Cornel Stan

# Energy versus Carbon Dioxide

## How can we save the world? 59 Theses

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# Preface

How do we save the world?

The world's population will be eight billion people in the next three years, and ten billion in the next three decades. On the other hand, technical and economic developments in the world are increasing annual per capita energy consumption sharply. The number of people multiplied from year to year by the respective per capita consumption shows an exploding energy demand. Whether Homo sapiens can somehow procure this energy is no longer the problem: The deconvolution of most forms of energy, however, generates carbon dioxide, which has already caused a threatening global warming. The climate neutrality of any form of energy production and transformation is now absolutely necessary. The closure of all coal-fired power stations, but also of carbon dioxide-free nuclear power stations, the banning of all internal combustion engines that move ships, aircraft, construction machinery and automobiles, are radical claims with no ideas or visions about the consequences. Alternative solutions are certainly not the matter of the respective claims carriers.

This book is dedicated to the search for forms and quantities of energy for the future, while maintaining climate neutrality, partly by drastically reducing, partly by recycling the resulting carbon dioxide emissions.

The path from energy to carbon dioxide begins in humans and animals with respiration and food, at the end of assimilation reactions appears besides other products the carbon dioxide. Otherwise, in the case of plants, the input of carbon dioxide generates food: this leads to an inverted cycle in comparison with humans and animals. This plant-like cycle is increasingly being taken into account in the construction of new machines and industrial plants, as numerous examples in this book show.

The planes, the tankers and the automobiles are always in the focus of criticism, but the true energy guzzlers and at the same time carbon dioxide emitters are others, as it is presented in the book. Electric drives instead of combustion engines also do not solve the conflict between energy and carbon dioxide. There are more efficient ways, which will be presented and analyzed in this book.

A central section of the book is devoted to energy without carbon dioxide, starting with the hopefuls - photovoltaics, wind power and hydropower - with their advantages, but also with their disadvantages.

Nevertheless, this work is centered on the promising solutions for energy generation with simultaneous climate neutrality from the perspective of energetic cycles: The water cycle *nature-electrolysis-machine-nature* is compared with the carbon dioxide cycle *nature-photosynthesis in plant-machine-nature*. The results of analysis are largely surprising from this perspective.

Energy production causes carbon dioxide emissions, this fact is well known. But the “inversed” fact that carbon dioxide can generate energy in form of heat, electricity and fuel is probably less so, which is why such projects are also presented in this book.

Numerous research and development projects in the relevant fields, with the active participation of the author, together with industrial partners from several countries, are a good opportunity to devote themselves to these topics.

Cornel Stan Zwickau, Germany, August 2021

# Table of Contents

# Part I

# Energy and carbon dioxide

# 1
# Matter

Is **matter** the counterpart of the idea, or a creation of the spirit? Plato (Greek philosopher, 428-348 BC) raised a demiurge, which is a benevolent God, as a carrier of ideas, who created from these the elements earth, water, air, fire and ether and set them as the basis for all other bodies.

Aristotle (Greek polymath, 384-322 BC), refined the wisdom of his teacher Plato: "Matter is the possibility of being formed".

To put it nicely – so you always expect matter to be something material, that is, a substance, a body, a **mass** – a body that is tangible, a mass as a weight!

*The manifestation of **matter** was, according to the state of knowledge at that time, the **mass**.*

And what or who formes such a mass? Again, the spirit, as a driver of the process between two states? So we slowly come to the energy!

Is **energy** "living reality and efficacy", as the Ancient Greek philosophers thought?

It was not until 1807 that Thomas Young (English physicist, 1773-1829) defined energy as the "strength


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of very specific effects that a body (i.e. a mass) can cause through its movement".

So the effect of a body evokes energy. Often this effect consists in the exercise of a force (by means of this mass) during a way, which is also called mechanical work (a form of energy).

Can the mass influence the energy, or vice versa?

