Statement of Fact Summary
On Relative Fuel Efficiency of Terreplane.

Statements of Fact fully Support the following conclusions:

- Terreplane will be able to attain passenger transit fuel efficiencies **5X the fuel efficiency** of reasonable alternatives.
- Terreplane will be able to attain parcel service that is over **7X the fuel efficiency of reasonable alternatives**. That Terreplane service will be same-day parcel service in many cases.

Statements of Fact on Specific Weight**

1. When cruising*, the energy expended by an aircraft is substantially proportional to the aerodynamic drag. *Cruising implies constant speed and altitude.
2. When cruising, the energy expended by an aircraft is substantially proportional to the weight divided by the Lift:Drag ratio (the product of which yields drag).
3. Gliders do not have engine fuel, and so, the weight is reduced by up to about 32% at takeoff and about 16% on average during the complete flight (16/84 = 19%).
4. An autonomous tethered wingless glider-craft supported by a linear motor has reduced weight due to: a) no cockpit or related people-interface hardware, b) substantially reduced weight associated with landing gear and hydraulics, c) substantially reduced weight due to reduced with structure weight, and d) slightly reduced weight due short stator replacing engines. The cumulative impact is about a 20% reduction in the takeoff weight (20/84 = .. 24% based on average flight weight).

The total is at least a 43% reduction.

Statements of Fact on Efficiency of Converting Fuel Energy to Thrust/Propulsion Energy.

5. Piston engine aircraft and jets have about an overall efficiency of converting fuel energy to thrust energy, and so, an analysis of the efficiency of fuel efficiency on a propeller engine is generally applicable to jet and prop aircraft. That thermal efficiency of fuel to thrust/propulsion is about 20% (piston engine) times 80% (propeller efficiency), or 16%.
6. A representative efficiency for converting fuel to thrust/propulsion by production of grid electricity is the thermal efficiency of electrical power generation times about 81% (90% for transmission efficiency X 90% for linear motor efficiency). A representative efficiency for electrical power generation is 38% (upper end of coal, much lower than combined-cycle power generation). The resulting overall efficiency is 30.8%.

The total is a 48% reduction.

Statements of Fact on Inefficiency of Air Travel Logistics.

7. Airports with good service typically require traveling (often driving) a significant distance to/from the airport at both origin and destination.
8. Any flight other than non-stop includes expending of fuel for diversion of the most direct flight path to the transfer hub airport as well as the expending of fuel for an additional takeoff and establishing the cruise altitude.
9. Commercial flights loose capacity due to weight of pilots, flight attendants, and any crew catching a

flight back home.

10. Flights circling in queue to land is a waste of energy.

This total is equivalent to about a 30% reduction.

In equation form, the resulting, relative amount of fuel used by Terreplane is described by the following equation:

$$(1\text{-}0.43)\ (1\text{-}0.48)\ (1\text{-}0.3)\ 14/[L{:}D]_{terreplane}$$

or

$$\textbf{Fraction Energy Relative to Airlines} = 0.207\ \frac{14}{[L{:}D]_{Terreplane}}$$

Where the value of 14 is taken as the cruising L:D ratio of a piston engine aircraft***.

Statements of Fact and Reasonable Interpretations on L:D Ratios.

11. It is the L:D ratio that relates flight to energy consumption; surrounding air pressure does not directly impact fuel consumption. Noted is that the air pressure may impact the optimal velocity to attain the maximum in the L:D curve for a specific aircraft.
12. Glider aircraft operating in air at 1 atm have some of the highest reported L:D ratios (do not have fuel; therefore, the specific (per passenger/load) weight of glider craft including a value of 70 for the Eta glider. Even the crude hang glider has a L:D reported at 15.
13. Jet engines and prop-engines are typically bulky and reduce L:D ratios by their presence.
14. Typical wing designs (shape of airfoil) are not designed for maximum lift; rather, wing airfoils are designed for stability and good performance over a range of aircraft pitch angles. Hence, an airfoil designed for a tethered glider that operates at only a 0 degree pitch angle can attain higher L:D ratios than one designed for performance over a range of angles.
15. Airfoil designs optimized for control over a range of pitch angles have forward upper surfaces where impacting air creates a downward force countering the desired lift. Similar "countering" forces are the forward upper surfaces of cockpits and respective passenger compartments. **The adverse impact of these surfaces is significant!**
16. A parcel service Terreplane vehicle designed for a maximum height of 1.5 ft (to handle majority of parcel service) and no preliminary constraints on velocity of operation should be able to attain L:D ratios in excess of 20. A value of 21 leads to a fraction 0.15; or more specifically, the fuel economy would be 7.2X that of typical airlines. This is likely more efficient than any other mode of service, including operation in low pressure tubes where magnetic drag is a factor of maglev suspension.
17. It is false that a high aspect ratio (large wing span relative to wing area) is necessary for a high L:D. The equations and assumptions that lead to this conclusion are based on: a) the absence of alternatives to increasing wingspan such as use of winglets and b) air foil designed created for high stability over a range of aircraft pitches.

* cruising refers to traveling without change in speed or altitude.

** specific weight is total weight divided by load. Weight is fully loaded takeoff weight.

*** 14 is a generous number for the L:D ratio of a piston aircraft since most are reported at less than this in gliding mode.