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(54) SYSTEMS AND METHODS FOR ENVIRONMENTALLY UNDISRUPTIVE DISPOSAL OF FOOD WASTE

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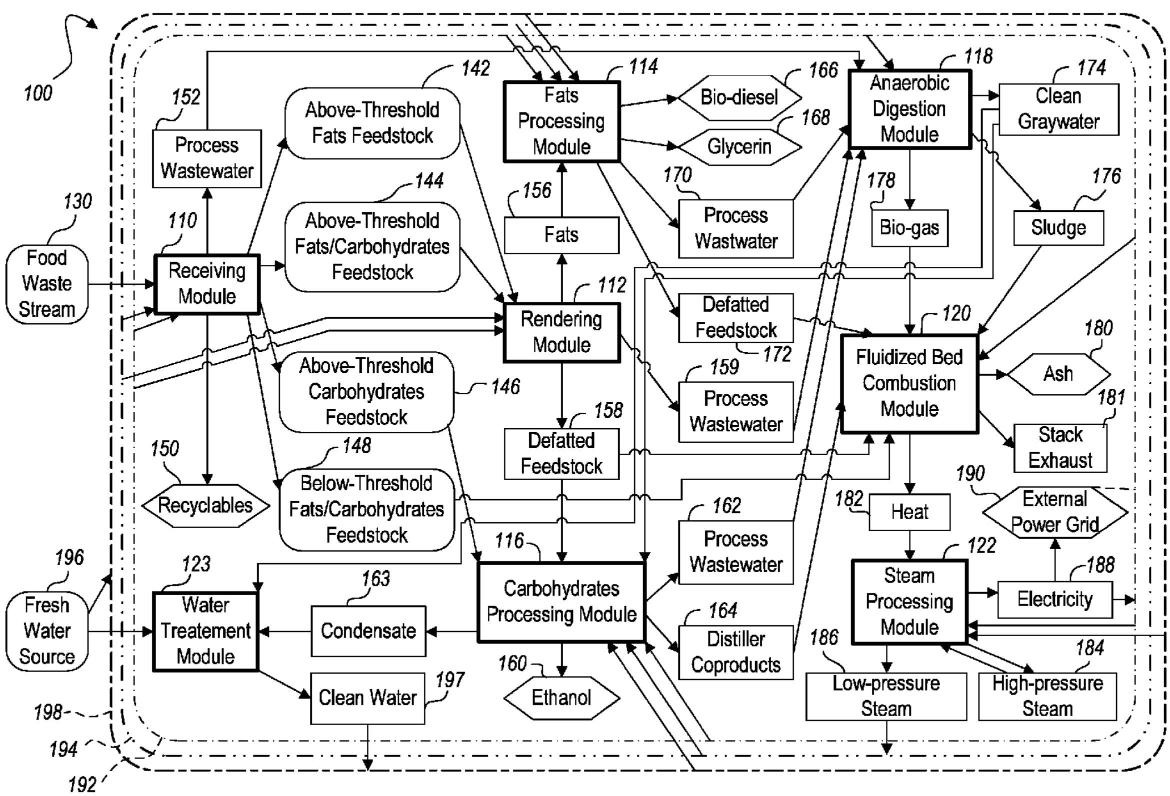
(57) **ABSTRACT**

A processing facility can dispose of food waste in environmentally undisruptive manners. The processing facility can convert the food waste into bio-energy and bio-fuel products, such as bio-diesel, ethanol, and electricity. The processing facility can sort the food waste based on the fats or carbohydrates content of the food waste, and the processing facility can include a fluidized bed combustion module for combusting portions of the food waste.



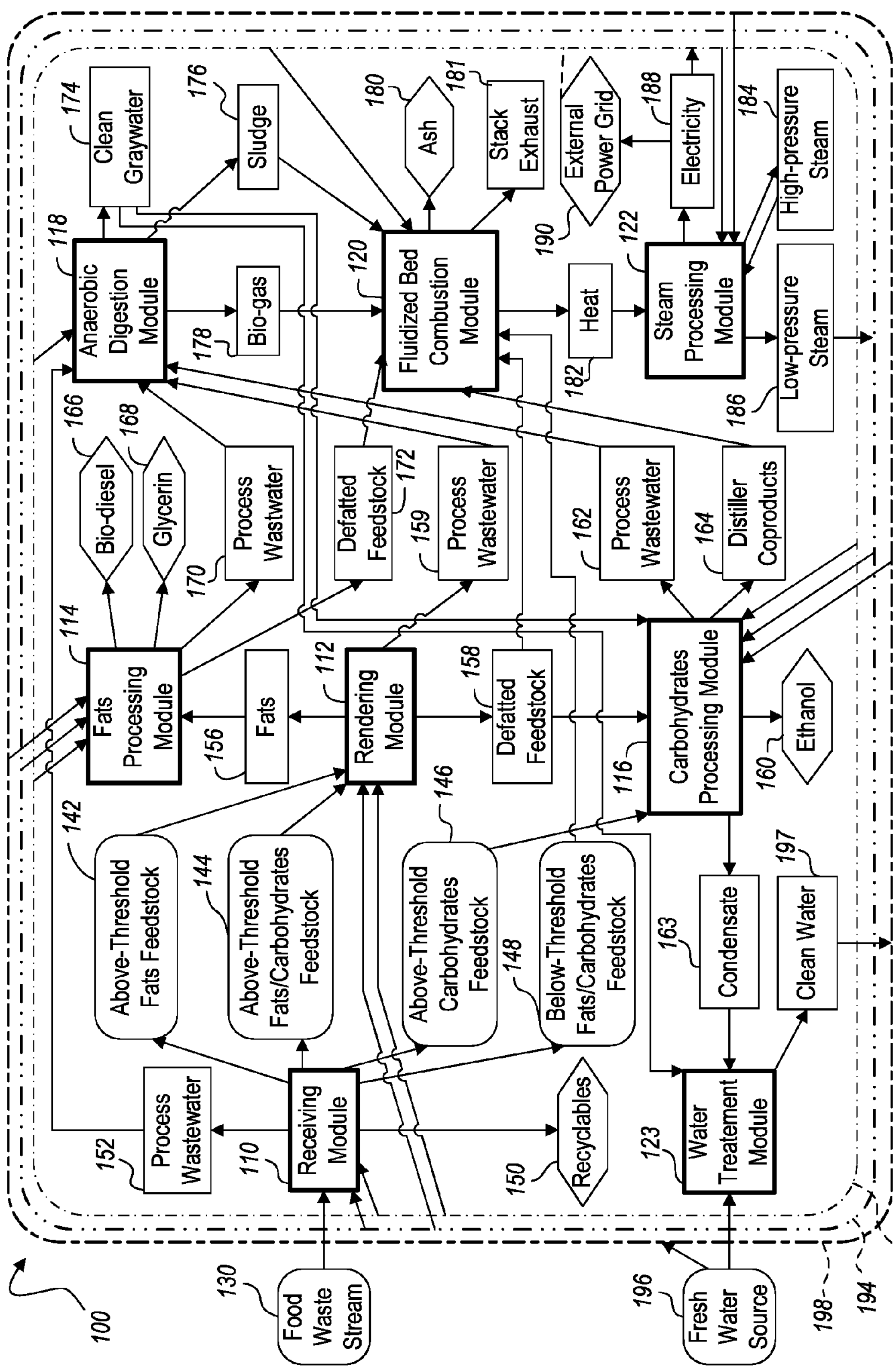
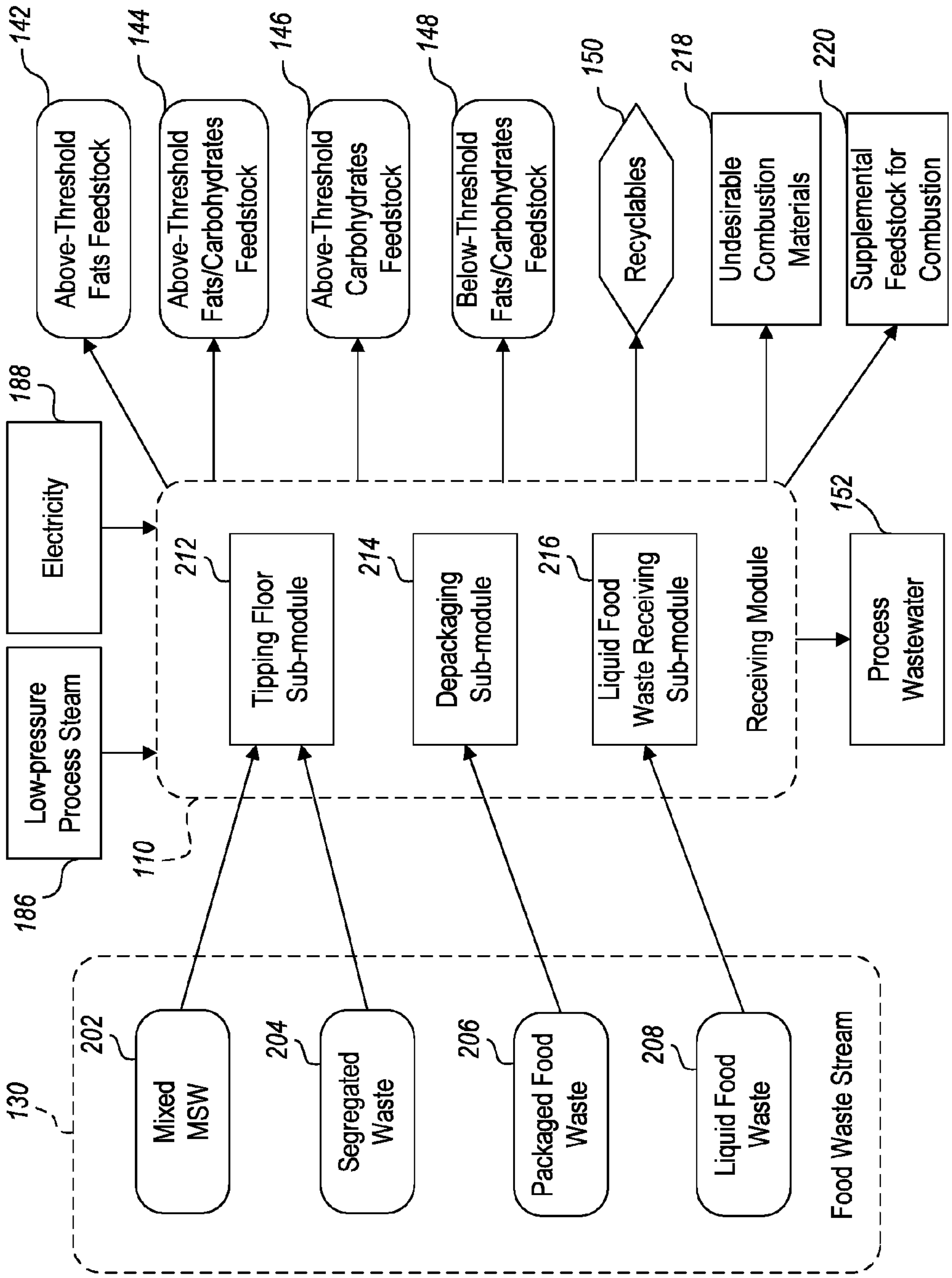

100
Food Waste Stream
130
Receiving Module
110
Process Wastewater
152
Recyclables
150
Above-Threshold Fats Feedstock
142
Above-Threshold Fats/Carbohydrates Feedstock
144
Above-Threshold Carbohydrates Feedstock
146
Below-Threshold Fats/Carbohydrates Feedstock
148
Fats Processing Module
114
Fats
156
Rendering Module
112
Defatted Feedstock
158
Carbohydrates Processing Module
116
Ethanol
160
Condensate
163
Clean Water
197
Water Treatement Module
123
Fresh Water Source
196
Bio-diesel
166
Glycerin
168
Process Wastewater
170
Defatted Feedstock
172
Process Wastewater
159
Process Wastewater
162
Distiller Coproducts
164
Anaerobic Digestion Module
118
Clean Graywater
174
Sludge
176
Bio-gas
178
Fluidized Bed Combustion Module
120
Ash
180
Stack Exhaust
181
Heat
182
External Power Grid
190
Electricity
188
Steam Processing Module
122
High-pressure Steam
184
Low-pressure Steam
186
198
194
192

