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(54) SOLAR AIR THERMAL ENERGY SYSTEM AND ENERGY PURCHASE AGREEMENT METHOD

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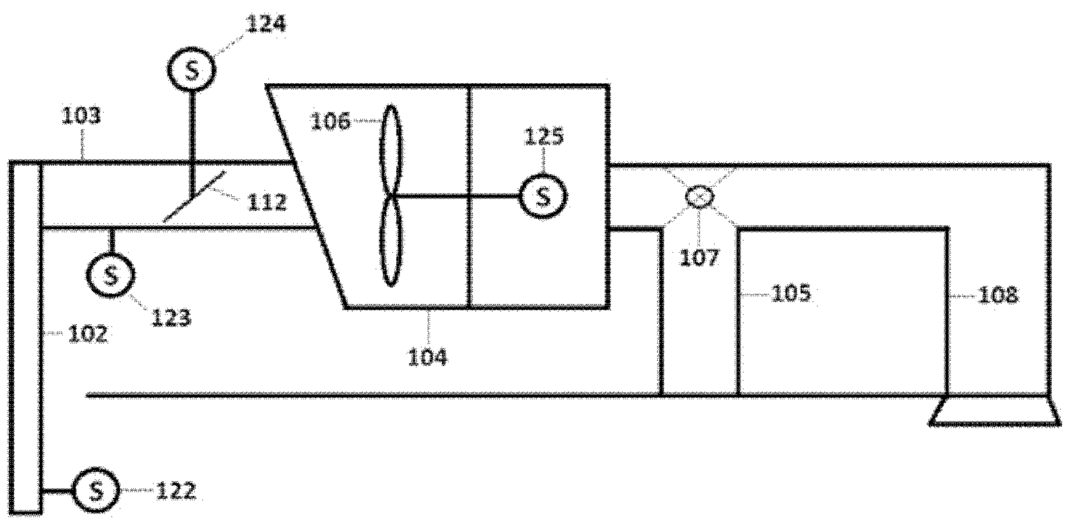
(57) **ABSTRACT**

A solar hot air system is provided containing a solar hot air collector and an inlet duct connected to the solar hot air collector and a building fresh air intake. A sensor is connected to the building fresh air intake, configured to measure fan speed and damper position. In addition, a sensor is connected to the inlet duct, configured to measure air volume and temperature. Further, a sensor is connected to the solar hot air collector, configured to measure internal and ambient temperature. A means for calculating a periodic fee to a user based at least in part upon an amount of generated energy is also provided.



