The Driver Is Energy

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Aluminum is a relatively new material in the industrial world. It became a commercially available metal in the decade before the 20th century started, when an electrolytic process was discovered that could economically reduce aluminum oxide to aluminum metal. The cost to manufacture aluminum immediately fell from tens of dollars per pound to less than a dollar per pound. As aluminum usage grew, the unique products of the metal were also discovered and put to use in a wide variety of applications. As I tell my grandchildren when I am including aluminum in their bedtime stories, aluminum is STRONG, LIGHT and DURABLE, and highly recyclable.

These properties, plus the ability to alloy aluminum with a large number of other metals to produce materials with specific capabilities and attributes make aluminum attractive for many uses. These materials can be used in packaging, structural, electrical conductor, aerospace, surface and marine transport, heat management, defense applications, coating and fuel applications. The materials can also be manufactured to enhance the surface characteristics for applications such as appliances, auto body sheet, aerospace surfaces, highly reflective or absorptive surfaces and building facades.

Since 1886, when the electrolytic process was patented, aluminum usage has grown so rapidly that it is the second most used metal in the world, and is used in quantities larger than all the other non-ferrous metals combined. Over 30 million tons of primary aluminum was produced in 2005, and over 45 million tons of fabricated aluminum products were sold. Those figures are expected to more than double over the next 20-25 years.

As stated earlier, aluminum is highly recyclable and can be easily reused over and over again without loss of properties. This figure shows in graphical form the life cycle flows of aluminum in the worldwide marketplace. Note that the "standing resource" of recyclable metal is approximately 540 million tons, which represents over 70% of all the aluminum metal ever produced.

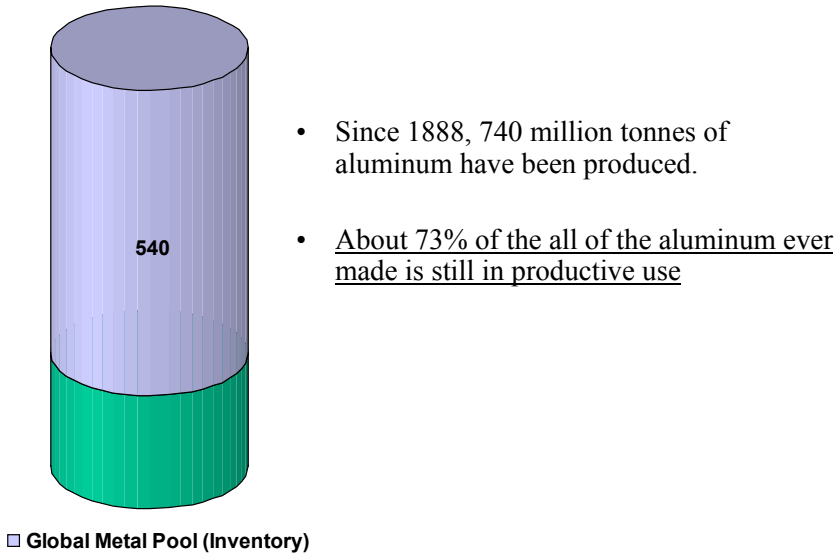


Fig. 1: Quantifying the Sustainability of Aluminum in Products

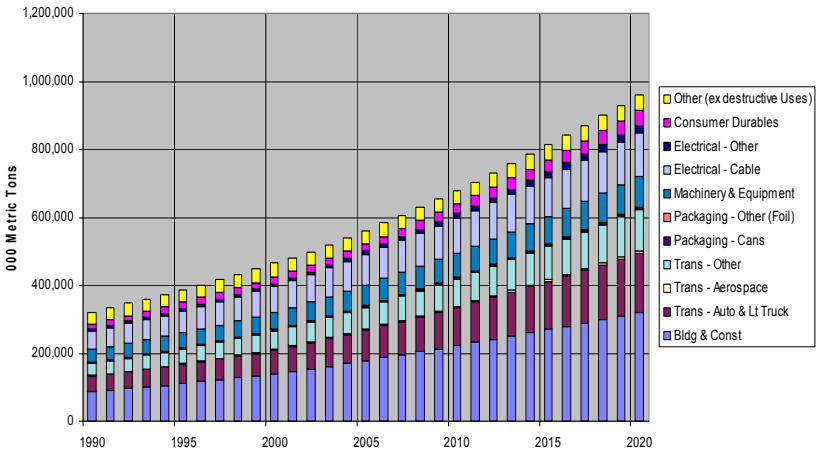


Fig. 2: Worldwide Aluminum Product "Inventory" by Market

It is available for use again, and again and again … and at a very low energy cost; a cost that is lower than recycled steel and almost all non-ferrous metals. This diagram depicts the aluminum flows through society as primary metal, recycled metal, used products and consumed aluminum materials are used to meet the growing market demands for aluminum products.