FIG. 1



142
Above-Threshold Fats Feedstock
144
Above-Threshold Fats/Carbohydrates Feedstock
146
Above-Threshold Carbohydrates Feedstock
148
Below-Threshold Fats/Carbohydrates Feedstock
150
Recyclables
218
Undesirable Combustion Materials
220
Supplemental Feedstock for Combustion
188
Electricity
186
Low-pressure Process Steam
110
212
Tipping Floor Sub-module
214
Depackaging Sub-module
216
Liquid Food Waste Receiving Sub-module
Receiving Module
152
Process Wastewater
130
202
Mixed MSW
204
Segregated Waste
206
Packaged Food Waste
208
Liquid Food Waste
Food Waste Stream

FIG. 2

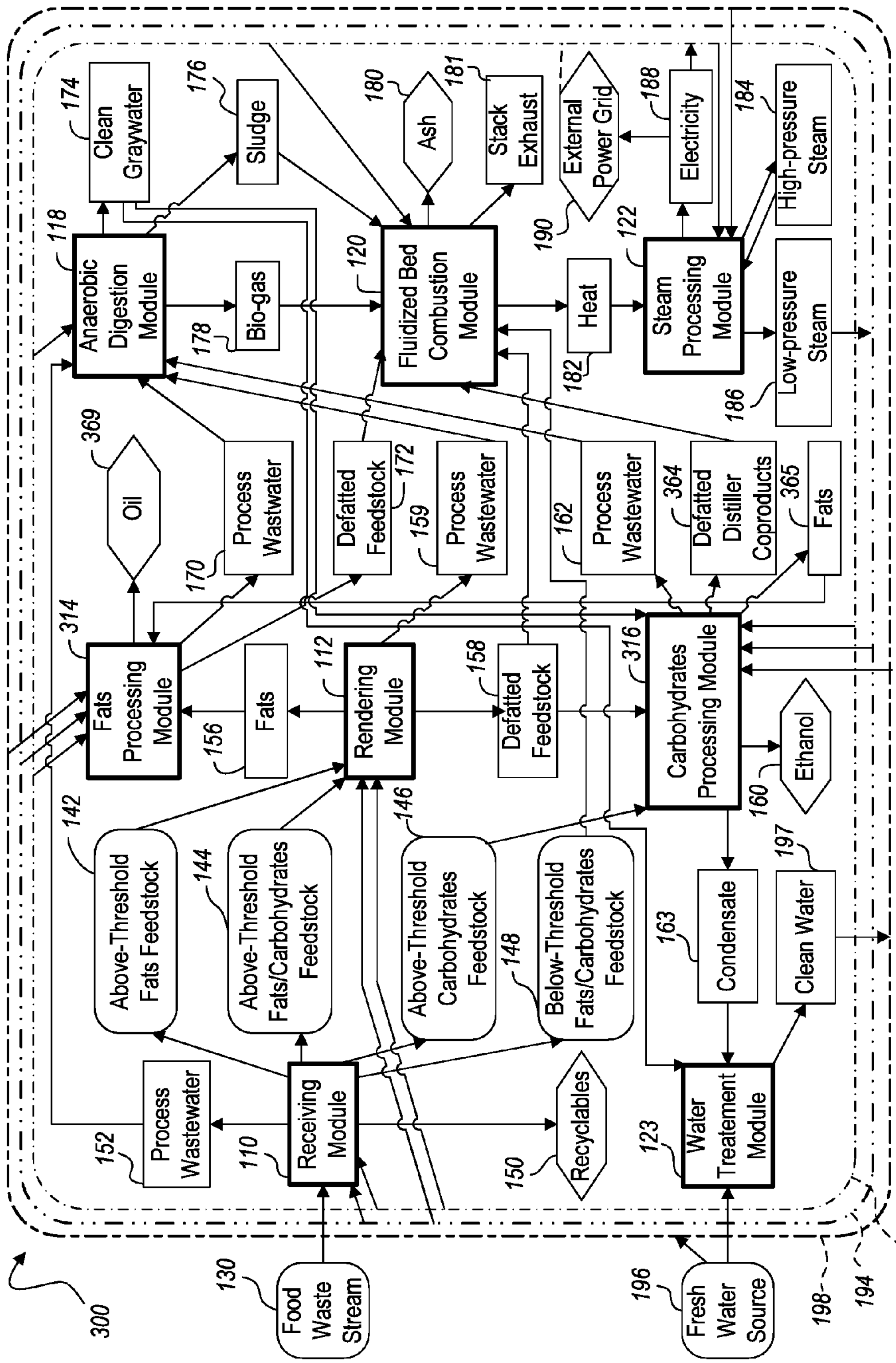

300
Food Waste Stream
130
Receiving Module
110
Process Wastewater
152
Recyclables
150
Above-Threshold Fats Feedstock
142
Above-Threshold Fats/Carbohydrates Feedstock
144
Above-Threshold Carbohydrates Feedstock
146
Below-Threshold Fats/Carbohydrates Feedstock
148
Fats Processing Module
314
Fats
156
Rendering Module
112
Defatted Feedstock
158
Carbohydrates Processing Module
316
Ethanol
160
Condensate
163
Clean Water
197
Water Treatement Module
123
Fresh Water Source
196
Oil
369
Process Wastwater
170
Defatted Feedstock
172
Process Wastewater
159
Process Wastewater
162
Defatted Distiller Coproducts
364
Fats
365
Anaerobic Digestion Module
118
Bio-gas
178
Clean Graywater
174
Sludge
176
Fluidized Bed Combustion Module
120
Ash
180
Stack Exhaust
181
Heat
182
External Power Grid
190
Electricity
188
Steam Processing Module
122
High-pressure Steam
184
Low-pressure Steam
186
198
194
192

FIG. 3

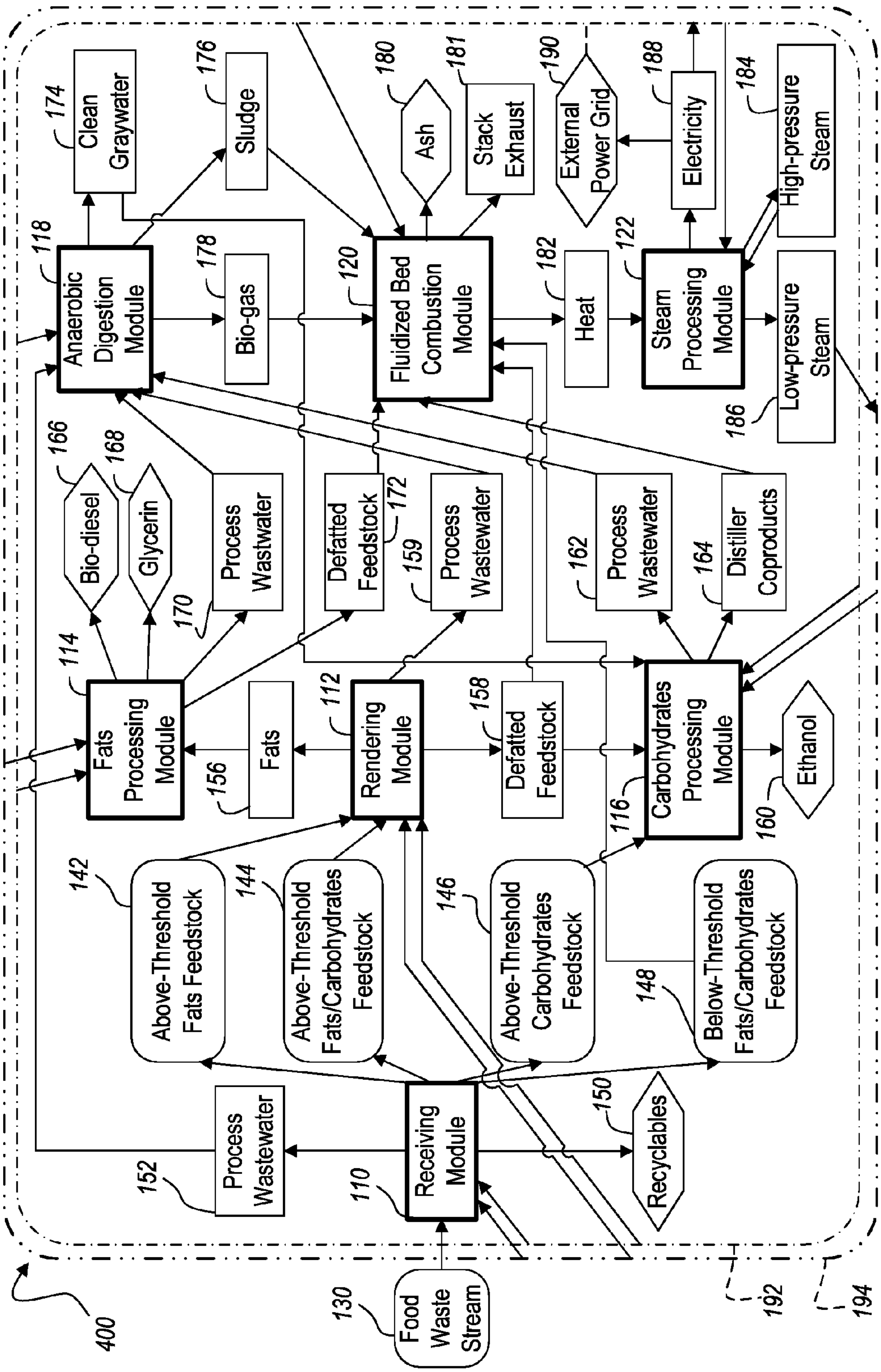

400
130
Food Waste Stream
110
Receiving Module
152
Process Wastewater
150
Recyclables
142
Above-Threshold Fats Feedstock
144
Above-Threshold Fats/Carbohydrates Feedstock
146
Above-Threshold Carbohydrates Feedstock
148
Below-Threshold Fats/Carbohydrates Feedstock
112
Rendering Module
156
Fats
158
Defatted Feedstock
114
Fats Processing Module
116
Carbohydrates Processing Module
160
Ethanol
166
Bio-diesel
168
Glycerin
170
Process Wastewater
172
Defatted Feedstock
159
Process Wastewater
162
Process Wastewater
164
Distiller Coproducts
118
Anaerobic Digestion Module
174
Clean Graywater
176
Sludge
178
Bio-gas
120
Fluidized Bed Combustion Module
180
Ash
181
Stack Exhaust
182
Heat
122
Steam Processing Module
190
External Power Grid
188
Electricity
184
High-pressure Steam
186
Low-pressure Steam
192
194

