The world gas crisis grows more serious with each passing day. Every day, it seems, new edicts are passed and gas prices skyrocket. Making use of energy sources other than “black gold” will refresh the world's economy and stabilize affairs worldwide.

Shortages of crude oil, real or imagined, cause instability in various aspects of life. Israeli agriculture is particularly hard hit from the global energy crisis, especially the fields of agriculture that require heating, such as indoor plantations and greenhouses. A popular fad in the 80's and 90's was growing flowers, especially roses. Due to the large quantities of heat required for roses to grow, the rose growing industry went into serious decline. Plantations of roses are generally heated by fuel combustion. In the 80's and 90's, oil was affordable, and so the rose growing industry flourished. Fuel is still the cheapest existing energy source, but its skyrocketing prices will eventually prevent it from becoming the chief source of greenhouse heating.

In modern, intensive, and precision agriculture, much use is made of machinery and vehicles. The tractor forms the basis of agricultural operation. It has many diverse muses and applications, and this is reflected in its range of structures and adaptations. Tractors that are used for plowing or irrigation tend to be large and heavy. Tractors that perform auxiliary work on crop growth are adapted for that particular line of work, as are tractors for shipping and transportation.

Several efforts have been made over the years to produce transformable tractors that can adapt to a wide range of uses. For example, tractors built with a suspension and shock absorption system such as that which exists in any automobile never really succeeded and remains an experimental curiosity. Despite a number of attempts to create a breakthrough in tractor design, the basic design of the tractor has remained pretty much the same throughout the years. Modern day tractors are similar in principle to the ones that existed 60 years ago. Since then, there has not been any real major innovation in tractor design. Generally speaking, tractor development has remained stagnant.

Most tractors are composed of the following subsystems:

1 – an engine that converts chemical energy into rotational mechanical energy
2 – a container of fuel
3 – a transmission system and gearbox damper that controls and directs the rotational mechanical energy from the engine toward the needs of the farmer
4 – a system of wheels or tracks that converts the rotational energy into tractor motion. It is controlled by the operator to achieve the desired results.
5 – a hydraulic system that converts the rotational energy into hydraulic energy which is conveyed through the pressure pipes to the components that need it, which return the hydraulic energy into mechanical energy
6 – a chassis that binds all of the parts together and is molded to function as a tractor
7 – auxiliary systems, such as the driver's cabin, air conditioning, radio, navigation system, electric system, lighting, and computers to assist in operating the tractor most effectively
Modern day tractors are equipped with the most cutting edge technology, but no major change has been innovated. The first subsystem, the engine, has a very low efficiency in converting chemical to mechanical energy. About two thirds of the energy stored in the fuel is dissipated. This dissipated fuel energy, in addition to monetary loss, results in excessive heat, noise, and other undesirable effects. The efficiency hasn't significantly improved in quite a long time. All of the efforts invested by scientists in improving engine efficiency are only improvements of superficial phenomena; the core combustion engine remains the same. There have been improvements, though, in valve systems and fuel injection systems. Lately, there was even an attempt to install crankshafts for water injection. As of yet, though, there has unfortunately been no breakthrough.

There has, however, been constant improvement in the third subsystem – transmission and damping. The current day propulsion system, like the rest of the tractor's subsystems, does not at all resemble that of the 40's. The combustion engine remains the Achilles heel in improving the tractor. This article deals with the low efficiency internal combustion engine. External combustion engines are even worse, as they are essentially steam engines which are now nearly out of use. They work on extraction of chemical energy from the coal or wood chips.

If both internal and external combustion engines are inefficient, what type of engine, then, should one use? The answer: electric engines, where the efficiency is very high, about 95%. In other words, 1/20 of the energy is wasted, as opposed to 2/3 of combustion engines. The conversion of electrical to mechanical energy in electric motors is a process that affords complete control by increasing or decreasing the number of coil windings as opposed to the mechanism currently employed by tractors. The placement of the motors on the wheels themselves and direct control of the electric motor's speed will provide the operator with the desired speed. The speeds of the individual wheels can be independently controlled. This enables the driver to steer a curve without an additional steering system by adjusting the wheels' speeds according to the curvature of the path to be traversed. Enabling individual wheel control reduces wear on the tires, significantly boosting movement and cultivation.

