An energy system for a processing or manufacturing facility is considered a cascading system, as it sequentially utilizes the output product or waste of higher energy processes as at least part of the input energy for lower energy processes. Multiple absorption chillers are incorporated throughout the system along the cascading process stages to step-down the energy in the output product of one stage to at or near the appropriate input energy level for a subsequent stage. Cooling capacity is created by the absorption chillers during each step-down phase for use elsewhere in the facility.
FIG. 1
FIG. 3

177°F WATER (86) → 177°F WATER SURGE TANK

WINTER BYPASS (156) → 177°F WATER (132) → BOOSTER WATER HEATER

NATURAL GAS (140) → 180°F WATER (144) → KNIFE STERILIZERS

120 → 128

10

TO WASTEWATER TREATMENT OR SEWER (152)
FIG. 5
FIG. 7

NATURAL GAS (256) → GAS TURBINE(S) 252 → 200°F WATER (264) I 
ELECTRICITY (260) ➔ 167°F WATER (116, 116°) D 

248 ➔ 10
CASCADING ENERGY SYSTEM

BACKGROUND

[0001] The present invention relates to energy systems for processing and manufacturing facilities.
[0002] Resource efficiency and conservation are important aspects of designing processing and manufacturing facilities.

SUMMARY

[0003] The present invention provides an improved energy system for a processing or manufacturing facility. The system is considered a cascading system, as it sequentially utilizes the output product or waste of higher energy processes as at least part of the input energy for lower energy processes. Multiple absorption chillers are incorporated throughout the system along the cascading process stages to “step-down” the energy in the output product of one stage to at or near the appropriate input energy level for a subsequent stage. Cooling capacity is created by the absorption chillers during each step-down phase for use elsewhere in the facility.

[0004] Additionally, the system is a fully balanced system in terms of energy consumption. Fluid flow rates are determined for the entire system such that little or no excess water is used and/or wasted. The system is designed such that components in the system get precisely the amount of water needed for each specific operation. Therefore, water consumption, and the associated costs, are also reduced as compared to existing systems.

[0005] In one embodiment, the invention provides an energy system for a facility. The energy system includes a first process stage resulting in an output fluid at a first temperature T1, a second process stage utilizing an input fluid at a second temperature T2 lower than the first temperature T1, and a third process stage utilizing an input fluid at a third temperature T3 lower than both the first and second temperatures T1 and T2. The system further includes a first absorption chiller in fluid communication between the first process stage and the second process stage. The first absorption chiller is operable to reduce the temperature of the input fluid of the first process stage from the first temperature T1 to the second temperature T2 to provide the input fluid for the second process stage. The system also includes a second absorption chiller in fluid communication between the first absorption chiller and the third process stage. The second absorption chiller receives fluid at the second temperature T2 from the first absorption chiller and is operable to further reduce the temperature of the fluid to the third temperature T3 to provide the input fluid for the third process stage.

[0006] No additional fluid is added to the output fluid in the system between the first process stage and the second process stage, or between the first process stage and the third process stage. Furthermore, no additional fluid is added to the output fluid in the second process stage. Additional fluid is added to the output fluid in the third process stage.

[0007] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a schematic view of a first process stage of a cascading energy system embodying the invention.

[0009] FIG. 2a is a schematic view of an absorption chilling section of the cascading energy system embodying the invention.

[0010] FIG. 2b is a schematic view of a refrigeration system operating with heat exchange from the absorption chilling section of the cascading energy system embodying the invention.

[0011] FIG. 3 is a schematic view of a second process stage of a cascading energy system embodying the invention.

[0012] FIG. 4 is a schematic view of a third process stage of a cascading energy system embodying the invention.

[0013] FIG. 5 is a schematic view of a fourth process stage of a cascading energy system embodying the invention.

[0014] FIG. 6 is a schematic view of a fifth process stage of a cascading energy system embodying the invention.

[0015] FIG. 7 is a schematic view of a sixth process stage of a cascading energy system embodying the invention.

