The Environmental Benefits of Buoyant Flight

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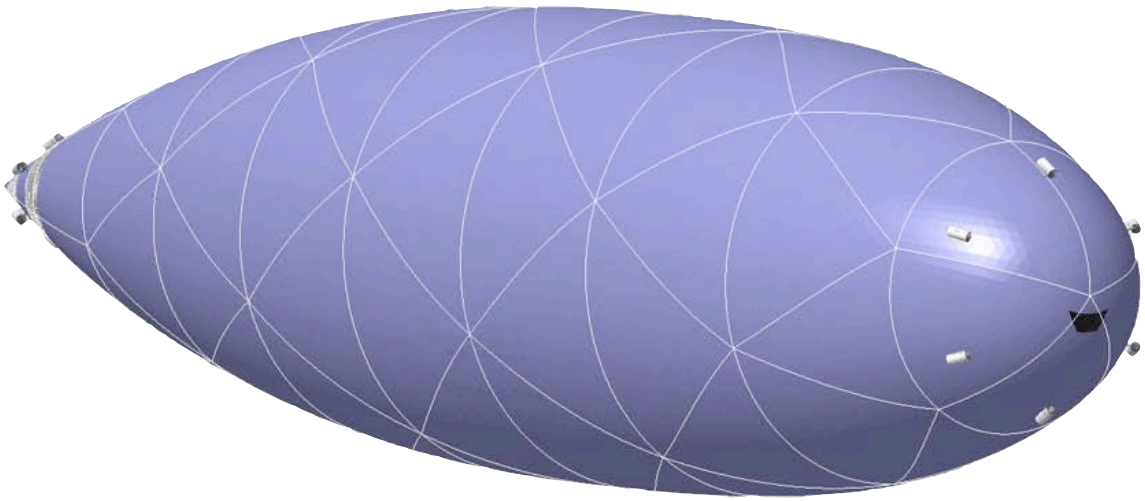
Overview: Airships provide an opportunity to meet the growing demands of an interconnected world while reducing the environmental impact humanity imposes upon the planet. There are numerous advantages to buoyant flight that are important to consider and to which this paper aims to introduce the reader.

Historically airships are extremely energy efficient, and modern airships have the potential to be even more so. A detailed description of why this is so is found later. Related to this are the extremely low emissions of both green house gases and other pollutants. When less fuel is burned, fewer emissions result. Generally, airships are also much quieter than other forms of aerial transportation, and a well designed airship using electric motor propulsion can be virtually silent. This improves the quality of life for those served by airship transport, and opens airships for use in ecotourism without jeopardizing the tranquility of remote biomes. With the capability to fly at variable speeds, including hovering, airships can allow ecotourists to observe sensitive monuments and natural wonders from a spectacular vantage point, with little to no impact upon these treasures. For cultures wishing to preserve their heritage without forgoing the revenue of tourism, this provides an attractive solution.

The designs proposed by Skylite Aeronautics also require very little to no ground infrastructure, allowing operations in austere locations without the need to build or maintain costly roads, ports, or airports, which themselves are disruptive to sensitive ecosystems. Neither does the GeoShip™ put additional strain on those roads already in place. This opens remote developing regions to the global marketplace. Perishable, organic produce can find willing buyers on the world stage, facilitating sustainable fair trade, where before, lengthy complicated logistics made such efforts infeasible.

Due to the large surface area inherent in airships, the potential to utilize photovoltaic solar energy systems to augment vehicle power, can further reduce emissions, enhance safety, and lower operating costs.

A new age of airships promises technology capable of connecting us through sustainable, efficient means, while simultaneously addressing issues inherent with current transportation technologies.



Skylite Aeronautics GeoShip™ is an advanced rigid airship with a unique geodesic structure, solar power augmentation, and significant innovations in maneuver and control. It will provide a sustainable, environmentally friendly option for global freight and passenger transportation.

