Sustainable Economics in History: A Model for a Green Future

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Abstract:

This paper develops the idea that the fundamental principles of sustainable economics have already been applied during the largest parts of human civilisation. What more or less unconsciously shaped the economic action of past life, should also be able to guide the green future of post-industrial societies - even in a more reflected way -, provided that people are willing to depart from the dogma of everlasting quantitative growth. The industrial mode of production was the first that broke the ancient rule of not taking more from nature than what is given in return.

Focussing on the allocation and transformation of energy, various historical modes of production are compared with the industrial and post-industrial society. By showing parallels between social and natural systems, the theory of ecosystem development, the ecological succession, is used to demonstrate that only green economics is fully in line with the laws of nature.

Keywords:

sustainable Economics; history of economics; ecological economics; energy economics.

Biographical notes:

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1 Introduction

During the whole history of mankind human societies have been more or less sustainable. Up until the industrial revolution most of the past economies were green economies. Only modern economies are based on high energy consumption and characterized by obsessions of economic growth. For many

consumers “growth” simply means the satisfaction of trivial wants while simultaneously creating ever more externalities damaging or destroying the environment (Daly 1993, p.40). The spirit of consumerism penetrates all walks of life. Consuming keeps *thanatos* away; to paraphrased Descartes: I produce and I consume, therefore I am. Since economies left the steady-state, human activities destroy the forests and pollute water, air, and the whole environment. The energy foundations of industrial civilisation are the non-renewable resources that have been accumulated during hundreds and thousands of years when mankind lived in non-growing economies.

Ivan Illich (1976, p.93 et seq.) was the first who described the *counter-productive-effects* as being a widespread phenomenon of growth based economies: From a certain threshold upward, those societies generate more damages than benefits. Despite increasing efforts there are ever less gains. The modern transportation system, for instance, does hardly improve mobility, but while further expanding, contributes through CO2 emissions to global warming, pollutes the environment and destroys natural habitats by new roads. Worldwide are millions of people killed and injured in road accidents every year. In the EU the externalized costs of road transportation amount to 650 billion euros per year (see “*Externe Kosten …“* 2012). Despite the Kyoto protocol and the following implementation measures, between 2006 to 2010 greenhouse gas emissions still increased by 2.3 per cent *(see “Greenhouse gas emissions…”* 2008). Beginning with the first study of the Club of Rome, numerous studies have shown convincingly that there are social and physical constraints limiting permanent growth in the future, and ignoring them would have fatal consequences.

Even the classical economists realised that economic growth has its limitations. Adam Smith did not advocate growth at any price and clearly foresaw its limiting constraints. Zweig (1979, p. 310,314) reconsiders Smith´s growth theory by pointing out that in his equilibrium model growth will eventually stop when a country´s potential for development is fully realized. While most classical economists feared and expected eventual collapse, John Stuart Mill, another forerunner of the limits to growth, held some optimistic reservation. He used the term *stationary state* to refer to an economy in which population and

capital stocks had ceased growing. His *stationary state* of economic life looked comfortable, without bustle – the ideal place for a *vita contemplative* – but threatened by an already vaguely anticipated growing population, rising pollution, noise and vanishing opportunities for solitude. Consequently his main assumptions to keep stability in place of collapse are a more or less constant population size, slower resource depletion and an increased life time of all forms of capital. He also anticipated the need for an institutional change: increased emphasis on the quality of services and goods should replace industrial mass production and prestige consumption (Mill 1857, Daly 1993b, p.365 et seq.). Based on the Mill´s stationary state concept, in the seventies of the last century Herman E. Daly coined the notion of a *steady-state* economy, a term he adapted from physical and biological science. The main difference to the former concept is the dynamic aspect. While the basis requirement is still quantitative replacement instead of growth, however, there are no restrictions in terms of quality and permanent improvement of life. While the modern life-style is based on economic insatiability and thereby destroying nature, the model of sustainable economics focuses on shaping economic action in a way that the ecological basis of human life is preserved even for distant future generations. A steady-state economy can deal much better with the problems of resource scarcity and environmental pollution.

In this paper the Weberian category of the *ideal type* is used to explicate sustainable economics as a model for the future economy as well as to review historical economies under the steady-state aspect. Various historical forms of so called primitive and developed societies may differ in their specific strategies of survival, but by applying the methodological tool of the ideal type we can identify common structures which at different degrees are prevalent in all of them. Energy shall be used as the common denominator to investigate the historical forms of sustainable economics (see also Wagner 1997/2013). Even non-energetic entities, such as knowledge or genetic information, are related to transformations of energy. The development of knowledge or the ability of DNA to construct a complex organism depends on the use of energy. Energy exists in different forms and states of availability (higher and lower entropy). All life on earth has its energetic basis in the stream of solar energy

radiated by the sun. Sun light enables the development of plant life and based on that the existence of animal and finally human life. All stored forms of energy: wood, coal, oil etc. are in the end of solar origin. In early history, humans used mainly direct solar energy to maintain their life. The more human societies started to rely on fossil fuels and other forms of stored energy, the former lifestyle of living in harmony with the ecological niche was replaced by a strategy of dominating nature.

Apart from energy, religion and ethical codes play a pivotal role in guiding economic and social behaviour. Particularly religious ideas exert profound impact on economic life. They do not only shape the nature of the produced goods and delivered services, but also the economic institutions and the social behaviour of a society. (Boulding 1968, pp.179 et seq.). As a kind of social suprastructure the religious commandments and ethical reflections determine ideas of sustainability (e.g. respecting nature and the creation), or in the case of western materialism open the gate to greed and heedlessness.

When mankind left the steady-state, economic action was no longer in line with the principles of nature. Instead of accepting and following the rules creating stability of the ecological systems, people more and more subsisted on exploitation of nature.

2 In Harmony with the Nature: The Use and Allocation of Energy in Sustainable Economics as derived from the Ecosystem Theory

The integration of nature in the economic theory can be traced back to French School of Physiocrats founded by the physician Quesnay during the 18th century. A second pillar of analysing economic processes in terms of energy transformation was erected by energy economists such as Serge Podolinsky and Wilhelm Ostwald in the 19 th century and Howard T. Odum in the last century (H.T. Odum 1971,1973; Ostwald 1912; Podolinsky 1883; see Wagner 1997, p.168 et seq.).