DETAILED DESCRIPTION

[0016] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0017] FIGS. 1-7 together illustrate a cascading energy system embodying the present invention. Each figure schematically shows a different process stage or section of the overall system. It should be noted that the illustrated process stages and sections are shown by way of example in relation to a food processing facility (e.g., a pork processing plant). However, other processing or manufacturing facilities can utilize components of the inventive energy system designed for use specifically with the specific processing and manufacturing stages of the particular facility. Those skilled in the art will understand that the illustrated embodiment includes detail, such as specific fluid temperatures, specific flow rates, and specific operations, that can vary according to the specific facility.

[0018] Referring to FIG. 1, a first process stage 14 is illustrated as a rendering stage, in which waste animal tissue (e.g., pork) is converted into stable, value-added materials in a manner typical of such processing. Water from a well 18 is provided to a boiler system 22 at line 26. Natural gas is supplied at line 30 to heat the water in the boiler 22 to generate steam at line 34, as is well known. The steam at line 34 is used in a rendering station 38 to carry out the rendering process. Water from the well 18 at a temperature of about 55 degrees Fahrenheit is also provided to the rendering station 38 for use therein at line 42. The well water is provided to the rendering station 38 at a flow rate of between about 700 to about 1,050 gallons per minute, and in the illustrated embodiment at a flow rate of about 712 gallons per minute for a lower capacity system and about 1,045 gallons per minute for a higher capacity system. These flow rates are much lower than conventional flow rates to rendering operations of about 1,500 gallons per minute for lower capacity systems and about 2,200 gallons per minute for higher capacity systems. Optionally, potable ambient-temperature water may be supplied to the rendering station 38 at line 46 from a wastewater treatment plant (see FIG. 5), as discussed further below.

[0019] As a result of the rendering operation at the rendering station 38, condensate returns to the boiler system 22 at
Additionally, the rendering operation results in output fluid or waste fluid in the form of water at a temperature T1 of about 200 degrees Fahrenheit at line 54. The output fluid maintains the flow rate of between about 700 to about 1,050 gallons per minute, and in the illustrated embodiment, a flow rate of about 712 gallons per minute for a lower capacity system and about 1,045 gallons per minute for a higher capacity system. In other embodiments, the output fluid could be steam or other gas/liquid combinations. As a byproduct of the high energy rendering operation, the output fluid is at a lower energy (i.e., a lower temperature) than the input fluid (i.e., steam) to the rendering operation. However, the cascading energy system 10 will make use of the output fluid from the rendering stage as at least a portion of the input fluid for one or more subsequent, lower energy operations. The output fluid can be collected in one or more surge tanks 58 to accommodate pressure changes in the system and until needed for the next section of the energy system 10. In the illustrated embodiment, three to six 75,000 gallon surge tanks can be used depending on system requirements and capacity. Line 62 provides fluid communication for the output fluid between the surge tanks 58 and the next sections 66a and 66b (see FIGS. 2a and 2b) of the energy system 10.

The fluid flow rate of the output fluid from the surge tanks 58 can be regulated to between about 500 to about 750 gallons per minute depending on system requirements and capacity. For a lower capacity system, the flow rate can be about 504 gallons per minute, while for a higher capacity system, the flow rate can be about 740 gallons per minute. Conventional rendering operations typically result in much higher output flow rates (e.g., about 1,500 gallons per minute for lower capacity systems and about 2,200 gallons per minute for higher capacity systems) of waste water at about 140 degrees Fahrenheit, much of which is simply dumped to a wastewater treatment stage or a sewer without being used further. In these conventional systems, the 1,500 to 2,200 gallons per minute flow rate is what is provided from the well or water source, and is at least about double that necessary with the present invention. The additional water results in a smaller temperature increase in the output water, which is why the conventional waste water exiting the rendering stage is only at about 140 degrees Fahrenheit. Therefore, with the energy system 10 of the present invention, more of the waste heat is retained for subsequent use. As will be further understood from the description below, the energy system 10 is a balanced system in terms of water consumption, such that little or none of this initial output fluid is wasted.