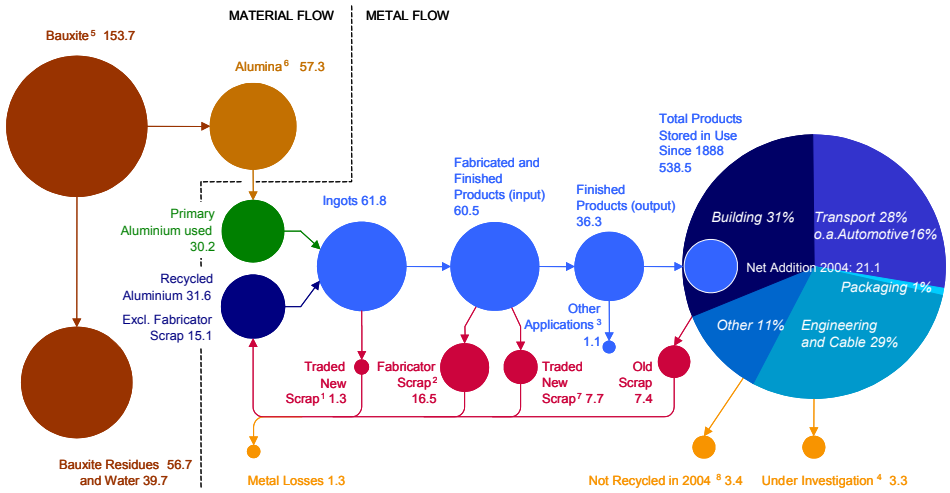


Fig. 3: Global Aluminum Flow 2004

A more simplified version is shown in Figure 4.

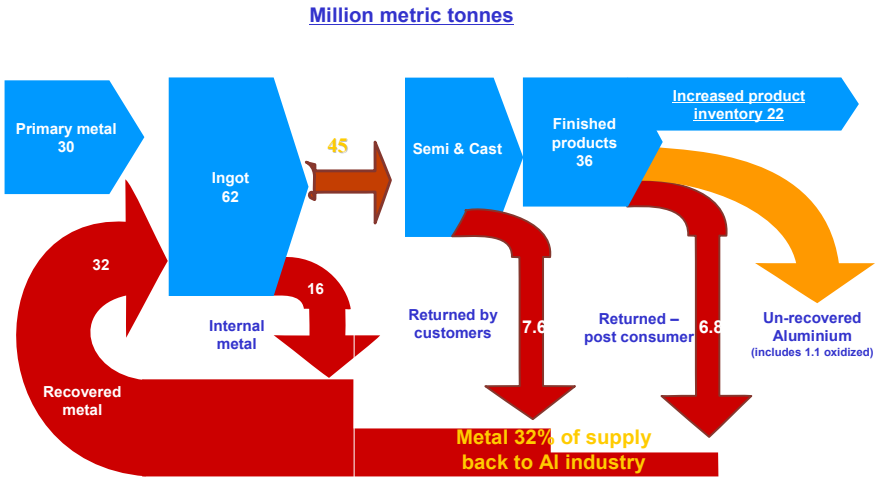
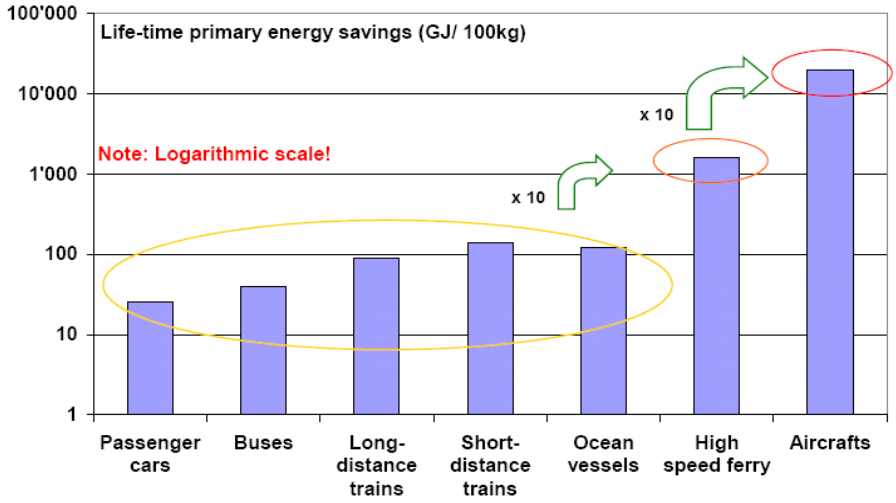