Warren, Allen and Haefner (1979) attempted in their account on the philosophical foundations of a general living systems theory to apply their conceptual framework to various sciences. Following this approach, we can use a set

of procedural rules to describe common functions of both social and natural systems. From empirical observation of the functional mechanisms of organisms, ecosystems and social subsystems, such as the economy, we can derive a set of basic rules that ensure stability no matter of the properties of the systems: All systems – whether social or natural ones – maintain themselves against an environment and the impact of other systems, they build structures of development to protect their borders against destabilizing forces, under which the function of growth is only one temporary strategy. More important are factors like diversity, symbiosis, or equilibrium with the environment. By departing from those general rules that ensure their proper functioning, social systems (e.g. the industrial economy) tend to become instable and finally collapse. The only cure would be a return to the fundamental principles that govern natural systems and guarantee their sustainable development.
The dynamics of industrial growth violates the mechanisms of ecological development. While nature systems have a general tendency towards stability and equilibrium, modern industrial economies are based on high rates of everlasting growth which undermines long-term stability.

The idea of a niche is probably the most profound pre-analytic vision of sustainable economics:

> *"At any time, every possible niche of life is filled, and the life within each niche is related to the other living groups about it (….) A given system might include a diversity of plant life, bacteria, insects, fish, amphibians, reptiles, and mammals, all living in harmony. While such systems are frequently fairly stable and can exist for long periods of time, if any one of the component groups is disturbed appreciably, all of the other will be affected."* (H. Brown 1954, p.12).

The term ecology was first used by Ernst Haeckel to describe the relationship of living beings within and with their environment. In English language the word first appears in 1873. (Ellenberg 1973, p.18; White 1967, p.1203). Ecosystems are defined as systems consisting of organisms within an environment. The environment might be open, but to a certain extent is capable of self-regulation. The ecological systems of the earth are mutually intercon-

nected and form the bio- or ecosphere of the planet (Ellenberg 1973, p.1; Ehrlich/Ehrlich/Holdren 1973, p.6).

Similar to the growth of organisms, the development of ecosystems follows different stages: a first stage of rapid growth focussing on pure quantitative increase (pioneering stage) is followed by a second stage of diversification and improved stability during which the development aim changes towards the improvement of quality (climactic stage). An example from everyday life may illustrate this: If there is a heap of fresh soil exposed to the sun, first the nutrient demanding plants with long roots (e.g. dandelion or shepherds' purse) conquer the fertile ground leaving no space for competitors. This is the fastest way of greening the heap. But only a few months later the way of rapid growing can no longer contribute to the stability of the whole system. At that time, new and diversified plant populations followed by animals, bacteria, and fungi settle on the ground and finally suppress those dominating species only specialised in quantitative growth. During the course of ecological succession, ecosystems develop ever more complex structures to enable their survival. Herbivores and carnivores establish feedback circles thereby ensuring their endurance within the system. Highly developed ecological systems are determined by a variety of symbiotic relationships of inhabiting species, an optimal supply of resources by an efficient use of energy, and a rapid increase of information. (Hampicke 1977, pp.311et seq.; E.P. Odum 1969, pp.262 et seq.; E.P. Odum u. J. Reichholf 1980, pp.139 et seq.; H.T. Odum 1973, p.222)

> *"On the basis of theoretical arguments, general observations, and limited experimentation, many ecologists believe that complexity tends to impart stability."* (Ehrlich/Ehrlich/Holdren 1973, p.7).

The example of a tropical rainforests may illustrate that stability, diversity and complexity of an ecological system are mutually interconnected factors that contribute to the sustainability of the system. Once destroyed by turning into farmland or pastures for cattle, the new area only offers living space to a very restricted number of species, the whole system become highly fragile and subject to further deterioration by soil erosion.

The strategy of ecosystem development is in its core the same as of the evolution in general: the creation of mechanisms enabling the systems of self control and best protection against undesired impacts from their environment. The general patterns of ecological development can be observed in complex macro systems, such as forests, lakes or mountains, as well as in miniature systems created in laboratories.

Table 1: Succession Stages of Ecological Systems

Features of Ecosystems	**Pioneering Stage**	**Climactic Stage**
Energy		
- amount of bio material maintained for each unit of the energy flow	low	high
Structure		
- number of species	low	high
- diversity and complexity	low	high
- stratification and specialisation	hardly developed	highly developed
- food chain	open	rather closed circles
Adaptation of organisms to their environment		
- life cycle	short, simple	long, complex
- central aim of growing	gaining size	better adaptation
- focus of production on	quantities	quality
Mode of growing	quick increase in volume	improvement of quality, „feedback-control”
General features		
- symbiosis	rare	often
- efficiency	low developed	highly developed
- stability against impact from outside	low	high
- entropy	high	low

Sustainable economies and stable ecosystems are also subject to the continued increase of entropy (Georgescu-Roegen 1973,1977; Rifkin/Howard

1980). Only if viewed from the perspective of material metabolism, the patterns of ecosystems are circular. Substances renew themselves in endless cyclic processes, but the flow of energy is always linear. Energy cannot be recycled, but finally dissipates within the local system. During the course of time, all energy will be devaluated into heat. By building stores and using tools of preservation, energy can be harnessed for later use. However, this requires human labor which itself is also a form of accumulated energy. The efficient use of energy creates additional leisure time, which then can be used to develop new skills and techniques. During those periods various crafts develop and contribute to welfare and social development. At some point in history, specialized classes detach themselves from physical labor and devoted their daily work exclusively to writing, mathematics or alchemy. Following the "invention" of money, an available surplus of accumulated energy could be represented in commonly accepted signs and symbols. Organized activities, money and leisure time promote a further extension and development of the human mind.

Compared with the growing economies of our days, the so called *primitive* sustainable societies were much more capable of maintaining their social order. Apart from the *life world* that shaped ritual and religion, one reason for this stability is the level of applied technology. In many of the early societies, the class of traders was kept under social control, because people assumed that they do little more than exploiting the fruit of labor of other classes and did not contribute to the creation of wealth. Aristotle distinguished already between the production of goods for use or consumption and those for the sole purpose of selling them on markets. The first he considered a natural exchange (*metadosis*) between producers, while the latter he criticized as the unproductive work of traders and grocers driven by the motive of profit making. In ancient China, according to the teachings of Confucius, classical education, virtue and ethical conduct rank much higher than technological or commercial skills and knowledge (Chen 1911, S.722).

