltage detected by the processor.

11. An energy reporting unit as claimed in any preceding claim further comprising a passive infra red sensor, which is operatively connected to the microprocessor.

12. A power outlet comprising an energy reporting unit as claimed in any preceding claim.

13. A light switch comprising an energy reporting unit as claimed in any preceding claim.

14. An electrical distribution board comprising an energy reporting unit as claimed in any preceding claim.

15. An energy monitoring system comprising one or more energy reporting units as claimed in any preceding claim and one or more external data collectors that are adapted to receive data wirelessly from the one or more energy reporting units.

16. A method of monitoring power usage comprising the steps of: monitoring the power usage of a machine using an energy reporting unit as claimed in any preceding claim during a fault free operating cycle and recording the energy usage signature of the fault free operating cycle, monitoring one or more subsequent operating cycles and recording the energy usage signature for the or each subsequent operating cycle, and comparing the signature of the or each subsequent operating cycle to the fault free operating cycle.

17. An energy reporting unit substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.
18. An energy monitoring system substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.
### Patents Act 1977: Search Report under Section 17

**Documents considered to be relevant:**

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<th>Category</th>
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<td>X</td>
<td>1-9 &amp; 12-16</td>
<td>US 2012/271579 A1 (DEOKAR et al) See figures 2A, 2B &amp; 4 as well as paragraphs [0064] and [0075].</td>
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<td>X</td>
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<td>US 2010/085036 A1 (BANTING et al) See figures 1, 7 and 12 especially as well as paragraph [0065].</td>
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<td>US 2009/309754 A1 (BOU et al) See paragraphs [0009], [0027] and [0034].</td>
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<td>WO 2006/078944 A2 (GUNN et al) See figures as well as paragraphs [0006] &amp; [0057]-[0061].</td>
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<td>WO 2013/102040 A1 (PHILLIPS et al) See figures 4 and 5 as well as paragraphs [0019] &amp; [0031].</td>
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**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC

Worldwide search of patent documents classified in the following areas of the IPC

G01R

The following online and other databases have been used in the preparation of this search report.
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