FIG. 2a illustrates the absorption chilling or energy step-down section 66a of the energy system 10. The 200 degree Fahrenheit water in line 62 enters one or more absorption chillers 70 at a flow rate of about 450 to about 700 gallons per minute depending on system requirements and capacity. For example, a lower capacity system might use a 285 ton absorption chiller receiving water at about 472 gallons per minute and a higher capacity system might use a 457 ton chiller receiving water at about 692 gallons per minute. These flow rates result from the output fluid from the surge tanks 58 being blended with other 200 degree Fahrenheit water provided from microturbines 228 and 240 (and possibly from turbine 252) at a lower relative flow rate (e.g., 425 to 650 gallons per minute), as discussed below with respect to an electricity generation stage 224 (see FIG. 6) and the electricity generation stage 248 (see FIG. 7). Suitable absorption chillers 70 are available from Carrier/Sanyo under model numbers TSA-16LJ-32 (285 ton) and TSA-16LJ-52 (457 ton). The absorption chillers 70 are constant flow devices, such that the flow rate is not changed by virtue of the fluid passing through the chillers 70 (i.e., any pressure losses in the chillers 70 are negligible relative to the overall system flow rate).

Referring again to FIG. 2a, a portion of the 177 degree Fahrenheit water exiting the chiller 70 at line 86 is diverted at line 108 into a second absorption chiller or chillers 112, which operates in the same manner as the first chiller 70 (with a cooling tower 74 and lines 78 and 82, and communicating with the lines 90 and 94) to reduce the energy in the 177 degree Fahrenheit water to a stepped-down temperature of about 167 degrees Fahrenheit exiting the chiller 112 at line 116. The portion of the 177 degree Fahrenheit water entering the chillers 112 enters at a flow rate of between about 375 to about 625 gallons per minute depending on system requirements and capacity. For example, a lower capacity system might use a 100 ton absorption chiller receiving water at about 396 gallons per minute and a higher capacity system might use a 173 ton chiller receiving water at about 615 gallons per minute. Suitable absorption chillers 112 are available from Carrier/Sanyo under model numbers TSA-16LJ-14 (100 ton) and TSA-16LJ-24 (173 ton).
ers 112 are constant flow devices, such that the flow rate is not changed by virtue of the fluid passing through the chillers 112.

The portion of the 177 degree Fahrenheit water exiting the first chiller 70 and that does not get diverted to the second chiller 112 continues in line 86 to a second process stage 120, which in the illustrated embodiment, is an equipment (e.g., knife) sterilization stage or operation illustrated in FIG. 3. This non-diverted water in line 86 has a flow rate of about 75 and 80 gallons per minute depending on system requirements. The lower capacity system would have a flow rate of about 76 gallons per minute (472 gpm–386 gpm=76 gpm) and the higher capacity system would have a flow rate of about 79 gallons per minute (692 gpm–613 gpm=79 gpm). It is combined with water at a similar flow rate from line 86 discussed below to achieve a total combined flow rate into the second process stage 120 of between about 150 and 160 gallons per minute depending on system requirements. The lower capacity system would have a flow rate of about 152 gallons per minute into the second process stage 120 and the higher capacity system would have a flow rate of about 158 gallons per minute into the second process stage 120. Optionally, and as shown in FIG. 2a, a winter bypass line 124 can be included in which some or all of the 200 degree Fahrenheit output water from the rendering stage 14 bypasses the chillers 70 and 112, can be utilized in the facility’s heating system (e.g., a radiant heating system), and can then proceed to the second process stage 120. Running the 200 degree water through a radiant heating system can result in output water at or about 177 degrees Fahrenheit.

Referring again to FIG. 3, the 177 degree Fahrenheit water in line 86 is the input fluid for the equipment sterilization stage 120 at a temperature T2 of about 177 degrees Fahrenheit. The input fluid enters a surge tank 128 before being provided by line 132 to a booster water heater 136. The surge tank 128 (e.g., a 65,000 gallon surge tank) regulates the flow rate of the input fluid to a rate suitable for the booster water heater 136. In the illustrated embodiment, fluid exiting the surge tank 128 enters the booster water heater 136 at a maximum rate of about 225 gallons per minute.

The illustrated booster water heater 136 is provided with a natural gas supply 140 to heat the 177 degree Fahrenheit water to about 180 degrees Fahrenheit. Because the input water at 177 degrees Fahrenheit is so close to the 180 degree Fahrenheit temperature requirement for the sterilization stage 120, the lower energy consumption booster water heater 136 can be used instead of a larger, higher energy consuming boiler. In conventional systems, well water or water at about 140 degrees Fahrenheit must be heated to 180 degrees Fahrenheit for the sterilization stage, thereby requiring a boiler and the use of more energy. In the event that the water in line 86 is coming from the facility’s heating system due to winter bypass, the booster water heater 136 may not be required, as the water in line 86 may be at about 180 degrees Fahrenheit.