Ethics, customs and religious teachings do not only regulate and stabilize social life, but also ensure a permanent and vivid stream of energy through the fabric of society. While in early cultures laws and punishment are hardly de-

veloped, respect of rules relies on moral self control. Family, society and surrounding nature are perceived as coherent and kept together by the same forces. Almost everywhere there is the concept of an all comprehensive energy, a *vital force* or divine power: *chi, mana, prana, numen ilu, él,* one can approach by rituals and which can be acquired and sometimes set in motion for one´s interests (Goldsmith 1974, p.323f; Malinowski 1957, p.358; Mynarek 1988, p.48).

In the following, it is described how former societies survived by developing strategies that did not thread the stability of their natural environment. Finally the question is asked how their lessons in elementary economics can be transferred to green future economics.

3 Sustainability in a Hunter and Gatherer Society

During 99 per cent of human history, mankind has lived in a non-growing economy. Hunting, gathering and subsistence agriculture shaped human life for hundred thousands of years. Due to the constraints of nomadic life, the first hunting and gathering groups could not accumulate much wealth. In Asia, such societies existed until 15000 to 10000 BCE, in Europe and Central until 5000 to 4000 BCE, and some isolated forms (e.g. the Inuit, the Unangan and other Siberian tribes) endured until the 20th century. As storage capacity was limited, and techniques of preserving food were hardly developed, economic growth could not occur. Nevertheless, there is some evidence that people´s life was not only determined by hardships and suffering. Sahlins (1974; 1978, pp. 155 et seq.) points out that these people had plenty of leisure time, and their needs were modest.

By mastering fire, a new and powerful source of energy was made available, and the scope of action tremendously enlarged. Life in early societies depended on a balanced ratio of food reserves and size of population in a given area. In a hunting and gathering society about two square miles of fertile land in the natural state were needed to support a single individu*al (Brown 1954, p.14).* The permanent thread of disappearance of food resources required nomadic life. Nomads needed only a minimum on tools, household items and

adornments to possess. People normally owned not more things than they could easily carry on the backs. Accumulation of wealth was not yet seen as a sign of social status. Population size was controlled by the volume of available food resources. As long as both were in balance, hunter and gatherer lived in a sustained manner and in harmony with their natural environment. The consumption of energy was lower than in any other society (Brown 1954, p.14; Buehl 1981, p.71; Perelman 1976, p.16, Mueller-Armack 1981, p.65). If as a result of growing population pressure, food reserves became scarce, groups of hunter and gatherer had to scatter about a larger territory. A faster growing population was often accompanied by spread of diseases and overhunting. Periodic collapses occurred. Overpopulation was finally the triggering event to change toward a new mode of life in the ecological niche: the agricultural society.

Illustration 1: Flows of Energy and Energy Transformations in Hunter and Gatherer Societies

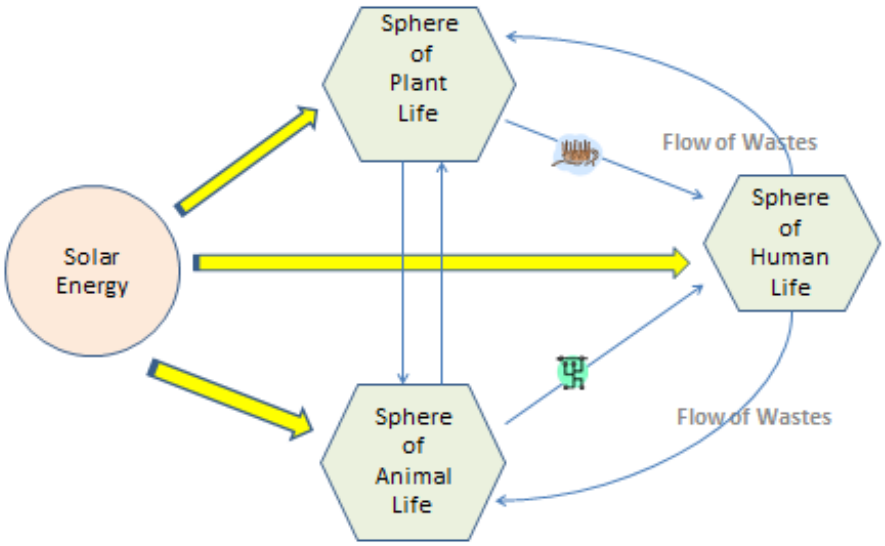

Illustration 1 illustrates the cycles of energy in a hunter and gatherer society. Solar energy is absorbed, processed and exchanged between the spheres of plant, animal and human life. All these three systems are self-maintaining subsystems. Both symbols, the hunter with the spear and the collection basket, denote the use of simple tools to gain or tap resources. Both outer lines indicate the streams of waste from the human sphere to the others.

4 Sustainability in Early Agricultural Societies

10000 years ago, man´s strategy in his niche changed. 7000 BC first scattered traces of agriculture can be found around Jericho. Hunter and gatherer did not change to agriculture out of their free will, but this turn was enforced by the depletion of existing food resources. More and more energy was then turned into the preparation of soil, sowing, weeding and harvesting plants. Increasing human control over the natural environment indicate the actual beginning of civilisation (Kemp 1971, p.105, Ehrlich/Ehrlich/Holdren 1973, p.10; Clark/Haswell 1970, p.28; Wittfogel 1932, p.584). Clearing of forests is conducted with primitive tools. In the beginning, harvests were poor. Because of decreasing yields, cultivated land was often abandoned after some time, and new soil cleared at other places. The use of oxen and horses, and fertilizers,

are later inventions. Eventually settled forms of living became more and more common. The agricultural way of life needed only a fraction of land formerly used to sustain life exclusively by hunting, fishing and gathering (Leonard 1981, p.25; Clark/Haswell 1970, p.29).

Still existing forms of nomadism were finally abandoned, and first small villages established. Driven by the need to survive long cold winters, people invented methods of preserving food and storing energy. Nearly all of the consumed resources were renewable ones. There was no need to accumulate things for longer, because all resources needed could be produced again during the course of one year. The main energy basis was sunlight and later more and more wood. Even the various forms of stored energy can be considered nothing else than transformed solar energy.

