A communicating environmental control system for a dwelling or building is provided. The environmental control system is intended for use in a dwelling which may be unoccupied for a long period of time, e.g., months. The control system operates in an economy mode to prevent damage to the dwelling and its contents by avoiding condensation of moisture within the dwelling. At the same time, the control system minimizes operating costs by running more when energy costs are lower and running less when energy costs are higher. The control system switches to a comfort mode when the dwelling occupants return. The control system is in communication with a remote owner, a remote utility, or a remote service provider, or more than one of these, through the Internet or other communication system.
FIG. 1A

FIG. 1B
FIG. 1C

FIG. 1D
3. Initialize controls
3.2 Connect environmental control system to network
3.3 Set humidity set points
3.4 Set temperature set point
3.5 Operate system
3.6 Humidity exceed setpoint?
Yes → 3.8 Shift to control by temperature
No → 3.7 System still operational?
Yes → 3.9a Temperature exceed setpoint?
No → 3.9b System still operational?
Yes → 4.0 Send alert
No → 3.0

FIG. 3
### Occupancy Modes

<table>
<thead>
<tr>
<th>Home</th>
<th>Away</th>
<th>Sleep</th>
<th>Vacant</th>
<th>User1</th>
<th>User2</th>
<th>User3</th>
<th>User4</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- **When my home is in Home Mode**: active
- **Use the following settings for the areas controlled by the Heating / AC thermostat**
  - **Cooling setpoint**: 80 °F
  - **Heating setpoint**: 68 °F
  - **Economical Cond.**
  - **Economy Profile**
- **My home is normally OCCUPIED during Home mode**

**FIG. 4D**

![Diagram](image)

- **When my home is in Away Mode**: active
- **Use the following settings for the areas controlled by the Heating / AC thermostat**
  - **Cooling setpoint**: 85 °F
  - **Heating setpoint**: 68 °F
  - **Economical Cond.**
  - **Economy Profile**
- **My home is normally OCCUPIED during Away mode**

**FIG. 4E**

![Diagram](image)

- **When my home is in Vacant Mode**: active
- **Use the following settings for the areas controlled by the Heating / AC thermostat**
  - **Cooling setpoint**: 90 °F
  - **Heating setpoint**: 45 °F
  - **Maximum Comfort**
  - **Balanced Comfort**
  - **Economical Comfort**
- **OCCUPIED during Vacant mode**

**FIG. 4F**
### FIG. 4G

Thermostat Scheduling

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
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<td>2</td>
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<td>Weekday</td>
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<td>28</td>
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<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>Weekday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIG. 4H**

Thermostat Scheduling

```
Select Thermostat: Heating / AC
Select Day Type: Weekday

Start >> Start at midnight in: Sleep mode
Then at 04:30am switch to User1 mode
Then at 05:00am switch to User2 mode
Then at 05:30am switch to Home mode
Then at 07:30am switch to Away mode
Then at 04:00pm switch to User2 mode
Then at 05:30pm switch to Home mode
Then at 10:00pm switch to Sleep mode

Apply to 3/18/2003 Apply to all Weekdays Back to Calendar...
```

**FIG. 4I**

- **Weekday**
- **New Day Type**
- **Weekday**
- **Weekend**
- **Holiday**
- **8/13/2002**

```
2/18/2003
```
### Configure Alert

<table>
<thead>
<tr>
<th>Alert Description</th>
<th>Destination</th>
<th>Channel</th>
<th>Configurable Priority</th>
<th>Single/Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature out of Range</td>
<td>Home Occupant</td>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Temperature out of Range</td>
<td>Service Provider</td>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Gateway Not Responding</td>
<td>Service Provider</td>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Temperature out of Range</td>
<td>Energy Provider</td>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Gateway Not Responding</td>
<td>Energy Provider</td>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Budget Limit Alarm</td>
<td>Home Occupant</td>
<td></td>
<td>2</td>
<td>Single</td>
</tr>
<tr>
<td>Device is Malfunctioning</td>
<td>Home Occupant</td>
<td></td>
<td>3</td>
<td>Single</td>
</tr>
<tr>
<td>Communication Failure</td>
<td>Home Occupant</td>
<td></td>
<td>3</td>
<td>Single</td>
</tr>
<tr>
<td>Ramping Recovery Failure</td>
<td>Home Occupant</td>
<td></td>
<td>12</td>
<td>Single</td>
</tr>
<tr>
<td>Duplicate IP address</td>
<td>Service Provider</td>
<td></td>
<td>12</td>
<td>Single</td>
</tr>
<tr>
<td>Temperature out of Range</td>
<td>Energy Provider</td>
<td></td>
<td>12</td>
<td>Single</td>
</tr>
</tbody>
</table>

Note: You may be the secondary email as another channel by updating personal data. Click here to update account personal data.

### FIG. 4J

- Temperature Reports
- Electricity Usage
- Cost & Consumption

### FIG. 4K
FIG. 4N

Configuration Data

Personal Data
Your personal account settings

Thermostat Data
Your thermostat data

Home Data
Information about your home

EM Switches
Energy Management Services

Programs
Your program listing

FIG. 4O

Thermostat Data

*Thermostat Name: Heating / AC

Heating
Type: Electric w/Electric Emergency
Stages: 1 2

Emergency Heating

Cooling
Type: Electric Heat Pump

Stages: 1 2

Additional controls: Humidifier Dehumidifier

Safety Limits:

Heat Limits: 95 High 50 Low°F

Cool Limits: 90 High 65 Low°F

Default Limits for Thermostat

Thermostat Summary Apply Reset

* - required

FIG. 4P

Electric: w/ Electric Emergency
Electric: w/ Electric Emergency
Electric: w/ Gas Emergency
Electric: w/ Oil Emergency
Electric Baseboard
Propane
Oil
Steam
Hot Water

FIG. 4Q

Electric Heat Pump
Electric Heat Pump
Electric Standard Central Air
Natural Gas
Evaporative
Program Participation

<table>
<thead>
<tr>
<th>Participate</th>
<th>Product Name</th>
<th>Supply Type</th>
<th>Effective Dates</th>
<th>Effective Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergency AC Curtailment</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>A Group</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>B Group</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Emergency HVAC Curtailment</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Emergency Hot Tub/Spa Curtailment</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Emergency Pool Pump Curtailment</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Emergency Shut Off</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Emergency Water Heater Curtailment</td>
<td>On Demand</td>
<td>01/01 - 12/31</td>
<td>12:00am - 11:59pm</td>
</tr>
<tr>
<td></td>
<td>Afternoon Peaker</td>
<td>Scheduled</td>
<td>04/01 - 10/01</td>
<td>12:00am - 6:00pm</td>
</tr>
<tr>
<td></td>
<td>Morning Peaker</td>
<td>Scheduled</td>
<td>01/01 - 12/31</td>
<td>6:00am - 12:00pm</td>
</tr>
</tbody>
</table>

FIG. 4R

Immediate Supply  Scheduled Supply  Program Definitions  Active Supply  Supply History  Reports

5.06

5.08A 5.08B 5.08C

Immediate Supply
Link to a tree diagram of the electrical distribution network. Selectable substrations display immediately available - and total capacity.

Scheduled Supply
Link to a tree diagram of the electrical distribution network. Selectable substrations display electrical distribution by times according to "Day Type".

Program Definitions
Shows a program summary table that lists and describes all available programs. Links are provided to view specific program details.

Active Supply
Link to a tree diagram of the electrical distribution network. Substrations are selectable and links are provided to display active supply at the node level.

Supply History
Supply History displays a table of past power generations. Generation date, time, program, production/actual amount of load, max total demand are listed.

Reports
This link goes to a set of reports for the utility operator.

FIG. 5A
FIG. 5B

Available Program Capacity

<table>
<thead>
<tr>
<th>Generate Program Name</th>
<th>Available Power</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency HVAC Curtailment</td>
<td>600 W</td>
<td>7193 W</td>
</tr>
<tr>
<td>Emergency Shut Off</td>
<td>600 W</td>
<td>7193 W</td>
</tr>
<tr>
<td>Emergency Water Heater Curtailment</td>
<td>0 W</td>
<td>515 W</td>
</tr>
<tr>
<td>Emergency Pool Pump Curtailment</td>
<td>0 W</td>
<td>209 W</td>
</tr>
<tr>
<td>Emergency Hot Tub/Spa Curtailment</td>
<td>N/A</td>
<td>0 W</td>
</tr>
<tr>
<td>Emergency AC Curtailment</td>
<td>600 W</td>
<td>7193 W</td>
</tr>
<tr>
<td>B Group</td>
<td>600 W</td>
<td>7193 W</td>
</tr>
<tr>
<td>A Group</td>
<td>300 W</td>
<td>7193 W</td>
</tr>
</tbody>
</table>

Duration: 0:13

Tue Mar 18 2003 14:30

FIG. 5C
**FIG. 5D**

Find Eligible Programs

Find Eligible Program for Phoenix

- **Date:** Month: 3, Day: 18, Year: 2003
- **Time:** Hour: 0, Minutes: 0
- **Desired Supply:** W

**Program Summary**

- **A Group:** HVAC Optional and Overrideable
- **B Group:** HVAC Optional and Overrideable
- **Emergency AC Curtailment:** Curtailment of AC systems Not Overrideable or optional
- **Emergency HVAC Curtailment:** Thermostats Curtailment program - Overrideable and Optional
- **Emergency Hot Tub/Spa Curtailment:** Hot Tub/Spa Curtailment Program
- **Emergency Pool Pump Curtailment:** Pool Pump Curtailment Program
- **Emergency Shut Off:** Emergency program will supply from all devices
- **Emergency Water Heater Curtailment:** Water Heater Curtailment Program

**Scheduled Supply**

- **Afternoon Peaker:** This program curtails Water Heater, Pool Pump, and HVAC between 12PM to 4PM
- **Morning Peaker:** Shutoff Water Heaters and Pool Pumps between 6AM and 12PM

**FIG. 5F**
Program Definitions

Program Name:
Description:

Supply Type: [On Demand] [Scheduled]
Available Time: From: HH 0 [ ] MM 0 [ ] To: HH 00 [ ] MM 00 [ ]
Available Dates: From: MM 1 [ ] DD 0 [ ] To: MM 1 [ ] DD 00 [ ]
Optional [ ] Overrideable [ ]

Device Types To Include: [ ] HVAC/TSTAT [ ] Water Heater [ ] Pool Pump [ ] Hot Tub/Spa

FIG. 5G

Circuit: Neighborhood Power Company
Daily Report for Electric Meter Total Usage: 647.32 kWh

Energy Consumption for Tuesday, March 18, 2003

Select Device: [Electric Meter] [Graph Type] [Date] [Month] [Year] [Day] [Refresh Chart]

FIG. 5H

FIG. 5I
COMMUNICATING ENVIRONMENTAL CONTROL SYSTEM

FIELD OF THE INVENTION

[0001] This invention generally relates to control of environmental conditions in a dwelling primarily by controlling humidity inside the dwelling and also by controlling a temperature of the dwelling.