The 180 degree Fahrenheit water is provided by line 144 to one or more knife or other equipment sterilizers 148 for an equipment sterilization operation. The water used for the equipment sterilization process is then sent in line 152 to another process stage of the energy system 10, and in the illustrated embodiment, to a wastewater treatment stage to be discussed further below. Alternatively, the water used in the equipment sterilization process can be sent through line 152 to a sewer. FIG. 3 also illustrates yet another optional winter bypass line 156 through which 177 degree Fahrenheit water from line 86 can bypass the equipment sterilization stage 120, be used in the facility’s heating system, and then proceed to another process stage, such as a third process stage 160 in the form of a sanitation stage (see FIG. 4) that utilizes input fluid at a temperature T3 of about 167 degrees Fahrenheit. The use of the water in the heating system cools the 177 degree Fahrenheit water in the winter bypass 156 to about 167 degrees Fahrenheit for input to the sanitation stage 160. In an alternative embodiment, the winter bypass line 156 could communicate directly with the 200 degree Fahrenheit water from winter bypass line 124. This could result in lower water consumption as less of the 200 degree Fahrenheit water is required to achieve a temperature of about 167 degrees Fahrenheit for input to the sanitation stage 160.

Referring to FIG. 4, 167 degree Fahrenheit input fluid enters the sanitation stage 160 at line 116 is combined with water at a similar flow rate from line 116 discussed below to achieve a total combined flow rate of between about 325 gallons per minute and 600 gallons per minute depending on system requirements. Some of the flow from the combined lines 116 and 116 is diverted off for cooling microturbines 228 and 240 as discussed below with respect to an electricity generation stage 224 (see FIG. 6), and optionally for cooling turbine 252 discussed below with respect to electricity generation stage 248 (see FIG. 7), which accounts for the decrease in flow rate from the combined flow rates of lines 116 and 116. The lower capacity system would have a flow rate of about 352 gallons per minute into the sanitation stage 160 and the higher capacity system would have a flow rate of about 582 gallons per minute into the sanitation stage 160.

The input fluid to the sanitation stage 160 passes through one or more surge tanks 164, and enters line 168 where it is mixed with cold well water from line 172 at about 55 degrees Fahrenheit and flowing at a rate of about 100 to about 200 gallons per minute to cool the 167 degree Fahrenheit input fluid to about 140 degrees Fahrenheit. In the illustrated embodiment, two to four 75,000 gallon surge tanks 164 can be used depending on system requirements and capacity. The surge tanks 164 in combination with the supply of well water from line 172 cooperate to regulate the pressure of the input fluid to a value suitable for the sanitation process or processes 176. In the illustrated embodiment, pressure requirements for fluid used in the sanitation process 176 can range from about 80 to about 300 pounds per square inch. The water balance of the system 10 is maintained as only the required amount/flow of well water is added to achieve the output needed for the sanitation process 176.

The 140 degree Fahrenheit water is then used in a sanitation process or processes 176 to sanitize various equipment and features within the facility. Output fluid from the sanitation process 176 travels through line 180 to another process stage of the energy system 10, and in the illustrated embodiment, to the wastewater treatment stage to be discussed further below. Alternatively, the water used in the sanitation process can be sent through line 180 to a sewer.

FIG. 5 illustrates a fourth process stage 184 in the form of a wastewater treatment stage. Wastewater from both the equipment sterilization stage 120 and the sanitation stage 160 is provided to the wastewater treatment stage 184 at line 188. The wastewater can enter line 192 and flow to a wastewater pre-treatment operation 196 in which methane gas is produced as a byproduct from the digester and exits the pre-treatment operation 196 via line 200. The pre-treated wastewater passes through line 204 to a second wastewater treat-
ment operation 208. Output from the second wastewater treatment operation 208 can be separated into potable water, which can exit via line 212 in communication with the rendering stage 14, greywater, which can exit via line 212 for use in facility toilets, irrigation, and the like, and remaining waste, which can exit via line 216 for disposal or further processing. The wastewater treatment stage 184 can include a bypass line 220 such that wastewater from line 188 bypasses the pre-treatment operation 196 and flows directly to the second wastewater treatment operation 208.