Through building houses and small villages, or by creating storages for food in order to protect the harvest against the trials and tribulations of nature, people also experienced the energetic potentials resulting from a division of labour. Contemporaneous with plant production, people domesticated animals which served as supply for meat, milk and leather. Herdsmen were probably the first who tamed horses and dogs to safeguard their herds. Through the invention of the plough and various techniques of soil improvement, harvests increased while human energy resources were saved, which then became available for other activities. The preservation of meat, fish, fruit and vegetables by drying or fermentation, and the further refinement of food, resulted in an improved use of natural resources further promoted by the development of specialist crafts. But even in an agricultural society, economic growth was a rare exception.

Following the dissemination of agricultural techniques, one important source of energy to maintain life changed from human labour to the energy of animals; instead of using almost exclusively solar energy in its original form, people burned more and more wood or charcoal, and also used wood to build large settlements. Storable forms of energy were used to an ever increasing extent (Odum 1971, pp.29 et seq.). The development of culture promoted all these changes. Language became more and more sophisticated, the invention of writing helped to find and disseminate more efficient ways in tapping

and using energy. Thus, agriculture became a tremendous power to change the balance of the ecological niche in a way that the ecological systems could deliver much more than what was actually needed for human consumption. But at the same time the diversity of the ecological systems started to decrease slightly, because only a restricted number of suitable crops could be cultivated where formerly existed a greater variety of plant life. By domesticating wild animals and wiping out so called *pests* and *parasites*, humans changed also the balance of animal life (Leonard 1981, p.10).

Nevertheless the ecological equilibrium of the niche was as long stable as population size and available food resources remained balanced. There was mostly a state of equilibrium between the total consumption and the primary production within the four seasons of a year (Odum 1971, p.17). During the further course of history, stability of these societies was gradually destroyed by internal dynamics resulting from two sources: First, specialisation led to more intensive use of natural resources. Plenty of rich resources enabled a faster population growth. As a result, first large towns developed, in which crafts and techniques to conquer nature were further refined. The former common property was step by step replaced by private property (Brown 1954, pp.18 et seq.; Marx 1972, pp.33 et seq.). Apart from technological advances, changes in the structures of property became the driving forces to regulate the energy allocations of agricultural societies.

Illustration 2: Flows of Energy and Energy Transformations in Early Agricultural Societies

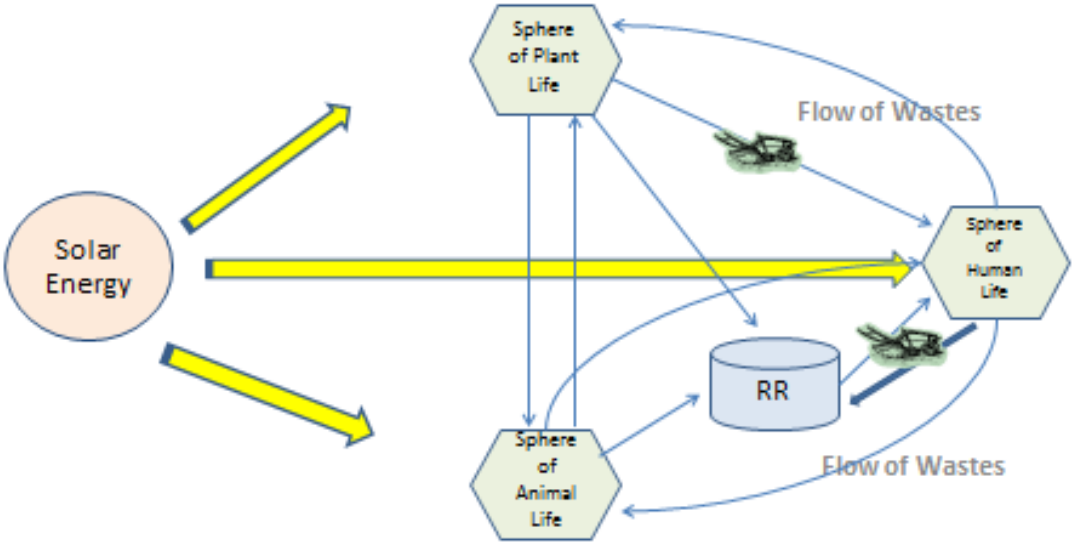

Illustration 2 illustrates the energy flows in historical agricultural societies. Transformed solar energy is accumulated in form of storages of renewable resources (RR), involving plant and animal activities, also including micro organisms, plus human work. Main aim of storage building is the uninterrupted satisfaction of human needs. The plough symbolizes the use of tools and simple techniques to harness, store and release energy reserves. Human work needed to maintain energy storages is indicated by the bold arrow. This is the amount of work spent to ensure the availability of resources all over the year.

To summarize: Even in an agricultural society, economic growth was a rare exception. People domesticated wild animals, cultivated land, and abandoned nomadic life. But still were all of the consumed resources renewable ones. There was no need to accumulate things for longer periods of time. The main energy basis of these societies was still sunlight.

5 Sustainability in the Asiatic Mode of Production

One particular type of a stationary agricultural society is the *Asiatic Mode of Production*, a niche strategy based on huge hydraulic energies mainly in ancient China, India and their neighbouring countries (Marx 1972; Wittfogel 1932, 1977). Having its origin in the dim and distant past, this mode of production shows a large historical range, characteristic feature is the erection and maintenance of huge water supply systems. Collective irrigation work, under the control of a priestly caste created the basis for an *Oriental Despotism*. Reservoirs and complex irrigation systems were not only used for agriculture, but also to get control of periodic monsoon and snow melt flooding that threatened the country. Similar irrigation systems can also be found in ancient Egypt, Mexico and the coastal parts of the Andes mountains, regions which also had been shaped by the absence of sufficient precipitations.