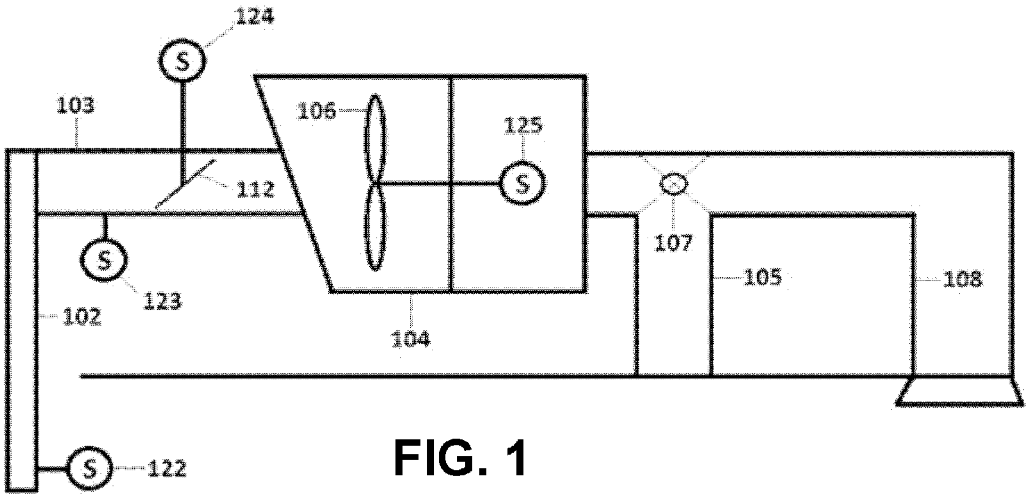

124
103
106
125
112
107
123
105
108
102
104
122

FIG. 1

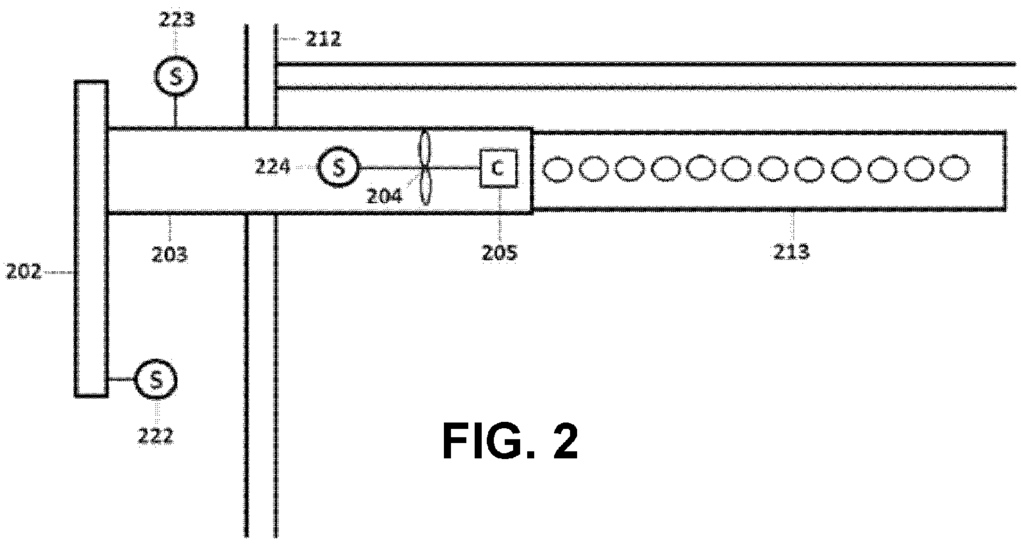

223
212
224
204
C
203
205
213
202
222

FIG. 2

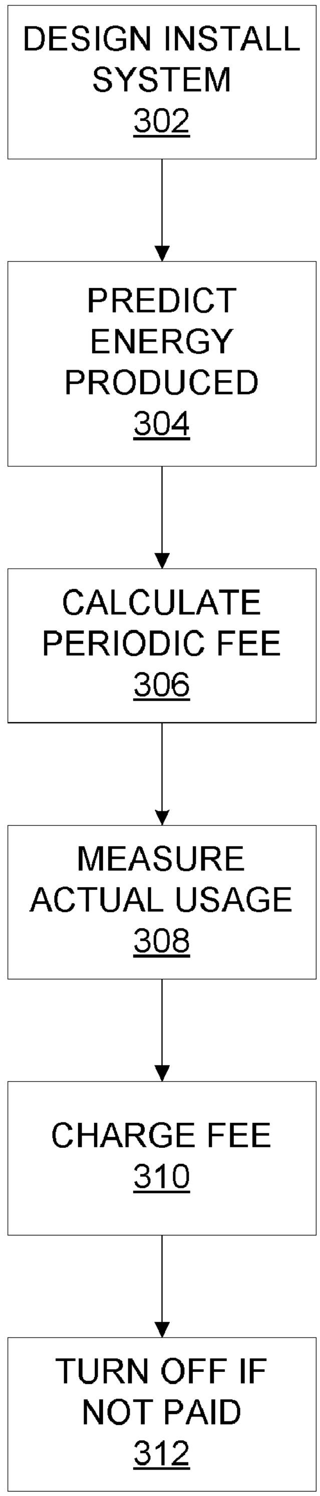

DESIGN INSTALL SYSTEM
302
PREDICT ENERGY PRODUCED
304
CALCULATE PERIODIC FEE
306
MEASURE ACTUAL USAGE
308
CHARGE FEE
310
TURN OFF IF NOT PAID
312