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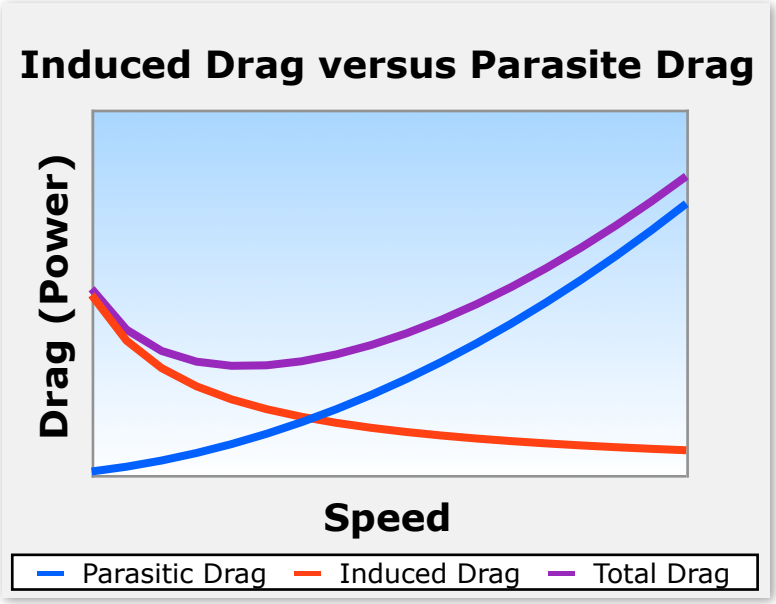
Historic photo of the rigid airship Graf Zeppelin, ca.1930.

Efficiency: Buoyant Flight is an inherently efficient form of transportation. This is the main reason why airships were so promising in the 1920s when airplanes still seemed somewhat of a speculative venture. While today they are forgotten by many, airships were quite successful. By 1937, commercial passenger airships of the Deutsche Zeppelin Reederei (DZR) had flown over half a million passenger-hours and a total of 52 million passenger-km safely on regional, transoceanic, arctic, and round-the-world voyages. All of this was accomplished using then state-of-the-art technology that by today's standards would be considered quite primitive. The lifting gas used, flammable hydrogen, was contained within large cells made from the membranes of cow intestines. The hull was covered in a doped cotton canvas, and control systems were operated manually by a large crew. Despite this, early airships were able to consistently transport both passengers and cargo years earlier than their heavier-than-air counterparts due to their inherent efficiency.



The chart above shows generalized drag curves for aircraft. Both heavier-than-air craft and semi-buoyant craft follow purple total drag curves. Fully buoyant aircraft follow a much lower blue curve, experiencing only parasitic drag. Drag must be matched by thrust to maintain flight speed.

Airships are so named because they float. Instead of floating on a sea of water, airships ride in a sea of air. While ships must part the waves, airships merely part the sky, which is a decidedly less viscous medium. The energy expended to accomplish this task is therefore considerably smaller. Furthermore, unlike heavier-than-air craft, the lift for airships is obtained primarily through displacement, and not aerodynamic lift. This is significant because when aerodynamic lift is produced, drag is unavoidably induced. So while both airships and airplanes must overcome parasitic drag, airplanes must also expend a great deal of energy to overcome induced drag. This extra drag is greatest at lower speeds, where airships are at their most efficient. (See chart above.)