FIG. 4

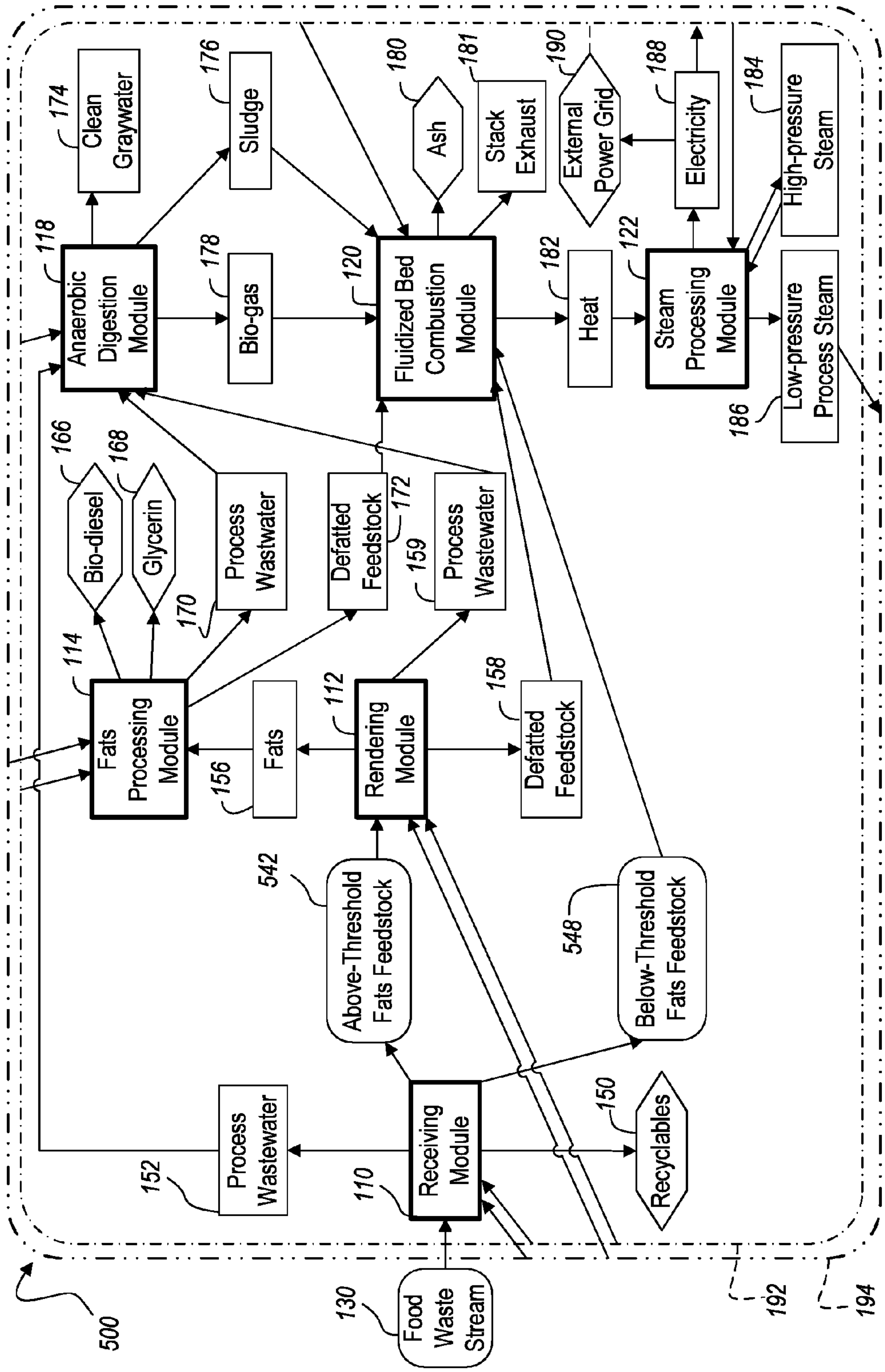

Food Waste Stream
130
Receiving Module
110
Process Wastewater
152
Recyclables
150
Above-Threshold Fats Feedstock
542
Below-Threshold Fats Feedstock
548
Rendering Module
112
Fats
156
Defatted Feedstock
158
Fats Processing Module
114
Bio-diesel
166
Glycerin
168
Process Wastwater
170
Defatted Feedstock
172
Process Wastewater
159
Anaerobic Digestion Module
118
Clean Graywater
174
Sludge
176
Bio-gas
178
Fluidized Bed Combustion Module
120
Ash
180
Stack Exhaust
181
External Power Grid
190
Electricity
188
Heat
182
Steam Processing Module
122
High-pressure Steam
184
Low-pressure Process Steam
186
192
194
500

FIG. 5

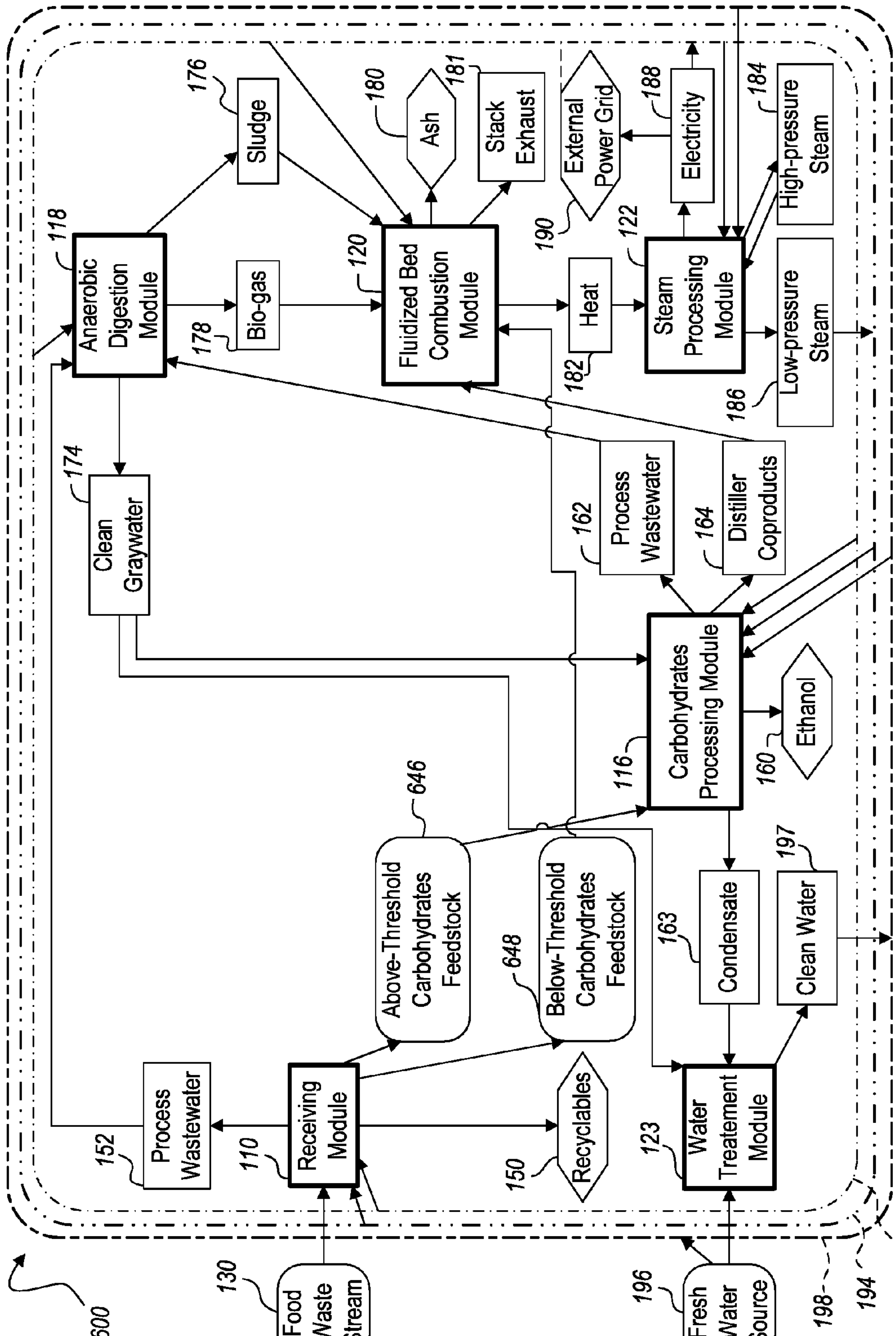

600
Food Waste Stream
130
Receiving Module
110
Process Wastewater
152
Recyclables
150
Above-Threshold Carbohydrates Feedstock
646
Below-Threshold Carbohydrates Feedstock
648
Anaerobic Digestion Module
118
Sludge
176
Bio-gas
178
Clean Graywater
174
Fluidized Bed Combustion Module
120
Ash
180
Stack Exhaust
181
External Power Grid
190
Heat
182
Steam Processing Module
122
Electricity
188
High-pressure Steam
184
Low-pressure Steam
186
Process Wastewater
162
Distiller Coproducts
164
Carbohydrates Processing Module
116
Ethanol
160
Condensate
163
Clean Water
197
Water Treatement Module
123
Fresh Water Source
196
198
194
192

FIG. 6

SYSTEMS AND METHODS FOR ENVIRONMENTALLY UNDISRUPTIVE DISPOSAL OF FOOD WASTE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/099,838, which was filed on Sep. 24, 2008, and of which the entire contents are hereby incorporated by reference herein.

TECHNICAL FIELD

[0002] The present disclosure relates generally to the field of waste disposal. More specifically, the present disclosure relates to systems and methods for disposing of food waste.

SUMMARY

[0003] In certain embodiments, a processing facility disposes of food waste in an environmentally undisruptive manner. The processing facility can convert food waste materials into one or more bio-energy or bio-fuel products. The processing facility can include a plurality of processing modules that are interrelated such that one or more outputs from one module are directed to one or more other modules within the processing facility. In some embodiments, the interrelation of the processing modules is substantially balanced such that during operation, the processing facility consumes relatively small amounts, or even no amount, of one or more process resources (e.g., electricity, water, and natural gas) from outsides sources.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The drawings depict only illustrative embodiments, and are, therefore, not to be considered to be limiting of the scope of the disclosure. Various embodiments will be described and explained with specificity and detail with reference to the accompanying drawings, in which:

[0005] FIG. **1** is a flow diagram of an embodiment of a processing facility for disposing of food waste;

[0006] FIG. **2** is a flow diagram of an embodiment of a receiving module that is compatible with the processing facility shown in FIG. **1**;

[0007] FIG. **3** is a flow diagram of another embodiment of a processing facility for disposing of food waste;

[0008] FIG. **4** is a flow diagram of another embodiment of a processing facility for disposing of food waste;

[0009] FIG. **5** is a flow diagram of another embodiment of a processing facility for disposing of food waste; and

[0010] FIG. **6** is a flow diagram of another embodiment of a processing facility for disposing of food waste.

DETAILED DESCRIPTION

[0011] It will be readily understood that the components of the embodiments as generally described and illustrated in the figures herein could be arranged and designed in a wide variety of different configurations. For example, some embodiments can include fewer than all components shown in an illustrated embodiment, while other embodiments can include more components. Thus, the following more detailed description of various embodiments, as represented in the figures, is not intended to limit the scope of the disclosure or claims.

[0012] With reference to FIG. **1**, in certain embodiments, a processing facility **100** comprises a receiving module **110**, a rendering module **112**, a fats processing module **114**, a carbohydrates processing module **116**, an anaerobic digestion module **118**, a fluidized bed combustion module **120**, a steam processing module **122**, and a water treatment module **123**, each of which is described further below. For the sake of convenience, the modules **110**, **112**, **114**, **116**, **118**, **120**, **122**, **123** may be referred to herein generally as processing modules. The processing modules can be interrelated such that one or more outputs (e.g., coproducts) from one processing module are directed to one or more other processing modules within the processing facility **100**. Some embodiments can include more or fewer processing modules than those depicted in FIG. **1**.

[0013] In certain embodiments, the processing facility **100** can convert at least a portion of a food waste stream **130** into one or more bio-energy or bio-fuel products. For example, in the illustrated embodiment, the processing facility **100** produces ethanol, bio-diesel, and electricity from separate portions of the food waste stream **130**. Other useful products can also be produced, such as, for example, glycerin and fertilizer ash.

[0014] The processing facility **100** can be substantially process energy self-sustaining. For example, in some embodiments, once the process modules are operational (e.g., once the fluidized bed combustion module **120** is hot enough to combust feedstock delivered thereto), the processing facility **100** generates sufficient amounts of electricity from the food waste stream **130** to maintain its own operation. The processing facility **100** can generate the electricity substantially without receiving energy from sources other than the food waste stream **130**, such as from an external power grid. In further embodiments, the processing facility **100** can generate excess amounts of electricity, which can be delivered to an external power grid. As further discussed below, in some embodiments, process steam generated by the processing facility **100** from the food waste stream **130** can be used to power equipment within the processing facility **100**, and can contribute to the process energy self-sustainability of the processing facility **100**.

[0015] As also discussed below, in some embodiments, the processing facility **100** can be substantially self-sustaining with respect to the production and use of process steam for a variety of applications in addition to or in place of powering machinery, and in further embodiments, can produce excess process steam. In some embodiments, the processing facility **100** can be substantially self-sustaining with respect to water usage, and in further embodiments, can produce excess water.

[0016] With continued reference to FIG. **1**, process flows of the illustrated embodiment of the processing facility **100** will now be described. The food waste stream **130** can be received into the processing facility **100** via the receiving module **110**. As described further below, the receiving module **110** can be configured to sort, separate, or otherwise segregate feedstock materials from the food waste stream **130** based on the fats content and the carbohydrates content of food waste present within the food waste stream **130**.

[0017] In particular, the receiving module **110** can direct the food waste stream **130** into one or more of a feedstock that comprises food waste having a fats content above a fats threshold value, as depicted at block **142**; a feedstock that comprises food waste having a fats content above a fats threshold value and a carbohydrates content above a carbohydrates threshold value, as depicted at block **144**; a feedstock that comprises food waste having a carbohydrates content above a carbohydrates threshold value, as depicted at block **146**; and a feedstock that comprises food waste having a fats content below a fats threshold value and a carbohydrates content below a carbohydrates threshold value, as depicted at block **148**. The term "food waste" is a broad term used herein in its ordinary sense, and it includes solid food products (e.g., solid foods or processed foods, such as breads, pastries, vegetables, and meats), liquid food products (e.g., beverages), solids and liquids used in the preparation of food products (e.g., beer waste, frying oils, and wash down water), edible or inedible byproducts from the manufacture of processed foods, and inedible portions of food products (e.g., fruit pits, and carrot tops) for which disposal is desired. Food waste can be generated by a variety of sources, such as, for example, dairy processing facilities, meat processing facilities, bakeries (small-scale or industrial), and individual households. The term "fats" is a broad term used herein in its ordinary sense, and it includes oils (e.g., vegetable oils), fats (e.g., animal fats), and greases (e.g., animal greases). The term "carbohydrates" is a broad term used herein in its ordinary sense, and it includes complex carbohydrates (e.g., starches) and simple carbohydrates (e.g., sugars).