FIG. 3

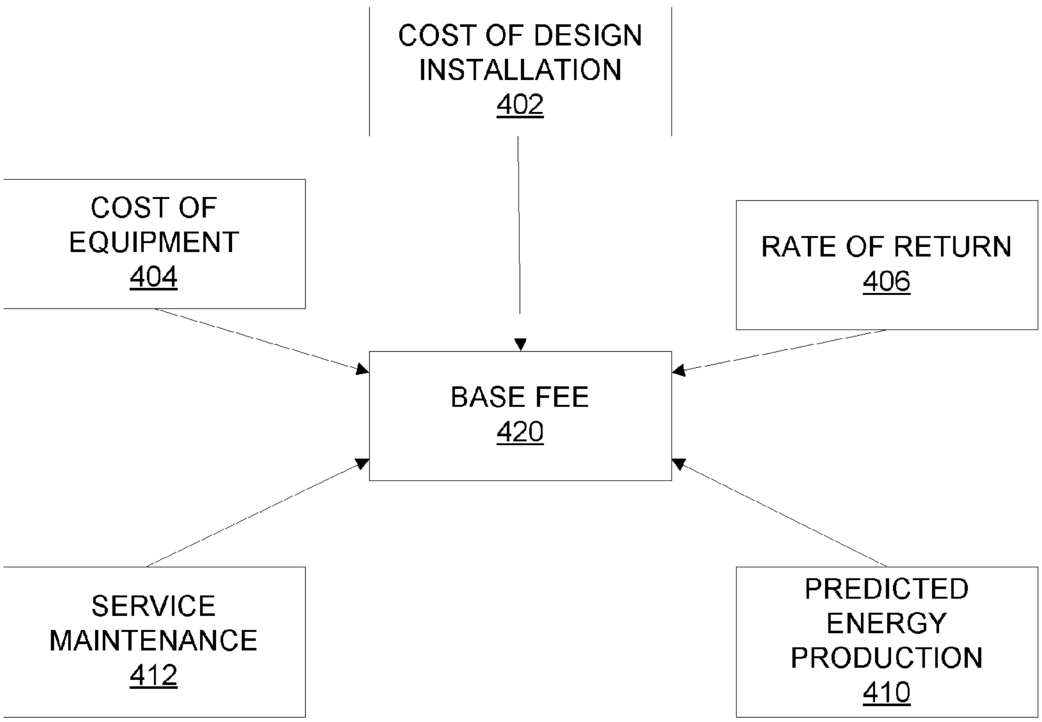

COST OF DESIGN
INSTALLATION
402
COST OF
EQUIPMENT
404
RATE OF RETURN
406
BASE FEE
420
SERVICE
MAINTENANCE
412
PREDICTED
ENERGY
PRODUCTION
410