If we burn a liter of gasoline (that's about 0.7 kilograms of mass) in a piston engine, work is done on the movable piston, and consequently at the crankshaft, being then is transmitted to the wheel. Has our kilogram of gasoline disappeared as a result of energy conversion? One would immediately say "yes": energy was paid for with mass. That is absolutely wrong! The gasoline reacted chemically with oxygen from the air, it came to other components (carbon dioxide, water and nitrogen). Is the mass of the resulting components smaller than the sum of the masses of gasoline and air? No, roughly speaking, it remains the same. More precisely, however, the mass after the energy development is larger than before! According to Einstein:

*E (energy) = m (mass) x* $c^2$ *(speed of light squared).*

*The manifestations of **matter** were, according to this state of knowledge, **mass** and **energy**.*

The greater the energy development, for example during the combustion of gasoline, the greater the mass of the products than that of the starting materials, because Einstein considered the speed of light to be constant (300 million meters per second).

For one kilogram of burnt gasoline, this increase would be 0.474 x $10^{-6}$ grams/kilogram of gasoline [1]. Not much for the weight of the car as a whole, but much for the course of physical processes in general.

At the speed of light, the electromagnetic waves, for example from the sun, are emitted by means of photons. Until recently, photons were considered as energy particles without an own mass. In the meantime, however, their tiny mass has been discovered. But there is something else interesting about the electromagnetic waves: Solar radiation, as the mother of all radiation, is concomitant emitted at all wavelengths, from cosmic rays to gamma, X-rays and ultraviolet to visible and infrared. Moreover, the intensity of the radiation at these wavelengths (watts/cubic meter) is very different [1].

A radiation from electromagnetic waves, whether from the sun, from a body (also human body), or from an electrical/electronic device is an information carrier due to the variable intensities and wavelengths.

The speed of light squared (physically speaking, this is a specific energy), as Einstein wanted it to be, is an information between the energy donor and the mass of the receiver. The information is an encoding that the receiver uses to sort the received energy in its own modules.

*The manifestations of matter are, according to the current state of knowledge,* ***mass****,* ***energy*** *and* ***information****.*

**Thesis 1: The manifestations of matter – *mass, energy and information* – influence each other during a process (state change) between two equilibrium states of a material system.**

# 2

# Energy versus carbon dioxide in the nutrition of human beings

Can a person feed directly with the energy of the sun's rays? Hardly. That would solve one of humanity's biggest problems, malnutrition. It is precisely in the regions of the world where this problem is particularly acute that the sun shines the most. But that doesn't work. The tourist, who is so hungry for the holiday sun in Mallorca, can get by lying in the sun for too long, without parasol and without cream, skin burns, headaches and diarrhea. The electromagnetic radiation of the sun collides with his body with all wavelengths, with high intensities, as a *heat flow* that is collected over hours as *heat* (a form of energy, like *work*). But collected is not stored, heat cannot be stored, it only works during the state changes of the poor subject. The form in which he stores this energy is called *Inner Energy*. But it stores them encoded, on wavelengths and intensities, in its various organs. The muscles get hot and want to spray water through the skin. The skin lets the water out through its pores, but its tissue on the surface is burned and dried by the sun's rays, in the end it is fiery red and peels off. The brain is not much better off: The increase in its internal energy through the


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enormous heat supply makes the molecules in the gray cells dance properly, which causes delusions in an unwanted half-sleep. If some wavelengths and intensity peaks can be avoided, then the solar radiation gives happiness to the human soul, it gives warmth to the body: but it cannot satisfy hunger, it cannot impart its energy to the body cells that need it for the preservation of body functions. The cells need carbons and hydrocarbons, which generate heat directly on site with the oxygen from the air through chemical reactions similar to combustion.

**Thesis 2: The *energy* that a person or any other living being needs for the nutrition of his body mass in order to perform a *work*, can neither be generated by solar radiation on the skin, nor by gusts of wind in the nose or by water massage of the muscle.**

When gasoline is burned with oxygen from the air in an internal combustion engine, as mentioned, carbon dioxide is produced in addition to water and nitrogen. And if in the cells of the human body hydrocarbons (carbohydrates) react chemically with oxygen from the inhaled air, similar to the combustion processes? Does carbon dioxide then also arise?

A person breathes air into the lungs on average 12 to 15 times per minute. The two lungs usually have a volume between 0.5 and 0.7 liters. So humans breathe in between 6 and 10.5 liters of air per minute. 8 liters per minute can serve as a guideline and comparison value. *The four cylinders of an automobile piston engine with a total swept volume of two liters suck in air 1500 times per minute at a speed of 3000 rpm.*

At an ambient temperature of 20 °C, the 8 liters that humans breathe in per minute contain 9.5 grams of air. *In comparison, the piston engine sucks in 3.56 kilograms of air per minute at 3000 rpm.*

The piston engine therefore takes up 375 times more air mass per minute than humans.