[0018] The above-threshold fats feedstock **142** and/or the above-threshold fats/carbohydrates feedstock **144** can be delivered to the rendering module **112** for further processing. The above-threshold carbohydrates feedstock **146** can be delivered to the carbohydrates processing module **116** for further processing. The below-threshold fats/carbohydrates feedstock **148** can be delivered directly to the fluidized bed combustion module **120** as a fuel source.

[0019] As shown at block **150**, recyclable materials can also be separated from the food waste stream **130**, which can provide a source of revenue for the processing facility **100**. As shown at block **152**, process wastewater from the receiving module can be delivered directly to the anaerobic digestion module **118**. The process wastewater **152** can include, for example, excess water contained within the food waste stream **130**.

[0020] The rendering module **112** can be configured to separate feedstock material received therein into a fats component, as shown at block **156**, and a defatted feedstock component, as shown at block **158**. The fats **156** can be delivered to the fats processing module **114** for further processing. The defatted feedstock **158** can be delivered to either or both of the carbohydrates processing module **116** and the fluidized bed combustion module **120**, depending on the carbohydrates content of the defatted feedstock **158**. For example, if some or all of the defatted feedstock **158** comprises a carbohydrates content above a threshold value, the defatted feedstock **158** can be delivered to the carbohydrates processing module **116** for further processing, and if some or all of the defatted feedstock **158** comprises a carbohydrates content below the threshold value, it can be delivered to the fluidized bed combustion module as fuel. As depicted at block **159**, process wastewater can be delivered from the carbohydrates processing module **116** to the anaerobic digestion module **118**.

[0021] As previously mentioned, the carbohydrates processing module **116** can receive feedstock having a carbohydrates content above a threshold value from one or more of the receiving module **110** (see, e.g., block **146**) and the rendering module **112** (see, e.g., block **158**). As shown at block **160**, the carbohydrates processing module **116** can be configured to produce ethanol from the feedstock thus received (e.g., via fermentation), which can provide a revenue stream for the processing facility **100**. As depicted at block **162**, process wastewater from the carbohydrates processing module **116** can be delivered to the anaerobic digestion module **118**. As depicted at block **163**, excess condensate from the carbohydrates processing module **116** can be delivered to the water treatment module **123**.

[0022] As depicted at block **164**, the carbohydrates processing module **116** can produce one or more distiller coproducts that are delivered as fuel to the fluidized bed combustion module **120**. For example, the distiller coproducts can include distiller cake and concentrated solubles that can be combusted in the fluidized bed combustion module **120**. The distiller coproducts **164** can be dewatered prior to being delivered to the fluidized bed combustion module **120**.

[0023] As previously mentioned, the fats processing module **114** can receive fats **156** from the rendering module **112**. As shown at blocks **166** and **168**, respectively, in some embodiments, the fats processing module **114** is configured to produce bio-diesel and glycerin from the fats **156**. The bio-diesel **166** and the glycerin **168** can each provide a revenue stream for the processing facility **100**. As depicted at block **170**, process wastewater from the fats processing module **114** can be delivered to the anaerobic digestion module **118**. As depicted at block **172**, the fats processing module **118** can also yield defatted feedstock that is delivered to the fluidized bed combustion module **120**.

[0024] As previously discussed, the anaerobic digestion module **118** can receive process wastewater from one or more of the receiving module **110**, the rendering module **112**, the fats processing module **114**, and the carbohydrates processing module **116**. From the process wastewater thus received, the anaerobic digestion module **118** can yield clean graywater, as depicted at block **174**; sludge, as depicted at block **176**; and bio-gas, as depicted at block **178**. At least a portion of the clean graywater **174** can be delivered to the carbohydrates processing module **116** and may be used, for example, as make-up process water in the fermentation process. Likewise, at least a portion of the clean graywater **174** can be delivered to the water treatment module **123** for further processing. The sludge **176** can be dewatered and delivered to the fluidized bed combustion module **120** as fuel, and water that is removed from the sludge **176** can be returned to the anaerobic digestion module **118**. The bio-gas **178** can be delivered to the fluidized bed combustion module **120** as fuel. As further discussed below, the bio-gas **178** can be selectively delivered to the fluidized bed combustion module **120** as a supplement to other feedstock to help maintain operation of the fluidized bed combustion module **120**

[0025] As previously discussed, the fluidized bed combustion module **120** can receive feedstock fuel from one or more of the receiving module **110** (see, e.g., block **148**), the rendering module **112** (see, e.g., block **158**), the fats processing module **114** (see, e.g., block **172**), the carbohydrates processing module **116** (see, e.g., block **164**), and the anaerobic digestion module **118** (see, e.g., blocks **176** and **178**). From the feedstock thus received, the fluidized bed combustion module **120** can yield process heat, as depicted at block **182**, stack exhaust, as depicted at block **181**, and ash, as depicted at block **180**. The ash **180** can be utilized, for example, as high quality fertilizer or construction fill material, or in the manufacture of cement. The ash **180** thus can provide a revenue stream for the processing facility **100**. As further discussed below, the stack exhaust **181** can comprise or can consist essentially of carbon dioxide and water. For example, the stack exhaust **181** can include only small or trace amounts of other gases or particulates.

[0026] The steam processing module **122** can be coupled with the fluidized bed combustion module **120** and can utilize heat **182** generated by the fluidized bed combustion module **120**. In some embodiments, the steam processing module **122** uses the heat **182** to produce high-pressure steam, as depicted at block **184**. The steam processing module **122** can utilize the high-pressure steam **184** to produce electricity, as depicted at block **188**, and low-pressure steam, as depicted at block **186**. In some embodiments, at least a portion of the electricity **188** (e.g., electricity in excess of that used to operate the processing facility **100**) generated by the steam processing module **122** is delivered to an external power grid **190**, and can provide a source of revenue for the processing facility **100**.

[0027] At least a portion of the electricity **188** generated by the steam processing module **122** can be delivered to an internal power grid, schematically depicted by a dashed line **192**, that services the processing facility **100**. In particular, as depicted by arrows directed inwardly from the internal power grid **192**, each of the receiving module **110**, the rendering module **112**, the fats processing module **114**, the carbohydrates processing module **116**, the anaerobic digestion module **118**, the fluidized bed combustion module **120**, the steam processing module **122**, and the water treatment module **123** can be connected to and receive electricity from the internal power grid **192**. As illustrated by a dashed line, the internal power grid **192** can also be connected to the external power grid **190** so as to deliver excess electricity thereto.

[0028] At least a portion of the low-pressure steam **186** generated by the steam processing module **122** can be delivered as process steam to a process steam distribution system, schematically depicted by a dashed line **194**, that services the processing facility **100**. For example, as depicted by arrows directed inwardly from the process steam distribution system **194**, each of the receiving module **110**, the rendering module **112**, the fats processing module **114**, and the carbohydrates processing module **116** can be connected to and receive process steam from the process steam distribution system **194**. In certain embodiments, the process steam can be used to heat portions of the various processing modules. In some embodiments, the process steam can be used to drive mechanical equipment, such as, for example, centrifuges and compressors, and can reduce the overall electricity consumption of the processing facility **100**. Portions of the processing facility **100** in addition to or other than those listed above can receive process steam via the process steam distribution system **194** as needed or desired

[0029] As previously mentioned, the water treatment module **123** can receive condensate **163** from the carbohydrates processing module **116** and/or clean graywater **174** from the anaerobic digestion module **118**. In some embodiments, the water treatment module **123** can receive fresh water from an outside water source, as depicted at block **196**, such as a well, a municipal water supply, or any other suitable water source. The water treatment module **123** can be configured to purify the water received therein to yield clean water **197** suitable for use as boiler water and/or as clean process water.

[0030] The clean water **197** can be delivered to a water distribution system, schematically depicted by a dashed line **198**, that services the processing facility **100**. The water distribution system **198** can be connected directly to the fresh water source **196**, and the clean water **197** can be used to supplement or replace water delivered from the source **196**. As depicted by arrows directed inwardly from the water distribution system **198**, each of the fats processing module **114**, the carbohydrates processing module **116**, and the steam processing module **122** can be connected to and receive clean water **197** from the water distribution system **198**. Additional or other portions of the processing facility **100** can receive clean water **197** via the water distribution system **198**, such as, for example, the water treatment module **123** itself, the receiving module **110**, and/or the rendering module **112**, as needed or desired.

[0031] Embodiments of the processing facility **100** and components thereof will now be described in greater detail. With reference to FIG. **2**, the receiving module **110** can be configured to receive the food waste stream **130** from a variety of different sources. For example, the food waste stream **130** can comprise one or more of mixed municipal solid waste (MSW) **202**, segregated waste **204**, packaged food waste **206**, and liquid food waste **208**, and the receiving module **110** can comprise one or more of a tipping floor sub-module **212**, a de-packaging sub-module **214**, and a liquid food waste receiving sub-module **216** for receiving the different sources of food waste.

[0032] The mixed MSW **202** can comprise food waste interspersed with other solid waste materials, and can be transported from residential, commercial, and industrial food processors, warehouses, and/or other points of origination in a conventional manner, or in any manner that hereafter becomes conventional. The mixed MSW **202** can be delivered to the tipping floor module **212** and separated using techniques presently known in the art or any techniques which become available hereafter.

[0033] The mixed MSW **202** can be sorted into at least four separate feedstock streams. For example, depending on its fats and carbohydrates content, the mixed MSW **202** can be directed into one or more of the above-threshold fats feedstock **142**, the above-threshold fats/carbohydrates feedstock **144**, the above-threshold carbohydrates feedstock **146**, and the below-threshold fats/carbohydrates feedstock **148**. As previously mentioned, the above-threshold fats feedstock **142** and the above-threshold fats/carbohydrates feedstock **144** can be delivered to the rendering module **112** to remove fats therefrom, and the defatted feedstock **158** can be delivered to the carbohydrates processing module **116** depending on its carbohydrates content (see FIG. **1**).

[0034] In certain embodiments, it can be undesirable to introduce fats into the carbohydrates processing module **116**, and in such cases, the above-threshold carbohydrates feedstock **146** that is delivered directly to the carbohydrates processing module **116** can be substantially free of fats content. In other embodiments, the above-threshold carbohydrates feedstock **146** can include fats, as discussed further below with respect to FIG. **3**.

[0035] Portions of the mixed MSW **202** that comprise food waste having fats content above a fats threshold value can be directed into the stream of above-threshold fats feedstock **142** or the above-threshold fats/carbohydrates feedstock **144**, depending on the carbohydrates content of the MSW. If the fats content is at or below the fats threshold value, the portions of mixed MSW **202** can be directed into the stream of below-threshold fats/carbohydrates feedstock **148**.

[0036] The fats threshold value can be a dynamic or variable value that is selected or otherwise determined based on one or more factors, which can include the desired inputs for and/or the desired outputs from the processing facility **100**, and which can vary depending on logistical, efficiency, economic, commercial, and/or regulatory considerations. For example, if bio-diesel is in higher demand than electricity, the fats threshold value can be set relatively low such that more food waste is processed through both the rendering module **112** and the fats processing module **114** to obtain a greater amount of bio-diesel **166**, and such that fewer fats are delivered directly to the fluidized bed combustion module **120** for conversion to electricity. Similarly, if electricity is in higher demand than bio-diesel, the fats threshold value can be set relatively high such that less food waste is processed through the rendering module **112** and the fats processing module **114** and such that more fats are combusted in the fluidized bed combustion module **120**.

[0037] A minimum fats threshold value can be dependent on the efficiency of the rendering module **112**. For example, if the rendering module **112** is unable to efficiently separate fats from feedstock having a fat content of less than about 3% fats by weight, the minimum fats threshold value may be set somewhat higher than 3% fats by weight to a level at which a usable amount of fats is separated from the feedstock via the rendering module **112**. For example, the minimum fats threshold value may be set at about 5% fats by weight. The fats threshold value at which the processing facility **100** actually operates may be scaled upwardly from the minimum threshold value depending on such factors as the costs associated with operating the rendering module **112**, the costs of commodities used in operating the fats processing module **114** (e.g., methanol), the opportunity costs lost by consuming electricity generated via the steam processing module **122** or water purified via the water treatment module **123** to operate the fats processing module **114**, and/or the selling price of bio-diesel or glycerin. For example, if the minimum fats threshold value is about 5% fats by weight, the actual fats threshold at which the processing facility **100** operates in various embodiments can be no less than about 5%, no less than about 10%, no less than about 15%, no less than about 20%, or no less than about 25% fats by weight, depending on factors such as those just described. Moreover, the operational fats threshold value can be adjusted as one or more of these factors changes.