FIG. 4

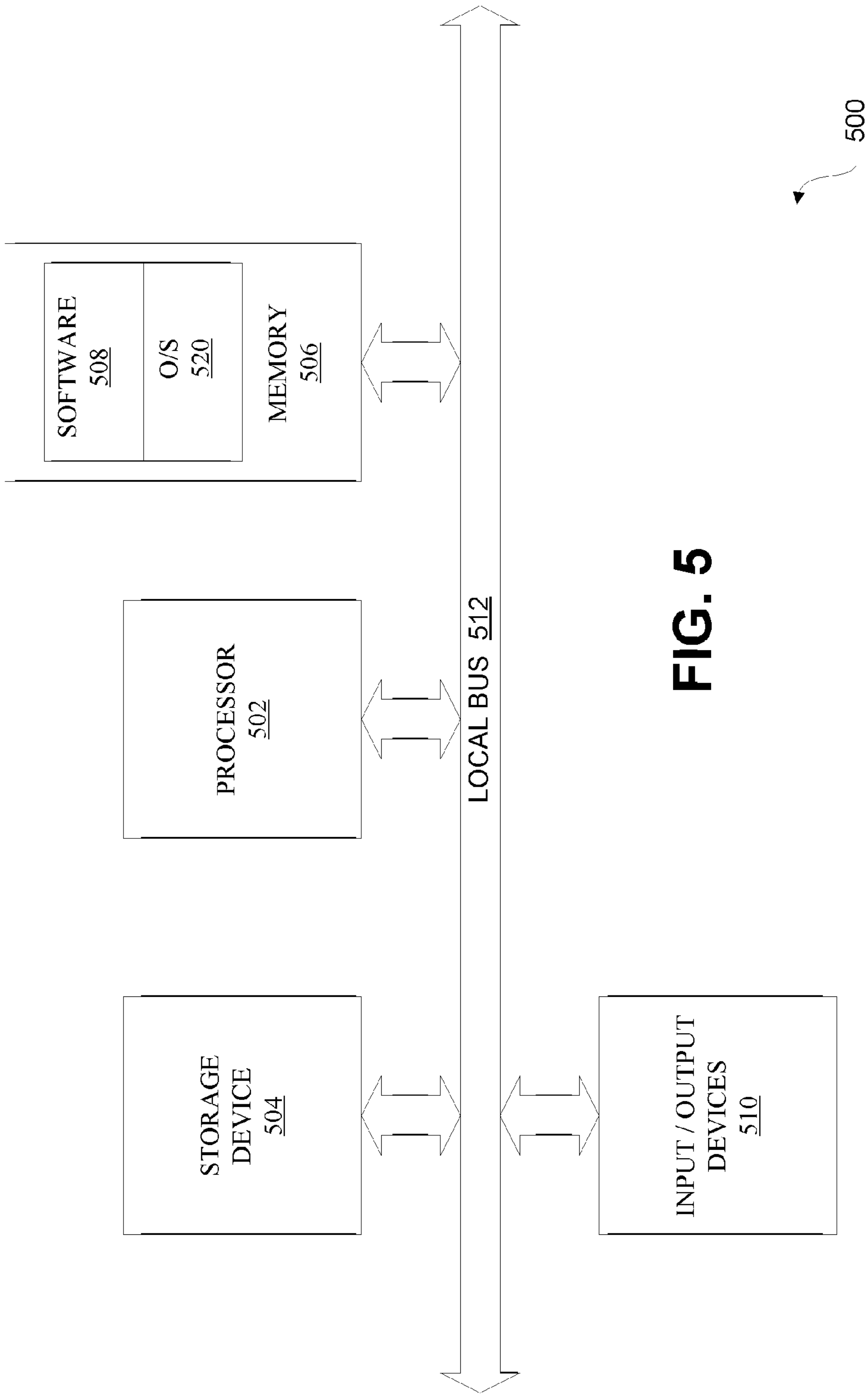

500
SOFTWARE 508
O/S 520
MEMORY 506
PROCESSOR 502
STORAGE DEVICE 504
LOCAL BUS 512
INPUT / OUTPUT DEVICES 510

FIG. 5

SOLAR AIR THERMAL ENERGY SYSTEM AND ENERGY PURCHASE AGREEMENT METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to copending U.S. Provisional Application entitled, "SOLAR AIR THERMAL ENERGY SYSTEM AND ENERGY PURCHASE AGREEMENT METHOD," having Ser. No. 61/487,559, filed May 18, 2011, Which is entirely incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to solar energy and more particularly, is related to providing energy services.

BACKGROUND OF THE INVENTION

[0003] The price of using fossil fuels and/or electricity to heat buildings has been increasing, is expected to increase and has negative environmental consequences. Many people are looking for alternatives to provide stable and lower costs for heating their facilities.

[0004] A building's heating load can be offset using solar heat in passive and active technologies. Passive solar involves design elements allowing solar thermal energy to lower a structure's heat loads. Other technologies, such as geothermal provide additional methods for stabilized thermal needs but rely on electricity to drive the system and complicated retrofit construction. Active solar, through hot water collectors and hot air collectors can also lower heat loads, but all of these options are often not selected due to their higher upfront costs.

[0005] In the field of solar hot water systems, one solution that has been tried is a business method for providing a utility and calculating a rate to charge the customer that is not based on energy usage. However, such a method only discusses solar hot water, and specifically that the rate charged is not based on the amount of energy used.

[0006] Another example in the solar field involves photovoltaic solar power, not solar heated air. This example involves the creation of financial instruments to purchase, lease, and maintain consumer premises equipment, and provides for shutting off the power if the consumer stops paying. This method does not provide for the proper financial structure to create a third-party ownership method or a fee based on energy production or displaced through heating systems.

[0007] Another example in the geothermal field involves a fee that is based on a base fee which results from the system installation cost and a periodic fee that is based on the geothermal energy used. This example is limited to geothermal energy and has a fee that is based primarily on the cost of the system and less so on energy used, and not based on the value of the energy displaced.

[0008] None of these examples apply directly to solar heated air and none provide a mechanism to understand the value of the energy produced or the energy displaced as a factor in recognizing the cost of the system. What is needed, therefore, are systems and methods for overcoming the shortcomings described above.