On the other hand, under the conditions shown, at full breath, man exhales an exhaust air in which there is an average of 0.605 grams of carbon dioxide per minute. Under the conditions shown, the engine delivers 750 grams of carbon dioxide per minute at full load, which is 1240 times more than a human being (both carbon dioxide values will be derived in the following paragraph).

Between the air intake ratio engine/human and the carbon dioxide output ratio engine/human there is as result a factor of around 1:3 (375:1240).

These values can be derived as follows: Man breathes 21% Vol. Oxygen in the 8 liters of air per minute, in addition 78% Vol. Nitrogen, 0.038% Vol. Carbon dioxide and, moreover, few traces of noble gases such as neon, argon and krypton. On exhaling it is 17% Vol. Oxygen (4% Vol. were thus retained), 78% Vol. Nitrogen (unchanged between inhalation and exhalation) and, now also 4.03% Vol. Carbon dioxide, which results from the combustion of the ingested food, or from the processes in the entire organism.

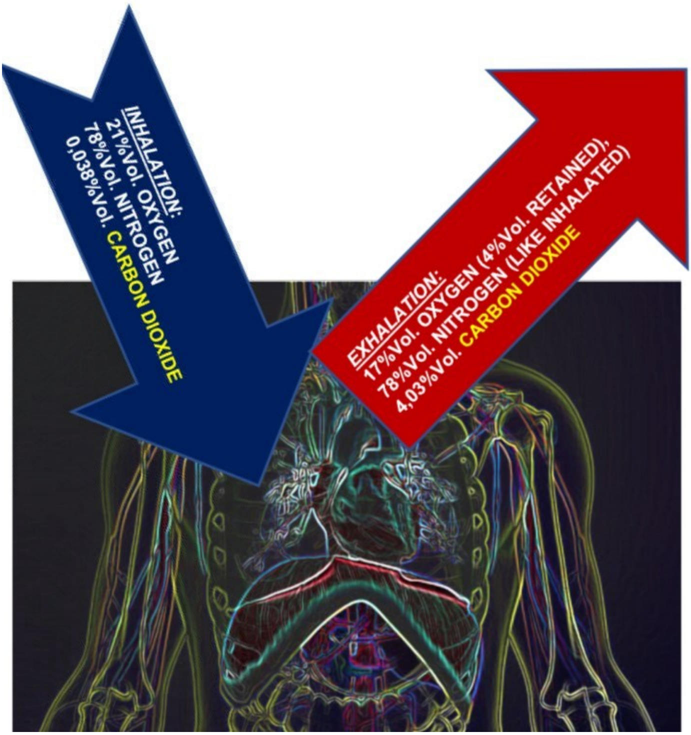


**Fig. 1** *A human breathes 9.5 grams of air per minute (8 liters, of which 0.038% Vol. $CO_2$); on exhale it is 4.03% Vol. $CO_2$, (but the oxygen concentration in the exhaled air decreased by 4%)*

*Conclusion:* of the inhaled air volume, 4% oxygen was retained, in the exhaled air volume appeared about 4% carbon dioxide. However, the carbon dioxide has molecules with a larger mass than those that make up 99% of the air (nitrogen and oxygen). For this reason, the exhaled air is heavier than the inhaled, a remarkable result!

The comparison between the air mass taken within a year and the carbon dioxide mass emitted between humans and the engine then leads to a completely new insight:

In the case of humans, the 9.5 grams of air per minute means 0.57 kilograms of air per hour, or 5 tons of air per year! The carbon dioxide emissions of 0.605 grams per minute add up to 318 kilograms per year.

