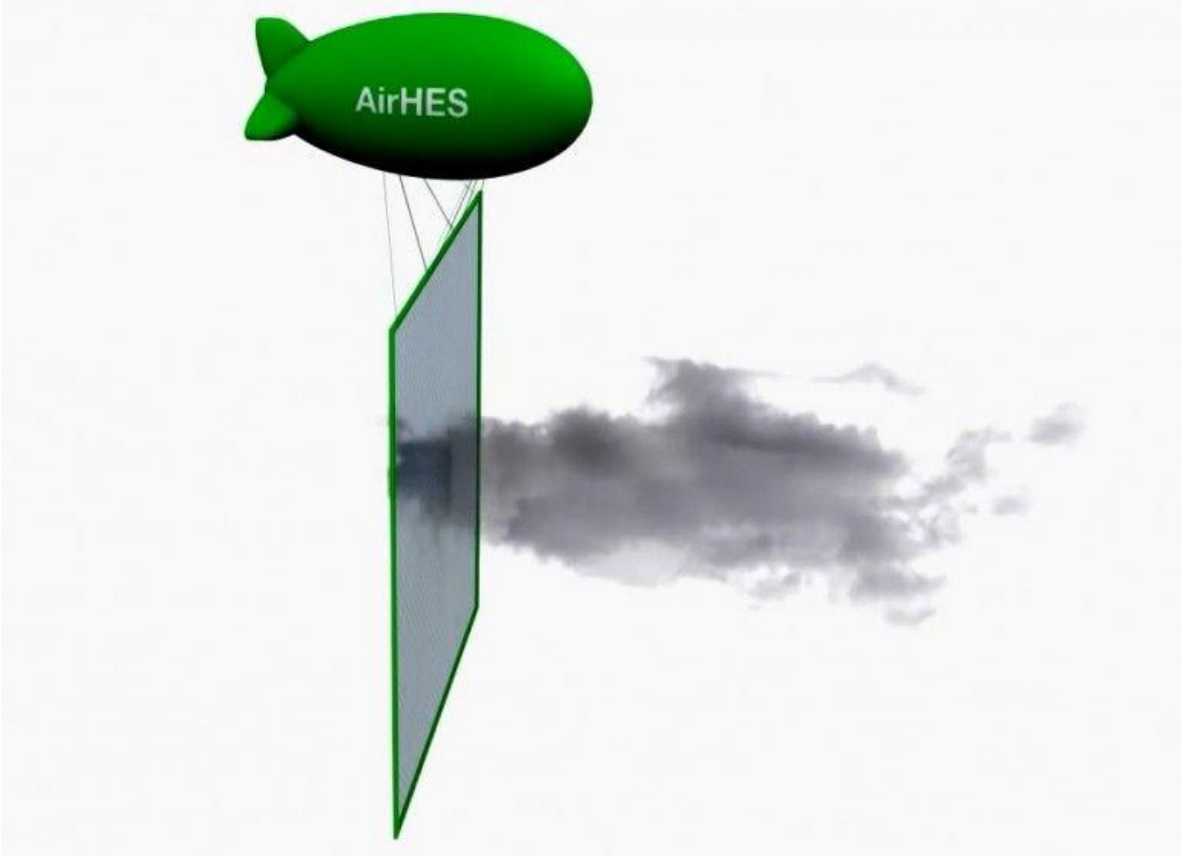
Air Hydroelectric Station (Air HES)