BACKGROUND OF THE INVENTION

[0002] Control of energy costs is important as the price of all forms of energy continues to rise, and the supplies of energy, at least in the short run, tend to remain fixed. Significant amounts of energy, and thus energy costs, are required for the care and maintenance of vacant buildings or dwellings. Examples include buildings that are used seasonally. These include summer lodges or homes in northern climates which are used in one season, such as summer, and are vacant in the winter off-season. Other examples include homes in southern climates which are occupied in the winter. These homes are then vacant in the summer off-season, where the weather may include summer storms, hurricanes, and other high-humidity weather events.

[0003] These buildings or homes require environmental systems for occupant comfort while they are occupied. Thus, homes or lodges which are occupied in the summer typically have an air-conditioning system to relieve the occupants from summer heat and humidity. These homes or lodges typically also have heating systems, usually integrated with the air-conditioning system, for occupant comfort when required. The cost of operating a heating and air-conditioning system, because of the cost of energy, tends to be much greater than the installed cost of the heating and air-conditioning system itself.

[0004] The same is true for homes or buildings in southern climates which are occupied during the winter by “snow-birds,” people who live further north during the summer and who migrate to the south in the winter. Their homes are occupied during the winter and are operated for comfort during that time, typically requiring both heating and air-conditioning at different times. These same homes are unoccupied during the summer months with the highest heat and humidity, and thus they require at least an air-conditioning system to maintain the temperature and humidity within reasonable limits.

[0005] Thus, unoccupied “snow-bird” homes in the south may have their highest cooling costs in the summer, even though the homes are not occupied. Owners may attempt to minimize these cooling costs by using a high temperature set point. However, there are still significant energy costs, and the cooling system may fail. If the cooling system fails, the building or home may incur damage because of high heat or high humidity, or from the consequences of high heat and humidity, such as mold and mildew damage.

[0006] Unoccupied homes and building in the north may have their highest heating costs in the winter, even though the homes are not occupied. Owners may try to minimize their costs by setting the temperature set point low, but there are still very high heating costs. If the heating system fails, the building or home may incur damage from burst pipes.

[0007] What is needed is a way to minimize the cost of maintaining an acceptable environment in a building that is unoccupied for a long period of time, e.g., months. What is also needed is a way to detect failure of the environmental control system, such as a heating and cooling system. These and other advantages of the invention, as well as additional inventive features, will be apparent from the description of the invention provided herein.

BRIEF SUMMARY OF THE INVENTION

[0008] In one aspect, an embodiment is an environmental control system for a building. The environmental control system includes a microprocessor controller configured for accepting at least two temperature set points and a humidity set point, an operating interface operably connected to the controller, a thermostat and at least one temperature sensor operably connected to the controller. The system also includes a humidistat and at least one humidity sensor operably connected to the controller. In one embodiment, the system also includes a communications interface operably connected to the controller and configured for communicating to a remote location over a telecommunications network. Preferably, the controller is programmed to operate an environmental system within the building with at least two different control points for temperature and humidity during a 24-hour cycle. The control points are different if they differ in at least one of temperature or humidity.

[0009] In another aspect, an embodiment is a method for controlling an environment in a building. The method includes providing an environmental controller for a building, the controller including a computer and a communications interface, setting a first humidity control point for an environmental system, and setting a second humidity control point, higher than the first humidity control point, for the environmental system. The method also includes operating the environmental system in accordance with the first humidity control point for a first portion of a day and in accordance with the second humidity control point for a second portion of the day, and communicating an alert when the second humidity control point is exceeded.

[0010] In another aspect, an embodiment is a method for controlling an environment inside a building. The method includes connecting to a communications interface for a microprocessor environmental controller for a dwelling, setting a first humidity control point for an environmental system, and setting a second humidity control point, higher than the first humidity control point, for the environmental system. The method also includes operating the environmental system in accordance with the first humidity control point for a first portion of a day and in accordance with the second humidity control point for a second portion of the day, and communicating an alert when the second humidity control point is exceeded.

[0011] Another embodiment is an environmental control system for a dwelling. The environmental control system includes a microprocessor controller configured for accepting at least two temperature set points and two humidity set points, an operating interface operably connected to the controller, and a thermostat and at least one temperature sensors operably connected to the controller. The system also includes a humidistat and at least one humidity sensor operably connected to the controller, and a communications interface operably connected to the controller and configured for communicating to a remote location over a telecommunications network, wherein the controller is programmed to oper-
ate an environmental system within the dwelling with at least two different set points for temperature and humidity during a 24-hour cycle.

[0012] Other aspects, objectives and advantages of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

[0014] FIG. 1A is a schematic representation of a first embodiment of a control system for environmental management of a building or home;

[0015] FIG. 1B is a schematic representation of a second embodiment of a control system for environmental management of a building or a home;

[0016] FIG. 1C is a schematic representation of a third embodiment of a control system for environmental management of a customer site, such as a building or a home;

[0017] FIG. 1D is a flowchart for one method of operating a device;

[0018] FIG. 2A is a block diagram of one implementation of the environmental system of FIG. 1C at a customer site;

[0019] FIG. 2B is a schematic illustration of a device for controlling a temperature or a humidity;

[0020] FIG. 2C is a psychrometric chart useful for investigating air temperatures, relative humidity, and related items;

[0021] FIG. 3 is a flowchart for a method of operating an environmental management system;

[0022] FIG. 4A is a graphical illustration of a customer GUI, according to an embodiment of the present invention;

[0023] FIG. 4B is a graphical illustration of a control panel of the GUI of FIG. 4A;

[0024] FIG. 4C is a graphical illustration of a virtual thermostat of the GUI of FIG. 4A;

[0025] FIG. 4D is a graphical illustration of an occupancy mode screen of the GUI of FIG. 4A;

[0026] FIG. 4E is a second graphical illustration of the occupancy mode screen of FIG. 4D;

[0027] FIG. 4F is a third graphical illustration of the occupancy mode screen of the GUI of FIG. 4D;

[0028] FIG. 4G is a graphical illustration of a thermostat scheduling calendar of the GUI of FIG. 4A;

[0029] FIG. 4H is a graphical illustration of a thermostat scheduling panel of the GUI of FIG. 4A;

[0030] FIG. 4I is a graphical illustration of a select day type drop down list of the GUI of FIG. 4A;

[0031] FIG. 4J is a graphical illustration of a configuration alert screen of the GUI of FIG. 4A;

[0032] FIG. 4K is a graphical illustration of a report screen of the GUI of FIG. 4A;

[0033] FIG. 4L is a graphical illustration of a daily temperature report pop up screen of the GUI of FIG. 4A;

[0034] FIG. 4M is a graphical illustration of a daily electrical report pop up screen of the GUI of FIG. 4A;

[0035] FIG. 4N is a graphical illustration of a configuration data screen of the GUI of FIG. 4A;

[0036] FIG. 4O is a graphical illustration of a thermostat data screen of the GUI of FIG. 4A;

[0037] FIG. 4P is a graphical illustration of a heating drop down list of the GUI of FIG. 4A;

[0038] FIG. 4Q is a graphical illustration of a cooling drop down list of the GUI of FIG. 4A;

[0039] FIG. 4R is a graphical illustration of a program participation screen of the GUI of FIG. 4A;

[0040] FIG. 5A is a graphical illustration of a utility GUI, according to an embodiment of the present invention;

[0041] FIG. 5B is a graphical illustration of an immediate supply screen of the GUI of FIG. 5A;

[0042] FIG. 5C is a graphical illustration of an available and program capacity pop-up of the GUI of FIG. 5A;

[0043] FIG. 5D is a graphical illustration of a scheduled supply screen of the GUI of FIG. 5A;

[0044] FIG. 5E is a graphical illustration of a find eligible program dialog of the GUI of FIG. 5A;

[0045] FIG. 5F is a graphical illustration of program summary table of the GUI of FIG. 5A;

[0046] FIG. 5G is a graphical illustration of program definition screen of the GUI of FIG. 5A;

[0047] FIG. 5H is a graphical illustration of a reports screen of the GUI of FIG. 5A; and

[0048] FIG. 5I is a graphical illustration of a portion of the reports screen of FIG. 5H.

