CLAIMS

1. A method of operating a solar system comprising a light receiving surface, a condensation subassembly, a water collection subassembly, a cleaning subassembly, one or more ambient sensors, a compressed air supply, and a process controller, wherein the method comprises:

receiving light at the light receiving surface of the solar system, the light receiving surface exposed to ambient air;

the condensation subassembly comprises an expansion chamber that is thermally coupled to the light receiving surface and thermally insulated from the ambient air;

controlling a compressed air expansion valve to release compressed air from the compressed air supply into the expansion chamber of the condensation subassembly wherein compressed air pressure of the compressed air supply differs from ambient pressure and the compressed air expands in the expansion chamber to thermally cool at least a portion of the light receiving surface below a dew point temperature of the ambient air to condense water from humidity in the ambient air on the light receiving surface by indirectly thermally cooling the light receiving surface via the thermal coupling of the light receiving surface and the expansion chamber of the condensation subassembly;

collecting the water from the light receiving surface into a water collection vessel of the water collection subassembly via water direction hardware positioned to direct the condensed water on the light receiving surface to the water collection vessel;

dispensing the collected water from the water collection vessel via a cleaning fluid duct of the cleaning subassembly over the light receiving surface via a water dispensing unit of the cleaning subassembly; and

controlling the release of the compressed air from the compressed air supply through the compressed air expansion valve as a function of at least one of a temperature condition, a humidity condition, and a wind speed condition of the ambient air based on an output of the one or more ambient sensors.

2. The method of claim 1 wherein the light receiving surface comprises a reflective face of a solar reflector module and the expansion chamber of the

condensation subassembly is thermally coupled to a backside of the solar reflector module.

3. The method of claim 1 wherein the light receiving surface comprises an input face of a photovoltaic module and the expansion chamber of the condensation subassembly is thermally coupled to a backside of the photovoltaic module.

4. The method of claim 3 wherein:

the compressed air supply is coupled to the compressed air expansion valve of the condensation subassembly; and

the photovoltaic module is configured to dedicate a portion of its photovoltaic output to the compressed air supply.

5. The method of claim 4 wherein the solar system further comprises a supplemental power receptacle configured to permit system operation under supplemental power when the photovoltaic output of the photovoltaic module falls below a minimum operational threshold.

6. The method of claim 1 wherein the light receiving surface comprises a transparent hydrophobic coating.

7. The method of claim 1 wherein the light receiving surface comprises an input face of a photovoltaic module and the method further comprises:

measuring a photovoltaic system performance of the photovoltaic module using a photovoltaic module power monitor;

comparing the photovoltaic system performance level to a hypothetical expected-maximum photovoltaic system performance level to determine a system performance degradation; and

dispensing water over the light receiving surface using the cleaning subassembly with regard to minimizing the system performance degradation.

8. The method of claim 1 wherein the solar system comprises a plurality of light receiving surfaces arranged to define an array of solar units, each associated with a condensation subassembly, a water collection subassembly, and a cleaning subassembly.

9. The method of claim 1 wherein:

the solar system comprises a plurality of light receiving surfaces arranged to define an array of solar units, each associated with a condensation subassembly, a water collection subassembly, and a cleaning subassembly; and

the compressed air supply comprises a central compressed air supply or a plurality of dedicated compressed air supplies in communication with individual solar units of the array of solar units.

10. The method of claim 1 wherein:

the compressed air supply comprises a water trap positioned to dehumidify compressed air from the compressed air supply before the compressed air enters the expansion chamber of the condensation subassembly;

the water trap is placed in fluid communication with the water collection vessel of the water collection subassembly via a supplemental water collection valve; and

the water trap prevents water entrainment on the interior surfaces of the condensation subassembly.

11. The method of claim 10 wherein:

the water trap comprises cooling fins to condense humidity in the compressed air to prevent water entrainment on the interior surfaces of the condensation subassembly.

12. The method of claim 1 wherein:

the light receiving surface comprises an input face of a photovoltaic or solar reflector module; and

one side of the expansion chamber of the condensation subassembly is thermally coupled to a backside of the module via a thermal conductivity material.

13. The method of claim 12 wherein an opposite side of the expansion chamber of the condensation subassembly comprises a layer of thermally insulating material.

14. The method of claim 1 wherein the water collection subassembly comprises a water collection filter positioned to remove particulates from the condensed water before it is directed to the water collection vessel.

15. The method of claim 1 wherein the water dispensing unit of the cleaning subassembly terminates in one or more water spray nozzles directed at the light receiving surface and comprises one or more cleaning accessories.

16. The method of claim 15 wherein the cleaning subassembly comprises a water diversion valve positioned to selectively divert wastewater generated by the activation of the cleaning subassembly from, or direct filtered wastewater to, the water collection vessel.

17. The method of claim 1 wherein the process controller activates the water dispensing unit of the cleaning subassembly for cleaning the light receiving surface prior to activation of the water collection subassembly for humidity condensation and water collection on the light receiving surface.

18. The method of claim 1 wherein the solar system comprises an ambient temperature sensor, an ambient humidity sensor, or a combination thereof, wherein the process controller activates the water collection subassembly as a function of ambient temperature, humidity, or a combination thereof.

19. The method of claim 1 wherein:

the light receiving surface comprises an input face of a photovoltaic module;

the solar system comprises a photovoltaic module power monitor and the process controller; and

the process controller activates the cleaning subassembly as a function of power generated by the photovoltaic module, as sensed by the power monitor.

20. The method of claim 1 wherein:

the solar system comprises the compressed air supply and the process controller;

the compressed air supply is coupled to the compressed air expansion valve of the condensation subassembly; and

the process controller activates the cleaning subassembly as a function of air pressure in the compressed air supply.

21. The method of claim 1 wherein:

the solar system comprises the one or more ambient sensors, the compressed air supply, and the process controller;

the compressed air supply is coupled to the compressed air expansion valve of the condensation subassembly; and

the process controller controls the release of compressed air from the compressed air supply through the compressed air expansion valve by measuring activation conditions that comprise release duration, pressure drop, or a combination thereof, such that

a negative air pressure gradient is formed across the expansion valve that is sufficient to lower the air temperature inside the expansion chamber and the surface temperature of the light receiving surface below the dew point temperature of the ambient air causing condensation to form on the light receiving surface.

22. The method of claim 1 further comprising operating the solar system by controlling activation conditions of the water collection subassembly as a function of air pressure in the compressed air supply and ambient sensor output and by the steps of controlling the release of compressed air from the compressed air supply through the compressed air expansion valve, wherein compressed air is not released from the compressed air supply until the water dispensing unit of the cleaning subassembly has cleaned the light receiving surface and the air pressure of the compressed air supply is sufficient to activate the condensation subassembly.

23. The method of claim 1 further comprising:

determining an optimal frequency, duration, or time-of-day for activation of the cleaning and collection subassemblies with regard to maximizing photovoltaic output of the light receiving surface, wherein the light receiving surface comprises an input face of a photovoltaic module; and

operating the cleaning and collection subassemblies with regard to maximizing the photovoltaic output of the light receiving surface.