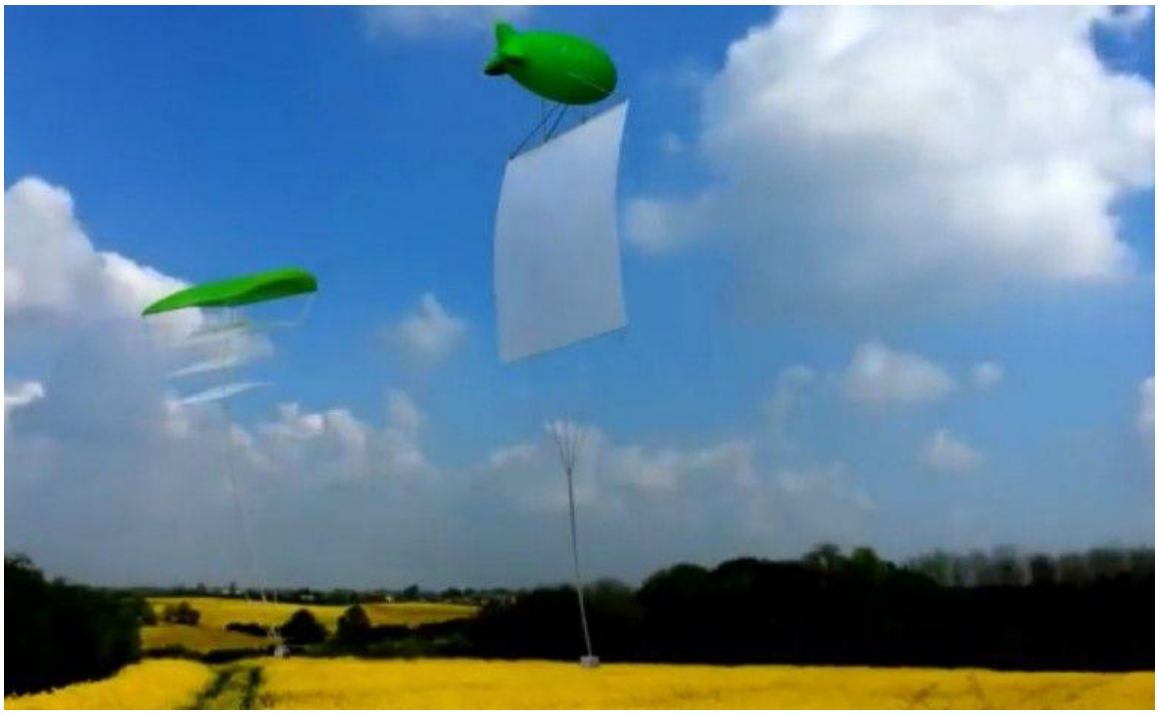
Peter Lobner, 8 February 2022

Russian inventor Andrey (Andrew) Kazantsev and his firm Air HES (https://airhes.com) have developed technology to condense moisture in the air at high altitude and deliver the clean water to users on the ground via a suspended collection system, while also taking advantage of the static head of water in the collection system to drive a small hydroelectric turbine to generate electric power. The high altitude moisture collection system can be suspended from a tethered aerostat at an altitude where temperature is below the dew point (several thousands of feet aloft), or, in locations with persistent winds, from a large paraglider on a tether.

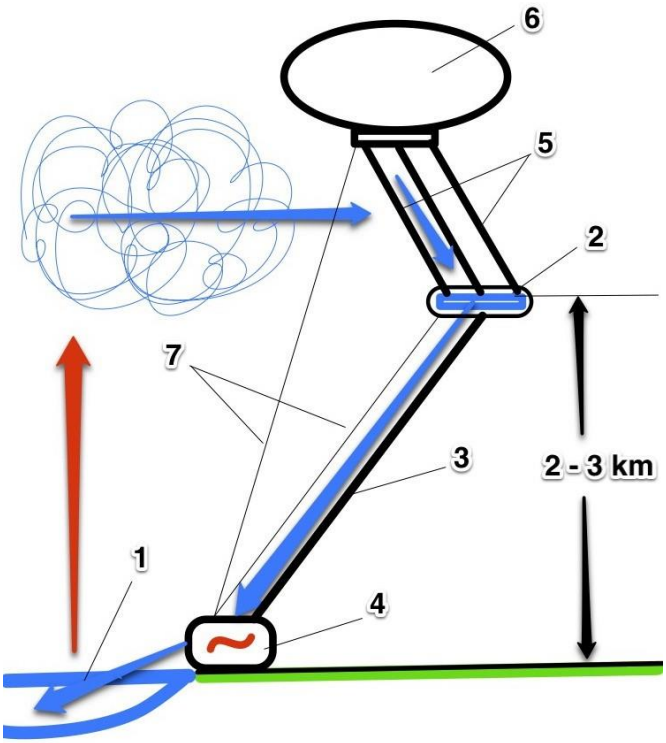
You can watch a short (1:52 minute) video on the Air HES concept here: https://www.youtube.com/watch?v=5u0-YUltih0



A curtain of vapor-condensing mesh is used to condense water in the air. Source: Trendhunter, 28 August 2014



Artist's concept of an aerostat and a paraglider deployed as airborne hydroelectric stations. Note the mesh collector suspended under each craft and the penstock (pipe) delivering the collected water to a station on the ground. Source: Trendhunter, 28 August 2014