SUMMARY OF THE INVENTION

[0009] Embodiments of the present invention provide a solar air thermal energy system and energy purchase agreement method. Briefly described, in architecture, one embodiment of the system, among others, can be implemented as follows. A solar hot air system is provided containing a solar hot air collector and an inlet duct connected to the solar hot air collector and a building fresh air intake. A sensor is connected to the building fresh air intake, configured to measure fan speed and damper position. In addition, a sensor is connected to the inlet duct, configured to measure air volume and temperature. Further, a sensor is connected to the solar hot air collector, configured to measure internal and ambient temperature. A means fir calculating a periodic fee to a user based at least in part upon an amount of generated energy is also provided.

[0010] Other systems, methods, features, and advantages of the present invention will be or become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features, and advantages be included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a schematic diagram of a first embodiment of a system according to the present invention.

[0012] FIG. **2** is a schematic diagram of a second embodiment of a system according to the present invention.

[0013] FIG. **3** is a process flow chart showing a method under a third embodiment of the present invention.

[0014] FIG. **4** is a diagram showing details of one of the steps of the third embodiment.

[0015] FIG. **5** is a schematic diagram illustrating an example of a system for executing functionality of the present invention.

DETAILED DESCRIPTION

[0016] Reference will be made in detail to embodiments of a system and method that satisfies the need for financing the system cost and the installation of a solar hot air system and charging a periodic fee based on the energy output of the system or the energy displaced by the system from the existing building system. A first exemplary embodiment of a system according to the present invention includes perforated solar hot air collector panels, spacing dips, extruded vertical bars, duct work to connect to a ventilation system, decorative capping, sensors to determine air flow and temperature, calculating means for determining a periodic fee amount of energy produced, and means for turning off the system in the event fees are not paid. A method according a third embodiment of the present invention may include the steps of designing and installing a solar hot air system to a customer's building, calculating a periodic fee to be charged to the customer, measuring solar hot air system production, and charging the customer for the energy produced or displaced.

[0017] FIG. **1** is a schematic diagram of a first embodiment of a solar hot air system **100** including a thermal collector **102** that allows air to enter the system **100** either at the collector surface via perforations, at the top, side or bottom of the collector cavity via appropriately sized intake vents, or from the interior of the space when recirculation of air through the solar hot air system is used. The thermal collector **102** captures solar energy by heating the air within the collector **102**, thereby transferring solar energy to the heated air. The air leaves the thermal collector **102** via a conduit, for example, a duct, grill, or wall penetration **103** connected to the thermal collector **102** and travels to a facility using the heated air, for example, a building. The heated air may enter the building, for example into an existing or fitted air intake system **104**. Such an air intake system **104** may already be present or may be added to the building to meet the fresh air demands of the building. As shown in FIG. **1**, the heated air may be delivered into the building, for example, through an existing ventilation system **105** impelled via a fan **106**.

[0018] The system **100** may have a motorized first damper **112** that may allow the thermal collector **102** to be bypassed, for example, when a temperature set point is exceeded thereby allowing the ventilation system **105** to draw regular air into the mechanical unit as conventionally designed without the solar system. The system **100** may also include a second damper **107** to bypass the building and provide heated air to a storage media **108** for usage on site for heating or other purposes or for use at a later time. Examples of the storage media **108** may include, but are not limited to pressurized or atmospheric storage vessels with water or other storage medium, ground storage for geothermal or other thermal storage systems such as masonry, brick, rock, water, or other effective forms of thermal mass. Examples of the exchange media may include, but are not limited to, copper tubing for direct or indirect hot water generation, air to water heat exchangers for hot water generation, air to water heat pumps for building heating or heat generation, and air to air heat pumps for building heating or heat generation.

[0019] The thermal collector **102** may be a perforated cladding system, non-perforated cladding system, glazed cladding system, or any effective cladding system with a cavity and/or substrate behind it which is designed to maximize solar energy generation. The cladding itself may he constructed of metal, plastic, polycarbonate, glazing (single or double layered) or any material shown to provide effective thermal conduction or effective transfer of solar energy to the location where energy is drawn.