Fig. 4: 2004 Global Aluminum Mass Flows

One of the most beneficial attributes of aluminum is that it can provide strength and energy absorption capabilities while being much lighter than traditional materials used in applications where these properties are important. In an automobile, aluminum can be used in

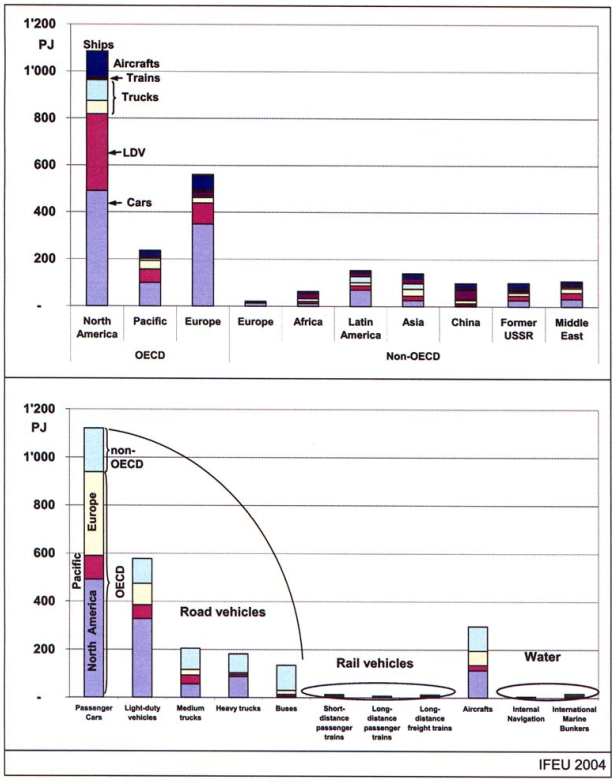
most, if not all applications where steel is traditionally used, and can achieve the desired results at a significant weight savings. This weight savings will result in increased fuel economy for the vehicle. The amount of fuel economy increase is dependant on the type of vehicle and the way the vehicle is used … but it is always positive. This chart, prepared by The Institute for Energy and Environmental research (IFEU) in Heidelberg, Germany depicts the fuel savings potential for vehicles on the basis of a 100 kg reduction in the vehicle weight. As you can see, autos, trucks, trains, buses, ferries, ships and planes all benefit.



Institute for Energy and Environmental Research Heidelberg Ltd. (2004)

Fig. 5: Potential Lifetime Energy Savings by Vehicle Type

This next graph from the same study is even more intriguing to me. It shows the energy savings potential if light weighting was practiced in each vehicle category … taking into account the number of vehicles in the category, the use of the vehicles and the amount of light weighting that is realistic to assume can be accomplished. The graph looks a little different because of the shear number of automobiles, but it shows the potential for light weighting. Of course, the lighter vehicles can only work if they can be made as safe as or safer than "traditional" vehicles, without loss of utility, styling or reliability.



Source: IFEU, 2004

Fig. 6: Potential Primary Energy Savings from Light Weighting

All of that can be accomplished with aluminum as a light weighting material. In fact it is happening today, and at a very rapid pace. For example, in the 2005 model year, aluminum became the second most used material in the average car produced. The aluminum content of the average automobile now exceeds the iron content, and is second only to steel on a weight basis.

This chart, prepared by Ducker Associates in 2006 shows the rate of growth of aluminum in automobiles produced in the three largest manufacturing markets in the world – Japan, Europe and North America. The growth rate has been rapid and fairly consistent and is expected to continue to increase at a 4% or greater rate for the next 10+ years. The average car produced in 2006 contains 127 kg of aluminum (279 pounds) and some models contain over 200 kg.

