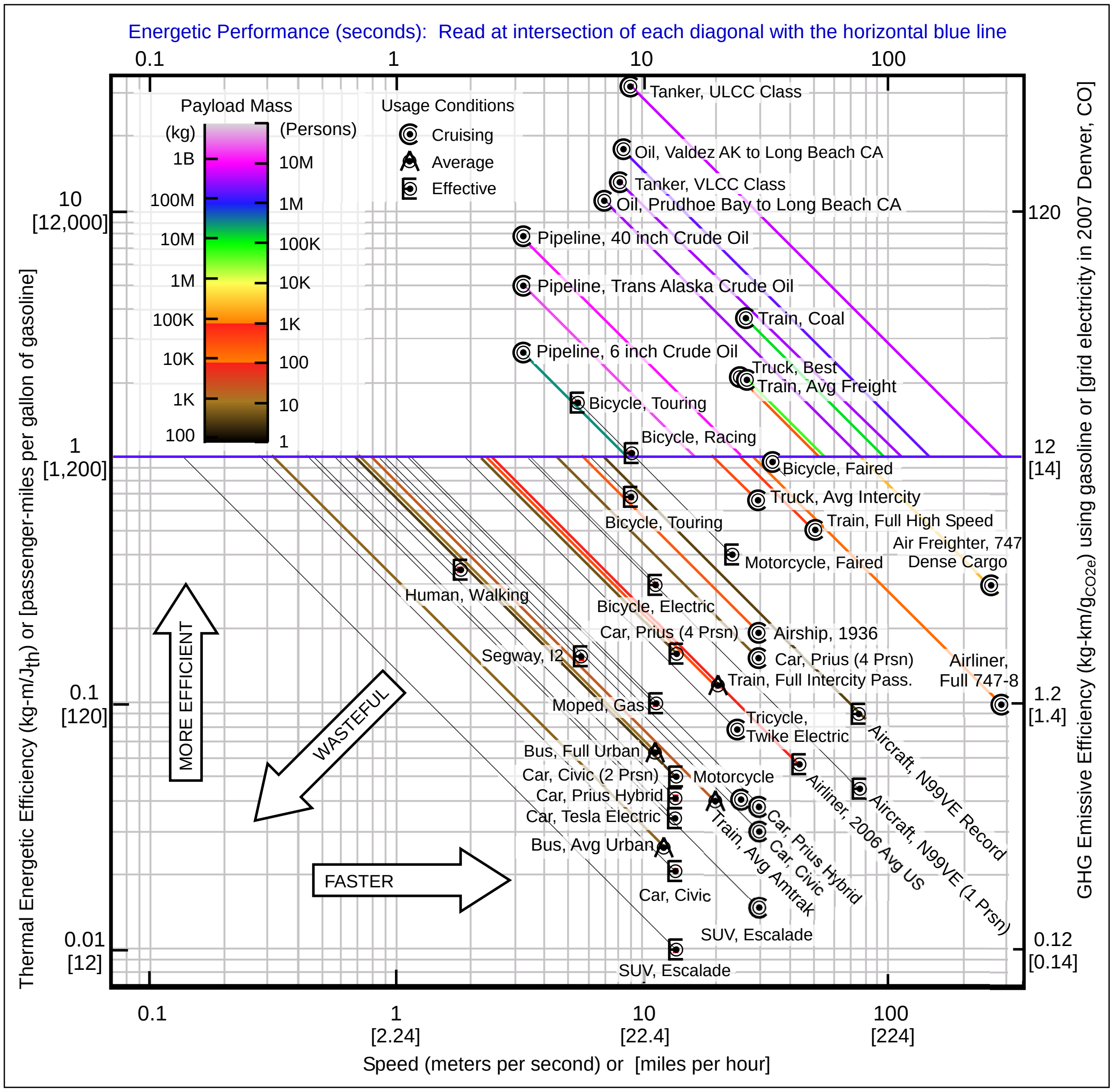
Speed, Efficiency and Waste in Transportation



The transportation matrix above indicates thermal efficiency, greenhouse gas emissive efficiency, and energetic performance for various modes at typical usage speeds. Vertical position in the graph indicates thermal efficiency in payload kilogram meters per thermal Joule, or 70 kg passenger miles per gallon of gasoline. Thermal efficiency is proportional to greenhouse gas emissive efficiency, as denoted on the right vertical axis. Horizontal position in the graph indicates speed. Horizontal position of the intersection of the diagonal lines with the horizontal blue line indicates energetic performance, which is the product of thermal efficiency and speed. Various conditions are differentiated by the data point icons. Effective values for mass transit take wait time into account are strongly influenced by utilization, delays and terminal pedestrian flow. Steady state cruising conditions are denoted, along with average conditions which include velocity changes in crowded environments. The price for convenience of personal transit is evident when compared to mass transit. It is ironic how efficiently petroleum (crude) is transported. If a person were to be transported around the world with the same efficiency as can be realized in the shipment of petroleum, it would only require two-thirds of a gallon of gasoline!

Vehicles with the highest level of energetic performance have efficient powerplants, high payload to gross mass ratios, or reduced friction with the surrounding environment. For practical personal transport at urban commuting speeds of 25 MPH or 11 m/s, as exemplified by the Neodymics Cyclemotor, the electric bicycle has the highest thermal efficiency (0.3 kg-m/Jth), GHG emissive efficiency (4.2 kg-km/gCO2e) and energetic performance (3.4 seconds).

Greenhouse gas emission is inversely proportional to thermal energetic efficiency. Electric bicycles provide the most efficient personal transportation possible without slowing below urban commuter speeds, or using a totally enclosed fairing. An electric bicycle will operate very efficiently at average urban transportation speeds of 25 miles per hour. When compared to automobile use, the reduction in greenhouse gas emission is about twenty-five fold. Indirect benefits to electric bicycle use include a reduced urban footprint on street infrastructure and parking facilities. The Neodymics Cyclemotor can enhance performance of existing bicycles, thereby increasing opportunities for bicycle use.

In evaluating transportation choices, efficiency is an important and well characterized consideration. Average speed is also important, since people are paid by the hour and "time is money." Multiplying thermal efficiency by speed, a quantity is obtained that we define as Energetic Performance. Using standard SI units, it expressed in seconds. By evaluating performance with respect to thermal instead of electrical energy, we are comparing apples to apples. Efficiency is determined by estimating the number of passenger-kilometers obtained per unit of thermal energy present in the fuel consumed. For electrically powered mopeds, the net powerplant efficiency, electrical transmission loss, charger efficiency, and battery discharge loss are all accounted for.

 Technical references are available.