[0020] The thermal collector **102** may be designed or provided in a variety of colors which may impact performance. Energy from the thermal collector may be generated in a number of different, or a combination of different methods which may include but are not limited to heat which develops on the surface of a cladding material, heat which develops on the back side of the cladding system and is then scrubbed from the back of the cladding via air movement, heat which is scrubbed from the back of a heated cladding surface and is directed through the solar hot air system to allow further temperature increases, transfer of energy to the interior air cavity via a clear cladding material designed to allow solar energy to heat a conductive surface behind the cavity, and heat which develops via a heated thermal mass at the back face of the solar hot air system.

[0021] In the same or another embodiment, monitoring equipment **122** may be installed to measure the production and usage of the system **100** at the location where energy is delivered to the conventional space or heating system **102**. Examples of such monitoring devices may include, but are not limited to, commercially available pre-configured monitors, such as by FatSpaniel Inc., Onset Computer or any client computer monitoring network such as energy management systems or a dedicated system management application. All metering and sensor equipment may be compatible with site specific controls or conditions from project to project. Data loggers may be used to obtain trending information for remote interpretation or energy calculations such as Hobo U30 Data Loggers or similar.

[0022] In the same or another embodiment, a sensor may be connected to the system **100** in one or more locations, for example, a duct sensor **123**, a damper sensor **124**, and an intake fan sensor **125**. Each sensor **123**-**125** may be configured to collect temperature measurements to measure and monitor the amount and temperature of pre-heated air that is delivered to the building and the amount of thermal energy delivered to the building. Such measurements may be used to form the basis for a calculation of the amount of thermal energy generated and/or displaced by the system.

[0023] In the same or yet another embodiment, one or more additional controls may be attached to the system so that existing controls of the system **100** may be overridden to deliver thermal energy into a building, or through a bypass **107** into a storage medium **108** for use at a scheduled time to take advantage of available thermal energy at a later time.

[0024] Furthermore, a means for turning off the system **100**, for example, if fees are not paid, may also be connected to the system **100**. The means for turning off the system **100** may be, for example, a control unit connected to the damper **112**. Another example of a means for turning off the system **100** may be a computer command issued to this device from a computer.

[0025] FIG. **2** is a schematic diagram of a second embodiment of a system **200** according to the present invention. Referring to FIG. **2**, the heated air from a solar thermal collector **102** may be directly piped into a building space **212** through a duct **203** and driven by a fan **204** into the space **212** through a distribution duct **213**. Such direct piping may displace the need for a fresh air system connected to the space **212** to provide lower temperature fresh air. The controls in FIG. **2** may be connected to temperature monitoring devices and control units that may communicate with existing control technologies of the building to optimize the use of pre-heated air over conditioned air from the heating system of the building.

[0026] In the same or another embodiment, commercially available pre-configured monitoring equipment may be installed to measure the production of the system **200** and usage at the collector **222**.

[0027] In the same or another embodiment, one or more sensors may be connected at one or more locations within the system **200**, for example, a duct sensor **223** may be attached to the duct **203**, or an intake fan sensor **224** may be positioned near the fan **204**. Such sensors may collect, for example, temperature measurements to measure and monitor the amount of preheated air and the temperature of pre-heated air that is delivered to the building, and thereby, the amount of thermal energy delivered to the building, forming the basis for a calculation of the amount of thermal energy generated by the system and/or displaced.

[0028] The system **200** may include a switch **205** that deactivates the fan **224** to insure the thermal collector **202** is not providing heated air to the space when a temperature set point is exceeded, thereby allowing fresh air into the building that is not preheated.

[0029] A calculating means for calculating a periodic usage fee to a user based on the usage of the system **200** may also be provided. The calculating means may be a computer storage device or media electronically connected to one of the sensors **223**, **224**, the computer storage media may be connected, for example, to the internet to permit remote calculation of the period fee, monitoring of the system's operation and other data. Other examples of access to the computer storage media may include, but is not limited to, access via a serial or parallel port, for instance, with a thumb drive, wireless access, such as Bluetooth or WiFi, or removable media, such as a portable hard drive.

[0030] Referring to FIG. **1**, a means for bypassing the system **100**, through override of the motorized damper **112** in the event fees are not paid, may also be connected to the system **100**. In FIG. **2** a means employed for bypassing the system **200** may be a switch connected to the fan **204**. The means for bypassing the system **200** may include converting the fresh air system to the prior configuration where unconditioned lower-temperature air is delivered to the building through the pre-existing heating system. The means for bypassing the system could be, for example, at least one electric switch. The means for bypassing the system **200** could be a computer command issued to the controller for the damper.