[0038] In some cases, the fats threshold value may be set relatively high, or simply may not be used, to permit faster processing of the mixed MSW **202** through the receiving module **110**. For example, the operational fats threshold value can effectively be set at 100% such that all of the mixed MSW **202** that contains fats is directed to the below-threshold fats/carbohydrate feedstock **148**, thereby eliminating the amount of sorting to which the MSW **202** is subjected, which can speed up the processing of the mixed MSW **202**. Stated otherwise, in some embodiments, the mixed MSW **202** is not sorted based on fats content such that substantially all fats contained in the mixed MSW are passed to the fluidized bed combustion module **120** as fuel. For example, the operational fats threshold value may effectively be set at 100% if many trucks filled with mixed MSW **202** are lined up and waiting for access to the tipping floor sub-module **212**, or in the case of a emergency in which generation of as much electricity as possible is desired.

[0039] Portions of the mixed MSW **202** that comprise food waste having both fats content above the fats threshold value and a carbohydrates content above a carbohydrates threshold value can be directed into the above-threshold fats/carbohydrates feedstock **154**. Like the fats threshold value, the carbohydrates threshold value can be dynamically changing value that is selected or otherwise determined based on a variety of factors, such as those mentioned with respect to the fats threshold value. For example, if ethanol is in higher demand than electricity, the carbohydrates threshold value can be set relatively low such that more food waste is processed through the carbohydrates processing module **116** to obtain a greater amount of ethanol, and such that the amount of carbohydrates burned in the fluidized bed combustion module **120** is reduced. In various embodiments, a minimum carbohydrates threshold value can be a carbohydrates content of about 10% carbohydrates by weight, and an operational carbohydrates threshold value can vary so as to no less than about 10%, no less than about 15%, no less than about 20%, no less than about 25%, or no less than about 30% carbohydrates by weight based on factors such as those described above with respect to the fats threshold value.

[0040] In some embodiments, the carbohydrates threshold is applied to the defatted feedstock **158** (see FIG. **1**). For example, once fats have been removed from above threshold fats/carbohydrates feedstock **144** via the rendering module **112** to produce the defatted feedstock **158**, it can be determined whether to pass the defatted feedstock **158** to the carbohydrates processing module **116** or the fluidized bed combustion module **120** depending on whether the carbohydrates content of the defatted feedstock is above or below the carbohydrates threshold value, respectively.

[0041] Portions of the mixed MSW **202** that comprise food waste having a small or insignificant fats content and a carbohydrates content above the carbohydrates threshold value can be directed into the stream of high carbohydrates feedstock **156**. As discussed below with respect to FIG. **3**, in other embodiments, portions of the mixed MSW **202** that include a significant fats content can nevertheless be sorted into the carbohydrates feedstock **156** for direct delivery to the carbohydrates processing module **116**.

[0042] In some cases, the carbohydrates threshold value may be set relatively high to permit faster processing of the mixed MSW **202** through the receiving module **110**. For example, the carbohydrates threshold value can effectively be set at 100% such that all of the mixed MSW **202** is directed to the below-threshold fats/carbohydrates feedstock **148**, thereby eliminating the amount of sorting to which the MSW **202** is subjected, which can speed up the processing of the mixed MSW **202**. Stated otherwise, in some embodiments, the mixed MSW **202** is not sorted based on carbohydrates content such that substantially all carbohydrates contained in the mixed MSW are passed to the fluidized bed combustion module **120** as fuel.

[0043] Food waste having a fats content below the fats threshold value and a carbohydrates content below the carbohydrates threshold value can be directed into the stream of low fats/low carbohydrates feedstock **158**.

[0044] With continued reference to FIG. **2**, additional segregation of the mixed MSW **202** is also possible. For example, as previously mentioned, recyclables **150**, such as, for example, metals, plastics, glass, corrugated paperboard, and paper, can be removed from the MSW and recycled. As depicted at block **218**, materials for which combustion is undesirable can also be separated from the MSW and disposed of in a suitable manner. Such undesirable combustion materials **218** can include materials that would produce excessive noxious gases (e.g., carbon monoxide, sulfur oxides, nitric oxides, and other undesirable gases in excess of levels deemed acceptable by one or more government agencies) or contaminate the ash **180** with heavy metals or chemical residues if the materials were combusted in the fluidized bed combustion module **120**. Examples of undesirable combustion materials **218** can include plastics, electronics components, and batteries.

[0045] In some embodiments, as depicted at block **220**, supplemental feedstock material can be separated from the mixed MSW **202** and directed to the fluidized bed combustion module **120** for use as fuel. The supplemental feedstock **220** can include organic materials such as, for example, yard waste, farm waste, and paper. The supplemental feedstock **220** can be used as a supplemental fuel source when feedstock derived from food waste runs low or contains a relatively small energy content (e.g., has a low BTU content).

[0046] With continued reference to FIG. **2**, in some embodiments, the segregated waste **204** can comprise MSW that has been separated at individual residences and/or businesses. For example, some communities may require households and businesses to segregate food waste from other forms of MSW. Laws and programs to this effect have been implemented in Japan and in some provinces and governmental agencies of Canada, and this trend is likely to continue. Food waste that has been segregated in this manner can be gathered and delivered to the tipping floor sub-module **212** for sorting. In some embodiments, the tipping floor sub-module **212** is configured to debag food waste delivered thereto.

[0047] As with the mixed MSW **202** described above, the segregated waste **204** can be separated into one or more of the feedstock categories that are based on the fats content and the carbohydrates content of the food waste within the feedstock (e.g., feedstocks **142**, **144**, **146**, and **148**). Similarly, recyclable materials **150**, undesirable combustion materials **218**, and/or supplemental feedstock **220** can be sorted from the segregated waste **204**, as described above.

[0048] With continued reference to FIG. **2**, the packaged food waste **206** can comprise, for example, dated, spoiled, recalled, contaminated, and/or damaged food products contained within retail packaging, such as, for example, within bags, pouches, wrappers, cans, bottles, or boxes. The packaged food waste **206** can be delivered to a depackaging sub-module **214**, which can comprise any suitable machine, system, or process for de-casing and/or de-packaging the packaged food waste **206** presently known in the art or that may be developed hereafter. A variety of such machines, systems, or processes may be used to accommodate different types of food or packaging. For example, some machines may be more suitable for use with liquid food wastes, while others may be more suitable for use with solid food wastes.

[0049] Depackaging various types of packaged food waste **206** can yield one or more revenue streams for the processing facility **100** that are separate from the bio-energy products harvested from the food waste. For example, some or all of the packaging removed from the packaged food waste **206** can be recycled. Additionally, in some governmental jurisdications, excise taxes that previously have been levied on cases, kegs, bottles, or cans of beer, wine, or other spirits can be rebated for destroying the food items.

[0050] As with other sources of the food waste stream **130** described above, the depackaged food waste can be separated into one or more of the feedstock categories that are based on fats and carbohydrates content of the food waste within the feedstock (e.g., feedstocks **142**, **144**, **146**, and **148**). Similarly, undesirable combustion materials **218** and/or supplemental feedstock **220** can be sorted from the packaging materials, as described above.

[0051] With continued reference to FIG. **2**, the liquid food waste **208** can be generated as a byproduct of, for example, commercial and industrial food processing facilities, including restaurants. The liquid food waste **208** can comprise, for example, grease trap trappings (e.g., brown grease); sewage grease (e.g., black grease); wash down water; beer waste and beer stillage; spirit and wine stillage; beverage waste; expired or re-called beverages, beer, wine, and spirits; and/or milk and milk products (e.g., whey and milk fat). In some embodiments, the liquid food waste **208** is transported via tankers, and the liquid food waste receiving sub-module **216** can be configured to receive the liquid food waste **208** from the tankers.

[0052] In some instances, the liquid food waste **208** can be delivered from the liquid food waste receiving sub-module **216** directly to the rendering module **112** or the carbohydrates processing module **116** (see FIG. **1**), depending on the fats and/or carbohydrates content of the liquid food waste **208**. As further discussed below, supplying the liquid food waste **208** to the rendering module **112** and the carbohydrates processing module **114** can help to reduce overall water consumption of the processing facility **100**.

[0053] In further instances, the liquid food waste **208** may have a fats content or a carbohydrates content that is below a fats or carbohydrates threshold value. In certain of such instances, the liquid food waste **208** can be delivered directly to the anaerobic digestion module **118**.

[0054] As shown in FIG. **1**, process steam **186** can be delivered to the receiving module **110** from the steam processing module **122** via the process steam distribution system **194**, and can be used for a variety of purposes. For example, process steam can be used to sanitize the food waste stream **130**, to clean out tankers and hauling trucks, and/or to melt or otherwise cause certain food waste materials to flow. Electricity **188** can also be delivered to the receiving module **110** from the steam processing module **122**, and can be used to operate machinery, lights, etc. Process wastewater **152** can be collected after use and delivered to the anaerobic digestion module **118**. The process wastewater **152** can comprise water that has a high content of organics and organic acids. The receiving module **110** is an example a processing module within the processing facility **100** that can both benefit from and contribute to self-sustainable attributes of the processing facility **100**.

[0055] With reference again to FIG. **1**, in certain embodiments, the rendering module **112** can comprise any of a variety of rendering systems known in the art, or any other suitable rendering systems that may yet be devised, that are capable of separating fats from water and other materials. In various embodiments, the rendering module **112** includes one or more cook sub-modules, one or more slurry sub-modules, and/or one or more centrifuge sub-modules. In some embodiments, the rendering module **112** comprises one or more grinding sub-modules, which can be used for size reduction. In certain of such embodiments, packaged food waste **206** (see FIG. **2**) can be sorted into a feedstock category (e.g., **142**, 144, 146, or 148) and passed to the grinding sub-module without being processed through the depackaging sub-module 214. The packaged food waste 206, with packaging (e.g., paper packaging or some plastic packaging) in place, can be ground up and passed through other sub-modules of the rendering module 112. The packaging material can then be burned with the ground food waste or separated from the food waste by any suitable method know in the art or yet to be devised. In some embodiments, one or more centrifuges, grinders, and/or other components of the rendering module 112 can be powered by process steam that is delivered from the process steam distribution system 194.

[0056] In certain embodiments, the fats processing module 114 can comprise any of a variety of fats processing systems known in the art, or any other suitable fats processing systems that may yet be devised. For example, in some embodiments, the fats processing system 114 comprises a bio-diesel plant configured to produce fuel-grade bio-diesel from fats removed from foods. The fats processing system 114 can comprise a glycerin recovery unit. The fats processing system 114 can include pretreatment, process equipment, storage, and load out sub-modules.

[0057] In certain embodiments, the carbohydrates processing module 116 can comprise any of a variety of carbohydrates processing systems known in the art, or any other suitable carbohydrates processing systems that may yet be devised. For example, in some embodiments, the carbohydrates processing system 116 comprises an ethanol plant configured to produce fuel-grade ethanol from feedstock having a high carbohydrates content via fermentation and distillation. The carbohydrates processing module 116 can include cook, fermentation, distillation, dehydration, evaporation, storage, and load out sub-modules.

[0058] In some embodiments, the carbohydrates processing module 116 is highly efficient with respect to water usage. For example, in various embodiments, a majority of, or even substantially all of, the water in which carbohydrates are fermented by the carbohydrates processing module 116 is obtained from the food waste stream 130 (e.g., from liquid food waste 208 shown in FIG. 2). In some embodiments, clean graywater 174 from the anaerobic digestion module 118 and/or clean water 197 from the water treatment module 123 can be used for fermentation.

[0059] In some embodiments, the carbohydrates processing module 116 can include a chiller that uses a refrigerant, which can also reduce the water consumption of the carbohydrates processing module. The carbohydrates processing module 116 can thus be significantly more efficient with respect to water usage than other ethanol plants, such as those that evaporate high volumes of water as blowdown water in cooling towers. Process steam generated by the steam processing module 122 can be used to operate the chiller (e.g., pumps and/or compressors), and can reduce electricity consumption of the carbohydrates processing module 116.

[0060] In certain embodiments, the carbohydrates processing module 116 can function substantially without discharging water outside of the processing facility 100. For example, rather than discharging excess thin stillage to a water treatment plant outside of the processing facility 100, or to tankers for transport outside of the processing facility 100 for use as fertilizer, the carbohydrates processing module 116 can deliver the excess thin stillage to the anaerobic digestion module 118.