[0033] FIG. 6 illustrates a fifth process stage 224, which in the illustrated embodiment is an electricity generation stage. One or more microturbines 228 receive the methane gas from line 200 coming from the wastewater treatment stage 184. Suitable microturbines 228 are available from Capstone under model numbers CR65 and CR65-ICH (65 kW). The methane gas provides the energy source for the microturbines 228 to generate electricity that is output at line 232 for the facility’s electrical system. Water from lines 116 and 116 (see also FIG. 2a) at temperature T3 of about 167 degrees Fahrenheit is also provided/diverted to the microturbines 228 for cooling. This diverted cooling water can have a flow rate ranging from about 425 to about 650 gallons per minute depending on system capacity. The lower capacity system would have a flow rate of about 440 gallons per minute (396 gpm+396 gpm=352 gpm+440 gpm) and the higher capacity system would have a flow rate of about 644 gallons per minute (613 gpm+613 gpm=582 gpm+644 gpm). As will be described further below, only a portion of the water diverted from lines 116, 116 is diverted to the microturbines 228. The flow rate to the microturbines 228 ranges from about 150 to about 200 gallons per minute, and in the illustrated embodiment is about 167 gallons per minute. The flow rate of the heated water exiting the microturbine 228 remains the same as the flow rate of the cooling water entering the microturbine 228. The 167 degree Fahrenheit water is heated via heat exchange with the microturbines 228 to about 200 degrees Fahrenheit and exits the microturbines 228 at line 236, where it then returns to the absorption section 66a by fluid communication with line 62.

[0034] The electricity generation stage 224 further includes a second microturbine or microturbines 240 powered by a natural gas supply 244 to generate electricity that is output to line 232 for the facility’s electrical system. Suitable microturbines 240 are available from Capstone under model numbers C65 and C65-ICH (65 kW). As with the microturbines 228, the microturbines 240 can be cooled by water provided/diverted from lines 116, 116 at the temperature T3 of about 167 degrees Fahrenheit. The flow rate of cooling water to the microturbines 240 ranges from about 250 to about 500 gallons per minute, with the lower capacity system having a flow rate of about 273 gallons per minute (440 gpm–167 gpm=273 gpm) and the higher capacity system having a flow rate of about 477 gallons per minute (644 gpm–167 gpm=477 gpm). The flow rate of the heated water exiting the microturbine 240 remains the same as the flow rate of the cooling water entering the microturbine 240. The cooling fluid is heated via heat exchange with the microturbines 240 to about 200 degrees Fahrenheit and exits the microturbines 240 at line 236, combining with the heated cooling fluid exiting the microturbine 128, where it then returns to the absorption section 66a by fluid communication with lines 62, 62, thereby providing an additional or alternate source of high-energy output or waste fluid for the energy cascading system 10. As shown in FIG. 2a, lines 62 and 62 are connected by a header or manifold for communication therebetween.

[0035] Referring now to FIG. 7, the illustrated energy system 10 can optionally include another electricity generation process stage 248, which can be separate from the electricity generation process stage 224 or can be combined with the electricity generation process stage 224. The electricity generation stage 248 includes one or more gas turbines 252 powered by a natural gas supply 256 to generate electricity that is output at line 260 for the facility’s electrical system. While the gas turbine 252 may likely be cooled by cooling water from an independent source, one skilled in the art would understand how it could alternatively be cooled by cooling water at the temperature T3 of about 167 degrees Fahrenheit from lines 116, 116 (as shown in FIGS. 7 and 2a). If cooled with the water from lines 116, 116, the flow rates of the cooling water provided to the microturbines 128 and 240 and the total amount and flow of water in the system 10, would likely need to be increased from those listed above to include sufficient cooling flow to the turbine 252. The flow rates described above for the microturbines 128 and 240 have been determined assuming that the turbine 252 would be cooled by an independent cooling source so as not to be a part of system 10. However, if the system 10 is designed as shown in FIGS. 7 and 2a, the cooling fluid to the turbine 252 is heated via heat exchange with the turbine 252 to about 200 degrees Fahrenheit and exits the turbine 252 at line 264, where it then returns to the absorption section 66a by fluid communication with line 62. It is to be understood that the heated cooling fluid in line 264 coming from the turbine 252 is about at the first temperature T1 (about the same temperature as the output fluid from the rendering stage 14), thereby providing an additional or alternate source of high-energy output or waste fluid for the energy cascading system 10.