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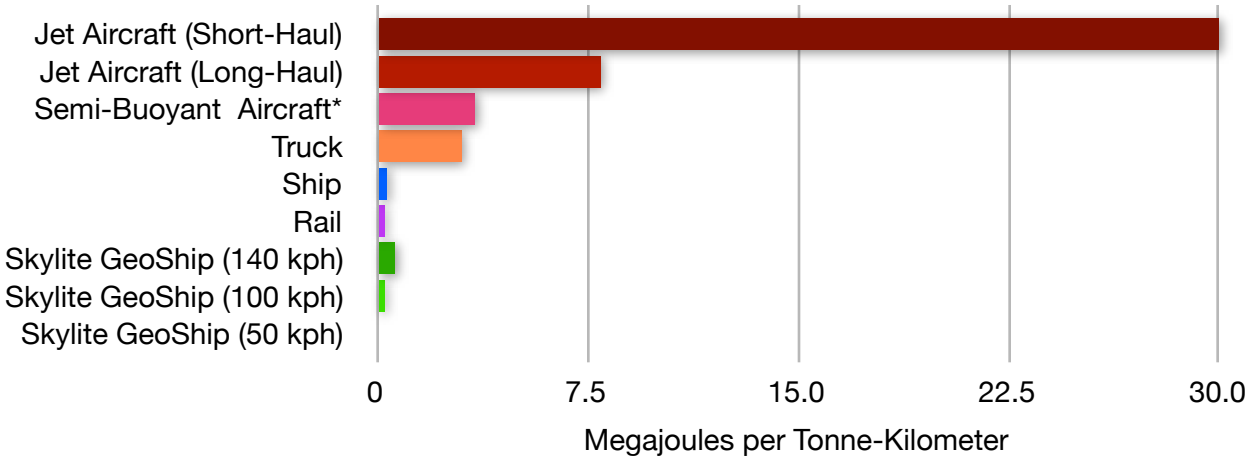
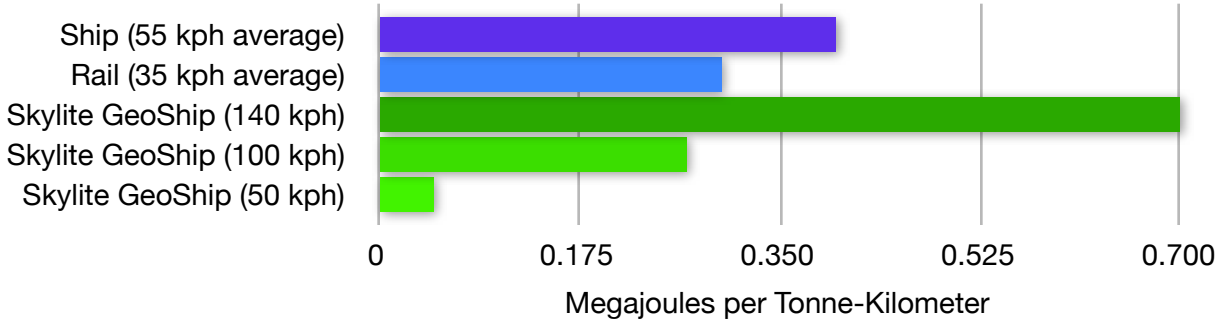
Emissions & Energy Intensity: Green House Gas (GHG) emissions in the transportation sector are directly linked to the energy intensity of the vehicle, with approximately 99% of the GHG emissions as CO_2. As can be seen in the charts below, short-haul jet aircraft use the most energy, followed by long haul jets. Proposed semi-buoyant aircraft (sometimes called hybrid airships) and trucks are next, with ship and rail significantly less. In comparison we have estimated the energy intensity of the GeoShip™ at a range of operating speeds. The GeoShip™ is designed to use less than 1% of the energy of short-haul jet aircraft while operating at speeds of 100 kph, and less than 9% of the energy of long haul jet aircraft while operating at speeds of 140 kph. Any transition from these highest intensity modes to lower intensity ones will therefore reduce the carbon footprint significantly. Transition from trucking, while not as dramatic, can reduce energy consumption and associated emissions by 75%. This will simultaneously reduce the impact on roadway infrastructure and will enable service to pristine areas without the need to build expensive and intrusive roads.



*The disparity in energy intensity between various modes of transportation reveals significant opportunities to reduce GHG emissions by utilizing the Skylite GeoShip ™ to meet a growing proportion of future transport needs. *Semi-Buoyant aircraft data based on DARPA estimates.*



Service speeds and energy intensity of selected transport modes shows the advantages of the GeoShip™. While rail and ship both provide low energy intensity transport, they also have low average service speeds. The energy expenditure of the Geoship™, operating at 100 kph, is lower than these transportation modes, yet it operates at twice the average velocity.