[0061] In some instances, rather than processing some or all of the process wastewater 162 from the carbohydrates processing module 116 via the anaerobic digestion module 118 and/or the water treatment module 123, the process wastewater 162 can be mixed with feedstock to form a slurry and delivered to the fluidized bed combustion module 120. In many instances, it can be desirable to deliver wastewater having a high salts content to the fluidized bed combustion module 120 in this manner. The salts can be included in the ash 180 produced by the fluidized bed combustion module 120.

[0062] As previously mentioned, the anaerobic digestion module 118 can produce bio-gas 178, sludge 176, and clean graywater 174 from the process wastewater it receives. Substantially all of the bio-gas 178, which generally comprises primarily methane and carbon dioxide, can be combusted in the fluidized bed combustion module 120. Combustion of methane, which is recognized as a potent greenhouse gas, and other bio-gases in this manner can prevent the release of greenhouse gases into the atmosphere.

[0063] The sludge 176 can be partially dewatered and sold as fertilizer. The sludge 176 can also be used as fuel for the fluidized bed combustion module 120. For example, in some embodiments, the sludge 176 produced by the anaerobic combustion module 120 can be dewatered to comprise between about 15% and about 20% solids by weight. The sludge 176 can then be mixed with other feedstock having a higher solids concentration such that the overall solids concentration of the sludge mixture is increased to a suitable level for combustion in the fluidized bed combustion module. In other embodiments, the sludge can be at least partially dewatered prior to delivery to the fluidized bed combustion module 120.

[0064] The clean graywater 174 produced by the anaerobic combustion module 120 can be delivered to the water treatment module 123 to remove organics, salts and other dissolved solids, and other materials that may be undesirable (e.g., for water that is to be used in a boiler). In some embodiments, the clean graywater 174 can be delivered to the carbohydrates processing module 116 without further processing.

[0065] The fluidized bed combustion module 120 can comprise a fluidized bed combustion chamber configured to operate at high temperatures and to combust materials that come into contact with a fluidized bed of heated material. For example, the fluidized bed can comprise fluidized silica that is heated to a temperature such that it is particularly suited to reduce or eliminate the amount of nitrous oxide produce during combustion. In various embodiments, the fluidized bed combustion module 120 can combust materials having a solids concentration by weight of at least about 20% or at least about 30% depending on the energy content present in the feedstock.

[0066] In many embodiments, the fluidized bed combustion module 120 can be substantially self-sustaining once operational. For example, in some embodiments, sources of energy from outside of the processing facility are used to initialize the fluidized bed combustion module 120. Such outside sources can include one or more of natural gas and electricity. Once the fluidized bed combustion module 120 is sufficiently hot to combust feedstock introduced therein, it can be run substantially continuously on only the feedstock delivered to it from the food waste stream 130. For example, once operational, the fluidized bed combustion module 120 can continue to operate without receiving natural gas or electricity from the external grid **190** as inputs.

[0067] Different feedstock materials are comprised of different energy content, thus the feed rate and selection of materials delivered to the fluidized bed combustion module **120** can be adjusted to maintain substantially continuous operation of the combustion module **120**. Different feedstock materials can be blended to achieve a mixture that contains a relatively uniform energy content and that can maintain relatively consistent and continuous operation of the fluidized bed combustion module **120**.

[0068] As an example, in some cases, bio-gas **178** can be delivered to the fluidized bed combustion module **120** as a supplement to other feedstock material having a higher energy content, but which is delivered to the combustion module **120** in small amounts. The bio-gas **178** can be introduced to the fluidized bed combustion module **120** to compensate for lower delivery rates of other feedstock materials to the fluidized bed combustion module **120**.

[0069] Operation of the fluidized bed combustion module **120** can be substantially undisruptive to the environment. For example, the fluidized bed combustion module **120** can be clean-burning, which may result from limitation of the feedstock delivered thereto to organic materials. The fluidized bed combustion module **120** can produce substantially only heat as a coproduct and stack exhaust and ash as byproducts. The stack exhaust can primarily comprise, or can consist essentially of, water and carbon dioxide. The fluidized bed combustion module **120** can be configured to burn off volatile organic compounds. As previously discussed, the receiving module **110** can be configured to remove undesirable materials from the feedstock delivered to the combustion module **120** that otherwise would produce noxious exhaust gases or contaminate the ash. Additionally, in many embodiments, the feedstock introduced to combustion module **120** can be primarily organic material such that operation of the combustion module **120** is substantially carbon neutral, or stated otherwise, substantially does not provide a net increase in greenhouse gases. For example, carbon dioxide generated in the combustion of agricultural plants and animal products, which may be released in the stack exhaust **181**, is generally regarded as "greenhouse neutral."

[0070] In some embodiments, one or more processing modules can be vented to the fluidized bed combustion module **120**. For example, in some embodiments, air from the receiving module **110**, the fats processing module **114**, the carbohydrates processing module **116**, and/or the anaerobic digestion module **118** can be vented to the fluidized bed combustion module **120**. Bacteria and other odor sources within the air can thus be burned off. Additionally, resultant sulfur and nitrogen compounds can beneficially fall out into the ash **180**.

[0071] The steam processing module **122** can comprise a boiler, a steam turbine, a generator, and a pollution control system. As is known in the art, the steam processing module **122** can utilize a boiler to create high-pressure steam from the heat produced by the fluidized bed combustion module **122**. In some embodiments, the high-pressure steam drives the steam turbine and is stepped down to low pressure steam. A generator can generate electricity from the activated steam turbine.

[0072] The water treatment module **123** can be configured to purify water via sand filtration, membrane filtration, and/or reverse osmosis. Numerous other suitable water-processing techniques are also possible.

[0073] In some embodiments, no water, or very little water, is delivered to the water treatment module **123** from the outside fresh water source **196**. The water treatment module **123** thus can aid in the substantially self-sufficiency of the processing facility **100** with respect to water usage. In some embodiments, the processing facility **100** can be balanced to be a net producer of clean water **197** such that excess clean water **197** can be sold or otherwise delivered outside of the processing facility **100**. For example, in some embodiments, water derived from the food waste stream **130** can be delivered to the anaerobic digestion module **118**, which can process the water into clean graywater **174** that is delivered to the water treatment module **123** for further processing into clean water **197** suitable for boiler water or process water.

[0074] As previously mentioned, in some embodiments, it can be advantageous to process substantially all process wastewater produced within the processing facility **100** via the anaerobic digestion module **118** and/or the water treatment module **123**. The processing facility **100** can operate substantially without discharging any wastewater outside of the processing facility **100**. In other embodiments, it may be more profitable to discharge, rather than re-use, the wastewater. In certain of such embodiments, the wastewater can be treated by the anaerobic digestion module **118** and then directed to outside water disposal or additional water treatment systems.

[0075] As previously mentioned, the processing facility **100** can be operated in a highly-efficient and substantially self-sustaining manner. The production capacities of each processing module can be matched to the size and content of the inputs thereto (e.g., the food waste stream **130**) such that the processing facility **100** can maintain substantially continuous and profitable operation. Moreover, the processing facility **100** can be adapted or adjusted based on the desired outputs therefrom, such as the amounts of products (e.g., bio-diesel, glycerin, ethanol, electricity, low-pressure steam, water, ash), coproducts (fats, bio-gas, sludge), or byproducts (e.g., stack exhaust). Balance can also be achieved among the processing modules with respect to the respective inputs (e.g., feedstock, electricity, process steam, process water) and outputs (e.g., altered feedstock or coproducts) of each module.

[0076] In some embodiments, a balance among the various processing modules of the processing facility **100** can be substantially static. For example, the size and content of the food waste stream **130** can be substantially consistent and predictable such that operation of the processing modules is also consistent or follows a regular pattern.

[0077] In other embodiments, achieving balance among the constituent processing modules so as to maintain substantially continuous operation of the processing facility **100** can be achieved dynamically. For example, the size and composition of the food waste stream **130** may vary significantly over time. As the food waste stream **130** varies, the processing facility **100** can adapt by delivering the food waste stream **130** to the appropriate processing modules, each of which can yield suitable feedstock for the fluidized bed combustion module **120**. For example, the fats processing module **114** can produce defatted feedstock **172** having a high energy content, and the anaerobic digestion module **118** can produce bio-gas **178** having a relatively low energy content. The processing facility **100** can be sufficiently adaptable to maintain substantially continuous operation of the fluidized bed combustion module **120**, despite variations that may arise in the food waste stream **130**. For example, if only small amounts of high energy feedstock is available, combustion of the high energy feedstock can be supplemented with biogas. Similarly, plant-based yard waste, agricultural waste, and/or paper waste can be used to supplement feedstock derived from the food-waste stream.

[0078] As previously discussed, dynamic balancing can also be achieved by varying the fats threshold and/or the carbohydrates threshold to thereby adjust the relative amounts of bio-diesel, ethanol, and/or electricity being produced by the processing facility **100**. The processing facility **100** can be dynamically balanced to increase a net output of bio-diesel, glycerin, ethanol, ash, electricity, low-pressure steam, and/or clean-water. Similarly, the processing facility can be dynamically balanced to curtail the production of bio-diesel, glycerin, ethanol, ash, electricity, low-pressure steam, clean-water, and/or stack exhaust.

[0079] In further embodiments, the relative sizes and capacities of the various processing modules of the processing facility **100** can be tailored to a known set of inputs or outputs. For example, in some geographic regions (e.g., tropical islands), the food waste stream **130** may predominantly comprise food wastes from the production of sugar, molasses, or rum that have a high carbohydrate content. The processing facility **100** thus can have a relatively larger carbohydrates processing module **116** to allow for greater amounts of ethanol production. In some geographic regions, it may be desirable to generate electricity, minimize water consumption, and/or curtail stack exhaust emissions, and the balance of the processing facility **100** can be adjusted accordingly.

[0080] As previously discussed, the processing facility **100** can be substantially electrically self-sustaining such that electricity derived from a food waste stream **130** is substantially sufficient to maintain operation of the processing facility once the fluidized bed combustion module **120** is operational. Additionally, use of process steam to drive motors, compressors, and other equipment of the processing modules can reduce the electricity consumption of the processing facility **100** and thereby increase its net electricity production. Similarly, the processing facility **100** can also be balanced and substantially self-sufficient with respect to process water consumption and/or process steam production and use, or can be a net producer of process water and/or process steam.

[0081] The processing facility **100** can be operated profitably due to a variety of factors. For example, landfills often consider food products as undesirable and, and often restrict or prohibit disposing of food product in the landfill, or may charge higher tariffs for such disposal. This can especially be true for large quantities of food waste, such as for food that is dated, spoiled, recalled, contaminated, or damaged. By accepting as feedstock food waste that is generally undesirable and often difficult and expensive to dispose of, or even prohibited from disposal in certain landfills, the processing facility **100** can utilize food waste in lieu of commoditized feedstock commonly used to produce bio-fuels, such as soybeans or corn, and can eliminate the commercial or commodity risks associated therewith.

[0082] In some embodiments, the processing facility **100** can be located at or near a landfill site to enable the ready interception of food waste that is already destined for the landfill. The food waste thus can be delivered to the processing facility **100** at little to no additional transportation cost to a waste carrier. In some embodiments, the processing facility **100** charges a smaller fee for access to a tipping floor of the processing facility **100** than would be charged to permit tipping of the food waste at a landfill.

[0083] MSW carriers often provide the services of collection, transportation, and tipping at published rates, which can generally be stable over long time periods, and may even be are mandated by local governments and regulatory agencies. Agreements reached between an MSW carrier and its customers under such long-term tariff rates can ensure both the future supply of feedstock for the processing facility **100** and the future costs (if any) for the feedstock.

[0084] Any or all of the foregoing factors can contribute to a profitable processing facility **100**. For example, by eliminating the use of commodity feedstock and the commercial or commodity risks associated therewith, by being self-sufficient with respect to process energy, and/or by limiting water requirements, the processing facility **100** can be substantially financially isolated from fluctuations in various commodities markets. Additionally, the processing facility can produce multiple and diversified income streams. Examples of income streams can include sales of ethanol, bio-diesel, glycerin, and electricity, which can be primary sources of income in some embodiments. In further embodiments, secondary sources of income can include sales of fertilizer or construction ash, sales of recyclables, de-packaging disposal fees, MSW tipping fees, waste water and liquid food waste disposal fees, and, in some cases, government "green" energy credits and tax incentives, such as "carbon credits" that are currently available in some governmental jurisdictions.

