The "Cost-Energy Equivalence Law"
- Energy, the source of all costs-

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Without exception, every action of a human being requires energy. Consequently, all products of a tangible or intangible nature generated by the actions of mankind are thus also based quantitatively on the consumption of energy. The products generated in this manner constitute values. The gauge for measuring these values under economic principles is their costs. It can be shown that this correlation also applies for fluctuating values caused by changes in market conditions. This means that, without exception, all of the costs occurring in the world economic system are to 100% energy costs. The elementary relationship between costs and energy amounts to a "Law of Equivalency of Costs and Energy". Application of this law to economic processes and thus to the structures of political action leads to surprising findings concerning fundamental correlations which have evidently not been recognized as such until now. This applies in particular to the consequences of the change in energy policy to alternative forms of energy, which will lead to a permanent and irreversible manifold increase in the consumption of fossil energy sources as compared to classic thermal power plants and thus to increased emissions of carbon dioxide.

Problem

Business cost calculations are mandatory and fundamental requirements for correct business action. Normally, costs are divided into cost types according to their causation to enable overview and evaluation of the underlying business processes. The supplier of a cost-generating good conducts the same process of division into cost types for his business evaluation and so does in turn any one of his pre-suppliers. This calculation chain continues working „backwards" in the line of causation. It generates as a consequence of its exponential growth, because it must always start again "from the beginning", a volume of data whose analysis is practically unmanageable due to its sheer size. Because of the disproportionate effort required to do so, the exponentially growing data volume generally prevents the tracing of a discrete cost type by business methods along this chain of calculations "backwards" to its absolute origin to establish its overall total. That is the reason why it has not been possible to determine by this method the overall total of the cost type "energy costs", as the central cost factor in the economy. For circumventing the described difficulties, the present paper describes an alternative approach based on the laws of natural science, which allows for the calculation of the costs occurring in business processes in their entirety and back to their origin.

Energy creates order and life

In the middle of the 19th century, a law of nature was formulated which describes in mathematical terms the empirical principle that "heat cannot transfer on its own from a colder body into a warmer one". This law of nature is called the 2nd law of thermo-dynamics. The

content of this law of nature culminates in the universally valid statement that all spontaneous physical and chemical processes tend towards a condition of greatest possible disorder [1]**.** The principle behind this increase in disorder is called entropy, the omnipresent and unlimited master of all observable processes.

Now, despite and contrary to the omnipotence of entropy, life originated and spread over the entire earth. This is astounding because the emergence and development of life is only possible if a continued increase in order takes place in the chemical systems forming the basis of life. The formation and development of order is synonymous with the generation and increase of information in the chemical building blocks constituting the basis for life.

Finding the answer to the conundrum "entropy generates disorder, life needs and constitutes order" had occupied the minds of the greatest scientists for nearly 100 years - without success. It was not until the middle of the 20th century that the chemist Ilya Prigogine [2], expanding on the work of the physical chemist Lars Onsager [3], succeeded in explaining the apparent inconsistencies. Their work was honoured by Nobel Prizes in Chemistry in 1968 and 1977. Today, it is standard textbook knowledge.

According to these findings, the dictates of entropy can be overcome if the chemical system being studied is supplied with excess energy. Order and the information resulting from it - and thus life - can only form if sufficient excess energy is available. The availability of excess energy is therefore one of the mandatory basic requirements for the formation and continued existence of life. Life is not possible without energy. In keeping with the Energy Principle, not only the formation of life, but also its continued existence is absolutely dependent on the presence of equivalent sources of energy to keep the chemical operation “life” running. The sustainment of life requires not only the mere existence of a state of life as such, but, of course, all growth, each movement and each activity of an animate being, whereby the equivalent amount of energy for each process is extracted from the available energy surplus and consumed. Consequently, everything man does, be this physical or intellectual activity or the making of tangible or intangible products, is linked to the presence of energy which is consumed by the actions of man.

