Candidate Technology 13: Atmospheric Water Generator[13]

Technology Name	Atmospheric Water Generator			
Technology Solution(s)	☐ Water Use Efficiency	☒ Increase Water Supply	☐ Reduce Use of Potable Water for Non-Potable Uses	☐ Water Management Tools
Sector(s)	☐ Agricultural	☒ Commercial	☒ Industrial	☒ Residential
Industry Segment(s)	**Commercial:** Offices, Hotels, Resorts, Nursing Homes, Healthcare Facilities, Athletic Clubs, Prisons and Schools **Industrial:** Remote Mines, Oil Rigs, Greenhouses **Residential:** All Residential			
Drought Resilience	☐ High	☒ Medium	☐ Low	
Water Benefits	☐ Reduces Water Use	☒ Increases Water Supply	☐ Produces/Uses Recycled Water	☐ Reduces Water Loss
Electric Benefits	☒ Energy Efficiency (**Reduces kWh**)	☒ Demand Response (**Ability to Shift Load?**)	☒ Distributed Generation (**Increase Ability to Produce Clean Energy**)	☐ Increase Energy Storage (**Ability to Store Energy**)
GHG Benefits	Yes., this technology provides on-site drinking water, avoiding the lead time, high costs and high GHG impacts of delivering critical potable water supplies to remote communities during emergencies, such as the recent multi-year drought.			
Implementation Timeline	☒ <= 3 years	☐ 3-7 years	☐ > 7 years	
Estimated Simple Payback	Cost not available to perform payback analysis.			

What is the technology?

Atmospheric Water Generators (AWG) are an emerging technology used for on-site production of potable water. The technology is focused on giving potable water to those who lack freshwater during emergency situations. This technology explores the possibility of using a dehumidification system run by solar thermal energy to 1) pre-treat feed air stream for air conditioning units and reduce latent heat, consequently reducing electrical power consumption and 2) condense atmospheric moisture and use it as an additional renewable source of water and further enhance the sustainability and independence of first-aid cabins.

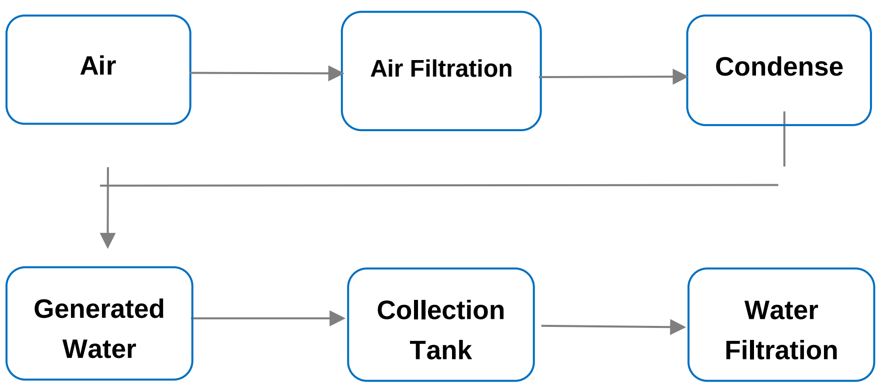
How does it work?

AWG devices filter and condense moisture in the air by cooling air below its dew point, producing water. There are three types of AWGs: cooling condensation, wet desiccation, and Peltier cooling. Cooling condensation and wet desiccation are the most widely used today.