Due to the lack of convenient transportation and communication systems, in ancient China the local villages and the central government were only loosely connected (Chen 1911, p.722). The technological basis of human life was solar energy which is transformed by human labor in combination with the forces of nature. Gregg uses the examples of the spinning wheel to highlight the underlying principle which also characterizes the general concept of energy economics: *"… (it) uses the available mechanical energy of a man, woman or child for producing material goods. The handloom does likewise. That mechanical energy is derived from the food eaten by the person. The energy in the food came from the sunshine that fell on the fields where that food grew."* (Gregg 1958, p.5)

The economic mode of the hydraulic society is entirely stationary. Supported by the available technology and under the established property system, the relationship of people with their natural environment was kept stable over thousands of years. Historical societies of this type had reproduced their structures in stereotype repetition and remained always on the level of simple reproduction. In China, a relatively stable population and a fairly even distribution of wealth contributed to social stability, promoted by religion (Buddhism and Daoism) and social ethics (Confucianism and ancestor cult) that deemed material welfare low and held spiritual life in high esteem (Chen 1911, p.68,

pp.718 et seq.). Many historians see a clear relationship between the self-regenerating character, the so called *stationary* nature of ancient Asian economies, and their religious foundation, especially the influence of the Hindu-Religions (e.g. Grossmann 1958, Wittfogel 1977, Taeube 1987). All eastern religions are based on ideas of harmony, stability and a final non-dualism of mind and matter. The Christian concept of man's dominance over nature is rather alien to all of them. In eastern religions we find a more reverent attitude towards nature. Daoism, for instance, believes in the natural order of things and sees all social disorder as a result of detachment from the perfect natural state of things (Chinese: *Dao*). With regard to politics and economics, Daoists therefore prefer the principle of non-intervention and laissez-faire (Chinese: W*uwe*i). Confucian economics, by contrast, do not believe in the self-regenerating power of the natural order, and for that disbelief require that the social order has to develop rules, norms and guidelines to govern economic life (see Chen 1911).

The Asiatic mode of production was not strong enough to transform its energy flows to a higher gamut. Even though technology in some areas reached a high level of skills (e.g. sophisticated inventions in silk or porcelain manufacture, and the production of other luxury goods), the basis of life remained agrarian. Human and animal power had been the main instruments to get food resources. Monoculture caused a certain reduction of ecological diversity, but the equilibrium of the ecological niche mostly leveled off at an acceptable state. The Asiatic mode of production did not collapse because of internal reasons, but was finally destroyed by outside invasions.

6 Ancient Greco-Roman Economics: First Attacks against Sustainability

Another society that emerged from the early agricultural niche strategy of mankind was antiquity. In the beginning, Greco-Roman antiquity was a steady-state economy which later turned into a society with aggressive imperial ambitions. The Greco-Roman world denotes a period from 1000 BCE and 500 CE (Finley 1973, p.29). In contrast to the Asiatic mode of production,

there existed strong dynamic forces pushing towards a radical change of man´s way of life. The material basis of human existence was formed by extensive agriculture without larger irrigation systems (apart from the Eastern regions of the Roman Empire). Main energy forces were slave work and the large-scale use of draft animals that played a much more important role than in India or China (Wittfogel 1932, S.600 et seq.). The slaves were property of private owners (and not property of the despotic state as at some times in Asia). In antiquity there was still sufficient room for leisure and private initiatives. As a result, private property could develop and the specialization of crafts made rapid progress. Small villages grew into larger towns surrounded by an urban fringe producing fruit and crops for local needs.

As it was held in China, there are also from ancient Greece records of a discourse on ethics and economics. In the writings of Plato and Aristotle, questions of proper economic conduct are always discussed in terms of right livelihood. In comparing the study of means of increasing wealth (the science of *Chrematistics*) with *Oikonomia*, the management of the household respecting the principles of a good housefather, Aristotle criticizes those economic actions which are primarily based on the exchange of goods on markets aiming only on profit making. He regarded wealth acquisition through exchange as unnatural, because it involves gains through someone else expense. His proposals for a right livelihood are based on the idea of a good life (*eudaemonia*), whereas the pure *Chrematistics* he deemed a false science. Aristotle´s aim is happiness and a virtues life, so he pleads for a self-reliant system without surplus, and a reduced volume of trade in favor of extended agriculture – a sustainable concept based on a proper reflection of human needs at his time. Time and again he is raising the question of what humans actually need: a *bios politicos*, i.e. a life in free self-determination striving for happiness or a *bios chrematisticos* which means alienated work, production and consumption ranking higher than people? (Aristotle 1915; see also Bien 1989; Finley 1973, p.18).

In Greco-Roman antiquity, while on the one hand far-sighted thinkers and philosophers were striving for a state of equilibrium between man and the ecological niche (and therefore promoted his concept of proper economic con-

duct), on the other hand there existed strong forces urging for human dominance over the environment. Finally profit seeking and imperial ambitions gained the upper hand against a life in harmony with nature. These harmful developments contributed to the decline of the ancient civilization. Soon the pressure toward the ecological systems grew, as evidence is given by some early records. Tertullian, who lived during the third century CE in Rome once stated:

> *"What most frequently meets our view is our teeming population; our numbers are burdensome to the world, which can hardly supply us from its natural elements; our wants grow more and more keen, and our complaints more bitter in all mouths, while nature fails in affording us her usual sustenance."* (quoted from Brown 1954, p.30).

7 Medieval Times in Europe: Sustainability and Growth as conflicting Orientations

The feudal societies of Europe with their characteristic system of serfdom, private landownership and aristocratic rule were another mode of production stemming from former agricultural communities whose reproduction was originally based on common property of land. The main pillars of agriculture at these times were keeping cattle and crop production. As natural precipitation was sufficient in most parts of Europe, no irrigation was needed. Manure was used as fertilizer. The rhythm of seasons left time for developing skills in spinning and weaving using wooden tools. Metalwork was rendered to the smith as a specialized craftsman. Mills used wind and waterpower.

With the establishment of the feudal system of landownership the human niche strategy changed. In the beginning, extensive pastural agriculture formed the basis of subsistence followed by hunting and fishing already using sophisticated techniques. W. Abel once researched the nourishing situation in former times and found out that in central Europa until the late middle ages people at average ate one hundred kilogram meat and approximately the same amount of fish per year. Later, the agglomeration of masses of people in towns required changes in the use of fertile soil leading to a transition from

a strategy of niche expansion to a more intensive use of natural resources. Trade and money lending gained importance. As a result, social stratification developed, and the gap between rich and poor grew bigger. As locals often enjoyed privileges compared to new settlers, social injustice increased. Sometimes growing tensions between urban and rural population provoked social unrests (Hoselitz 1973, p.108; A. Weber 1963, p.280).

It is sometimes claimed that the medieval economy was an autarky relying on decentralized structures; apart from trade with luxury commodities, exchange with remote regions had almost been non-exiting, and life was based on a more or less closed city economy (Polanyi 1957).

Mueller-Armack (1981, p.55), however, rejects the assumption of closed medial city economies. He refers to archives and records on economic history that provides convincing evidence of an already highly developed exchange of goods, not only luxury items, but stretching down to things of everyday life such as cereals, wood, linen, meat, minerals and fish – all of them subject of regularly trade. M.I. Finley (1973, p.125) comes to the same conclusion.