The generation of values

Without exception, everything man does requires energy; thus all tangible or intangible products made through the action of man are based on energy consumption and are equivalent to energy and thus correspond to 100 % to the consumed, equivalent amount of energy. It should be noted that, depending on the efficiency of the individual production step for the same product created by the use of energy, different energy requirements exist. Thus, identical products can be made with differing inputs of energy. Where the products made by man “are important for the satisfaction of man’s subjective needs”, economists define this importance of a product or good as a “value”. [4] As long as prehistoric man produced values - spear, club, flint, etc. - only for his own use, an objective comparison of these values was not possible, nor was it necessary. It was not until the division of labour and thus bartering began to develop over the history of mankind that standards of value could be and had to be introduced.

In principle, the energy employed by man to create these values cannot be measured in physical terms, and thus not in economic terms. Thus, the created values cannot be established

by measurement techniques. This does not affect the fundamental fact, as deduced above, that values are based quantitatively on energy, and on nothing else, even if the required energy cannot be measured. Initially, values can only be compared with one another. Identical objects of the same size and of the same quality have the same value. In order to be able to measure values where the required energy cannot be measured, the economic sciences introduce the term “costs”. “Costs as the yard stick for values is the basis for virtually all definitions of costs regardless of how different the wording may be in detail." [5] The term "costs" thus can be employed without restriction as a measurement for "values“. They correspond to the “counter-value” a buyer is willing to pay for the value of a good. Costs are measureable in monetary terms, so that it is also possible to measure values. Because the generation of values is based quantitatively on energy consumption, the “costs” defined in economics are pure energy costs in the context presented in this paper. As the existence of life on earth is dependent without exception on energy, quantitatively and without exception, all costs of the world economic system are thus energy costs.

This conclusion derived from the fundamental concept of physical chemistry of life as described above means that, without exception, 100 % of each dollar, euro or yen spent on this planet results from energy. This relationship forms a fundamental link between the natural sciences and economics, which is called the “Cost-Energy Equivalence Law” in this paper. The business economics question raised in the problem statement is thus answered through the application of a law of natural sciences. It is surprising that this connection, which is founded on scientific, textbook standard knowledge, has evidently not found its way into the public consciousness.

Energy content and value change

In the preceding Section it was shown that the manufacture of a product is only possible through the employment of energy, but that the physical amount of energy needed to create the product is not measureable and thus is unknown. Furthermore, it was established that the energy requirement for manufacturing and thus the energy content of goods of the same value is of differing amounts due to the differing levels of efficiency during manufacturing. The energy content of a product is thus unknown. Consequently, the value of the product is independent of its physical energy content. This means that, without exception, all values and thus their costs result from the consumption of energy, but the amount of consumed physical energy is unknown.

Although the term “value” related originally to a single individual as “important for the satisfaction of its subjective needs”, an objective notion of generally comparable values may result only from the market activities of a plurality of individuals. Values are volatile and vary according to supply and demand in keeping with the particular market situation. As a consequence, the costs change accordingly. We thus face the question of whether the equivalence between costs and energy remains valid where values change. Even if values, and thus their costs, are volatile and vary depending on the market, this does not alter the fact that values and their costs result exclusively from energy consumption. Since the values and their costs exchanged in the market are independent of the input of energy originally required for their manufacture or acquisition, but consist quantitatively, on the other hand, of energy, this results in the logical consequence that all costs consist of energy, even in the case of fluctuating values. The statement in the “Cost-Energy Equivalence Law” that “100 % of all

of the costs occurring in the world economic system are energy costs" thus retains its full and strict quantitative validity even with fluctuating market values. Commercial transactions made in the market are thus, without exception, barter transactions with energy following the "Cost-Energy Equivalence Law".

The seller of a value offers a good whose physical energy content is unknown. The buyer must defray these costs out of his own assets which are made up of the total of all of the values belonging to him, whereby they result exclusively from the consumption of energy, which quantity is also unknown. Although neither the buyer nor the seller know the physical energy content of their values that are available for exchange, there is a strict quantitative correlation between the costs and the physical energy content of this exchange of values: If, for instance, in the event of an exchange double the amount of costs is demanded for the offered value, the amount of energy of the acquired value pertaining to these costs which is unknown, but actually existent, will double.

This statement is based on a fundamental mathematical rule: A multiplicative conversion of a quantity by a known factor leads to a quantitatively clearly defined equivalent multiple of the quantity even if the quantity itself is unknown! Each change in the amount of energy to be provided in the form of costs caused by multiplication results in a change in the exchanged value in accordance with the same factor and thus in a change in its energy content, even though the absolute quantity of the energy content remains unknown.