Schematic of an Air Hydroelectric Station. Source: Air HES

In the schematic diagram, the tethered (7) airship (6) lifts the condensation surfaces (5) to a height where ambient atmospheric temperature is below the dew point for current atmospheric conditions (i.e., at of above the base of the clouds, typically at 2 - 3 km in many regions of the world). At that altitude, super-cooled atmospheric moisture condenses on the surfaces (5) and a drainage system on the surfaces directs the condensate to a collection point (2) that supplies a long penstock to the ground (3). Water under pressure from a static head in the penstock flows through a small hydroelectric turbine generator (4) on the ground, producing electricity and discharging clean water to a collection point on the ground (1). Evaporation at the collection point (red arrow) may return some moisture to the atmosphere by evaporation.

It seems like a simple cycle, but there are important design tradeoffs to be made. For example, the water column in the penstock "pipe" will be heavy and water pressure will increase with the length (depth) of the water column, as shown in the following table.

Height of water column (m)	Height of water column (ft)	Pressure at bottom of the column (kPa)	Pressure at bottom of the column (psi)	Volume of 10 cm diam fresh water column (m^3)	Volume of 3.9 in diam fresh water column (ft^3)	Weight of 10 cm diam fresh water column (kg)	Weight of 3.9 in diam fresh water column (lb)
100	328	978	142	0.79	27.9	790	1,742
500	1,640	4,889	709	3.9	137	3,900	8,598
1,000	3,281	9,778	1,418	7.9	279	7,900	17,460
3,000	9,843	29,333	4,254	23.6	833	23,600	52,030

The table shows that a 500 meter (1,640 foot) water column 10 cm (3.9 inches) in diameter will weigh 3.9 metric tons (4.3 tons) and the water pressure at the bottom of the column will be 4,889 kPa (709 psi). The water column must be controlled to a reasonable height consistent with penstock material (i.e., lightweight synthetic tubing), allowable hydroelectric turbine inlet conditions, and the ability of the tethered aerostat to support the combined weight of the tether, the collection apparatus and the water in the system.

The Air HES has been tested in Russia using the small prototype shown in the following photos. No large scale system has been built and tested.

Air HES sub-scale test device, Seliger, Russia, July 30, 2013. Source: Air HES

In 2014, NewAtlas reported:

> “The designers say they have produced and flown a scale prototype of the blimp and water collection system, which they claim produced around 4 liters (1.05 gal) of water per hour for each square meter of mesh at 4,000 ft (1,200 m).”
>
> “They are now working toward constructing a full-size, fully functional prototype of the complete system, and one that will be large enough to produce significant amounts of water and electricity. The team calculates that, as a balloon 60 ft (18 m) in diameter yields around 7,000 lb (3,175 kg) of lift, this will be more than a sufficient size to carry the expected weight of the vertical tether and the water load collected.”

The team's ultimate goal is to test a 1,000 square meter (10,700 square foot) mesh collector, which they estimate could produce up to 185 kW of electric power.

Significant business investments are needed to make the Air HES system a viable commercial proposition. On the Air HES website, inventor Andery Kazantsev states: “I decided to free all my patents. Now Air HES project is free.”

For more information

- Colin Jeffrey, “Air HES system to collect water and generate electricity from the clouds,” NewAtlas, 27 August 2014: https://newatlas.com/air-hes-cloud-power-clean-water-energy-vapor/33512/
- Rahul Kalvapalle , “The Air Hydroelectric Station Will Generate Power From Clouds,” Trendhunter, 28 August 2014: https://www.trendhunter.com/trends/air-hydroelectric-station
- Chuck Bednar, “Proposed Device Looks To Use Cloud Moisture To Develop Energy, Drinking Water,” RedOrbit, 8 September 2014: https://www.redorbit.com/news/science/1113228256/cloud-power-for-renewable-energy-and-clean-water-air-hes-090814/

Patents

- US20150104292A1, “Aero-hydroelectric power station,” filed 1 February 2013, published 16 April 2015: https://patents.google.com/patent/US20150104292A1/en?oq=US2015104292
- RU2500854C1, “Aero-hydroelectric power station,” 17 April 2012, https://russianpatents.com/patent/250/2500854.html
- EP2840184A1, “Aero-hydroelectric power station,” filed 1 February 2013, published 25 February 2015: https://patents.google.com/patent/EP2840184A1/en?oq=•EP2840184A1

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