While the invention will be described in connection with certain preferred embodiments, there is no intent to limit it to those embodiments. On the contrary, the intent is to cover all alternatives, modifications and equivalents as included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

[0050] A first embodiment of an environmental control system according to the present invention is depicted in FIG. 1. In this embodiment, the control system 1.10 includes a central processing unit (CPU) such as a microprocessor 1.11 and a memory 1.11a. Microprocessor 1.12 preferably resides inside a house or other building and is used for controlling an environmental system for the house or building. The microprocessor is in communication with the outside world through communications interface or node 1.12a, which may be an Internet portal, an Ethernet connection, a USB connection, a telephone line, a radio antenna, or any other suitable equipment or combination for outside communications. Communications interface 1.12a may connect to a remote owner by the Internet 1.12c and the remote owner's local graphical user interface (GUI) 1.12e. The control system for the home or building may also connect to a local service provider or utility via the Internet or via a secure network 1.12d and their graphical user interface (GUI) 1.12d. The system may connect to both the utility, for energy cost data and related communications, and to a local service provider, for monitoring the system in case of equipment failures, malfunctions or emergency repairs, and so on.

[0051] Microprocessor 1.11 receives instructions and programming from a user, owner or operator through a graphical user interface 1.13, or from the remote owner GUI 1.12e. Alternatively, the local utility or a service provider, such as a repair service, may also control the system through its GUI 1.12d. Programmable microprocessor controllers suitable for environmental control of a building or dwelling are available from Ranco or Maple Chase, Plain City, Ohio. A user may also send instructions through a mouse 1.19a or a keyboard 1.19b. In addition, users may communicate with the system and send commands using the communications interface 1.12a. Other inputs to the CPU include temperature inputs
from at least one temperature sensor 1.13a, a humidity reading from at least one humidity sensor 1.13b, and there may also be at least one moisture sensor 1.13c. There may be many embodiments of each of these sensors.

For example, a temperature sensor may be a thermocouple, a thermistor, or other temperature sensing and reporting device. A humidity sensor may be a relative humidity sensor, a wet bulb sensor taking a wet bulb temperature reading, in combination with the dry bulb reading from the temperature sensor. Any other sensor which can sense relative or absolute humidity, or other property that leads directly to a reading of relative or absolute humidity, may be used. In this instance, a wet bulb reading and a dry bulb reading, along with a look-up table stored in the memory 1.11a of CPU 1.11, allows the CPU to calculate the relative humidity of the area with temperature sensor 1.13a and humidity sensor 1.13b.

Moisture sensor 1.13c is intended to be any sensor that can detect water that condenses on a surface, and thus indicates that the environmental control system is not adequately controlling the temperature, the humidity, or both. Examples of moisture sensors are graphite/epoxy sensors made by Sensorex Corp., Garden Grove, Calif. Such a moisture sensor may be placed near a wall or a window facing the outside of the house or dwelling. If any moisture condenses on the wall or on or near the window, the dew point temperature has been reached, and the condensate may cause damage. In addition, condensation may encourage the growth of mold, mildew, or other harmful organisms.

An alternative to a moisture sensor is a reading of relative humidity. If a reading of 100% relative humidity is reached, moisture will condense and corrective action should be taken. Thus, a relative humidity sensor may be used in lieu of a moisture-detecting sensor, since they will both detect or suggest harmful condensation. Relative humidity sensors are made by a number of manufacturers, including Honeywell, Inc., Minneapolis, Minn. Models include the HH-4000 series, the HHI-3610 series, and the HII series. They are also made by Humirel, Inc., Chandler, Ariz.

CPU 1.11 controls humidistat 1.12 and thermostat 1.14 which control a heater or furnace 1.15. The thermostat receives a control or set point from the CPU and controls heater or furnace 1.15 in accordance with the set point. CPU 1.11 also controls a humidistat 1.16 and a second thermostat 1.17, either of which may control an air-conditioning unit 1.18. Alternatively, the second thermostat 1.17 may be the same thermostat as 1.14 which jointly controls the central HVAC system. There may be two systems or there may be one combined unit. In an alternate embodiment, CPU 1.11 is incorporated into a thermostat with a humidity control capability. This combines 1.11a, 1.12, 1.14, 1.13a-c, 1.16 and 1.17 as well as 1.12a and 1.13 all in a single device. This single device is a thermostat with humidity sensing and snowbird functionality. Alternatively, air-conditioning unit 1.18 may simply be a dehumidifier. Humidistsats are available from a variety of manufacturers, including Mapel Chase, Plain City, Ohio. Humidistsats are made by several manufacturers, include Ranco Inc., Plain City, Ohio.

Another implementation of an environmental control system is shown in FIG. 1B. In this illustrated embodiment, a gateway node 1.28 to the customer site 1.21 communicates to a remote control system 1.31 via an “always on” or “on-demand” secured wired or wireless digital communications network 1.27 through a cable modem, DSL modem, WIMax Wireless Modem, Cellular Data Modem, Fiber Optic Modem or other suitable means, to connect to a private or public network including the Internet. The remote control system 1.31 may be implemented in software which is stored and executed on a back-end server 1.29. In one embodiment, the remote control system 1.31 and the back-end server 1.29 may be provided by or serviced by or maintained by, a third party, i.e., a service provider, 1.20, who may provide more than one of these services. Access to remote control system 1.31 may be provided at the utility or any service provider through a secure digital communications network 1.30 such as a virtual private network (VPN). Remote access to the system may be provided to the customer GUI 1.35 through the back-end server 1.29 via the internet 1.34.

In the embodiment of FIG. 1B, the customer site 1.21 includes one or more metered devices 1.26, shown as an electric meter, one or more controlled devices 1.25, shown as a pool pump (illustrated graphically as a pool), and a metered and controlled device 1.24, shown as a water heater. It should be noted, however, that any particular site may include zero, one or more of each type of device. In the illustrated embodiment, the environmental control system at the customer site 1.21 also includes a thermostat 1.22 and a humidistat 1.23. Each of devices 1.22, 1.23, 1.24, 1.25 and 1.26 communicates with the gateway node or gateway 1.28. Thermostat 1.22 may control a furnace or strategically placed electric heating coils in the air ducts. Humidistat 1.23 may control a dehumidifying system for removing water from warm, moist air, or may control a humidifying system for adding moisture, typically to add moisture to cooler air for more comfort. The humidifying system is preferably placed at what will be the warmest site of the environmental control system during cooler temperatures, so that the water added will more readily be absorbed by the passing air. A variable speedfan can help as part of a humidifying system.

As discussed more fully below, the customer has access to the system and is able to monitor and control the nodes or the devices, or both, through the user interface 1.35. The utility, an energy service provider or energy broker, from here on referred to collectively as “the utility” 1.31 also monitors and controls the usage of electricity by controlling the nodes or the devices, or both. More specifically, the utility 1.31 may define, modify, implement, and engage one or more Power Supply Programs (hereinafter PSP or PROGRAMS) which are designed to alleviate or reduce energy demand during peak periods. A PROGRAM may be either mandatory or optional. The user, through the user interface 1.35, may be able to subscribe or sign up for one or more optional PROGRAMS. A PROGRAM may be either automatically implemented when a predetermined set of conditions occur, such as time of day, or may be engaged, by the utility 1.31, as electricity demands require.

For example, a PROGRAM may automatically shift discretionary residential loads out of peak demand periods and credit consumers who participate with KWH rebates based on their actual (measured & verified) contributions. In one embodiment, the rebates would be directly related to the cost of the fuel or electricity during the shifted period. This PROGRAM delivers the same results Time Of Day rates were designed to deliver without a variable KWH cost component. Rebates for shifting demand provide the consumer incentive versus higher rates in peak periods. Further, the PROGRAM provides a variable rebate based on a customer's actual contribution, instead of a fixed rebate.
A block diagram of a useful environmental control system according to the present invention is also depicted in FIG. 1C. In this embodiment, the utility portion 1.40 of the system includes utility control system 1.41 and its utility interface 1.42. The utility portion interfaces with the consumer portion 1.50 through a gateway node 1.51. Gateway node 1.51 provides two-way communication between the consumer portion 1.50, consumer network 1.53, and the utility. Gateway node 1.51 may be a telephone line, an internet connection, a wireless receiver/transmitter, or any other suitable communications devices. The user or owner may interface to node 1.51 through local interface 1.55, which may be a microprocessor controller and may include a graphical user interface (GUI).

Inside consumer portion 1.50, and reporting to local interface 1.55 and gateway node 1.51 may be a plurality of nodes 1.52 and a plurality of devices 1.54. These may include metered device 1.54a, such as a pool heater, reporting through load metering node 1.52a. The meter may be a reading from an energy supply, such as a reading from a Roots blower or other device to report gas consumption. The device may include a dehumidifier 1.54b, reporting through a control node 1.52c, such as a humidistat. The devices may also include an air conditioning system 1.54c, a controlled and metered device, reporting through a thermostat or load control node 1.52c. There may be a meter or device to measure consumption on the air conditioning system, such as one or more current transformers, that report to node 1.52c. Of course, there may also be additional load or control nodes to report total energy consumption by the consumer portion or house.

The environmental control system preferably uses the information provided by the metering devices, load control nodes, and control nodes to track and control energy consumption in the consumer portion. FIG. 1D provides a simplified flowchart of a method 1.60 for managing energy to the building. The process measures 1.61 the energy use of a device, such as a dehumidifier or an air conditioning system. In this embodiment, the controller may limit or cut off energy 1.62 to the device during a first time period. An example is limiting the low temperature of an air conditioning device, e.g., running the air conditioner only until the temperature reaches 80°F, and then stopping the electricity to the compressor by using an automatic thermostat. Another example is limiting the high range of humidity of a dehumidifier to 80%, i.e., running the dehumidifier only when the relative humidity is above 80%, and then stopping the electricity to the cooling coil by using an automatic humidistat. Based on utility company tariffs, the utility may reward the customer by providing lower rates or by providing rebates 1.63 based on actual energy savings.

The controller preferably controls the environment of the building or dwelling in the most economical manner possible, consistent with comfort for people in the building when people are in the building. Thus, in a home that is not occupied in the summer, an owner may set the air-conditioning or humidity controls higher, to lower the cost of the energy required to keep the home at a reasonable temperature and at a non-condensing relative humidity. One way to do this is to program the air conditioning or dehumidifying equipment to react only to the level of the humidity, rather than the temperature.