With its statement that "without exception, 100 % all of the costs occurring in the world economic system are energy costs" the "Cost-Energy Equivalence Law" not only describes the strictly quantitative correlation between costs and energy, but also allows for a quantitatively exact statement on the change in the energy content based on changing costs, even though the absolute energy content continues to be unknown. An increase in the costs by the factor x results in an increase in the energy content of the acquired value by factor x.

After a product is manufactured, its value is equivalent to its manufacturing costs - this is an important statement for manufacturers who want to succeed in the market. Upon entering the market, the manufacturing costs are of no more relevance; the costs now demanded are equivalent to the forming market values. Changes in value, and thus the equivalent change in the energy content, are only possible as a consequence of the commercial exchange in the market. Losses in value and thus losses in the applied energy can also occur due to obsolescence and destruction. Irrespective of the cause for a change in value, it must be stated as a fact that the "Cost-Energy Equivalence Law" maintains fully valid even in the event of changes in value. "*Without exception, 100 % all of the costs occurring in the world economic system are energy costs."*

<u>The energy reservoir</u>

The energy reservoir and thus the access to energy have changed markedly over the course of evolution. The sole source of energy for stone-age man was the sun, which made all life

possible. Originally, all resources of animate and inanimate nature were free, that is, they were available to users for free in the form of plants, animals and minerals. The values created by man from these resources in the form of weapons and clothing were initially only for their own use. The market was born with the start of the division of labour and the barter in the goods created by man. Because there was only barter trade, the terms "buyer" and "seller" did not exist. It was not until monetary currency was created that these terms had any meaning, whereby it is easily overlooked in today's marketplace that the monetary value to be paid by the buyer, like the product value offered for sale is comprised of nothing other than energy! With the increased energy requirements during the creation of settlements, possession was gradually taken by the developing communities, or, indeed, their rulers, of all of the resources - from agricultural areas to ore deposits to water streams. With the exploitation of fossil energy sources, beginning at the start of the industrial age, mankind has tapped into a second source of energy. In principle, this energy source is also free, but by the time these sources were being used, the earth had already been divided into "possessions" so that each owner of the land automatically became the owner of the sources of fossil energy carriers. Fossil energy carriers thus are no longer free, but must be acquired by applying costs. Starting with the creation of human settlements, this also applies to farm land and water currents, which serve to harvest energy for free from the available solar energy. These sources of energy have owners, who demand costs for the harvested energy. The owners of the global energy sources today are thus the actual and true controllers of the world economic system.

The use of the two energy sources, the sun and the fossil energy carriers, has shifted markedly since the start of the industrial age. Today, more than 92 % of the physically measurable energy requirements needed for global value added are powered by fossil sources. Another 6.5 % results from hydraulic electricity generated through the conversion of solar energy [6]. The immediate biological energy consumption of mankind for physical and intellectual value added from the consumption of agrarian products cannot be stated in the lists of primary global energy consumption because it is not directly measurable. A calculation of the biological energy requirements of the global population based on the direct consumption of agrarian products shows that the required amount of energy obtained for direct human value added from the conversion of solar energy makes up for about 1.4 % of the global energy requirement. [7] The two energy sources together provide mankind with the energy surplus referred to above which is absolutely necessary for the existence of life.

These figures result in a fundament consequence for the volatility of values and the costs to be paid for them. In the preceding Section it was shown that the energy content of a product, and thus the energy content of its value, is not measureable and therefore unknown. The costs of the value are thus independent of its physical energy content. Global energy requirements, on the other hand, are unequivocally physically measureable so that their costs can be stated in both monetary units and in physical measuring units such as kilowatt hours. For this reason, not only do more than 92% of the costs of the world economic system directly correlate quantitatively to the market value of global energy consumption, but they are also the direct measure for the physical energy consumption of mankind through fossil energy carriers.

The modern barter transaction with energy takes place between the owners of energy sources. Even though the complexity of these barter transactions, in the form of the world economic system, is miles beyond that of the Stone Age, the basic principle of the exchange of energy has not changed at all. Everything that must be paid for must be paid for with energy, irrespective of any change in value. The "Cost-Energy Equivalence Law" is universally valid. This law is based solely on the established physical principle of the 2nd law of thermo-dynamics from which it derives by the logical linkage of the physical parameter "energy" with the parameters "value" and "costs" that are defined within the science of economics.