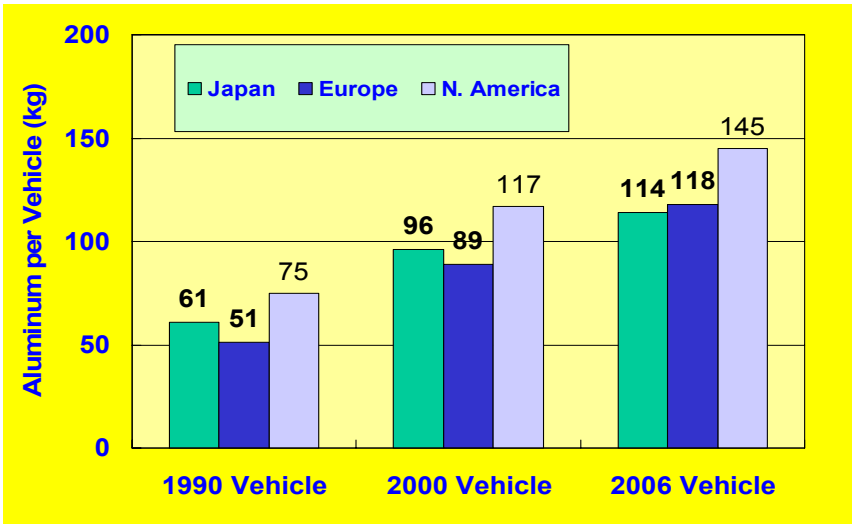


Fig. 7: Demand of Aluminum for Automotive Applications (kg/vehicle)

This next graph, also from the Ducker Research Report, shows the implications of this light weighting. Here the fuel savings over the lifetime of the vehicle is shown based on the year that the vehicle was manufactured.

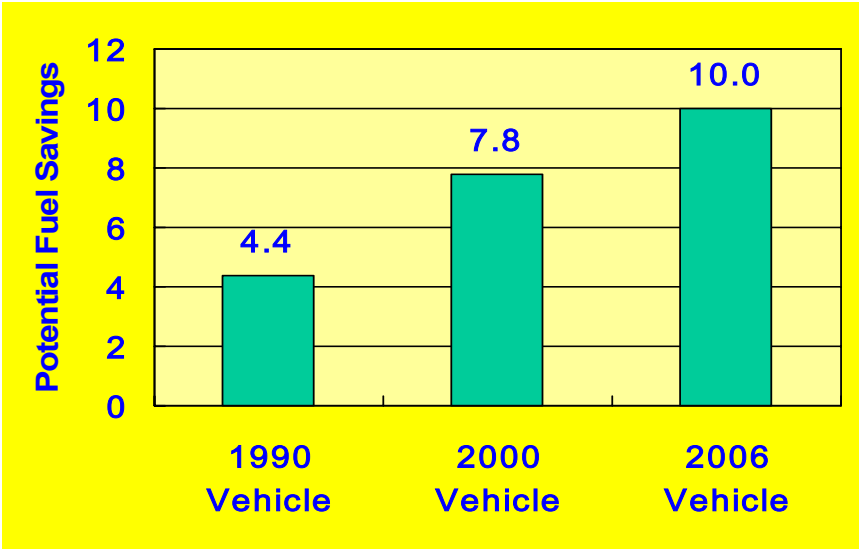


Fig. 8: Reducing Mass Improves Fuel Economy

This takes into account the fuel efficiency of a "traditional" vehicle manufactured that year and a lighter vehicle that contains the average amount of aluminum used per vehicle in that year. As aluminum usage grows, and the number of vehicles produced increases, the fuel savings also increases dramatically. With projections that the worldwide production of automobiles is expected to increase from the 50 million per year level of today to on the order of 100 million per year in the future as developing economies provide their citizens with increased purchasing power, the fuel savings potential from light weighting becomes enormous.