For example, in the system depicted in FIG. 1A, CPU 1.11 may be programmed during the summer to keep the humidity below about 80% relative humidity. Humidistat 1.16 receives this set point from the CPU and controls air conditioner 1.18 or a dehumidifier to keep the relative humidity below 80%. Feedback is received from humidity sensor 1.13 to ensure that the humidity is properly controlled. One or more moisture sensors 1.13c may be placed in appropriate locations to ensure performance of the system. Since water condenses on cooler surfaces, the moisture sensor may be placed in a lower portion of the building or dwelling, such as near a floor or in a basement or sub-level of the building. Moisture may harm equipment or goods stored in the building, and a moisture sensor may be placed on or near valuable equipment or storage areas.

With reference to FIG. 2A, an example of a communicating system applied to a specified customer site, e.g., a residence or home 2.18 will be used to illustrate several functions of the system. In the illustrated embodiment, the home 2.18 includes gateway node 2.1, and eight load metering nodes 2.20 coupled to eight devices 2.22.

A load metering node 2.20A is coupled to a whole house meter 2.22A. The whole house meter 2.22A could be associated with revenue grade power (electricity), gas or water. However for purposes of illustration, the whole house meter 2.22A is associated with electricity delivered to the home 2.18. The load metering node 2.20A monitors and reports the total house consumption of electricity. The load metering node 2.20A measures and reports total consumption as well as instantaneous demand and records consumption in total. Furthermore, the load metering node 2.20A may store interval data in non-volatile memory in accordance with industry standards and system management requirements for the entire home to other control nodes 2.20 within the home 2.18 and/or any other node associated with its aggregation group, the delivery supply chain or any other node needing or authorized to receive or access it.

In addition, the home 2.18 has first and second load control nodes 2.203, 2.20C associated with its heating and air conditioning systems one controlling the main living space, i.e., the first floor HVAC system 2.22B and the other controlling the second floor bedroom space, i.e., the second floor HVAC system 2.22C. Third, fourth and fifth load control nodes 2.20D, 2.20E, 2.20F are associated with a refrigerator/freezer 2.22D, an electric water heater 2.22E, and a well pump (for yard irrigation) 2.22F, respectively. Sixth and seventh load control nodes 2.20G, 2.20H are associated with a roof mounted photovoltaic system 2.22G (comprised of a storage battery bank and inverter capable of generating 2500 watts of 240V, 60 Hz AC power for up to 12 hours) and a dishwasher 2.22H.

The system described herein will work with any “utility” provided product such as, but not limited to, gas, water, electric or steam. For ease of illustration, electricity is the only utility product being used in this example. Each node 2.20 in this example has control parameters stored in its associated memory, which the control program for the node 2.20 uses to determine the optimum operating characteristics for the management of its associated load or generation capacity. In one embodiment of the present invention, a gateway node 2.1 may be utilized to aggregate the premise nodes 2.20 and consolidate the communications process and/or control processes with upper level nodes 2.20 or any other nodes directly or indirectly in the system.

The nodes are connected in a network (as described above), but may operate autonomously or require direct commands to change their operational state. In one embodiment,
the nodes 2.20 include basic logic so that if the node 2.20 is severed from the network either intentionally or by accident, the node 2.20 will continue to perform their management and monitoring functions to optimize their attached loads performance based on the last known condition of their associated utility supply chain. In its simplest form, the home 2.18 may participate in any number of conservation or demand limiting programs, i.e., Power Saving Programs or PROGRAMS. The following illustrates how the nodes 2.20 may support these PROGRAMS. However, the following should not be interpreted to limit the present invention to any such PROGRAMS. Nodes 2.20 may be programmed and configured to perform a plurality of control and interface functions and are not limited or constrained in their ability.

[0070] For example, the nodes 2.20 may be configured in a Load Limit or Load Cap Program. The term load limit or load cap may be interpreted in this example to mean a limit or cap on either the KW demand or the total cost of operation making this example either a physical energy usage or economic control process. Because of the optional metering capability of each node 2.20 and its ability to receive economic data from the supply chain serving it, the node 2.20 is capable of making decisions based on its rate of consumption as well as the cost it is incurring at any point in time.

[0071] With reference to FIG. 2B, the thermostat 2.3 in one embodiment is a wall mounted device which has a control panel 2.4 with a display screen 2.5 and a plurality of input buttons 2.7. In the illustrated embodiment, the input buttons 2.5 includes a system button 2.7A, a fan button 2.7B, an occupancy button 2.8b, and a hold/resume button 2.8a. The input buttons 2.5 further include a first control button 2.9a and a second control button 2.9b.

[0072] Using the input buttons, the customer can control the HVAC system and other parts of the system. The thermostat 2.6 is in communication with the gateway node 2.1 (see FIG. 2A) and the gateway node can query the current temperature and set point values of the thermostat 2.6. Further, the gateway node 2.1 can change the heating and cooling set point(s) and offset values of the thermostat 2.6. In one embodiment, the thermostat 2.6 may inform the gateway node 2.1 when its relay outputs or contact inputs change state, or the gateway node can poll for this status. When this occurs, the gateway node can query the thermostat and send the current temperature and corresponding input or output status to the system. It is understood that a different controller, such as a humidistat, may be used in place, or in addition to, the thermostat described herein.

[0073] The thermostat, or humidistat, or other control device, may operate in a fallback mode upon loss of communication with the gateway node. When communication resumes, the gateway node can ascertain the state of the thermostat and restore the desired functionality. All changes made at the thermostat can be communicated to the gateway node or be received during a poll of the thermostat. In one embodiment, the following functions can be accessible directly from the thermostat: view current temperature; view current heating or cooling set point; override heating and cooling set points; resume scheduled heating and cooling set points; view heat/cool/auto mode; change heat/cool/auto mode; and activate/deactivate the fan.

[0074] If the humidity-based controls are not able to control the moisture at the ambient temperature of the building or house, it may be necessary to cool the air in order to reduce the moisture to acceptable levels. Thus, in one embodiment, the CPU may shift control from the humidistat to the thermostat if the humidistat is not able to keep the moisture level to an acceptable level. Cooling the air reduces the amount of moisture the air is able to retain, and thus reduces the relative humidity, i.e., the amount of moisture in the air compared to the maximum amount possible in the air at a given temperature. Of course, further cooling the air to reduce moisture requires more energy and is thus undesirable. However, the cost of the energy may be less than that required to repair the damage caused by high humidity or condensing humidity.

[0075] An example of two, using the psychrometric chart in FIG. 2C, may help to illustrate the difference between temperature and humidity control of a building. In this illustration, humidity control may be considered to be the “economy mode,” while normal temperature control is considered the “comfort mode” of operation of the system. In one example of economy mode, the humidity is controlled at 80% (line A), and the temperature is not controlled. If the temperature of air with a relative humidity (RH) of 90% rises from 70° F. (point B) to 90° F. (point C), the relative humidity is still being controlled at 80%, and the air remains at 80% RH. However, the absolute humidity, the actual ratio of pounds of moisture per pound of dry air at 80% relative humidity, rises from about 0.013 to about 0.025 (see scale on right side of graph). This will be uncomfortable for many people.

[0076] Air from the outside may be at 90% RH during the summer, and this air will diffuse into the building. Air at 90° F., 90% RH (point E), has an enthalpy value of about 52 BTU/lb of dry air (point F), while air at 90° F., 80% RH, has an enthalpy value of about 49 BTU/lb of dry air. The 3 BTU/lb difference is supplied by the dehumidifying system, in addition to the energy required to condense the moisture. This is the minimum energy consumption required to maintain an 80% RH level.

[0077] The system may then be switched from economy mode to comfort mode using temperature control rather than humidity control, with a set point of 80° F. (line G). The air conditioning system will lower the temperature of the air and will also cause condensation of some of the moisture in the air. The maximum amount of moisture possible will then drop to 0.023 pounds of moisture per pound of dry air (point H). In this example, there may be no direct control over the humidity, which may equilibrate to about the same humidity as make-up air from the outside, i.e., 90% RH. In this case, the absolute humidity may gradually drop to about 0.020 pounds of moisture per pound of dry air (point I), and the environment will feel more comfortable to people inside the building. The standard psychrometric chart indicates that air at 90° F., 90% RH has an enthalpy value of about 52 BTU/lb of dry air, while air at 80° F., 90%RH, has an enthalpy value of about 41 BTU/lb. The difference, about 11 BTU/lb of dry air, must be supplied by the air conditioning system, in addition to the energy required to condense the water from the atmosphere. These examples show the difference in energy required for comfort mode and for economy mode, almost a four-fold difference, 11 BTU per lb of dry air in comfort mode, versus 3 BTU in the economy mode, in addition to the energy required for moisture condensation.

[0078] If a house or building is filled with air at 90% RH, the house will likely not be at the same temperature everywhere. The attic or higher levels of the house may be at a higher temperature, while the lower levels or the basement may be at a lower temperature. To continue with the examples given above, with air controlled to a set point of 80% RH, the
wet bulb temperature of the air will be about 83°F. There is only a very small temperature difference between the temperature of the air and the temperature at which condensation occurs, the dew point or wet bulb temperature. A small temperature difference may thus lead to condensation in lower or cooler levels of the house, and may provide conditions for mold or mildew growth. Thus, sensors for the detection of higher levels of relative humidity, condensation, or moisture may be prudent.

A flowchart indicating one operating algorithm 3.0 is depicted in Fig. 3. In this algorithm, the controller is turned on and initialized 3.1 and is connected 3.2 to a network for communication with the owner, whether local or remote. The humidity set point, or more than one set point is entered or programmed in 3.3, as are one or more temperature set points 3.4. The information having been entered, the system is placed into an operating mode 3.5, such as an economy mode or a comfort mode. In operating the building system in an economy mode, the CPU may check on whether the humidity level exceeds 3.6 the set point. If the humidity level is below the maximum set point, the CPU may check on whether all aspects of the system are operational 3.7, e.g., voltage inputs OK, temperature does not exceed a maximum, energy consumption and costs are consistent with systems goals or set points, and so on.