The economy of this period shows a parallel existence of different strategies of economic action. Although the life style of large parts of the population was still close to nature, there is also evidence of an affluent coin production, a booming money economy with rapidly growing interest rates. Technology still missed a dynamic component. As human thought had been shaped by Christianity, economic decisions were still reflected by ethical principles of the Bible, such as fair prices, restrictions regarding moneylenders or the profit margin of traders. But at the same time, a considerable number of religious holidays left plenty of time for contemplation and leisure. Considered as ideal was a life following and respecting God´s will as it is already realized in the natural world.

During the final stages of feudal society, people finally freed themselves from religious confinements. Promoted by the emergence of Protestantism, worldly success was no longer seen as opposed to a pious life, but even as fulfillment of religious duties (Weber 1979). Afterwards, as an undesired *side-effect*, ruthless profit seeking, greed and heedlessness became widely tolerated

standards of behavior. Thus, the ground for the following industrial revolution was step by step prepared. Beginning in the middle of the 17th century, in Europe the system of energy circulation changed profoundly. Triggering event of this change from wood to coal (as central non-animal source of energy) was the destruction of forests due to exceeded cutting (Brown 1954, pp.33 et seq.; Ehrlich/Ehrlich/Holdren 1973, p.24).

But this was not the simple replacement of one source of energy by another, but rather the starting point for a new strategy of brutal exploitation of the ecological niche. As originally easy accessible sources were depleted or due to growing needs and population growth no longer sufficient, they had to be replaced by the less accessible coal and other energies. Resulting from this change, an increasing amount of energy must be used for tapping additional resources applying ever more complex technologies.

The following table gives an overview on some features of sustainable economies in history (see Wagner 1997, p. 104)

Table 2: Overview: Features of Sustainable Economies of the Past

Type of Sustainable Economy **Features**	**Hunter and Gatherer Society**	**Agricultural Society**	**Asiatic Mode of Production**	**Greco-Roman Antiquity and Medieval Times**
ENERGY	solar energy; human labor	solar energy; human labor; animal power; wood	solar energy; water and wood; human labor; animal power	solar energy; wind and water; human labor; animal power; since medieval times also charcoal and coal
TECHNOLOGY	primitive tools and weapons; nomadic life-style; magic practices	slash-and-burn land clearance; domestication of animals; use of draft animals; invention of the plough; development of specialist crafts	irrigation systems and hydraulic techniques; developed of new forms of cooperation and division of labor; conscription work; centralized administration	slave work (antiquity), serfdom (medieval times); highly developed crafts; use of organic fertilizers in agriculture

CULTURE/RELIGION	tribal life; children are commonly educated; animism; first awareness of a duality of mind and matter	further sophistication of language, alphabet and literature; worship of nature spirits, reverence to female goddesses; development of rational techniques to conquer nature	man is seen a part of a universal order of things; nature and society are governed by identical laws (the rule of heaven); cyclic conception of time; belief in reincarnation	*antiquity:* ideas about cyclic structures of nature and the whole cosmos; formal logic, discourse; democracy among the property owning classes; *medieval times*: human thought still confined within the framework of Christian religion; technology still misses a dynamic component
PROPERTY	private property hardly developed; people possess not more than what they could carry	originally common land property; later transformation into different forms of private property	two parallel systems: common property within the local communities, while the state owned the irrigation systems and the centralized infrastructure	private property on land and people (slaves, bondsmen); establishment of a system of exchange on markets; monetary based allocation of goods
ENTROPY	low	increasing, but still relatively low	increasing, but still relatively low	rapidly increasing

8 The End of Sustainability: The Industrial Strategy of Man in his Ecological Niche

Due to the low consumption of resources and energy, the entropic degradation in historical steady-state economies was relatively low. In all these societies, people had a more or less self-sufficient life following the seasons and respecting nature, which was often worshipped as a goddess and an inexhaustible source of energy. The common feature of all historical economies can be identified in their low consumption of energy. Until the eve of the industrial age, the average rate of energy consumption remained fairly stable, man´s life style was close to nature (Sahlins 1974; 1978, p.160; A. Weber 1963, p.46).

Since the 18th century, when industrial revolution started, the energy basis of human life changed profoundly. Industrial economies depend on the mining of the limited non-renewable resources taken from the bowel of the earth. The whole industrial civilisation could not be maintained without continuous supply of fossil fuels. Human needs and desires grow without limits. The limited capacity of the ecological systems to provide resources and to assimilate wastes is dangerously disregarded. Nature is no longer worshipped as a goddess, but treated as an exploitable basis of raw materials and place where wastes can be disposed. The new deity is money, and *growthmania* is the essential spirit of the time. The entropic degradation is high.

The original turning point toward the industrial revolution was the transformation of mainly agrarian and crafts based modes of production (over the craft system period) into the system of an industrial factory characterised by using modern technology and accompanied by an ever increasing division of labour. Complex machines and equipment needed more energy. The traditional wind energy was too unstable and water energy too confined to certain places to serve as main resources for industrial production (Marx 1974, pp 356 et seq.).Through the change from wood to coal and the invention of the steam engine, modern production became gradually independent of geographical factors. Later oil and gas became the thriving forces of industrial development.

At the same time, more and more of former self sufficient ways of life were replaced by the production of goods for the exchange on markets. The energetic basis of this change was the gigantic use of primary energy that has been accumulated during millions of years of the geological evolution.

> *"What characterizes the industrial societies is their enormous consumption of energy and the fact that this consumption is primarily at the expense of `capital´ rather than of `income´, that is, at the expense of solar energy stored in coal, oil and natural gas rather than of solar radiation, water, wind and muscle power."* (Cook 1971, p.135).

Cook (ibid.) compares the energy consumption of different historical economies with the following results:

Table 3: Kilocalorie Consumption per day in Current and Historical Economies

Historical Economy	Consumption of Kilocalories per Day
HUNTER AND GATHERER SOCIETIES	2.000 - 4.000
EARLY AGRICULTURE	12.000
INDUSTRIAL REVOLUTION (1850-1870) AND SHORTLY AFTER	70.000
END OF 20th CENTURY (USA, GB, GERMANY)	230.000

In contrast to steady-state economies of the past, which did not reduce the stability of ecological systems and sometimes even contributed to it, the industrial niche strategy exists on expense of nature. The increasing consumption of energy makes it ever more difficult to tap new resources. We have to dig further and further, deeper and deeper to get even the diluted forms of resources. Dangerous and harmful technologies of energy tapping are needed, e.g. fracking. If at one point in future it takes us one unit of energy to get one unit of energy, the net energy will be zero.