[0036] Referring again to FIG. 2a, the absorption chiller 70' is included in the absorption section 66a and is essentially a duplication of the absorption chiller 70 (with a cooling tower 74 and lines 78 and 82, and communicating with the lines 90 and 94) to reduce the energy in the 200 degree Fahrenheit water to a stepped-down temperature of about 177 degrees Fahrenheit exiting the chiller 70' at line 86 that communicates with line 86. Together, lines 86 and 86' provide the 177 degree Fahrenheit water of temperature T2 to the equipment sterilization stage 120 and to the chillers 112, 112'. Depending on the capacity of the chiller 70, the absorption chiller 70', as shown in FIG. 2a, could be eliminated such that only absorption chiller 70 is needed. In such an embodiment, the 200 degree Fahrenheit water line 264 exiting the electricity generation stage 248 is fed directly to line 62 for input into the chiller 70.

[0037] FIG. 2a also illustrates an absorption chiller 112 that is essentially a duplication of the absorption chiller 112 (with a cooling tower 74 and lines 78 and 82, and communicating with the lines 90 and 94) to reduce the energy in the 177 degree Fahrenheit water entering at line 108 to a stepped-down temperature of about 167 degrees Fahrenheit exiting the chiller 112' at line 116. Line 116' provides the 167 degree Fahrenheit water of temperature T3 to the sanitation stage 160, the electricity generation stage 224, and optionally to the electricity generation stage 248 as described above. Depending on the system capacities, the absorption chiller 112 may be eliminated in favor or using only the chiller 112. The duplication of chillers 70, 70' and 112, 112' provides
increased and redundant system capacity that facilitates system maintenance. Stages of the system 10 can be shut down for maintenance without requiring shut down of the entire system 10.

[0038] Those skilled in the art will understand that modifications to the illustrated embodiment can be made without departing from the scope of the invention. For example, it is understood that while each of the rendering stage 14, the electricity generation stage 224, and the electricity generation stage 248 can together provide the source of high-energy water at the first temperature T1, other embodiments may include fewer or more stages to provide the source of high-energy water used in the cascading energy system 10. Furthermore, the number of stages utilizing input fluid at each of the second temperature T2 and the third temperature T3 can vary from the illustrated embodiment. Furthermore, and as mentioned above, the specific processes described with respect to each stage and the specific water temperatures and flow rates set forth in the above description of the illustrated embodiment are by way of example only, and can vary depending upon the specific facility in which the energy system 10 is utilized.

[0039] In addition, the system can be utilized in facilities in which the initial output or waste fluid is steam instead of hot water. Steam absorption chillers can be used in place of or in combination with the illustrated water absorption chillers 70, 70', 112, 112' to vary the number of energy step-down phases as appropriate for the particular system.

[0040] Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. An energy system for a facility, the energy system comprising:
   a first process stage resulting in an output fluid at a first temperature T1;
   a second process stage utilizing an input fluid at a second temperature T2 lower than the first temperature T1;
   a third process stage utilizing an input fluid at a third temperature T3 lower than both the first and second temperatures T1 and T2;
   a first absorption chiller in fluid communication between the first process stage and the second process stage, the first absorption chiller operable to reduce the temperature of the output fluid of the first process stage from the first temperature T1 to the second temperature T2 to provide the input fluid for the second process stage; and
   a second absorption chiller in fluid communication between the first absorption chiller and the third process stage, the second absorption chiller receiving fluid at the second temperature T2 from the first absorption chiller and operable to further reduce the temperature of the fluid to the third temperature T3 to provide the input fluid for the third process stage.

2. The energy system of claim 1, wherein the first process stage is an animal rendering stage, the second process stage is an equipment sterilization stage, and the third process stage is a sanitation stage.