The GeoShip™ energy intensity is highly dependent upon speed, but the GeoShip™ also provides considerably higher levels of service for the energy used. When we focus on ship, rail, and the GeoShip™, we see they have similar efficiencies. However, shipping averages 55 kph and rail averages 35 kph due to crossings, grades, and other interruptions. Maximum average speeds of 140 kph can be used by the GeoShip™ when transporting time-sensitive goods that

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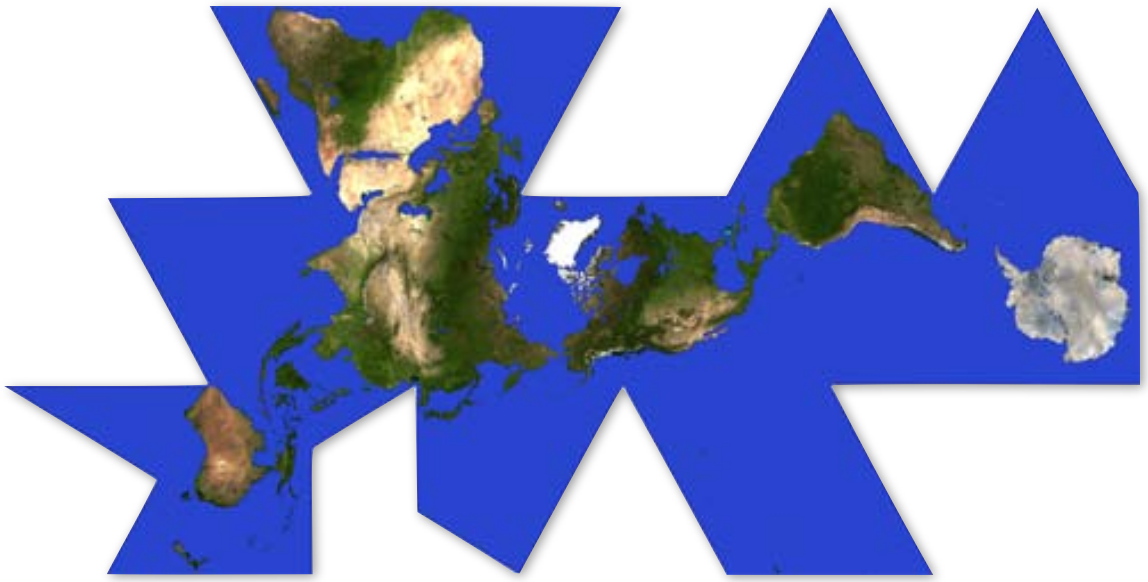
would otherwise be transported by less efficient jet and truck freight. While still outperforming ship and rail, slower speeds of 100 kph will allow minimization of the associated emission footprint. During ecotourism sightseeing flights, speeds will often be less than 50 kph. This will provide a dramatically reduced emission footprint and could feasibly be powered by fully sustainable onboard solar energy.

Additional reductions will be achieved beyond those implied by the GeoShip's lower energy intensities. Because more direct routes can be taken by the GeoShip™, irrespective of rail lines, sea lanes, ports, or roads, the distance traveled from origin to destination will be significantly less than other transportation modes. Initial estimates show an efficiency dividend of 10% to 50% due to this reduction in travel distance. One can imagine multi-modal transits encompassing trucking to a port, loading onto a ship, traversing a circuitous sea lane around a coast, transfer to rail cars and travel along grade-constrained tracks, offloading to a truck, following congested roadways, eventually arriving at the destination. Compare this to point-to-point delivery by GeoShip™ and the environmental benefits will clearly be greater than those indicated by energy intensity alone.



About Skylite Aeronautics: Skylite Aeronautics is committed to providing environmentally sustainable aerial transportation with the lowest carbon footprint achievable. In addition to the inherent efficiencies of buoyant flight, we optimize the sustainability of the GeoShip™ through the use of net-carbon-neutral biofuels, solar photovoltaic power generation, and concurrent systems engineering that collectively provide a superior sustainable transportation system. This enables the GeoShip™ to travel at competitive velocities with energy consumption rates an order of magnitude less than the most efficient uses of jet aircraft, trucking systems, and semi-buoyant aircraft.

While this discussion has focused on the energy efficiency of the Skylite GeoShip™, this technology further provides competitive advantages in ways unavailable to conventional transportation. The limited infrastructure requirements facilitate the entry of remote and developing economies into the global market with a limited infrastructure investment. The GeoShip™ provides unique performance capabilities, including low acoustic signature, hover, and large volume capacity. These advantages combine to both reduce the emissions footprint of existing transportation markets and to open new markets unavailable through conventional transportation systems. To learn more about the Geoship™ and Skylite Aeronautics, please contact us at info@skylite.aero.

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