> *"Modern man is the only specie to have broken the solar-income budget constraints, and this has thrown him out of ecological equilibrium with the rest of the biosphere."* (Daly 1977, p.23).

Even being extremely harmful, resource depletion is not the ultimate thread caused by industrial growing economies as still assumed by Daly and the first Club of Rome studies in the seventies of the last century: The large-scale release of carbon dioxide and the resulting global warming, the pollution of environment by various kinds of industrial emissions, may lead to the extinction of mankind long before the question of final resource depletion will be on the agenda.

Illustration 3: Flows of Energy and Energy Transformations in Industrial Societies

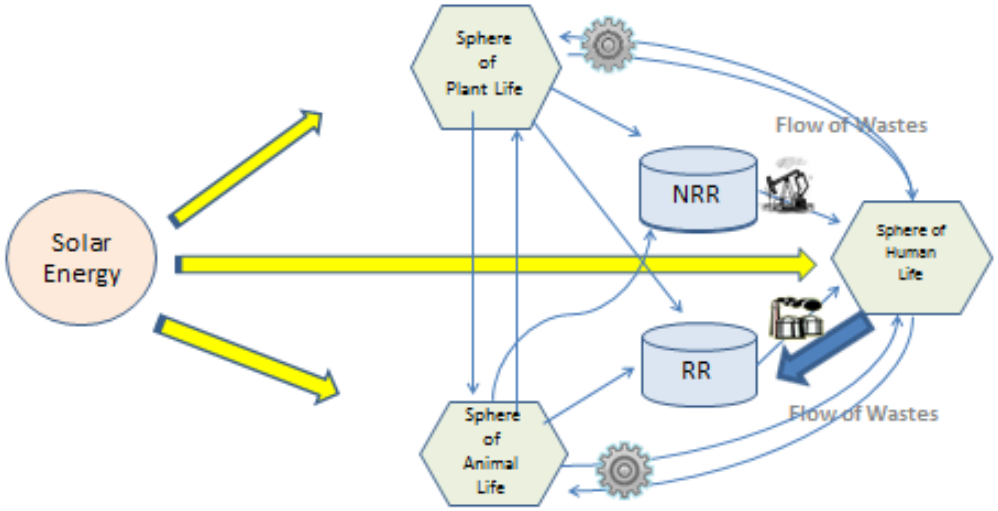

Illustration 3 provides an overview on the streams and transformations of energy in industrialised societies. Renewable resources (RR) und non-renewable resources (NRR) are used to satisfy human needs. The two parallel symbols represent various industrial technologies to tap resources and energies. The bold arrow denotes the human efforts to create and to keep the accumulated resource storages.

Already at the beginning of the industrial age, there had been voices warning against the threads and dangers lying ahead: Gerald Alonzo Smith (1993, pp. 183 per seq.) highlights that J.C.L. Sismonde de Sismondi (1773-1842) was the first economist of modern times who questioned the notion that growth in economic productivity was an end in itself. Sismondi wrote in an era of transition from the craft system to the factory system and while analysing the side effects of the ongoing changes of his time, he turned back to the Greek and especially Aristotle for his inspiration. He clearly advocates the idea of sufficiency. While comparing the former economic society in which craftsmen and farmers worked mainly for themselves with the industrial society in which labourers worked for others, he saw a departure from natural habits to work and leisure. Sismondi was the first who criticized the economic theoreticians for making the increase of production a national goal.

Today, while trying to ward off the thread of annihilation, the individual feels captivated into a trap of conditions and circumstances he or she has no means to master. The all pervasive power of the dominating life style paralyses human action, made worse by the non-transparency of many causal chains. The modern niche strategy actually produces a much greater sense of perceived insecurity than most of the past societies. A phenomenon, R. Borsodi already analyst in 1938:

> *"In any primitive economics society, the feeling of security of the individual has its basis in his freedom of access to natural resources. So long the hunter can take his bow and arrow and secure food for himself, he has this feeling of security. He has probably less material security than the wage-earner of modern economic society. The chances of his going hungry, because of the absence of game, are probably greater than the chances of the wage-earner going hungry because of unemployment. But the fact that his insecurity has its sources in phenomena which he can understand, and the fact that he has a bow and arrow, creates psychic offset against the material limitations of his situation and gives him a sense of mastery over the hazards with which he is confronted."* (Ralph Borsodi 1938, p.311).

9 Energy, Technology, and Culture in Sustainable Economics of the Past and the Future

> *"…there is a choice between transformation and distinction. Humanity is now approaching a point of critical instability which will spread to all its interdependent societies. This is the `checkpoint Charlie´ which could mark humanity´s passage into a new age or into oblivion."* (Lazlo 1985, p.19).

In a green economy the flows of matter and energy should be held at the lowest feasible level. As a result, entropy will kept low, and the human species can reach the longest possible life-span on earth. Sustainable resource management is of utmost importance. Reducing pollution and taking care not to exceed the waste processing capacities of the ecological systems is a further fundamental aim of a steady-state economy. The steady-state concept rec-

ognizes the circular processes in the natural world with respect to the transformations of matter. Regarding energy, the entropic degradation of all energy transformations is taken into account, and solar energy is seen as basis of all permutations of life. It is sole physical concept. Thus, things that are non-physical, like knowledge and ethical codes, are not held constant.

> *"The future steady state could be a good deal more comfortable than the overgrown, overcentralized, overextented, and overbearing economy into which growth has pushed us."* (Daly 1977, p.70).

As already mentioned, the non-growing economy is not a concept of recent years developed only in the wake of discussions about current resource depletion and environmental pollution, but can long back at a long strand of thought in history, beginning with Plato and Aristotle in the West and Confucius Lao Zi in the East. The general idea is that in such an economy, the rules that govern economic life are tried to reconcile with those that govern nature (i.e. controlling the functions of ecological systems).

The following illustration summarizes the main changes in the flow energy including its technological ramifications, and also shows some linkages between sustainable economies of the past and future.