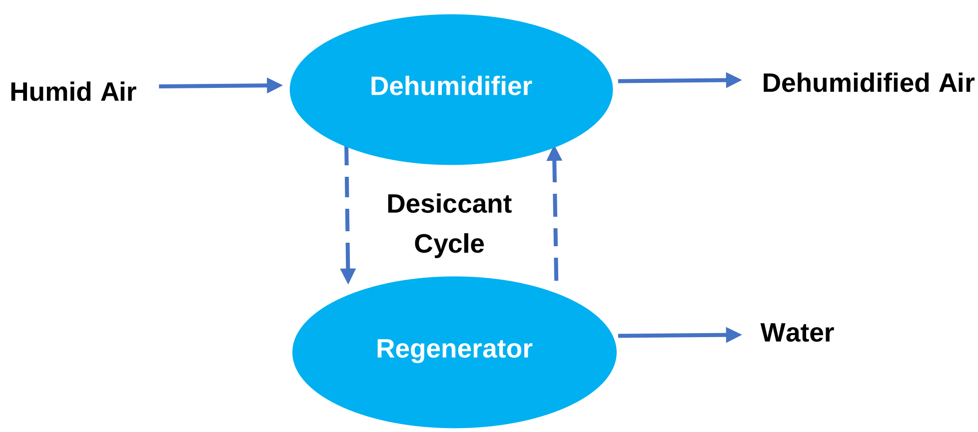
[13] Data provided by multiple manufacturers.

The technology, however, is strongly limited by the environmental conditions required for operation. Most products in the market, require a minimum 30 percent humidity, moderate temperatures, and a large amount of energy for optimal operation. Most companies offset the large energy requirements by partnering their products with high-efficiency solar panels. Thus, AWGs partnered with solar panels are entirely self-sufficient, making it the ideal alternative to high-cost water deliveries. A notable mention for AWGs is Sun-to-Water, one of the first companies to utilize wet desiccation, boasting an operating cost of $0.04 - $0.08 per gallon.

Most technology developers use mature refrigeration technologies in packaged units to condense and collect moisture. Large scale operations use wet desiccation, utilizing salts for moisture extraction. If the water is intended for human consumption, some units include ultraviolet or other disinfection technologies. Some also add minerals to improve the taste of the water. In the pre-commercial stage, the market is saturated with start-ups, with multiple companies claiming the same patents.



Operating schematic for cooling condensation atmospheric water generators



Operating schematic for wet desiccation atmospheric water generators

Bundling AWG with Solar Photovoltaics (PVT)

The process will intake fresh air and split into two streams. The major stream goes into the desiccant wheel (stream 2) and the minor steam goes to a heat exchanger (steam 4) where it exchanges enthalpy with the regeneration stream (steam 6) and condenses water. The humidity set-point on the wheel is lowered to force the dehumidifier to work at its full capacity at all times. The major air (stream 2) enters the dehumidifier at a certain state (usually relatively cool and moist compared to the outlet).

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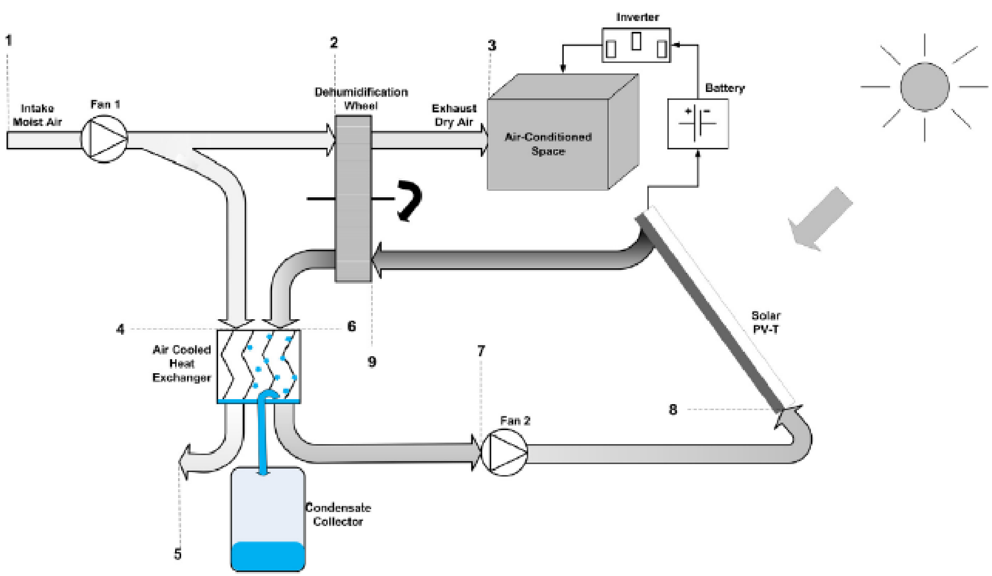

Fig. 3. Schematic of the proposed dehumidification system integrated with solar PVT.