*The engine needs 3.56 kilograms of air per minute, which is 1871.136 tons annually - presupposed it would run throughout the year, continuously, at full load at 3000 rpm. However, the engine does not run continuously at full load and lively speed throughout the year.*

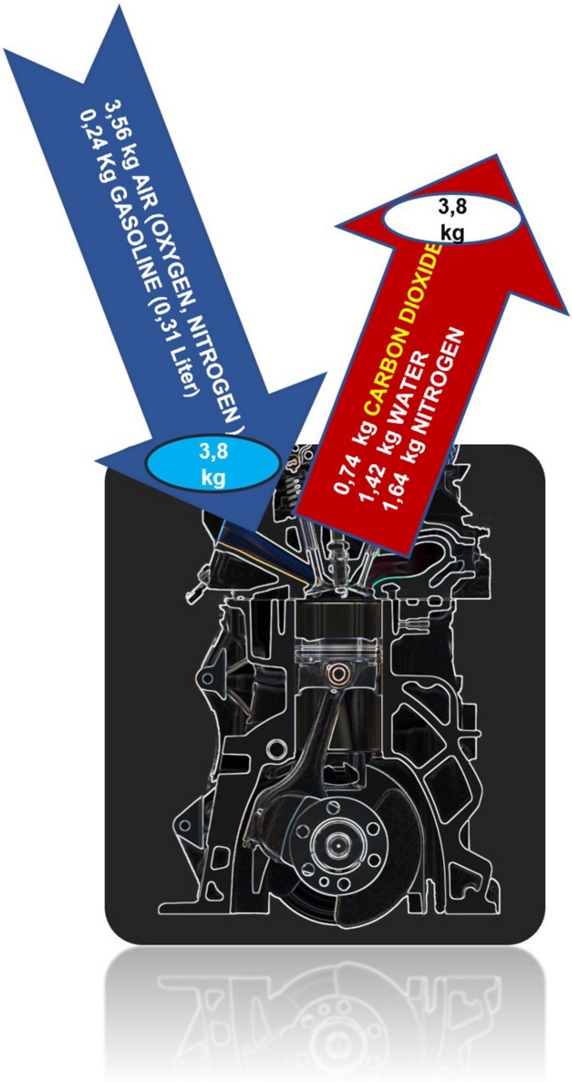


**Fig. 2** *A two-liter piston engine sucks in at 3000 rpm 3.56 kg of air per minute, plus 0.24 kg of gasoline and, after combustion, emits 0.74 kg of* $CO_2$*, 1.42 kg of water and 1.64 kg of nitrogen*

And the human? He would inhale 2100 m$^3$ of air per year, if he allowed himself a pleasant time in an armchair, provided that this condition would not change for the whole year. Under these conditions, carbon dioxide emissions would amount to 163 kilograms per year (4.03% Vol. $CO_2$ in the exhaled air multiplied by the $CO_2$ density). But if the same human were strongly stressed, it would inhale 25,000 m$^3$ of air and exhale 1980 kg of $CO_2$.

*And the engine? The average annual driving distance of an automobile in the European Union is statistically 15,000 kilometers in urban-rural traffic, not always at full load, but according to a driving profile between idle, partial load and rarely full load. So, an automobile functions about 2 hours a day, but the human being functional 24 out of 24!*

*The average annual fuel consumption of a mid-size automobile with piston engine is 7 liters of fuel/100 km, which is 1050 kilograms of fuel per year. This results in, with a usually complete combustion of the gasoline, 3255 kg of $CO_2$ [2].*

*Carbon dioxide emissions from automobiles have been reduced by the European Union to a fleet value of 95 grams of CO2/km] from 2020. 0.095 kg/km results in 1425 kg $CO_2$/year at 15,000 km/year. For a $CO_2$ limitation of 20 g $CO_2$/km, which would mean a fleet consumption of 0.88 liters of fuel/100km, the annual carbon dioxide emissions would be just 300 kilograms (to be compared with the mentioned 163 – 1980 kg exhaled yearly by a human).*

**Thesis 3: The combustion engine of a modern, common automobile emits over an annual driving distance of 15,000 kilometers in urban-rural traffic, according to a usual EU driving profile, just as much carbon dioxide per year as an average person with a work program which is usual in Europe.**

*For a single internal combustion engine in an automobile, however, it will hardly be possible to achieve a fuel consumption of 0.88 l/100km, which could lead to 20 grams of carbon dioxide emissions per kilometer. There are two alternative solutions for this: either a combination of combustion engine/electric motor in the propulsion system of each individual car, or the production of a disproportionate number of electric cars compared to combustion cars within a brand [2].*

*Before such solutions are found, however, it is recommended to use $CO_2$-neutral bio-fuels, which will be discussed in detail in a further chapter.*

Humans feed on many energy sources that contain carbon, just like the engine. Even if the annual carbon dioxide emissions of humans and engines are comparable, there is currently a fundamental difference between the respective energy sources: The foods with which humans feed contain carbon atoms, which are recycled in a natural, relatively short-term biological cycle. However, the engine has so far been fed mainly on fossil fuels – fuels from oil, as well as natural gas – which achieved such structures over millions of years. The carbon dioxide emitted by the engine as a result of its combustion is accumulated in the atmosphere, without recycling, within a measurable time interval.