Illustration 4: Historical Stages in the Use of Energy and Entropy

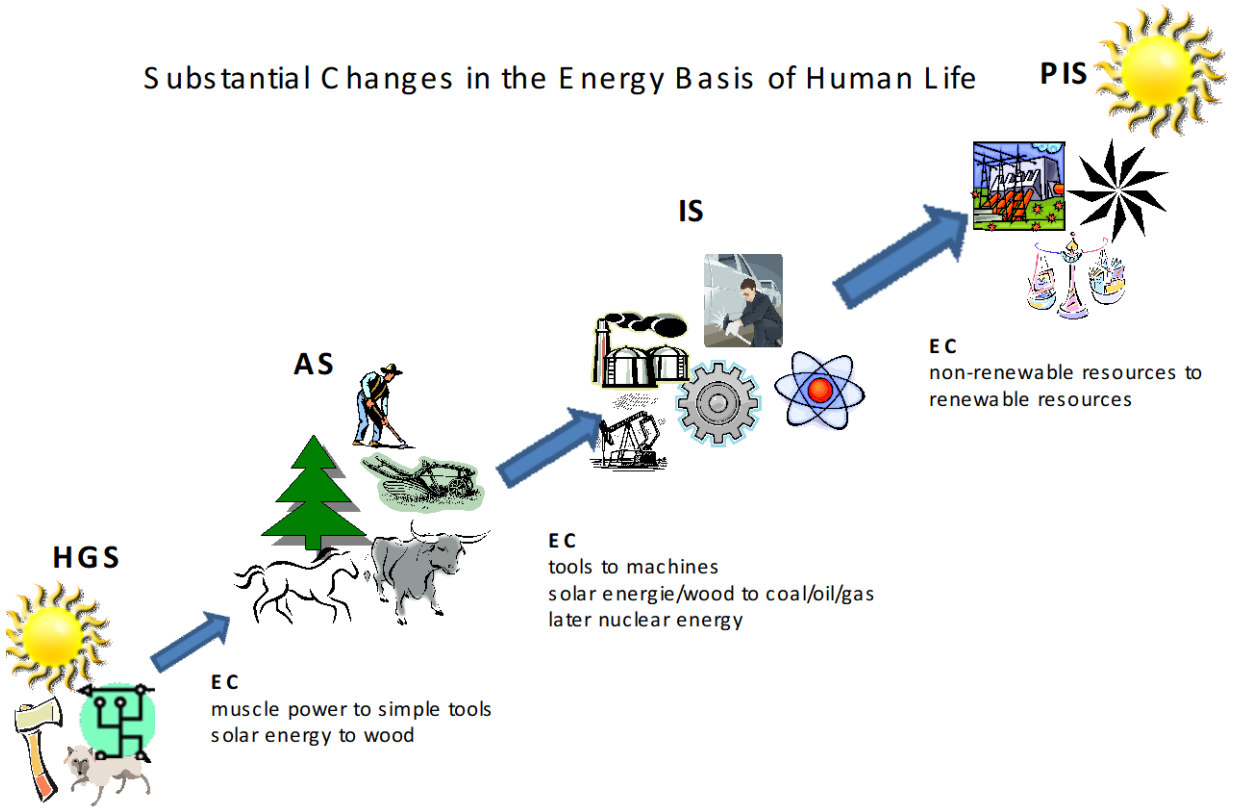

Illustration 4 illustrates the great turning points in Man´s strategy in his ecological niche. While changing from a hunter and gatherer society (HGS) into a society based on agriculture (AS), the prevailing human muscle power is replaced by the use of tools. The following widespread use of wood (e.g. for buildings, boats, and burning as firewood) indicate the first energy change (EC), i.e. the transition to new structures of energy use in human history. Many centuries later the change to coal, oil, gas (and later nuclear energy) is a further turning point at which the pattern of entropy and energy use change again. New machines open the door to an industrialised society (IS) and terminate the long period of sustainability. Today, mankind approaches another EC. The way into the post-industrialised society (PIS) shall be based on the use of renewable resources, in order to ensure the sustainability of human life on this planet.

Since all natural resources are scarce, economic growth cannot last for ever. What is called growth in fact often means destruction. A booming economy is mostly accompanied by growing environmental pollution and thereby paid by an increasing deterioration of the natural environment. The external costs of such growth, however, are not paid by private companies or consumers. In

order to avoid the exhaustion of raw materials and the destruction of the biosphere by harmful wastes and emissions, alternative roads to manage global economic affairs have to be paved.

This paper argues that the different stages of ecological system development as outlined in chapter two can serve as successful model of growth and a key paradigm of future economics. While industrial societies with high growth rates behave like ecosystems in their pioneering stage, if willing to follow the principles of ecological succession, the post-industrial society should replace quantitative growth by qualitative aims, such us self sufficiency, happiness and spiritual development. Comparable with a mature ecological system, which at the climatic stage is fairly stable, a sustainable future economy must be organized as a system capable of return into a state of equilibrium after suffering from disturbances.

Solar, wind and most other renewable energies are low pollution, low impact sources of energy and do not thread the stability of the ecological environment. These are the lessons of sustainable economics of past societies: Mankind has to recognize that there exists limits to growth, and violating the waste processing abilities of ecological systems threatens the very foundations of human life. Economic action has to be harmonized again with the mechanisms ensuring stability and equilibrium of ecological systems. We should not only consider the interests of current mankind, but future generations have also to be taken into account.

In greening the economy, the population issue is one of the biggest challenges of the future. Is there enough energy for a world population of 7.1 billion people whereof 2.8 billion live in poverty? One part of the solution is managing downward current overconsumption in the developed countries.

> *"Green economics is reformulating the concept of demand in making consumption effective, not stimulating it, and also bringing in supply-side realism."* (Kemmet/Heinemann 2006, p.75).

While past societies relied on religious and ethical codes to develop their niche strategy, green economics chooses a holistic approach. By accepting questions of social justice and ecological appropriateness, and integrating

them in economic theory and practice, the reductionist paradigm of classical economics is rejected, while former concerns of *moral economics* are reconsidered. When taking economic decisions, the interdependencies of the economic, social and ecological spheres should be acknowledged as well as the interests of non-human forms of life. The current paradigm of green economics is interconnected and interdisciplinary by its very nature. In learning from successful models of sustainable economies of the past, the study of energy transformations and allocations are most decisive to shape global future.

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