[0031] A third embodiment of the present disclosure is a method for providing the services of solar pre-heated air systems such as the first embodiment shown in FIG. **1** and the second embodiment of FIG. **2**. At least a portion of the method under the third embodiment may be executed, for example, by a computer. Under the method of the third embodiment, for example, customers may avoid the upfront cost of purchasing and installing a solar hot air system, while a vendor may generate a profit by, for example, installing a solar hot air pre-heating system, and metering usage of the solar hot air pre-heating system that would be the basis of billing. Turning to FIG. **3**, a vendor may evaluate, design, and install a solar hot air system for heating fresh air to be delivered into a building (block **302**). The designer may estimate energy the solar hot air system will produce for the building (block **304**) and calculate a periodic fee (block **306**). The vendor and customer may enter into a term contract before the vendor can complete installation and metering and delivery begins. In situations that do not allow accurate metering of energy production, actual energy savings can be compared with projections to confirm an agreed upon rate and agreed margin of error.

[0032] The vendor may develop a periodic fee (block **306**) reflecting the cost for energy produced by the system and the predicted amount of energy that will be produced (block **304**) or the amount of energy produced by the system as actually measured (block **308**) as credited against the estimated fee, although this fee will include additional charges for monitoring and measuring.

[0033] FIG. **4** is a detail of elements that may contribute to a base fee **420** used to calculate the periodic fee of block **306** (FIG. **3**). The elements of the base fee **420** may include a cost of designing and installing the system **402**, an equipment cost **404**, a rate of return **406**, predicted energy production of the system **410**, and estimated service maintenance costs **412**. The rate of return **406** may includes the financing costs. The predicted energy production **410** may affect the length of the contract.

[0034] The periodic fee may be based on payments as negotiated based on the method for calculating the periodic fee. The periodic fee may be calculated using a base fee **420**. This can be created, for example, at a time agreed upon between the client and vendor and may represent a total fee necessary to secure financing, form the basis for tax-based incentives, and generate profit for the vendor.

[0035] While the system is in use, there may be sensors and meters that measure the energy produced **308**, delivered, and/or displaced while combining where available the savings provided to the client. This may include savings related to recaptured heat losses from the building, de-stratification savings in certain circumstances and displaced/combustion efficiency savings compared with fossil fuels.

[0036] Finally, there may be a means of turning off the delivery of pre-heated air to the building heating system via the energy metering mechanism, for example, the damper sensor **124** (FIG. **1**). The delivery of pre-heated air may be turned off, for example, by opening a dampener **112** (FIG. **1**), or with similar equipment to by-pass the delivery of the heated air into the air delivery unit to the building. This may indicate to the metering mechanism that there is no air being drawn into the building from the solar hot air system, and therefore no energy being delivered that may be billed.

[0037] As previously mentioned, at least a portion of the present system for executing the functionality of the third embodiment described in detail above may be a computer, an example of which is shown in the schematic. diagram of FIG. **5**. The system **500** contains a processor **502**, a storage device **504**, a memory **506** having software **508** stored therein that defines the abovementioned functionality, input and output (I/O) devices **510** (or peripherals), and a local bus, or local interface **512** allowing for communication within the system **500**. The local interface **512** can be, for example but not limited to, one or more buses or other wired or wireless connections, as is known in the art. The local interface **512** may have additional elements, which are omitted for simplicity, such as controllers, buffers (caches), drivers, repeaters, and receivers, to enable communications. Further, the local interface **512** may include address, control, and/or data connections to enable appropriate communications among the aforementioned components.

[0038] The processor **502** is a hardware device for executing software, particularly that stored in the memory **506**. The processor **502** can be any custom made or commercially available single core or multi-core processor, a central processing unit (CPU), an auxiliary processor among several processors associated with the present system **500**, a semiconductor based microprocessor (in the form of a microchip or chip set), a macroprocessor, or generally any device for executing software instructions.

[0039] The memory **506** can include any one or combination of volatile memory elements (e.g., random access memory (RAM, such as DRAM, SRAM, SDRAM, etc.)) and nonvolatile memory elements (e.g., ROM, hard drive, tape, CDROM, etc.). Moreover, the memory **506** may incorporate electronic, magnetic, optical, and/or other types of storage media. Note that the memory **506** can have a distributed architecture, where various components are situated remotely from one another, but can be accessed by the processor **502**.