If there is a problem that cannot be overcome, the system may send an alert or alarm 4.0. The alert or alarm may be sent to the local utility, to a local contractor, such as an HVAC service company, or to the remote owner, for appropriate action. If the humidity is within its set point, such as below a maximum, the unit may instead shift to control by temperature 3.8. Alternatively, if a moisture sensor has noted condensation within the vacant home or building, the controller may also shift to temperature control, at least for a period of time until the excess moisture has evaporated. If the environmental system has shifted to temperature control and is unable to control the temperature, such as by the temperature exceeding the maximum set point 3.9a, there may be a major problem. The house may have lost power, there could be a mechanical problem with the fan or the air conditioning compressor, and so forth. In these instances, an alarm may be sent 4.0 as noted above for help. If the system has shifted to temperature control and is able to adequately control the desired temperature, further operational checks may be run 3.9b, such as input voltages OK, energy consumption or cumulative costs OK, and so forth.

In another economy mode, the home or building environmental system may be programmed to take advantage of time-of-day, real time or off-peak utility pricing. For example, some electric utilities charge more for use during peak hours, such as 9 a.m. to 5 p.m., during the day, and have lower charges for off-peak use, such as 5 p.m. to 9 a.m. during the night, weekends and holidays. The home or building environmental system may be programmed to dehumidify the air during the night, with minimal operation during the day, in order to further minimize costs. Some homes or buildings may also have contracted with the energy utility for a maximum energy consumption, such as a Load Limit or Load Cap Program, or a minimum energy consumption. These maximum or minimum energy consumptions, and the extra costs or penalties associated with them, may be entered and used as part of a calculation or algorithm to manage energy consumption of the dwelling. That is, the environmental control system may then dehumidify air during periods of lower energy costs and allow humidity levels to rise somewhat during periods of higher energy costs, in accordance with the requirements for avoiding condensation, mildew, and other damage from high humidity.

For example, the unoccupied house or building may experience about three air changes per day due to normal air infiltration through gaps and leaks in the building. The environmental system may be programmed to run during off peak hours to a humidity level (or temperature level) well below the desired set point, in order to avoid running during the peak or day time hours. It may be possible to lower the humidity (or temperature) of the house to a low level, say 40% R.H., when 80% is the maximum desired level. If the house achieves a 40% level during off-peak hours, it may be possible to avoid running the fans and dehumidifiers during the day when rates are higher. In this example, the humidity of the house will rise during the day in accordance with the actual infiltration rate, the local temperature, and so forth. However, the environmental system may not use energy again until the humidity rises above the set point.

The program stored in the controller may use actual peak and off-peak utility rates to calculate the lower night-time set point or run times in order to minimize costs. That is, the dehumidifier, the fans, and possibly an air-conditioning compressor, may be operated for a longer period of time and may consume more energy during the off-peak period in order to lower the air humidity or temperature, or both. This additional run time will only be cost-effective if the incremental costs of off-peak running are less than the incremental savings from avoiding day-time or peak pricing of the same energy inputs.

In addition, in order to minimize run times and also to minimize costs, it may be useful to have a fan with a variable speed rate, an air-conditioning system or compressor, or a dehumidifier, that also can run with a variable speed rate. Running a fan or a compressor at full speed for a period of time may result in higher energy costs for that device for that period of time. If the device has a variable speed, the environmental system can utilize the device only to the extent it is needed, and for a lesser expenditure of energy and thus cost. Variable speed devices include fans with a voltage-controlled speed and a resulting variable energy consumption. These devices may also include an AC or DC-operated refrigerant compressor for an air-conditioner, the compressor having a variable capacity, and thus variable energy consumption. Typically, the energy used for fans and compressors is electricity. However, it is also possible to run these and other devices from other utilities or sources of energy, such as gas or steam, or other energy source.

A traditional HVAC forced air system consists of a heating unit, a cooling unit, a fan and air filtration system. Air is drawn from the conditioned space through a return air duct system, and is filtered and then passes through the fan chamber where it is then directed through a heating chamber followed by a cooling chamber. In the case of a heat pump, the heating and cooling are performed by the same chamber using a common coil, and may be supplemented by a resistive heating strip chamber, or fossil fuel furnace such as oil or gas. In climates where heat pump operation may be marginal during periods of extreme cold weather, Air is then passed into the supply duct system where it is transported back to the conditioned space through a series of ducts and registers. In a cooling scenario, the heating chamber is inoperative and only the cooling process is active. As air passes through the cooling
coil, the cooling coil reducing the ambient air temperature by absorbing heat. At the same time, moisture in the air condenses on the cooling coil and flows down the coil as a result of gravitational forces and is collected into a drip pan at the bottom of the chamber from there the moisture is piped to a suitable point of disposal.

[0086] By default, as mentioned earlier, this process removes humidity from the air. Another important point is that traditional HVAC units have a multi-speed fan. This fan is designed to operate at several speeds depending on its design and operates at a low speed setting when the heating process is active and at a high speed when the heating process is active. It does this because heated air is lighter and moves easily through the duct system requiring less force to move sufficient air into the conditioned space to recover the temperature to the designated set point. Cooled air, because it is denser, requires greater force to move it through the duct system and therefore requires a higher fan speed to move an equivalent amount of air through the environmental system. As a result, traditional HVAC systems have multi-speed fans built in but are solely used to compensate for the air density.

[0087] An environmental control system according to embodiments of the present invention takes advantage of this capability to utilize the lower speed fan settings to reduce the humidity levels in the home. It accomplishes this task by using a two-way communicating control node capable of modifying the fan speed settings to operate in their normal high setting when recovery of the ambient air temperature is required, and in the low speed setting to reduce the humidity levels in the home. To dehumidify the vacant home or building, the environmental system operates the air conditioning compressor to cause the cooling coil to drop in temperature and operate the fan at a low speed causing more humidity to be removed from the air as it passes through the cooling coil at a slower rate allowing more moisture to be removed. The cooled air then follows its normal path through the supply duct system and would pass the dryer and colder air into the conditioned space.

[0088] Through a learning process, the system will be able to determine and record in its memory, the rate of dehumidification its associated HVAC unit is capable of delivering. HVAC units equipped with multi-speed or variable capacity compressors operate more efficiently than standard single speed compressor units. For dehumidification in a home with a multi-speed or variable capacity compressor, the low speed compressor setting would be used to reduce the amount of energy the system uses. To complete the dehumidification control process, one of two additional two-way communicating sensors or a combination of both would be needed. Because the cooling coil as it removes humidity from the air might become over loaded with condensation and begin to freeze up, sensors to detect either airflow or the presence of icing of the compressor coil may be needed. The system is capable of utilizing inputs from these sensors to either increase the fan speed to cause the coil to defrost, or to cycle the compressor while operating the fan in either a low or high speed to force warm air through, thus defrosting the coil.

[0089] In heating season, as the outside temperature drops so do the humidity levels, resulting in low relative humidity levels. Just as humidity removal in summer makes the air feel colder, removal of humidity in winter has the same effect. The major difference is that in winter, the resulting cold feeling creates an indoor air comfort level that is undesirable and customers raise the temperature as the humidity levels drop to maintain a more comfortable environment. This condition dries out wood doors and floors, resulting in shrinkage of wood products. Air that is too dry will also shrink human sinuses resulting in personal discomfort. By increasing the humidity levels, the temperature can be maintained at a lower level while retaining the same relative level of comfort.

[0090] In addition, by increasing the humidity level, wood products will not tend to shrink as much and sinuses conditions will not plague the customer. To accomplish humidity control during the heating season, the addition of a humidifier boosts the humidity levels of the conditioned air space, allowing a lower temperature setting to be maintained and thus reducing the amount of energy required to maintain a satisfactory comfort level. The system is capable of managing the humidity levels using the humidity-sensing node described earlier in the cooling section but does not require the additional freeze and defrost sensors. Unfortunately, traditional humidification systems are designed to only work when the heating process is active. This is because they depend on the heated air exiting the heating chamber to pass through a series of mesh grids or membrane that is soaked with water. As the heater air passes through these grids or membranes, it picks up moisture and transports it through the air duct system into the conditioned air space.

[0091] To improve on this process, the system may incorporate a modified duct humidification process which heats this grid or membrane to permit unheated air passing through it to transport moisture into the conditioned space, not requiring the main heating process to be active to accomplish its task. In addition, the system is capable of controlling remote, distributed humidification units throughout the site, like the units available for sale today in a number of retail stores, which are specially equipped with a two-way communications node controller integrated into them. A less elaborate adaptation of this fully integrated solution is a wall plug adapter with an integrated two-way communicating control node, relay contactor and optional humidity sensor. This unit can be used to adapt traditional humidification units or vaporizers and make them an integral part of the humidity control system. An additional sensor device is used to measure moisture content on surfaces, which are exposed directly to the outside like glass windows. As the humidity level rises in the site, excess moisture may gather on these cold surfaces, resulting in condensation accumulation. To manage this condition, optional communicating sensors to detect moisture accumulation are included with the system.

[0092] In any case, it is clear that when the building or home is occupied, the people inside will typically require heated air in cooler seasons and cooled, de-humidified air in warmer seasons. Thus, when the building is occupied, the CPU will likely be programmed more for comfort, using temperature control, rather than programmed for economy, using humidity control, preferably with a temperature back-up. The user will input any changed occupancy conditions by an input to the CPU, using the local GUI or the remote communications link. The occupancy change will then trigger the mode of control used by the CPU.

