Pluvinergy

The Pluvinergy hypothesis proposes to integrate civilization's energy needs into sustainable balance with the biosphere. By dominating a small area of the atmosphere with its wind structures, Pluvinergy creates a one-terawatt sustainable engine process using solar energy, ambient heat and energy already in the atmosphere as elevation and potential temperature. To reduce cost, most of the engine components and the energy collection processes occur in the open atmosphere. Because forming wind structures in the open atmosphere is inexpensive, the final energy costs are orders of magnitude less than any other current energy technology.

The engine is a three-stage energy concentration process, where two of the engine cycles occur partially or completely in the open atmosphere. Its byproducts are largely positive; fresh water and food, reforestation, CO2 sequestration, wetlands repair and reconstruction, local wind flow management, and direct cooling or warming of the planet.

One powerplant produces sufficient power and water for nearly all of Sothern California, so the scale of operation is very large. Its necessary scale makes a powerplant costly and, if used widely as envisioned, it has implications for the planet's climate operation. These effects are beneficial and controllable by design, the opposite of current energy regimes. This is why, the concept is offered as a book, for discussion of such implications.

The process can be thought of as harnessing the natural refrigeration cycle of the planet. Pluvinergy uses humidity as the working fluid, for harnessing the gravitational stratification resulting from molecular inertia in the first part of the cycle. The second cycle collects thermal and solar energy at the planet's surface into the cool humid wind flow from the first cycle. Third, as the humid fluid warms, it rises, causing water to condense and precipitate, releasing its latent heat, which in turn creates stronger updrafts. These are the main mechanisms for creating and managing the wind flow structures which form the engine. Since heat high in the atmosphere radiates with the 4^{th} power of temperature change, radiation into space is accelerated. To start the process, the first cycle depends on an initial flow from 100 km2 of greenhouses. The cycle components are the same in all three stages, but the greenhouse is necessary for the first cycle because it is too small to form reliable wind structures without containment.

The first cycle downdraft process was first conceived of by Philip Carlson http://en.wikipedia.org/wiki/Energy_tower. It has been coined an "Energy Tower" by Dr. Dan Zavslasky and Dr. Rami Guetta from Technion. Pluvinergy uses a design similar to Philip Carlson's original conception as well as his original California geology. The downdraft process is possible because by lifting only 20 grams of water, one-kilogram dry air can be made to fall. The additional energy comes from the potential temperature. This concept tells us that molecules higher in the atmosphere usually have greater velocity as result of lower air pressure. See: http://en.wikipedia.org/wiki/Potential_temperature. The resulting wind inertia captured by the downdraft process represents less than a 2% of the total energy captured into humidity, depending on the starting elevation. Latent heat of evaporation holds the other 98%+ of the energy captured. The result is 12 tons water vapor, and 2.5 Gigawatts of energy absorption per second, and 300 MW of net power production.

Pluvinergy uses the latent heat in the humidity produced to power a subsequent updraft process. This concept has been popularized as the “solar updraft tower” or “Solar Chimney.” http://en.wikipedia.org/wiki/Solar_updraft_tower . Pluvinergy eliminates the costly updraft tower by using a steep mountainside as in the original downdraft concept. Additionally the greenhouse cost is also substantially reduced by using the energy stored in humidity as latent heat from the prior downdraft process. Further, instead of elevating greenhouse temperature above ambient temperature, Pluvinergy achieves convection by releasing latent heat from the humidity at near ambient temperature. Keeping temperature low absorbs energy from the ambient instead of losing the prior energy collected, as condensation, mostly on the greenhouse membrane. Using humid air instead of a dry air cycle provides one larger cost reduction; food can be grown in the greenhouse, at the same time that its evapotranspiration adds more latent heat to the wind flow. Besides food, this cycle also produces about 800 MW of power.

The second and third energy concentrating processes repeat the same processes but in the open atmosphere. Second stage downdrafts produce 60 tons of water vapor per second. Since these are extremely inexpensive components, three or four second stage units are built so that one or more can always provide humid air flow from upwind of the greenhouse complex. Each unit produces about 1.5 GW of power when operating.

The third stage produces hundreds of tons of water in humidity per second. The second and third cycles involve minimal cost because the lands and the open atmosphere provide the greenhouse effect, without additional cost. The updraft component forms in the open atmosphere for these two cycles, eliminating the cost of the larger towers and conduits. Updrafts from the first stage provide the updraft component for the second cycle. This combined updraft from the first stage and the second stage two cycles in turn form the updraft component for the third stage, along with the third stage’s own updraft effect. The last structure forms and is held together through entrainment of winds into the engine’s vortex structures.

The final cycle, despite involving nearly a terawatt of energy concentrating flux, incurs no additional capital costs because all of its components form in the open atmosphere. See a conceptual video of the process here. https://www.youtube.com/results?search_query=pluvinergy

The first stage costs 2 to 8 billion dollars because of the extensive greenhouse complex. The rest of the powerplant and infrastructure costs an additional 2 to 4 billion dollars. Cost depends on power yield and other design factors. The minimum scale estimated for the greenhouse component is 100 km2. That is why it is so expensive.

This minimum scale is required so that the engine can dominate the immediate atmosphere under varying conditions. This minimum scale is about two times larger than the minimum requirements within the lower troposphere, where the engine operates. Since there is no limit on how high the ascending wind structure can go, other than limiting the vortex structure and humid-air feeding rate, the size of the greenhouse complex is an open question. There are many such operational questions about the design.

1. Is energy scale large enough to dominate atmospheric dynamics in the sphere of engine operations?
2. Do vortex structures entrain and select incoming winds as proposed?
3. Does it stand up to higher ambient wind characteristics expected?
4. Can the engine structures retain order under extremely low elevation jet-stream conditions?
5. Heat radiates rapidly from land, are heat stores sufficient for nighttime operation?
6. Will engine operate successfully under humid weather conditions?
7. Will powerplant retain vortex structures from escaping in extremely humid conditions?
8. Are secondary storms benign, or are these dangerous to surrounding regions.
9. Is recycling through dry desert winds sufficiently robust always retain the engine process?

Better mathematical modeling can resolve these operational questions. Answering these questions tell us how to make the engine work reliably and more efficiently with experience. However, there are larger questions.

10. Since the engine accelerates radiation of atmospheric heat into space, will the planet be cooled too much when many engines are operating?
11. Water vapor is the largest greenhouse gas, how will we be sure Pluvinergy does not add to climate change heating?
12. If the engines produce so much wealth in energy, water, food, and new arable land, how will such overwhelming economic disruption be controlled?
13. How can we be sure powerplant operations work for the good of the environment instead of at its expense?
14. Transition zones in desert ecologies are especially delicate and precious, how will these be protected?

The book describing Pluvinergy addresses these and many other questions extensively, but these issues cannot be answered lightly, they will remain pertinent issues well into the development of the technology.