[0085] In various embodiments, the processing facility **100** can provide one or more additional benefits. For example, with respect to landfills, the processing facility **100** can extend the life of the landfills; reduce odors, diseases, putrid organics, vermin, and insects; reduce bio-hazard and water pollution sources; and reduce the risk of fires. The processing facility **100** can have a low impact on water supplies, such as may result from utilizing the high water content present in waste foods, by efficient use of excess process steam for both heating and cooling, by recycling water via the anaerobic digestion module, and by operation of a dedicated water treatment module. The destruction of spoiled, recalled, or damaged food products can also eliminate the so-called "cradle-to-grave" risk that can be associated with such products. Further, the processing facility **100** can be balanced so as to meet or exceed any environmental regulations imposed on the processing facility **100** by one or more governmental bodies.

[0086] In addition to the foregoing environmental benefits, the outputs of the processing facility **100** can be substantially undisruptive to the environment. For example, the stack exhaust from the processing facility **100** can meet or exceed environmental regulations, the ash can be clean and free of heavy metals, and the bio-fuels can be clean-burning and substantially carbon-neutral.

[0087] FIG. **3** illustrates another embodiment of a processing facility **300**. The processing facility **300** is similar to the processing facility **100** in many respects, thus like features are identified with like reference numerals. The processing facility **300** includes a fats processing module **314** such as the fats processing module **114** discussed above with respect to FIG. **1**. Rather than processing the fats **156** received from a rendering module **112** into biodiesel and glycerin, the fats processing module **314** can be configured to process the fats **156** into a clean or polished oil **369** that is in a form suitable for industrial uses, such as, for example, soap manufacture. The oil **369** can be sold to provide an income stream for the processing facility **300**.

[0088] In further embodiments, the fats processing module **314** can be configured to produce biodiesel and glycerin from the fats **156**. Based on such factors as the commodity price of materials used in the manufacture of biodiesel and glycerin (e.g., methanol and caustic) and/or the selling price of biodiesel or glycerin, the processing module **314** can be configured to produce either the oil **169** or biodiesel and glycerin, depending on which is more profitable.

[0089] The processing facility **300** can further include a carbohydrates processing module **316**, such as the carbohydrates processing module **116**, which is configured to separate fats **165** from an above-threshold carbohydrates feedstock **146**. For example, in some cases, the above-threshold carbohydrates feedstock **146** can comprise a fats content by weight that is less than a given fats threshold value at which the processing facility **300** is operating. Processing the above-threshold carbohydrates feedstock **146** via the carbohydrates processing module **316** significantly, or substantially completely, reduces the carbohydrates content of the feedstock **146** such that the distiller coproducts **164** (see FIG. **1**) comprise a fats content by weight that is above the fats threshold value. Stated otherwise, the fats content of the distiller coproducts **164** can be concentrated by fermentation activity of the carbohydrates processing module **116**. Fats can be separated from the distiller coproducts **164** such that the carbohydrates processing module **316** yields defatted distiller coproducts **364** and fats **365**. The defatted distiller coproducts **364** can be delivered directly to the fluidized bed combustion module **120** as fuel, and the fats **365** can be delivered to the fats processing module **314** for further processing. The carbohydrates processing module **316** comprises a decanter and/or other suitable equipment to aid in segregating the fats **365** from the defatted distiller coproducts **364**.

[0090] FIG. **4** illustrates another embodiment of a processing facility **400**. The processing facility **400** does not include a water treatment module **123**. Clean water can be delivered to processing modules from outside sources, such as wells or municipal water lines. As shown by the use of like reference numerals, other features of the processing facility **400** can be similar to those of the processing facility **100**.

[0091] FIG. **5** illustrates another embodiment of a processing facility **500**. The processing facility **500** is similar to the processing facility **100** in many respects, thus like features are identified with like reference numerals. The processing facility **500** does not include a carbohydrates processing facility, thus a receiving module **110** segregates a food waste stream **130** into an above-threshold fats feedstock **542** and a below-threshold fats feedstock **548**. The above-threshold fats feedstock **542** is delivered to a rendering module **112** in a manner such as described above. The below-threshold fats feedstock **548** is delivered to a fluidized bed combustion module **120** as fuel. In addition, the processing facility **300** does not include a water treatment module **123**.

[0092] FIG. **6** illustrates another embodiment of a processing facility **600**. The processing facility **600** is similar to the processing facility **100** in many respects, thus like features are identified with like reference numerals. The processing facility **600** does not include a fats processing facility, thus a receiving module **110** segregates a food waste stream **130** into an above-threshold carbohydrates feedstock **646** and a below-threshold carbohydrates feedstock **648**. The below-threshold carbohydrates feedstock can include food waste having a carbohydrates content that is above a carbohydrates threshold value, but which also includes a fats content that is unsuitable for delivery to a carbohydrates processing module **116**. The above-threshold carbohydrates feedstock **646** is delivered to the carbohydrates processing module **116** in a manner such as described above. The below-threshold carbohydrates feedstock **648** is delivered to a fluidized bed combustion module **120** as fuel.

[0093] Without further elaboration, it is believed that one skilled in the art can use the preceding description to utilize the present disclosure to its fullest extent. The examples and embodiments disclosed herein are to be construed as merely illustrative and not a limitation to the scope of the present disclosure in any way. It will be apparent to those having skill in the art that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure described herein.

[0094] Additionally, any suitable combination of the features of one or more embodiments is possible. For example, one or more of the fats processing module **314** and the carbohydrates processing module **316** of the processing facility **300** can replace the corresponding fats processing module **114** and/or carbohydrates processing module **116** of the processing facility **100**. Similar substitutions can be made with some or all of the respective components of the processing facilities **100**, **300**, **400**, **500**, **600**. Where like or similar components are disclosed in multiple embodiments, the description of those components with respect to one embodiment can apply to the other embodiments as well. Various modifications and improvements of the embodiments specifically disclosed in the description above are within the scope of the disclosure and appended claims.

1. A system for converting food waste into bio-energy, the system comprising:

a receiving module in which a food waste stream is received and sorted based on relative fats and carbohydrates levels of food waste within the food waste stream, wherein the receiving module sorts the food waste stream into at least a first feedstock that comprises food waste having a fats content above a fats threshold value and a second feedstock that comprises food waste having a carbohydrates content above a carbohydrates threshold value;

a rendering module configured to receive the first feedstock from the receiving module and to separate fats from the first feedstock;

a fats processing module configured to receive fats from the rendering module and produce one or more of bio-diesel and glycerin from the fats;

a fluidized bed combustion module configured to receive from the rendering module at least a portion of the first feedstock that has been defatted, and further configured to receive at least a portion of the second feedstock, wherein the fluidized bed combustion module is configured to combust the feedstock materials received therein.

2. The system of claim **1**, further comprising a steam processing module coupled with the fluidized bed combustion module, wherein the steam processing module is configured to produce high-pressure steam using heat produced by the fluidized bed combustion module and to convert the high-pressure steam into electricity and low-pressure steam, wherein at least a portion of the electricity produced by the steam processing module provides power to the receiving module, the rendering module, and the fats processing module.

3. The system of claim **2**, wherein at least a portion of the low-pressure steam is delivered as process steam to one or more of the receiving, rendering, and fats processing modules.

4. The system of claim **2**, wherein at least a portion of the electricity produced by the steam processing module is provided to an external power grid.

5. The system of claim **2**, further comprising a carbohydrates processing module configured to receive the second feedstock from the receiving module and to produce ethanol and distiller coproducts from the second feedstock, wherein at least a portion of the distiller coproducts are delivered to the fluidized bed combustion module.

6. The system of claim **5**, wherein the receiving module further sorts the food waste stream into a third feedstock that comprises food waste having both a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value, wherein the third feedstock is delivered to the rendering module for fats extraction, and wherein fats removed from the third feedstock is delivered to the fats processing module and at least a portion of the defatted third feedstock is delivered to the carbohydrates processing module.

7. The system of claim **6**, further comprising an anaerobic digestion module that receives process wastewater from one or more of the receiving, fats processing, and carbohydrates processing modules, wherein the anaerobic digestion module produces bio-gas that is delivered to the fluidized bed combustion module.

8. The system of claim **7**, wherein bio-gas produced by the anaerobic digestion module is selectively delivered to the fluidized bed combustion module to supplement feedstock material delivered to the fluidized bed combustion module from the fats processing and carbohydrates processing modules so as to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

9. The system of claim **8**, wherein water is recycled within the system such that a majority of make-up water used by the carbohydrates processing module is delivered to the carbohydrates processing module from the anaerobic digestion module, and wherein the anaerobic digestion module produces said majority of make-up water from process wastewater received from one or more other modules within the system.

10. The system of claim **9**, wherein the carbohydrates processing module comprises a chiller that uses a refrigerant.

11. The system of claim **10**, wherein at least a portion of the low pressure steam is delivered from the steam processing module to the chiller to operate the chiller.

12. The system of claim **5**, further comprising an anaerobic digestion module that receives process wastewater from one or more of the receiving, fats processing, and carbohydrates processing modules and that produces bio-gas from the process wastewater, wherein at least a portion of the bio-gas produced by the anaerobic digestion module is selectively delivered to the fluidized bed combustion module to supplement feedstock material delivered to the fluidized bed combustion module from the fats processing and carbohydrates processing modules so as to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

13. The system of claim **5**, wherein water is recycled within the system such that a majority of make-up water used by the carbohydrates processing module is delivered to the carbohydrates processing module from an anaerobic digestion module, and wherein the anaerobic digestion module produces said majority of make-up water from process wastewater received from one or more other modules within the system.

14. The system of claim **13**, wherein the carbohydrates processing module comprises a chiller that uses a refrigerant, wherein at least a portion of the low pressure steam is delivered from the steam processing module to the chiller to operate the chiller, and wherein water that has been processed by the anaerobic digestion module is delivered to the carbohydrates processing module as process water.

15. The system of claim **5**, wherein at least a portion of the electricity produced by the steam processing module provides power to the carbohydrates processing module and at least a portion of the low-pressure steam produced by the steam processing module is delivered to the carbohydrates processing module as process steam.

16. The system of claim **15**, wherein when the fluidized bed combustion module is operational to combust materials received therein, a rate of delivery of feedstock materials into the fluidized bed combustion module is controlled such that the fluidized bed combustion module remains operational to combust materials received therein and such that electricity produced by the steam processing module is sufficient to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

17. The system of claim **1**, further comprising a carbohydrates processing module configured to receive the second feedstock from the receiving module and to produce ethanol and distiller coproducts from the second feedstock, wherein at least a portion of each of the distiller coproducts is delivered to the fluidized bed combustion module.

18. The system of claim **17**, wherein the receiving module further separates the food waste stream into a third feedstock that comprises food waste having a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value, wherein the third feedstock is delivered to the rendering module for fats extraction, and wherein fats removed from the third feedstock is delivered to the fats processing module and at least a portion of the defatted third feedstock is delivered to the carbohydrates processing module.

19. The system of claim **17**, further comprising an anaerobic digestion module that receives process wastewater from one or more of the receiving, fats processing, and carbohydrates processing modules and that produces bio-gas from the process wastewater, wherein at least a portion of the bio-gas is selectively delivered to the fluidized bed combustion module to supplement feedstock material delivered to the fluidized bed combustion module from the fats processing and carbohydrates processing modules so as to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

20. The system of claim **17**, wherein when the fluidized bed combustion module is operational to combust materials received therein, a rate of delivery of feedstock materials into the fluidized bed combustion module is controlled such that the fluidized bed combustion module remains operational to combust materials received therein and such that electricity produced using heat generated by the fluidized bed combustion module is sufficient to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

21. The system of claim **17**, wherein water is recycled within the system such that a majority of make-up water used by the carbohydrates processing module is delivered to the carbohydrates processing module from an anaerobic digestion module, and wherein the anaerobic digestion module produces said majority of make-up water from process wastewater received from one or more other modules within the system.

22. The system of claim **1**, wherein when the fluidized bed combustion module is operational to combust materials received therein, a rate of delivery of feedstock materials into the fluidized bed combustion module is controlled such that the fluidized bed combustion module remains operational to combust materials received therein and such that electricity produced using heat generated by the fluidized bed combustion module is sufficient to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

23. The system of claim **1**, wherein the receiving module separates the food waste stream into a third feedstock that comprises food waste having a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value, wherein the third feedstock is delivered to the rendering module for fats extraction, and wherein fats removed from the third feedstock is delivered to the fats processing module and at least a portion of the defatted third feedstock is delivered to a carbohydrates processing module.