[0093] Customer Control Node Management System and Methods

[0094] With references to FIGS. 4A through 4R, the remote user interface 1.12e may be implemented as a web page or graphical user interface ("GUI") 4.02. The GUI 4.02 may be accessible from remote locations, as discussed above. In one embodiment, the customer may access the GUI 4.02 through
a web browser or other display device like a television. In another embodiment, the customer may access the GUI 4.02 through a remote device, such as a mobile phone and/or personal digital assistant. By entering a user I.D. and password, the customer or owner may access his or her account.

[0095] With reference to FIG. 4A, after the customer logs on to the system, a system home page 4.04 may be displayed. The system home page 4.04 includes an information section 4.05, a plurality of navigation buttons 4.06, a navigation menu 4.08, an automatic mode panel 4.10, and an economy profile panel 4.12. In the illustrated embodiment, the information section 4.05 is for an exemplary customer, Earl Minem is shown. The information section 4.05 includes a greeting, the time and date, as well as several links. Actuation of the links may, for example, redirect the customer to the help page, an e-mail contact section, frequently asked questions, or may log the customer off of the web site.

[0096] The plurality of navigation buttons 4.06 includes a device management button 4.06A, and/or a configure alerts button 4.06B, and/or a systems data button 4.06C, and/or a cancel curtailment button 4.06D and/or a device status button 4.06E. The navigation menu 4.08 includes links to several areas of the GUI 4.02 as described below.

[0097] When initialized, the GUI 4.02 displays a homeowner control center 4.12 in the control panel. In the illustrated embodiment, the homeowner control center 4.12 includes a plurality of hyperlinked icons 4.14. In the illustrated embodiment, the hyperlinked icons 4.14 include a direct access icon 4.14A, a scheduling icon 4.14B, a my reports icon 4.14C, an alerts icon 4.14D, a configuration data icon 4.14E and a user help icon 4.14F. Selection of a home link within the information section 4.05 will return the GUI 4.02 to the homeowner control center 4.12.

[0098] With reference to FIG. 4B, when the customer selects the direct access icon 4.14A, a plurality of direct access icons 4.16 will be displayed in the control panel 4.10. In the illustrated embodiment, the customer has direct access of the HVAC system and the whole house meter. Correspondingly, a heating/AC icon 4.16A and a whole house meter 4.16B are displayed within the control panel 4.10. In another embodiment, all devices to which the customer may have access are accessible here, e.g., a second thermostat or the water heater.

[0100] With reference to FIG. 4C, selection of the heating/AC icon 4.16A, displays a virtual thermostat 4.18 within the control panel 4.10. The virtual thermostat 4.18 contains an information section or display 4.20 and a plurality of thermostat buttons 4.22. The display section 4.20 includes information related to the actual or real time conditions at the site. In the illustrated embodiment as shown, the current temperature within the customer home or building is 67°F. The heating and cooling set points are set to 58°F and 85°F, respectively. The system is in an automatic mode and the heating and cooling systems are in an off condition. Furthermore, as indicated, the occupancy mode is set to “Away”. As discussed below, the system allows the customer to program the HVAC systems use the virtual thermostat 4.18 and according to occupancy modes using heating and cooling set points. By using the thermostat buttons 4.22, the customer can change the current operating parameters of the thermostat.

[0101] For example, selection of a change system mode thermostat button 4.22A allows the customer to select between automatic and manual modes. Selection of a change fan mode button 4.22B allows the customer to change the fan mode from “on” to “automatic.” Furthermore, selection of an override temperature button 4.22C or an override occupancy button 4.22D allows the customer to override the current temperature and occupancy schedules as defined below. Selection of a cancel override button 4.22E allows the customer to cancel a temperature or occupancy change which was input using the override temperature button 4.22C or the override occupancy button 4.22D. A cancel curtailment button 4.22F allows a customer to cancel any utility-initiated curtailment program (where permissible).

[0102] Returning to FIG. 4B, selection of the whole house meter icon 4.16B displays information within the control panel 4.10 related to the current power being delivered or utilized by the customer house or building. Additionally, information related to the accumulated power draw over a predetermined period of time may also be displayed. This information may be displayed graphically and/or numerically.

[0103] Returning to FIG. 4A, selection of some of the menu items within the navigation menu 4.08 are redundant with the icons 4.14 in the homeowner control center 4.12. For example, selection of a direct access button 4.08A displays the direct access icons 4.16 within the control panel 4.10.

[0104] Selection of the scheduling icon 4.14B or a scheduling menu item 4.08B, displays icons for each thermostat within the customer site or an occupancy mode icon (not shown). With reference to FIGS. 4D, 4E, and 4F, selection of the thermostat scheduling icon or the thermostat menu item underneath the scheduling icon 4.14A, a scheduling menu item 4.08B, displays an occupancy mode screen 4.24 within the control panel 4.10. In one embodiment, the control system allows the customer to define one or more occupancy modes (see above). Within each occupancy mode, the customer may set one or more parameters which control one or more devise, such as the HVAC system or humidifier, while the occupancy mode is active. For example, in one embodiment, the customer may set a cooling set point, a heating set point, and may also set an economy profile.

[0105] In the illustrated embodiment, the customer has eight occupancy modes. For example, the control system may include a home occupancy mode, an away occupancy mode, a sleep occupancy mode, and a vacant occupancy mode, as well as four user-defined occupancy modes. Each of these modes is indicated with a respective tab 2.26 along the top of the occupancy mode screen 4.24. As shown in FIG. 4D, selection of a tab 2.26 allows the customer to set the parameters for each mode.

[0106] For example, in the illustrated embodiment under the home occupancy mode, the cooling set point is set to 80°F, the heating set point is set to 68°F, and the economy profile is set to economical comfort. The economy profile may be used to control the HVAC system and/or other devices based on characteristics of the supply chain, e.g., cost or availability of power. In one embodiment, each profile has an associated set point offset, e.g., ±5 degrees. The parameters for each mode may be set to a set of default parameters by selection of a default button. Any changes made within the occupancy mode screen may be applied to the respective mode through selection of an apply button 4.30. In a further example, with reference to FIG. 4E in the away mode, the cooling set point is set to 85°F, and the heating set point is set to 58°F.

[0107] In the illustrated embodiment, the economy profile is set through an economy profile drop down list 4.32. With
With reference to FIG. 4G, selection of the thermostat scheduling icon or the thermostat menu item under the scheduling menu 4.0813, displays a thermostat scheduling calendar 4.34 within the control panel 4.10. In the illustrated embodiment, the thermostat scheduling calendar 4.34 displays the month corresponding to the current date. However, the thermostat scheduling calendar 4.34 may be navigated using a navigation bar 4.36. Each day on the calendar 4.34 may be defined as a weekday, a weekend, or a holiday. In the illustrated embodiment, all Saturdays and Sundays have been defined as weekends, and all Mondays, Tuesdays, Wednesdays, Thursdays and Fridays have been defined as weekdays. However, it should be noted that any day may be defined as any type of day. Each day within the calendar 4.34 is a hyperlink. Selection of the hyperlink for any particular day on the calendar 4.34 displays a thermostat scheduling panel 4.36 as shown in FIG. 4I. The thermostat scheduling panel 4.36 includes a thermostat dropdown list 4.38 and a select date drop down list 4.40. The thermostat drop down list 4.38 allows the customer to select between one or more thermostats which may be present within the customer building or home. The select date type drop down list 4.40 allows the customer to select between various pre-defined day types as well as to define a new day type. The thermostat scheduling panel 4.36 permits the customer to select the occupancy mode which will be used for various time periods during the day.

For example, in the illustrated embodiment, at midnight of the selected day, the thermostat will be in the sleep occupancy mode. Beginning at 4:30 a.m., the thermostat will be in the user 1 occupancy mode and so forth as shown. The thermostat scheduling panel 4.36 also includes an apply button 4.42, an apply to current day button 4.42, an apply to all button 4.44, and a back to calendar button 4.46. Selection of the apply to current day button 4.42 will apply the start times and defined occupancy modes in the thermostat scheduling panel 4.36 to the selected day in the thermostat scheduling calendar 4.34. Selection of the apply to all button 4.44 will apply the scheduled start times and occupancy modes defined in the thermostat scheduling panel 4.36 to all of the day types which are selected in the select day type drop down list 4.40. As shown in FIG. 4I, the select day type drop down list 4.40 may include a number of pre-defined day types such as weekday, weekend, or holiday as well as the number of user-defined day types.

With reference to FIGS. 4A through 4I, selection of the alerts menu item 4.08D displays a configure alert screen 4.48 within the control panel 4.10. The system includes a number of pre-defined alerts, for example, thermostat temperature out of range control, gateway node not responding, budget limit alarm, device malfunctioning, communication failure, ramping recovery failure, or duplicate IP address. For each alert, the customer may select or designate the destination, i.e., who gets notified for each alert, and how they are notified. In the illustrated embodiment, the configure alert screen 4.48 includes a destination drop down list 4.50 for each alert. The destination drop down list 4.50 allows the customer to select who gets notified when the alert occurs.

For example, in the illustrated embodiment, the drop down list may include the home occupant, the service provider or the energy provider. The configure alert screen 4.48 also includes one or more check boxes 4.52 to indicate how the communication of the alert is to occur, for example, whether or not it is to occur by e-mail or through the customer or utility interfaces 1.126. The configure alert screen 4.48 may also include a check box 4.54 for each alert to indicate whether or not the alert is configurable. The configure alert screen 4.48 may also include an entry box 4.56 for each alert which allows the customer to indicate what priority the alert should have. However in the another embodiment, the priority may be used to, e.g., provide a different delivery system based on the priority. In the illustrated embodiment, this is primarily for information purposes. Furthermore, the configure alert screen 4.48 may also include an alert type drop down list 4.58 which allows the customer to indicate whether or not a single alert should be sent or whether an alert should be sent each time an alert condition occurs. For example, if over a pre-determined amount of time, for example an hour, a thermostat temperature is out of range, the system may be set to deliver a single alert or to send an alert each time the temperature is out of bounds.