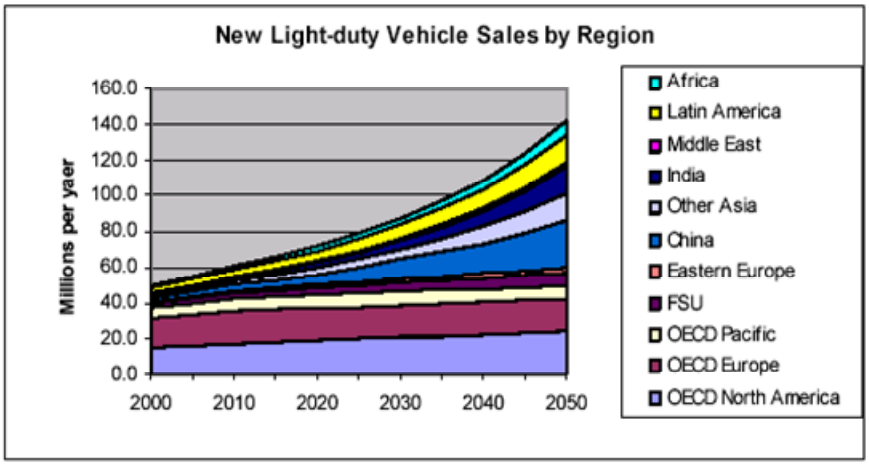


Fig. 9: Continued Growth of Autos and Light Trucks

Alcoa and the International Aluminium Institute have developed a global Aluminum Model that makes it possible for projections to be made about energy and material requirements for the industry, the size of the recycled aluminum market, and the market demands for various categories of products made from aluminum and a number of other parameters of interest. The model is built on detailed worldwide data from 1950 through the present, and this information, along with some assumptions about changes in recycling rates, energy use, specific market conditions, etc. are used to predict future scenarios. It is a great tool!

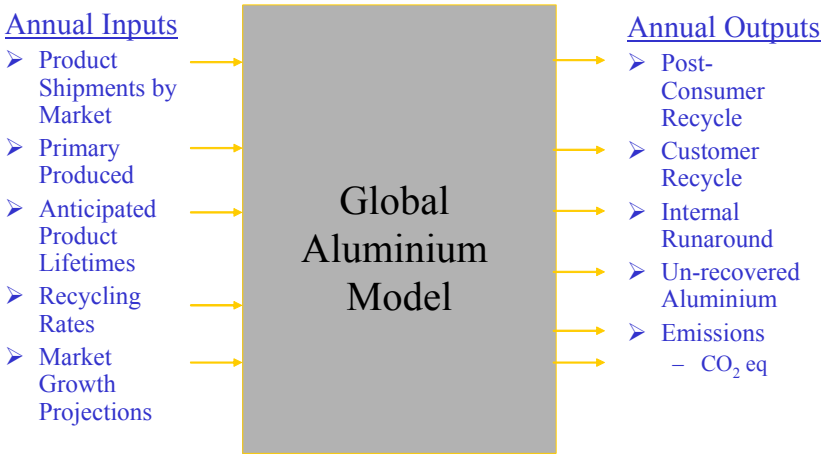


Fig. 10: Global Mass Flow Model

For example, we have used the model to determine the energy and greenhouse gas implications of the increased production of aluminum over the next 25 years. As I stated earlier, the growth rate of the industry is significant.

In terms of greenhouse gases, we have carefully measured greenhouse gas emissions for all aspects of the industries production chain, from mining to refining, to smelting, to metal casting, to metal fabrication and product recycling after the end of its useful life. Those data allow us to project the GHG emissions for each year in the future as each of the listed segments grows to meet market demands. Based on these calculations, our industry is projected to be responsible for over 400 million tons of GHGs by the year 2020.

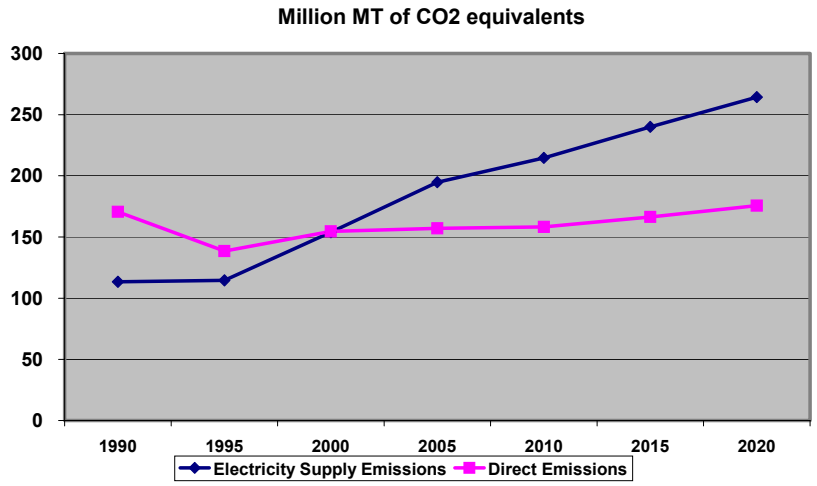


Fig. 11: Aluminum Production GHG Emissions

However, the model also allows calculations to be made to determine the GHG savings that will occur as a result of the use of lighter weight aluminum in transport applications to replace heavier traditional materials. Based on the growth rates for aluminum use in automobiles predicted by Ducker and others, as well as the increasing use of aluminum in trucks, trains, buses, and ships, the model demonstrates that by 2017, the savings in fuel use will be large enough to completely offset the GHGs produced by the entire aluminum industry to make all the products that will be sold that year; for transport applications and all other applications as well. We call that the "Greenhouse Gas Neutral" year for our industry. From that point on, we will produce less GHGs that are saved by the aluminum use in vehicles.