[0040] The software **508** defines functionality performed by the system **500**, in accordance with the present invention. The software **508** in the memory **506** may include one or more separate programs, each of which contains an ordered listing of executable instructions for implementing logical functions of the system **500**, as described below. The memory **506** may contain an operating system (O/S) **520**. The operating system essentially controls the execution of programs within the system **500** and provides scheduling, input-output control, file and data management, memory management, and communication control and related services.

[0041] The I/O devices **510** may include input devices, for example but not limited to, a keyboard, mouse, scanner, microphone, etc. Furthermore, the I/O devices **510** may also include output devices, for example but not limited to, a printer, display, etc. Finally, the I/O devices **510** may further include devices that communicate via both inputs and outputs, for instance but not limited to, a modulator/demodulator (modem; for accessing another device, system, or network), a radio frequency (RF) or other transceiver, a telephonic interface, a bridge, a router, or other device.

[0042] When the system **500** is in operation, the processor **502** is configured to execute the software **508** stored within the memory **506**, to communicate data to and from the memory **506**, and to generally control operations of the system **500** pursuant to the software **508**, as explained above.

[0043] The embodiments described above, linked directly to solar hot air system technology, provide mechanisms for buildings to displace heating fuels, usually fossil fuels, with solar energy captured in a collector. The system design, installation, and financing allows customers to adopt these systems quickly, without upfront costs, and allows the system to be owned, maintained and operated by a third party. Such arrangements have never been considered for solar hot air systems because of the complication in creating a structure for 3rd party ownership where the energy is not easily metered, as can be done with electric and hot water systems. Such an arrangement allows the system owner to indirectly benefit the system host by leveraging tax incentives which lower the system's installation and equipment cost. If ownership passes to the host, for example, as an option under the contract, the host may benefit from a free fuel (sunlight) for the life of the system. With the addition of thermal storage, the system and the savings may be expanded by allowing the building to use thermal energy stored on site during times when the system overproduces.

[0044] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A solar hot air system comprising:

a solar hot air collector;

an inlet duct connected to the solar hot air collector and a building fresh air intake;

a sensor connected to the building fresh air intake, configured to measure fan speed and damper position;

a sensor connected to the inlet duct, configured to measure air volume and temperature;

a sensor connected to the solar hot air collector, configured to measure internal and ambient temperature; and

means for calculating a periodic fee to a user based at least in part upon an amount of generated energy.

2. The solar hot air system of claim **1**, further comprising means for turning off the system.

3. The solar hot air system of claim **2**, wherein the means for turning off the system is a switch or valve connected to the damper bypassing the solar hot air collector.

4. The solar hot air system of claim **1**, wherein the inlet duct is connected to a fan providing air into the conditioned space of the building.

5. The solar hot air system of claim **4**, wherein a sensor is connected to the solar hot collector, the inlet duct and ambient air and provides information to a control software that is connected to and controls the fresh air intake for the conditioned space.

6. The solar hot air system of claim **4**, wherein the means for turning off the system is a switch or valve that shuts off the fan providing air to the conditioned space.

7. A method of providing a solar hot air system for a building, comprising the steps of:

designing and installing a solar hot air system to the building;

via use of a computer, calculating a periodic fee;

measuring the actual thermal energy produced and used; and

charging a periodic fee, the periodic fee comprising a base fee and a usage charge based on the system's production.

8. The method of claim **7**, where the calculation of the fee is based on monitoring the amount of energy produced by the system by calculating energy from an amount of air and the air's temperature delivered to the building versus the ambient air.

9. The method of claim **7**, where the calculation of the fee is based on modeling an expected output of the system.

10. The method of claim **7**, where the calculation of the fee is based on a measurement of a damper actuation and an amount of air moved by the fan in the system.

11. The method of claim **7** where the calculation of the fee is based on the value of energy displaced from the existing heating system.

12. The method of claim **8** where the calculation of the fee is based on the value of energy displaced from the existing heating system.

13. The method of claim **9** where the calculation of the fee is based on the value of energy displaced from the existing heating system.

14. The method of claim **10** where the calculation of the fee is based on the value of energy displaced from the existing heating system.

* * * * *