3. The energy system of claim 2, wherein the first temperature T1 of the output fluid from the rendering stage is about 200 degrees Fahrenheit, wherein the second temperature T2 of the input fluid to the equipment sterilization stage is about 177 degrees Fahrenheit, and wherein the third temperature T3 of the input fluid to the sanitation stage is about 167 degrees Fahrenheit.

4. The energy system of claim 2, wherein the energy system further includes a heater in the equipment sterilization stage to heat the input fluid to a sterilization temperature above the second temperature T2.

5. The energy system of claim 2, wherein the energy system further includes a cold water supply in the sanitation stage to mix cold water with the input fluid to cool the input fluid to a sanitation temperature below the third temperature T3.

6. The energy system of claim 1, further comprising a fourth process stage, wherein an output fluid from at least one of the second and third process stages is an input fluid for the fourth process stage, and a fifth process stage, wherein an output from the fourth process stage provides an energy source to the fifth process stage.

7. The energy system of claim 6, wherein the fourth process stage is a wastewater treatment stage and wherein the fifth process stage is an electricity generation stage, the wastewater treatment stage providing methane gas to power a turbine used for the electricity generation stage.

8. The energy system of claim 1, further comprising an electricity generation stage and wherein at least a portion of the fluid reduced to the third temperature T3 by the second absorption chiller is diverted to the electricity generation stage to act as a cooling fluid for a turbine used in the electricity generation stage.

9. The energy system of claim 8, wherein the electricity generation stage results in an output fluid at about the first temperature T1 and that is provided to the first absorption chiller.

10. The energy system of claim 8, wherein natural gas is used to power the turbine.

11. The energy system of claim 1, wherein the first and second absorption chillers provide cooling capacity for the energy system.

12. The energy system of claim 11, wherein the first and second absorption chillers provide a chilled output fluid at a temperature of about 50 degrees Fahrenheit.

13. The energy system of claim 1, wherein the first process stage is an electricity generation stage, the second process stage is an equipment sterilization stage, and the third process stage is a sanitation stage.

14. The energy system of claim 13, wherein a portion of the fluid reduced to the third temperature T3 by the second absorption chiller is diverted to the electricity generation stage to act as a cooling fluid for a turbine used for the electricity generation stage.

15. The energy system of claim 13, further comprising a wastewater treatment stage, wherein output fluid from at least one of the equipment sterilization stage and the sanitation stage is an input fluid for the wastewater treatment stage, and wherein methane gas generated at the wastewater treatment stage powers a turbine used for the electricity generation stage.

16. The energy system of claim 13, wherein the first temperature T1 of the output fluid from the electricity generation stage is about 200 degrees Fahrenheit, wherein the second temperature T2 of the input fluid to the equipment sterilization stage is about 177 degrees Fahrenheit, and wherein the third temperature T3 of the input fluid to the sanitation stage is about 167 degrees Fahrenheit.

17. The energy system of claim 13, further comprising an animal rendering stage that results in an output fluid at about the first temperature T1 and that is provided to the first absorption chiller.
18. The energy system of claim 1, further comprising a first cooling tower in fluid communication with the first absorption chiller and a second cooling tower in fluid communication with the second absorption chiller.

19. The energy system of claim 1, wherein the first absorption chiller includes at least two absorption chillers in fluid communication, and wherein the second absorption chiller includes at least two absorption chillers in fluid communication.

20. The energy system of claim 1, further including a bypass line between the first process stage and the second process stage such that output fluid from the first process stage selectively bypasses the first and second absorption chillers.

21. The energy system of claim 1, wherein the output fluid is regulated to a flow rate that provides a balanced system of water consumption so that little or none of the output fluid is wasted.

22. The energy system of claim 21, wherein no additional fluid is added to the output fluid in the system between the first process stage and the second process stage, or between the first process stage and the third process stage.

23. The energy system of claim 22, wherein no additional fluid is added to the output fluid in the second process stage.

24. The energy system of claim 22, wherein additional fluid is added to the output fluid in the third process stage.

25. The energy system of claim 21, wherein at least one surge tank is provided to regulate the flow rate of the output fluid.

26. The energy system of claim 21, wherein the output fluid is regulated to a flow rate of about 500 to about 750 gallons per minute.