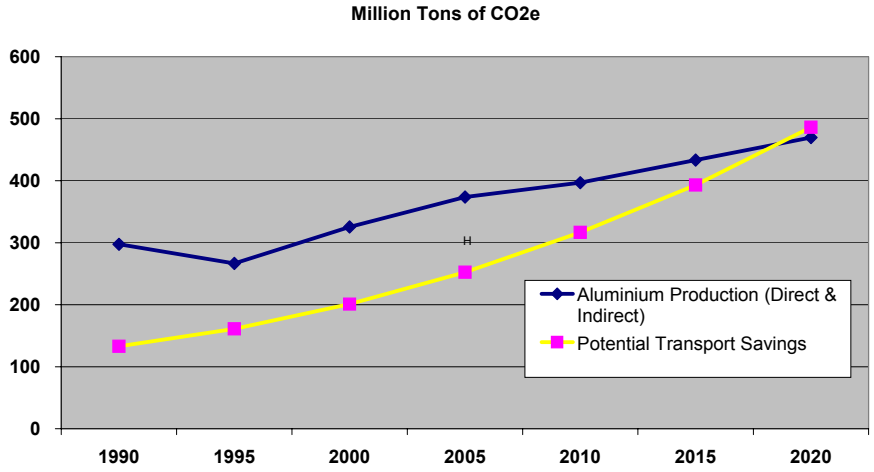


Fig. 12: Potential GHG Savings

The model also lets us look at energy savings, and the same types of calculations can be done for total energy. In this case, the curves cross a bit later, in 2024, but they do cross because the energy saving from light weighting is so significant. At about this time, we think there may be some major shifts in the way vehicles are powered, but I continue to believe that light weighting will continue to be important as drive trains become more complex. Lighter components will be needed.

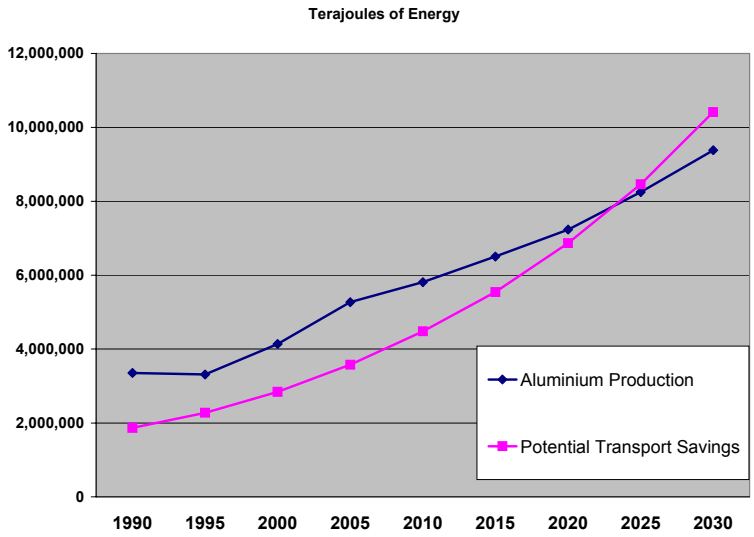


Fig 13: Potential Energy Savings

One final point. The energy that is saved through light weighting is mainly petroleum based fuel, at least for the next 10 years or so, and much of that type of fuel is imported into the major automobiles markets of Japan, Europe and North America. However, the energy used by the industry is mainly in the form of electric power generated nearby (hydro power, gas, coal and nuclear) and domestic fuels such as gas, coal and biofuels. So the savings in energy by light weighting can facilitate a move toward domestically available fuels and away from imported fuels.

In summary, I believe that the driver for innovation in the transport industry will be energy (cost and supply), assisted by increasing concerns about safety, reliability, recyclability and performance. Aluminum will play a positive role in all of these areas, and can truly help the transport industry address areas where consumers will be more demanding.

I was struck by a phrase that I read recently, but I cannot remember where. The phrase was, “aluminum is the metal with a future.” I agree.