The configure alert screen 4.48 also includes a submit button 4.60 and a reset button 4.62 for updating the system with any input changes or resetting the alerts to default values. The configure alert screen 4.48 may also include a personal data update link 4.64. Activation of the personal data update link 4.64 will display a personal data screen (not shown) within the control panel 4.10 which allows the customer to update its personal information such as address, telephone and e-mail information as well as user name and passwords. The personal data screen may also allow the customer to enter or update a budget threshold, e.g., a monthly budget threshold. As discussed above, the system may be set to send an alert when the monthly budget threshold has been reached and/or is likely to be reached based on current usage.

With reference to FIGS. 4A and 4K through 4M, selection of the my reports icon 4.14C or the reports menu item 4.08C, will display a report screen 4.66 in the control panel 4.10. The report screen 4.66 includes a plurality of reports icons 4.68. Selection of a reports icon 4.68 will display a pop-up screen within the control panel 4.10. For example, selection of a daily temperature icon 4.68A will display a daily temperature report pop-up screen 4.70 as shown in FIG. 4I. Likewise, selection of a monthly temperature icon 4.68B will display a monthly temperature report pop-up screen (not shown). The daily temperature report pop-up screen 4.70 may allow the customer to select between multiple thermostats using a thermostat drop down list 4.72. The daily temperature report pop-up screen 4.70 may also include a plurality of drop down lists and/or buttons 4.74 which allow the customer to change the date or dates of the information being displayed in the report screen 4.70. For example, the customer may designate a specific date or navigate through the calendar by days or months.

The report screen 4.66 may also include a daily electrical usage icon 4.68C. With reference to FIG. 4M, selection of the daily electrical usage icon 4.68C will display a daily electrical report pop-up screen 4.72. As with the temperature report pop-up screen 4.70, the daily electrical report pop-up screen 4.76 includes a service device drop down list 4.78, which allows the customer to select the device for which data is being displayed. The daily electrical report pop-up screen 4.76 also includes a plurality of navigation buttons 4.80 which allow the customer to navigate through the calendar as well as to display electrical usage information on a
monthly or a yearly basis. A refresh button 4.82 updates the electrical report pop up screen 4.76 based on any changes made within the service device drop down list 4.78 or the navigation buttons 4.80. Selection of a close button 4.84 closes the daily electrical report pop up report 4.76.

[0115] With reference to FIG. 4N, selection of a configuration data menu item 4.08E displays a configuration data screen 4.86 within the control panel 4.10. The configuration data screen 4.86 includes a number of configuration data icons 4.88. Selection of a personal data icon 4.88A displays a personal data screen 4.90. Selection of a thermostat data icon 4.88C displays a list of the thermostats within the customer site. Each thermostat may be selected and a thermostat data screen 4.90 will be displayed within the control panel 4.10, as shown in FIG. 4O. The thermostat data screen includes a first section for defining the heating section of the corresponding HVAC system and a cooling section for defining the corresponding cooling section of the HVAC system. The heating section includes a heating drop down list 4.92 which allows the customer to select the type of heating which corresponds to the current thermostat as shown in FIG. 4P. A cooling drop down list 4.94 allows the customer to set the type of cooling corresponding to the current thermostat as shown in FIG. 4Q. As shown in FIG. 4P, the thermostat data screen 4.90 allows the customer to set a plurality of high and low limits. For example, in the illustrated embodiment, the customer may set safety, alert, heat, and cool high and low limits. These limits may be used in controlling the corresponding HVAC system, as well as setting or delivering alert messages.

[0116] Selection of a home data icon 4.88C on the configuration data screen 4.86 displays a home data screen (not shown) within the control panel 4.10. The home data screen allows the customer to define various parameters regarding their home or the customer site, including details about the construction as well as defining water heaters and other devices which may be found at the customer site such as swimming pools, whirlpool baths, hot tubs, heated ponds, saunas, fountains, decorative lighting systems, auxiliary heat systems, and/or irrigation systems.

[0117] Selection of an energy switch icon 4.88D on the configuration data screen 4.86 displays information and allows the customer to modify parameters related to any energy management switches at the customer house or building.

[0118] With reference to FIGS. 4N and 4R, selection of the program icon 4.88E on the configuration data screen 4.86 displays a program participation screen 4.96 in the control panel 4.10. The program participation screen 4.96 provides a list 4.98 of all available power supply programs ("PSP") or PROGRAMS. The program participation screen 4.96 also includes a plurality of corresponding check boxes 4.100 which allow the customer to designate which PROGRAMS the customer desires to participate. The program participation screen 4.96 may also include other information regarding the listed PROGRAMS, including supply type, effective dates, and effective times. Each PROGRAM listed on the program participation screen 4.96 may be a hyperlink which, when selected, displays additional information related to the selected PROGRAM.

[0119] As discussed above, the customer GUI 4.02 allows the customer to view, configure and/or modify various parameters of the system. Generally, the type and nature of parameters which may be viewed or modified will be defined by the utility. As shown above, some of these parameters may be configured and/or modified using various drop down boxes, check boxes and/or entry boxes. However, it should be noted that some of these entry boxes, drop down lists and/or check boxes may be used to display certain parameters; however the utility may designate that the customer cannot modify these parameters.

[0120] Utility Control Node Management System and Method

[0121] With reference to FIGS. 5A through 51, as discussed above, the utility interface 1.12/f may be accessible through a conventional web browser or through a secure network connection. The connection may be to a provider of the utility, such as a gas or electric company, or a repair service provider. With specific reference to FIG. 5A, after an authorized user at the utility logs onto the system, a utility graphic user interface 5.02 is displayed. The utility GUI 5.02 includes a plurality of navigation links 5.04 on a utility display panel 5.06.

[0122] In the illustrated embodiment, the navigation links 5.04 include an immediate supply link, a scheduled supply link, a program definition link, an active supply link, a supply history link, and a reports link. The navigation links also include a link to the utility GUI 5.02 home page and a link to log off the system. The utility display panel 5.08 includes a plurality of utility icons 5.08.

[0123] In the illustrated embodiment, the utility icons include an immediate supply icon 5.08A, a scheduled supply icon 5.08B, a program definition icon 5.08C, and active supply icon 5.08D, a supply history icon 5.08E and a reports icon 5.08F. As discussed above, the utility interface 1.12/f may be used to define or modify PROGRAMS, to display information regarding the current active supply of electricity over an electrical distribution network, provide information relating to the capacity of electricity available through implementation of one or more of the PROGRAMS, to supply historical data related to the distribution of electricity and to generate one or more reports.

[0124] With reference to FIG. 5B, when the immediate supply icon 5.08A is selected, an immediate supply screen 5.10 is displayed within the utility display panel 5.06. The immediate supply screen 5.10 includes a power distribution network section 5.12 and an information section 5.14. In the illustrated embodiment, the power distribution network section 5.12 included a meter 5.16 which provides an indication of the immediate capacity in watts (in real time) for the power distribution network.

[0125] In the illustrated embodiment, the power distribution network includes a single transmission substation, designated "ts1," and a single distribution substation, designated "ds1." Under the distribution substation, the following nodes are available: Phoenix, Richmond, Philadelphia and Philly non-curtailed, as shown. Within the control system, one or more PROGRAMS may be defined which when activated may curtail one or more devices across one or more customer sites. The meter 5.16 gives a graphical indication of the immediate power supply which is available from the PROGRAMS defined in the power distribution network.

[0126] Underneath the meter 5.16, a collapsible/expandable tree 5.18 is displayed. Each of the levels in the tree 5.18 are selectable. When a particular level within the tree 5.18 is selected, information regarding that level and the power distribution network below it are displayed within the information section 5.14. For example, as shown in FIG. 5B, when the
distribution substation dSS1 is selected, information regarding the distribution substation dSS1 and all subordinate nodes are displayed.

[0127] In the information section 5.14 for each level of the distribution network, the immediate capacity and the total capacity are displayed. Immediate capacity is the real time instantaneous capacity available for the given level based on the defined PROGRAMS and the current status of all devices within those PROGRAMS. For example, for substation dSS1 for all devices currently in a defined PROGRAM, those devices are drawing 1,040 watts. If the defined PROGRAMS were implemented, those devices would make available or supply 1,040 watts. The total capacity is the average for the current hour over a predetermined period, for example, the last seven weeks.

[0128] The information section 5.14 also includes a refresh button 5.20 which, when activated, refreshes or updates the information within the information section 5.14. Information related to each node, i.e., Phoenix, Richmond, Philadelphia or Philly non-curtailed, may also be displayed in the information section by selection of the corresponding level within the power distribution network section 5.12. The information section 5.14 may also include a review/request supply link 5.22 for each component listed in the information section 5.14.

[0129] With reference to FIG. 5C, selection of the review request link 5.22 for a given node or station displays an available program capacity pop-up 5.24. The available program capacity pop-up 5.24 lists all defined PROGRAMS that are available for the given node at the current time. Each PROGRAM includes a corresponding checkbox 5.26 which enables the utility to activate a given PROGRAM. For each PROGRAM listed, the instantaneous, real time available power is listed in a box 5.28 for each PROGRAM. The total capacity 5.30 is also listed for each PROGRAM, i.e., if all defined devices within a given PROGRAM were currently drawing power. The available power refers to the instantaneous power which would be available if the respective or corresponding PROGRAM were activated.