24. The system of claim **1**, wherein the food waste stream comprises food contained in packaging material and wherein the receiving module comprises a depackaging sub-module configured to separate food waste from the packaging material.

25. The system of claim **1**, wherein the food waste stream comprises liquid food waste having one or more of a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value, and wherein the receiving station is configured to direct the liquid food waste to one or more of the rendering module, the fats processing module, and a carbohydrates processing module.

26. The system of claim **1**, wherein the receiving module removes items from the food waste stream that would cause the fluidized bed burner to exhaust noxious gases.

27. The system of claim **1**, wherein the fats threshold value comprises a fats content by weight of about 5% and the carbohydrates threshold value comprises a carbohydrates content by weight of about 10%.

28. A system for converting food waste into bio-energy, the system comprising:

a receiving module that directs a food waste stream based on relative levels of fats and carbohydrates of food waste within the food waste stream, wherein the receiving module directs at least a portion of the food waste stream into a first feedstock that comprises food waste having a fats content that exceeds a fats threshold value and a second feedstock that comprises food waste having a carbohydrates content that exceeds a carbohydrates threshold value;

a fats processing module configured to receive and alter the first feedstock;

a carbohydrates processing module configured to receive and alter the second feedstock; and

a fluidized bed combustion module configured to combust feedstock delivered thereto,

wherein at least a portion of the first feedstock is delivered to the fats processing module and is converted to one or more of bio-diesel and glycerin and at least a portion of the first feedstock is delivered to the fluidized bed combustion module and is combusted, and

wherein at least a portion of the second feedstock is delivered to the carbohydrates processing module and is converted to ethanol and at least a portion of the second feedstock is delivered to the fluidized bed combustion module and is combusted.

29. The system of claim **28**, wherein the receiving module further directs the food waste stream into a third feedstock that comprises food waste having both a fats content that exceeds the fats threshold value and a carbohydrates content that exceeds the carbohydrates threshold value, wherein at least a portion of the third feedstock is delivered to the fats processing module and at least a portion of the third feedstock is delivered to the carbohydrates processing module.

30. The system of claim **29**, wherein the third feedstock is delivered to a rendering module, wherein fats separated from the feedstock by the rendering module is delivered to the fats processing module, and wherein at least a portion of the defatted third feedstock is delivered to the carbohydrates processing module.

31. The system of claim **29**, wherein the receiving module further directs the food waste stream into a fourth feedstock that comprises food waste having both a fats content below the fats threshold value and a carbohydrates content below the carbohydrates threshold value, and wherein the fourth feedstock is delivered directly to the fluidized bed combustion module.

32. The system of claim **28**, wherein when the fluidized bed combustion module is operational to combust materials received therein, a rate of delivery of feedstock materials into the fluidized bed combustion module is controlled such that the fluidized bed combustion module remains operational to combust materials received therein and such that electricity produced using heat generated by the fluidized bed combustion module is sufficient to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

33. The system of claim **28**, further comprising a steam processing module coupled with the fluidized bed combustion module, wherein the steam processing module produces high-pressure steam using heat produced by the fluidized bed combustion module and converts the high-pressure steam into electricity and low-pressure steam, and wherein the steam processing module provides at least a portion of the electricity and the low-pressure steam to the receiving module, the fats processing module, and the carbohydrates processing module.

34. The system of claim **28**, further comprising a anaerobic digestion module that receives process wastewater from one or more of the receiving, fats processing, and carbohydrates processing modules and that produces bio-gas from the process wastewater.

35. The system of claim **34**, wherein bio-gas produced by the anaerobic digestion module is selectively delivered to the fluidized bed combustion module to supplement feedstock material delivered to the fluidized bed combustion module from the fats processing and carbohydrates processing modules so as to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

36. The system of claim **28**, wherein electricity is generated from heat produced by the fluidized bed burner, and wherein at least a portion of the electricity provides power to the receiving, bio-diesel, and carbohydrates processing modules.

37. A system for converting food waste into bio-energy, the system comprising:

a food waste stream comprising a first feedstock that comprises food waste having a fats content above a fats threshold value and a second feedstock that comprises food waste having a carbohydrates content above a carbohydrates threshold value;

a fats processing module configured to produce bio-diesel from a portion of the first feedstock;

a carbohydrates processing module configured to produce ethanol from a portion of the second feedstock; and

a fluidized bed combustion module configured to combust feedstock delivered thereto,

wherein when the fluidized bed combustion module is operational to combust materials received therein, a rate of delivery of portions of the first and second feedstocks into the fluidized bed combustion module is controlled such that the fluidized bed combustion module remains operational to combust materials received therein and such that electricity produced using heat generated by the fluidized bed combustion module is sufficient to maintain operation of the system substantially without input of energy sources other than the food waste stream into the system.

38. A method of converting food waste into bio-energy, the method comprising:

providing a system that comprises a fats processing module, a carbohydrates processing module, a fluidized bed combustion module, and a steam processing module;

separating fats from a first feedstock that comprises food waste having a fats content that exceeds a fats threshold value;

producing bio-diesel from the fats via the fats processing module;

producing ethanol from a second feedstock that comprises food waste having a carbohydrates content that exceeds a carbohydrates threshold value via the carbohydrates processing module;

combusting an input feedstock via the fluidized bed combustion module, wherein the input feedstock comprises at least a portion of the first feedstock that is not converted to bio-diesel and at least a portion of the second feedstock that is not converted to ethanol;

generating electricity and low-pressure steam via the steam processing module; and

regulating the content and feed rate of the input feedstock into the fluidized bed combustion module so as to maintain substantially continuous operation of the fluidized bed combustion module and so as to generate sufficient electricity and process steam to operate the system substantially without using energy sources other than the input feedstock.

39. The method of claim **38**, further comprising separating the first feedstock and the second feedstock from a food waste stream.

40. The method of claim **38**, wherein the system further comprises an anaerobic digestion module, wherein the method further comprises producing bio-gas via the anaerobic digestion module from process wastewater that results from said production of bio-diesel and ethanol, and wherein the input feedstock that is combusted via the fluidized bed combustion module further comprises at least a portion of the bio-gas.

41. A method of converting food waste into bio-energy, the method comprising:

providing a system that comprises a rendering module, a fats processing module, a carbohydrates processing module, and a fluidized bed combustion module;

channeling a food waste stream into a first feedstock that comprises food waste having a fats content above a fats threshold value, a second feedstock that comprises food waste having a carbohydrates content above a carbohydrates threshold value, and a third feedstock that comprises food waste having both a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value;

separating fats from the first feedstock and from the third feedstock via the rendering module;

producing bio-diesel via the fats processing module from the fats separated from the first feedstock and from the fats separated from the third feedstock via the rendering module;

producing ethanol via the carbohydrates processing module from the second feedstock and from a defatted portion of the third feedstock;

combusting an input feedstock via the fluidized bed combustion module to generate electricity, wherein the input feedstock comprises at least a portion of the first and third feedstocks that is not converted to bio-diesel and at least a portion of the second and third feedstocks that is not converted to ethanol; and

regulating the content and feed rate of the input feedstock into the fluidized bed combustion module so as to maintain substantially continuous operation of the fluidized bed combustion module and so as to generate sufficient electricity to power the system substantially without using outside sources of electricity.

42. The method of claim **41**, wherein the system further comprises an anaerobic digestion module, wherein the method further comprises producing bio-gas via the anaerobic digestion module from process wastewater that results from said production of bio-diesel and ethanol, and wherein the input feedstock further comprises at least a portion of the bio-gas.

43. A method of converting food waste into bio-energy, the method comprising:

providing a system that comprises a fats processing module, a carbohydrates processing module, and a fluidized bed combustion module;

channeling a food waste stream into a first feedstock that comprises food waste having a fats content above a fats threshold value and a second feedstock that comprises food waste having a carbohydrates content above a carbohydrates threshold value;

producing bio-diesel from the first feedstock via the fats processing module;

selectively delivering the second feedstock either to the carbohydrates processing module for production of ethanol and distiller coproduct or to the fluidized bed combustion module based at least partially on the carbohydrates content of the second feedstock; and

combusting an input feedstock via the fluidized bed combustion module to generate electricity, wherein the input feedstock comprises at least a portion of the first feedstock that is not used in producing bio-diesel and either the second feedstock or at least a portion of the distiller coproduct produced from the second feedstock.

44. The method of claim **43**, wherein the system further comprises a rendering module, the method further comprising:

channeling the food waste stream into a third feedstock that comprises both a fats content above the fats threshold value and a carbohydrates content above the carbohydrates threshold value; and

selectively delivering the third feedstock to one or more of the rendering module, the carbohydrates processing module, and the fluidized bed combustion module based at least partially on the relative levels of fats and carbohydrates in the third feedstock.

45. A method for converting food waste into bio-energy, the method comprising:

providing a system that comprises a fats processing module and a fluidized bed combustion module;

segregating a first feedstock from a food waste stream, wherein the first feedstock comprises food waste having a fats content that exceeds a fats threshold value;

separating fats from the first feedstock;

producing bio-diesel from the fats via the fats processing module;

combusting an input feedstock via the fluidized bed combustion module to generate electricity, wherein the input feedstock comprises at least a portion of the first feedstock that is not converted to bio-diesel; and

altering the fats threshold value to thereby alter the relative amounts of bio-diesel and electricity produced by the system.

46. The method of claim **45**, wherein altering the fats threshold value is based on a relative demand for bio-diesel versus electricity.

47. The method of claim **45**, further comprising segregating a second feedstock from the food waste stream, wherein the second feedstock comprises food waste having a carbohydrates content that exceeds a carbohydrates threshold value, and wherein the method further comprises converting at least a portion of the second feedstock into ethanol.

48. The method of claim **47**, further comprising altering the carbohydrates threshold value to thereby alter the relative amounts of ethanol and electricity produced by the system.

49. The method of claim **45**, further comprising:

separating recyclable packaging material from the food waste stream; and

collecting revenue for at least a portion of the recyclable packaging material.

50. A method for converting food waste into bio-energy, the method comprising:

providing a system that comprises a carbohydrates processing module and a fluidized bed combustion module;

segregating a first feedstock from a food waste stream, wherein the first feedstock comprises food waste having a carbohydrates content that exceeds a carbohydrates threshold value;

producing ethanol from the first feedstock via the carbohydrates processing module;

combusting an input feedstock via the fluidized bed combustion module to generate electricity, wherein the input feedstock comprises at least a portion of the first feedstock that is not converted to ethanol; and

altering the carbohydrates threshold value to thereby alter the relative amounts of ethanol and electricity produced by the system.

51. The method of claim **50**, wherein altering the carbohydrates threshold value is based on a relative demand for ethanol versus electricity.

52. A method for environmentally undisruptive disposal of food waste, the method comprising:

providing a food waste stream;

converting a portion of the food waste stream into bio-diesel via a fats processing module;

converting a portion of the food waste stream into ethanol via a carbohydrates processing module;

combusting a portion of the food waste stream via a fluidized bed combustion module to generate electricity;

delivering process wastewater from each of the fats processing module and the carbohydrates module to an anaerobic digestion module to produce clean graywater; and

delivering at least a portion of the clean graywater to the carbohydrates processing module as process water.

53. The method of claim **52**, wherein substantially all process wastewater output from the carbohydrates processing module is delivered to the anaerobic digestion module for processing of the process wastewater.

54. The method of claim **52**, further comprising:

delivering condensate from the carbohydrates processing module to a water treatment module and delivering a portion of the clean graywater from the anaerobic digestion module to the water treatment module; and

cleaning the condensate and clean graywater via the water treatment module.

55. The method of claim **54**, further comprising providing a steam processing module configured to convert clean water into steam, wherein substantially all clean water used by the steam processing module is provided by the water treatment module.

56. The method of claim **52**, wherein a source of the food waste stream is physically situated at a first location, and wherein the fats processing module, the carbohydrates processing module, and the fluidized bed combustion module are physically situated at a second location that is closer to a landfill than is the first location.

57. A method for environmentally undisruptive disposal of food waste, the method comprising:

providing a system that comprises a carbohydrates processing module, an anaerobic digestion module, and a fluidized bed combustion module;

receiving food waste into the system from a source outside of the system;

converting at least a portion of the food waste into ethanol via the carbohydrates processing module;

combusting at least a portion of the food waste via the fluidized bed combustion module to thereby produce electricity for powering the system;

cleaning water via the anaerobic digestion module from process wastewater delivered to the anaerobic digestion module from one or more modules within the system; and

providing water that has been cleaned by the anaerobic digestion module to the carbohydrates processing module such that the cleaned water constitutes a majority of make-up water used in operation of the carbohydrates processing module.

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