The external appearance of this futuristic tractor will still be similar to current tractors. While the arrangement of its internal components will be different, there will not be any changes to the cabin, wheels, or chassis. James Watt, a Scottish engineer, invented several important mechanisms of the steam engine and is considered to be the inventor of the modern steam engine in 1774, hence the eponymous unit of power – the watt, symbolized as W. In 1878, the German engineer Niklaus Auto designed the first four stroke engine, the internal combustion engine. The diesel engine was invented in 1897 by the German engineer Rudolf Diesel. The efficiency of engines has not improved much since; it is still very low compared to electric motors.

Units of power, such as W, are of work per unit time. Similar to flow rates being expressed in
cubic meters per second, W is the amount of work done per second. A kilowatt kW, is 1,000 W. The Israel Electric Company charges for the kilowatt-hour, or kW-h, which is a unit of energy. This means, for example, that if an electrical device runs on half a kilowatt for 5 hours, it has consumed \(0.5 \times 5 = 2.5\) kilowatt hours of energy.

The inventors Watt, Auto, Diesel, and others dealt extensively with energy conversion, such as from chemical to mechanical and more. The development of the calorimeter has enabled the measurement of chemical energy stored in various materials. The calorie is a measured unit of energy. One watt-hour is equal to 860 calories. A kilo-calorie, or 1,000 calories, is abbreviated as kcal. A kilo-calorie is colloquially referred to as a calorie without the prefix kilo.

A calorie, being a unit of work, can also be expressed in units of force multiplied by distance, such as a Newton-meter, or N-m. This unit is also called a Joule, after the English physicist James Prescott Joule, the founder of thermodynamics, and is noted as J. Joule discovered that energy and heat can be converted from one to the other. Watts are thus Joules per second.

Power is generally expressed in the automobile industry in units of horsepower, noted as hp or c.v. in French. While force is often expressed in Newtons, in the past, it was expressed in force kilograms, noted by kgf. This caused a lot of confusion between kilograms of mass and force kilograms, and so nowadays it is generally avoided as an expression of force. So it's now simply kg for mass and N for force. The connection between the two is the gravitational acceleration constant g. The Newton is essentially the amount of force necessary to accelerate one kilogram of mass to one meter per second squared. The relationships are:

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1 \text{ Newton} = 1 \text{ kilogram} \times \text{m/sec}^2
\]
\[
1 \text{ kgf} = 9.81 \times \text{kg} \times \text{m/sec}^2
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\[
1 \text{ kgf} = 9.81 \text{ Newtons}
\]

We thus have the following units:

- force – N, kgf
- work/energy – N-m, J, cal, kcal, kW-h
- power – cal/sec, kcal/h, W, kW, hp

What we would like to know is what is the weight of a battery that contains as much energy as the chemical energy exuded from the diesel compartment of a typical tractor or automobile. While its dimensions or also important, they are less critical from a physical perspective than the weight is. The following data will help us to calculate the answer. The energy output attainable from diesel oil is 10,200 kcal/kg. In other words, every kilogram of diesel oil provides us with 10,200 kcal of energy. Its density is 0.85 kilograms per liter. A typical 100 liter container can thus hold \(100 \times 0.85 = 85\) kg of diesel oil.

The question may now be rephrased as: How much will a battery that provides as much energy as 85 kg of diesel oil weigh? A typical 12 volt car battery of 60 ampere hours weighs 13 kg, which is
13*9.81 = 127 N. This battery has a total stored energy of 60A-h X 12V = 720W-h, or 0.72 kilowatts per hour. In units of calories, this equals 0.72*860 = 619.2 kcal. The caloric value of the above diesel compartment is 10,200 X 85 = 867,000 kcal. One would then require 867,000/619.2 = 1,400 (!) car batteries to produce the same energy as a diesel engine, and it would weigh a total of 13*1,400 = 18,200 (!!!) kilograms, or 18.2 metric tons!

Adding more than six tons of weight to a tractor is problematic, and even more so for an automobile. Developing a battery that stores a lot energy and weighs for little is the main challenge for electrical vehicles. A high energy storage capacity per unit weight is what is demanded in the immediate future. Current day car batteries store 47.7 kcal per kg of weight, as opposed to diesel fuel which store 3,400 kcal per kg. Diesel fuel is thus 3,400/47.7 = 71.28 times more efficient than batteries. According to this calculation, the challenge can also be redirected towards developing a car battery that weighs 13/71.28 = 0.183 kg, or less than 200 grams.