[0130] The available program capacity pop-up 5.24 also includes a duration drop-down list 5.32. The available program capacity pop-up 5.24 may be utilized to immediately activate one or more PROGRAMS to free up capacity for selected duration. For example, in the illustrated embodiment if the emergency HVAC curtailment program and the emergency shut-off program were activated, the instantaneous available power would be 1200 watts. The available program capacity pop-up 5.24 also includes a submit button 5.34, a closed button 5.36 and a refresh button 5.38. If one or more of the checkboxes 5.26 were selected, and the submit button 5.34 were selected, the utility control system would broadcast a curtailment signal to shut down the affected devices or otherwise curtail those devices. Activation of the closed button 5.36 closes the available program capacity pop-up 5.24. Activation of the refresh button 5.38 updates the available power available for each PROGRAM.

[0131] With reference to FIG. 5D, selection of the scheduled supply button 5.08B displays a scheduled supply screen 5.40 in the utility display panel 5.06. The scheduled supply screen 5.40 includes a power distribution network tree 5.42 and an information section 5.44. As in the immediate supply screen 5.10, the tree 5.42 displays the stations, substations and nodes within the power distribution network. Each of the stations, substations and/or nodes may be selectable within the tree 5.42. Information related to the capacity available at the selected level within the tree 5.42 is displayed within the information section 5.44. In the illustrated embodiment, the power available at the given level during predetermined time periods of the current day are shown. This information is reflective of the capacity or power available from the scheduled PROGRAMS. For example, based on the activated programs, between military time 0000 and 0600, the scheduled programs in Philadelphia have a capacity of 832 watts. For each station, substation or node within the network, the utility or local service provider may review scheduled programs or create a new schedule for programs. The scheduled supply screen 5.40 also includes a refresh button 5.46 which when activated updates the information in the information section 5.44.

[0132] Within the create schedules section of the GUI 5.02, a find eligible programs pop-up dialog 5.48 as shown in FIG. 5E is available. This dialog 5.48 allows the user at the utility to enter some or all information regarding a desired program or criteria for a program and search for any available program that fits the input criteria.

[0133] With reference to FIG. 5F, activation of the program definition button 5.08C displays a program summary table 5.50 in the utility display panel 5.10. The program summary table 5.50 lists and describes all available PROGRAMS. In the illustrated embodiment, each listed program may include a link 5.52 which leads to additional specific PROGRAM details. The program summary table 5.50 may also include a new button 5.54.

[0134] With reference to FIG. 5G, selection of the new button 5.54 displays a program definition screen 5.56 in the utility control panel 5.10. The program definition screen 5.56 creates a new PROGRAM (see below). In one embodiment, the new PROGRAM may be broadcast to each customer site. The customer may view the new PROGRAM along with the other available PROGRAM and subscribe to the new PROGRAM or any other available PROGRAM (see above).

[0135] In the illustrated embodiment, the program definition screen 5.56 includes a program name entry box 5.58 and a description entry box 5.60, both of which allow the user to enter appropriate text information.

[0136] The program definition screen 5.56 further includes a set of mutually exclusive supply type buttons 5.62 which allow the user to define a type associated with the PROGRAM. In the illustrated embodiment, the type may be one of "on demand" or "scheduled." An on demand PROGRAM can be implemented at any time, as needed, by the utility. However, an on demand PROGRAM may be limited to specific time periods. A scheduled PROGRAM is generally scheduled for specific days during specific time periods.

[0137] The program definition screen 5.56 also includes a set of drop down lists 5.64 which may be used to set PROGRAM available dates and times. The PROGRAM may also be identified as "optional" or "overrideable" using one or more checkboxes 5.66. An optional PROGRAM may be opted into or subscribed to by the user. An overrideable PROGRAM means that once subscribed, the user may override the PROGRAM while it is running.

[0138] The program definition screen 5.56 may also include a plurality of checkboxes to 5.68 which is used to identify the types of devices which may be included in the PROGRAM. In one embodiment, the system includes HVAC systems, water heaters, pool pump and hot tubs/spas. A PROGRAM may be defined to include all devices used in control-
ling the environment. The program definition screen 5.56 includes back button 5.70, a save button 5.72, and a reset button 5.74. Activation of the back button 5.70 returns the GUI 5.02 to the previous screen without saving the PROGRAM. Activation of the save button 5.72 saves the current PROGRAM and returns the GUI 5.02 to the previous screen. Activation of the reset button 5.74 sets the values in the program definition screen 5.56 to default values.

[0139] Selection of the active supply button 5.08D displays a screen within the utility display panel 5.06 which provides detail regarding any active PROGRAMS. This screen may include a tree similar to the trees described above which details the power distribution network. The screen will also provide information related to all of the active PROGRAMS for any selected station, substation or node within the power distribution network. For example, for a given active PROGRAM, the following information may be provided: based on real time data received, how many customers have signed up for the given program, how many customers are actively contributing to the given PROGRAM, and how many customers have opted out of the program. Furthermore, each device which may be affected by the program may be viewed.

[0140] Selection of the supply history button 5.08E displays a screen within the utility display panel 5.06 which provides historical data regarding any active program. The same type of information available for the active PROGRAMS (see above) may be available for any past time or time period.

[0141] With reference to FIGS. 51 and 51, selection of the report button 5.08F displays a reports screen 5.76 within the utility display panel 5.06 which provides a graph of energy consumption for a given period of time for a given device or set of devices. In the illustrated reports screen 5.76, the total hourly energy consumption for Mar. 18, 2003 (as measured by the electric meters) is shown. The reports screen 5.76 includes an input section 5.78 which allows the user to select the device, e.g., electric meter, thermostat, water heater, pool pump or hot tub/spa, or the time period, e.g., daily, hourly, or monthly. The input section 5.78 also allows the user to change the time and/or date for which data is shown. The reports screen 5.76 also includes a refresh chart button 5.80 which may be used to update the graph to show updated real-time data and/or to reflect any changes made in the input section 5.78.

[0142] All references, including publications, patent applications, and patents cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein. Except where specified, the steps of a method need not be performed in the precise order given in the method.

[0143] The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) is to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms “comprising,” “having,” “including,” and “containing” are to be construed as open-ended terms (i.e., meaning “including, but not limited to,”) unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., “such as”) provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[0144] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

What is claimed is:

1. An environmental control system for a building, the system comprising:
   a microprocessor controller configured for accepting at least two temperature set points and a humidity set point; an operating interface operably connected to the controller; a thermostat and at least one temperature sensor operably connected to the controller; a humidistat and at least one humidity sensor operably connected to the controller; a communications interface operably connected to the controller and configured for communicating to a remote location over a telecommunications network; and wherein the controller is programmed to operate an environmental system within the building to control temperature as a primary factor within the building during periods of occupancy and to control humidity as the primary factor within the building during periods of un-occupancy.

2. The system of claim 1, wherein the controller is programmed to operate a variable speed fan of the environmental system at a low speed setting and a compressor of the environmental system to control humidity within the building.

3. The system of claim 1, wherein the controller is programmed to operate the environmental system to control humidity as a secondary factor within the building during periods of occupancy and to control temperature as the secondary factor within the building during periods of un-occupancy.

4. The system of claim 1, wherein the operating interface comprises a graphical user interface.

5. The system of claim 1, wherein the humidistat comprises a second thermostat and wherein the controller controls humidity using the second thermostat and a relative humidity sensor.

6. The system of claim 1, further comprising at least one moisture sensor operably connected to the controller.

7. The system of claim 1, further comprising an additional temperature sensor and/or humidity sensor operably connected to the controller.
8. A method for controlling an environment in a building, the method comprising the steps of:
providing an environmental controller for a building, the controller comprising a computer and a communications interface;
setting a first humidity control point for an environmental system;
setting a second humidity control point, higher than the first humidity control point, for the environmental system;
operating the environmental system in accordance with the first humidity control point for a first portion of a day and in accordance with the second humidity control point for a second portion of the day; and
communicating an alert when the second humidity control point is exceeded.

9. The method of claim 8, further comprising the steps of:
setting a first temperature control point for the environmental system; and
operating the environmental system in accordance with the first temperature control point and the first humidity control point for a first portion of the day.

10. The method of claim 8, further comprising the steps of:
setting a first temperature control point for the environmental system;
setting a second temperature control point for the environmental system; and
wherein the environmental system is operated in accordance with the first temperature control point and the first humidity control point for a first portion of a day, and in accordance with the second temperature control point and the second humidity control point for a second portion of the day.

11. The method of claim 8, wherein the first or second humidity control point is entered by using a wet bulb set point temperature and a dry bulb set point temperature.

12. The method of claim 8, wherein the first or second humidity control point is entered by using a relative humidity set point.

13. The method of claim 8, further comprising the step of setting a maximum temperature limit for the first portion of the day when utility costs are higher, wherein the temperature is not directly controlled during the first portion of the day unless it exceeds a temperature set point.

14. The method of claim 8, further comprising calculating an energy savings based on operations for the first and second portions of the day.

15. A method for controlling an environment inside a building, the method comprising the steps of:
connecting to a communications interface for a microprocessor environmental controller for a dwelling;
setting a first humidity control point for an environmental system;
setting a second humidity control point, higher than the first humidity control point, for the environmental system;
operating the environmental system in accordance with the first humidity control point for a first portion of a day and in accordance with the second humidity control point for a second portion of the day; and
communicating an alert when the second humidity control point is exceeded.

16. The method of claim 15, further comprising the steps of:
setting a temperature set point for the environmental system; and
programming the controller to manage the environmental system in accordance with the temperature set point when the temperature exceeds the temperature set point.

17. The method of claim 16, further comprising the step of generating an alarm when the temperature set point is exceeded.

18. The method of claim 15, wherein the environmental control system being operated comprises an air conditioning system and/or a dehumidifying system.

19. The method of claim 15, further comprising the step of calculating a periodic energy cost for operating the environmental system.

20. The method of claim 15, further comprising the steps of:
operating at least one of a variable speed fan and a variable capacity compressor as a part of the environmental system;
calculating a maximum rate of dehumidification; and
operating the environmental system to minimize energy costs using the maximum rate of dehumidification while maintaining humidity levels at or below the set point levels.