Atmospheric Water Generator Process Streams

As water absorbs onto the desiccant, the heat of sorption is released and warms up the surrounding air. When the process air leaves the dehumidifier, it is often drier and warmer than its entry status. Water vapor molecules are deposited on the dehumidification wheel to begin to accumulate until saturation. The wheel is rotating at very slow rate to increase residual time for water vapor molecules. Once that part of the wheel is saturated it will ultimately reach the regeneration phase (point 9). In the regeneration phase, the saturated portion of the wheel is exposed to a hot dry air stream that comes from a heat source, supplied by the hybrid PVT system.

This technology was tested in Sydney, Abu Dhabi and London for their dissimilar climates. Abu Dhabi possessed the highest rate of potential water collection, that reached up to 18.5 kL a year. Sydney generated 13.8 kL a year while London generated up to 10 kL of water a year. Most of energy required can be met by the thermal gain of the solar hybrid PVT array during the day.

However, the photovoltaic panels mounted on top of the first aid cabin is not enough to meet its energy demand, requiring constant energy from an additional source.

Economic Drivers

The industry of atmospheric water generators is new in the United States. The new technology provides economic and environmental benefits at the residential, commercial, and industrial scale. Financial incentives must be put in place to encourage adoption from single-family homes and multi-family housing units. With economies of scale, as production increases and competitors enter the market, full life-cycle costs will be decrease, as maintenance and retrofitting costs are minimal. Units equipped with solar panels will increase initial cost, which will increase the economic barrier to entry, but will drastically lower operational costs. If utilized solely for emergency applications, solar-powered AWGs are not recommended due to the lower production capacity and higher costs. For continual use, solar-powered units are highly recommended. Due to the early market position of AWG technology, no cost-benefit analyses have been conducted. A pilot program in Tulare County would provide data for a full cost-benefit analysis.

What are the benefits?

Technology Name	Atmospheric Water Generator (AWG)
Sector	Commercial, Industrial, Residential
Industry Segment	**Commercial:** Offices, Hotels, Resorts, Nursing Homes, Healthcare Facilities, Athletic Clubs, Prisons and Schools **Industrial:** Remote Mines, Oil Rigs, Greenhouses **Residential:** All Residential
Water Benefits	<u>Level of Drought Resilience</u>: Medium
	<u>Type of Drought Benefit</u>: • Increases Water Supply • On-site production of small quantities of potable water. • The ability to produce critical drinking water supplies “from air” would be very beneficial to residents that remain dependent on private wells (not connected to municipal water supplies).
Water Resources	<u>Type of Water Resource Benefit</u>: Because potable water is produced, there is less demand for potable water used for both potable and non-potable settings.
Electric Benefits	**Renewable Energy:** 100% off-grid power and water production for residential and commercial buildings: solar or wind power and 100% off-grid water production, storage and dispensing for remote mines, oil rigs, greenhouses, villages without plumbing infrastructure and other similar facilities.
Cost-Benefit Analysis	Although energy and water savings data were estimated, no explicit cost estimates were provided from information sources gathered to perform a cost-benefit analysis.
Other Benefits: Health and Safety	• Filters the air with Anti-Bacterial filter • Destroys and removes all bacteria and impurities.

Technology Name	Atmospheric Water Generator (AWG)
Other Benefits: Environmental	Reduces GHG Emissions • A green solution for water sustainability • Fully replaces the need for bottled water or water purifier on faucets. • Extracts moisture from the air to produce pure drinking water • Provides on-site drinking water, avoiding the lead time, high costs and high GHG impacts of delivering critical potable water supplies to remote communities during emergencies, such as the recent multi-year drought.
Other Benefits: Economic	• Pure water production and purification 24/7 • Reduce social costs of waiting, lack of hygiene, illness, social unrest.