## Thesis 4: An internal combustion engine, would need in the future, like humans, energy carriers that undergo photosynthesis, such as biowaste, or have undergone organic changes, such as biogas. Only then will a comparison between human carbon dioxide emissions and such of the combustion engine be permitted.

Which of the foods for humans contain carbon atoms, which then, as a result of energy processing in the organism, become carbon dioxide? The answer is clear: all of them! A human needs hydrocarbons, proteins and fats, all of which contain carbon atoms. Minerals such as iron, cobalt, copper, manganese, selenium or zinc, as well as vitamins such as thiamine, niacin or pyridoxine are contained in such a small percentage that they are negligible for a pure mass balance.

As far as the amount of food is concerned, a healthy person who is neither lazy nor competitive athlete needs a daily food intake of an average of 2000 kilocalories, i.e. 8363 kilojoules. The nutritionists generally share this food very strictly: daily 264 grams of carbohydrates (hydrocarbons in motor language), 66 grams of fats, 72 grams of proteins. In addition, at least 2.2 liters of water per day. And if it ever becomes a beer instead of water, its carbohydrates should be deducted from the above-mentioned food limit.

The strictly recommended carbohydrates, fats and proteins should be listed at this point, for a better understanding, in their tasty form, so as not to remain too abstract. It is recommended to make such a balance for a whole year, because man does not eat the same quantity of bananas or potatoes every day. It is also very revealing to make a qualified comparison between the recommendations of nutritionists and reality, as in Tab. 1.

As an example, people in Germany eat on average, 1.6 times more annually than they should. The statistics do not provide any information on the differences between ascetics and gourmands.

*The combustion engine works with both fossil and regenerative fuels.*

*A diesel fuel from petroleum generally consists of 84% carbon and 16% hydrogen, natural gas (methane) of 75% carbon and 25% hydrogen. The calorific value of both fuels is approximately the same, rather slightly greater for methane. It is therefore more advantageous to burn a kilogram of methane instead of a kilogram of diesel fuel for the same energy retention in the form of heat. However, after methane combustion, more water and less carbon dioxide will be found in the exhaust gas than in the case of diesel fuel combustion [2].*

*In the future, however, the methane for the combustion engine should no longer come from fossil natural gas, but from biogas, in order to ensure recycling of carbon dioxide emissions in nature.*

*The remains of all the above-listed foods of the people are the best basis for biogas production for the engine food in the form of methane. Similar recyclable fuels include, among others, alcohols such as methanol and ethanol.*

Ethanol is not only right for the combustion engine, but also for many people. In the internal combustion engine it burns quickly and well. In humans it burns quickly, but tasty, from whisky and cognac to grappa and fruit spirit.

If a person cannot feed directly with the energy of the sun's rays, then ethanol is an indirect product of solar radiation, via photosynthesis in the plants from which it was produced. Could man not obtain his energy as *work* and *heat* only from ethanol, like an internal combustion engine?

The daily energy ration for a person, of an average of 2000 kilocalories, i.e. 8363 kilojoules, as mentioned before, is at this point, for the following comparison, a little more detailed:

In general, for a woman of the best age and in the best form is recommended an energy intake of one kilocalorie per kilogram of body weight, per hour. For a woman who weighs 65 kilograms in 24 hours, this makes 1560 kilocalories per day (please to excuse the temporary use of kilocalories, because people have become accustomed to it, but the kilojoules will come soon in this chapter!).

For a man of the best age and in the best form, 2400 kilocalories per day are recommended, after all, he is heavier than the woman and burns the kilocalories more intensively. But even in this respect, man is not the same as man, even if in good shape: For a competitive athlete is recommended a daily energy intake of 6000 to 8000 kilocalories.

A kilocalorie corresponds to 4.184 kilojoules (or kilo-Newton-meters, more precisely formulated: kilo- kilogram-meters-per-second-squared-by-meter).