Examples of application

With the "Cost-Energy Equivalence Law", a large number of connections between global economic life and its political and monetary settings can be traced back to a simple principle. It is interesting in this context that there are a great number of highly qualified institutions that expend large quantities of human resources with the goal of determining energy requirements or "ecological balance sheets" of products and activities with high precision. The knowledge and application of the "Cost-Energy Equivalence Law" is an effective means of overturning the methodology of these institutions and thus of significantly increasing their efficiency. A life cycle assessment is simply identical to the cost content of the examined process.

One perennially discussed topic is the problem of "irresponsible" transport distances constantly criticized by ecologically minded "experts" milk transports crisscrossing Europe, kiwis from New Zealand travelling around the globe, flowers by air from Tanzania, beech wood from Germany to China and much more. It is, however, a fact that these flows of commerce, that have their origin in cost efficiency, consume less energy than alternative solutions that avoid the above transport routes on "environmental" grounds, and thus destroy energy.

The constant demand by politicians and economists for economic growth to prevent a collapse of the global economic system appears in a new light when one considers the "Cost-Energy Equivalence Law". Aside from growth due to the increased efficiency of the employed energy, economic growth is quite simply identical with an increase in energy consumption! In other words, such demands directed at each economic system and thereby also at each individual is tantamount to the demand to increase consumption, and thus the consumption of energy. Whether or not this demanded behaviour is leading in the right direction, given the limited available energy, or if there are better, more prudent approaches, urgently needs objective clarification.

Evaluation of **"**renewable energy**"** under the "Cost-Energy Equivalence Law"

One extremely interesting and important example for applying the "Cost-Energy Equivalence Law" is the evaluation of the use of **"**renewable energy**"**, whereby "for saving the global climate" the generation of electrical power is to be converted from conventional thermal power plants to so-called alternative energy sources such as solar collectors, wind, photo voltaic, bio-energy and the like, whose sole common energy source is the sun. Solar energy as such is free. The conversion of solar energy into electric energy, however, either directly or indirectly via wind or bio-energy generates costs all the same. Under the "Cost-Energy Equivalence Law", more than 92% of these costs come from fossil energy. The purchase and conversion of chemically bonded fossil energy into electrical power in thermal power plants

generates costs which also result from the consumption of fossil energy. It is a fact that it is fossil energy carriers that are needed and will be consumed to generate renewable energy.

If one compares the costs of the various energy conversion processes that directly reflect the physical energy content, as described in the preceding Section, one finds that the costs of wind energy are three times the costs of the energy from thermal power plants required to generate the same amount of energy and that the costs of photovoltaic are seven times as high [8]. The production of electrical power from "renewable energy" will thus consume 3 to 7 times the amount of fossil energy carriers that are consumed through the direct use of fossil energy carriers in thermal power plants.

The official political argument for overcoming this economic imbalance is prognosticate that, due to the rising costs for fossil energy carriers in the near future electrical power from renewable energy can be produced more cheaply than in conventional thermal power plants. However, this assumption is a fundamental error! As has been shown in this paper, under the "Cost-Energy Equivalence Law", 92 % of the costs of the global economic system and thus, of course, of the costs for renewable energy are comprised of costs for fossil energy carriers. Rising costs for fossil energy carriers thus result by necessity in rising costs for renewable energy!

Not before efficiency for wind and photovoltaic is increased by the factors 3 and 7, respectively, will renewable energy be able to compete with energy from thermal power plants in producing electrical power. Given the mature state of the art of both of these processes and for of all other processes to generate "renewable energy", such an extraordinary increase of efficiency is an absolute technical impossibility. Thus, for all time to come, the use of "renewable energy" for the production of electrical power will consume an amount of fossil energy carriers, which is needed for the generation of electrical power that is a multiple of the amount of fossil energy carriers consumed in conventional thermal power plants. "Renewable energy" wastes fossil energy carriers and increases the carbon dioxide emissions whenever it is used to generate electrical power. That is exactly the opposite of what the public is being told by politicians when it comes to the promotion of "renewable energy".

Literature:

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