



## ENERGY AND SOCIETY: AN OVERVIEW

Manfred Groll

*Prof. Em., formerly: Institute of Nuclear Technology & Energy Systems (IKE),  
University of Stuttgart, Stuttgart, Germany*

### ABSTRACT

Each individual human being, groups of individuals, whole nations depend on the availability of energy for their survival. Without energy, no civilization can develop and sustain. In our globalised civilization, hundreds of millions of people cannot satisfy their needs for energy, be it in the elementary form of food, (clean) water for drinking, cooking and irrigation, (clean) air and (clean) soil for production of crops, or be it in energy required for heating/refrigeration, light, radio, TV, etc. Modern industrialized societies with their huge energy demand for industry, the transportation sector and for building up or maintaining elevated living standards for a large part of their populations, are fighting for the limited natural resources, notably fossil energy resources. Our present world energy economy is essentially based on fossil fuels. Their use causes emission of CO<sub>2</sub> which is the main contributor to global warming. Climatologists predict, that disastrous consequences due to climate change can only be avoided, if the temperature rise of the atmosphere can be kept below 2 K; and this means a maximum of 450 ppm CO<sub>2</sub> in the atmosphere. The paper gives an overview on the interrelation of energy and environment/ecology, including economic aspects (E3 scheme). The still exponential world population growth puts significant pressure on the worldwide energy demand and on environmental pollution. This aspect together with the role of education is discussed in an expanded scheme (E5). These problems, known since years and discussed once and again, cannot be reasonably tackled without accounting for the interrelation of the energy issue and the societal (economic/political) system. The question arises to which degree can solutions be found which benefit the majority of the people. Are acceptable solutions possible at all in a world under the dominance of capitalistic/imperialistic system? These questions will be discussed in the frame of a further expanded E7 scheme (including the issues of (in)equality and exploitation).

**Key words:** *Energy, Economy, Ecology, Population Explosion, Education, (In)Equality, Exploitation*

### 1. INTRODUCTION

We are living in a time where a great number of catastrophic events captures our attention: exceptional weather conditions, like extended draughts and floods, frequent and very strong hurricanes; extinction of millions of species from fauna and flora; and another disaster is looming, a world-wide water shortage. All this is to a large part the result of man-made climate change which is a consequence of excessive utilization of fossil energy. Since the end of World War II, there are continuously and world-wide military interventions and full-scale wars in pursuit of obtaining or maintaining control over energy resources, resources of other important raw materials, supply lines and markets, and this is accompanied by dozens of millions of deaths and same number of refugees. These wars are man-planned and cause additionally, as collateral damage, catastrophic destructions of the environment. Most of the described phenomena are somehow linked to energy. It is clear that without sufficient available energy, billions of people will never escape (extreme) poverty. Our present world energy economy is essentially based on fossil fuels (over 80 % of the primary energy consumption and nearly 65 % of the electricity generation). Their use is the main contributor to global warming. Climatologists predict, that disastrous

consequences due to climate change can only be avoided, if the temperature rise of the atmosphere is kept below 2 K; and this means a maximum of 450 ppm CO<sub>2</sub> in the atmosphere. Parallel to the fight for fossil energy resources, there is an ongoing struggle over binding goals concerning the reduction of CO<sub>2</sub> emissions, and how the necessary reduction measures, especially in the less developed countries, should be financed, and who should pay the bill. The energy issue is in the center of human life and society. Since decades, enormous effort is spent to tackle the important energy-economy-ecology issue. But energy is interrelated with other aspects of human life and society: the problems associated with the ever increasing population, the maldistribution of wealth in societies and world-wide, the redistribution of wealth from bottom to top. There is the under-representation/discrimination of groups, the inequality intrinsically coupled with the exploitation of the many by the few in power, the exploitation of the periphery nations by the central powers. In the following sections, the discussion of the problem will start from the elementary human needs and the key role of energy, and go on to the whole complex of energy and society. In the conclusions, the question will be raised whether and how the existing critical situation for mankind can be overcome, and well-known, but not applied solutions will be presented/recapitulated.

## 2. ELEMENTARY HUMAN NEEDS; KEY ROLE OF ENERGY

Human life is not possible without **food, water, air, soil**. Man can survive without air for about a minute, without water for a couple of days, without food for a few weeks, Soil is the basis for food production. In all these aspects, energy plays a key role.

Energy is important for individual human beings to maintain body metabolism and body temperature. Thereby produced entropy is removed and thus the fight against entropy increase can continue, until death. Energy is equally important for societies/civilizations. Without energy, no advanced agriculture and habitation are possible, and industrialization would be impossible. The basic human needs have been commodified and received a price tag. Only air is still for free. What is worse: they are objects of speculation and they are scarce. Figure 1 shows the critical situation: a large part of humanity has no access to these fundamental commodities and lives in miserable conditions.

- “water crisis”: ~ 29 % of world population (~ 2.2 bill.) have no access to clean water  
 ~ 2 mio. children die annually because of unclean water (water-related diseases)
- “food crisis”: ~ 2 bill. people are food insecure  
 > 820 mio. people suffer permanently from starvation  
 ~ 50 mio. die every year from hunger (6 mio. children)  
 ~ 12 bill. could be easily fed
- “land crisis”: # in agricultural oriented/dominated countries agricultural land is in the hands of feudal landlords and there are masses of landless peons  
 # agricultural private and state companies buy or lease land abroad  
 # small farmers living on subsistence agriculture loose their livelihood
- “energy crisis”: ~ 1 200 mio. have no access to electricity (~ 15 % of world population)  
 ~ 3 000 mio. rely on traditional (non-commercial) use of biomass (collected wood, dung, etc.) for cooking (~ 40 % of world population)  
 Non-commercial biomass accounts for about 10 % (!!!) of the total world energy consumption

Fig.1 Access to water, food, land, energy

## 3. ENERGY - ECONOMY - ECOLOGY (E3-SCHEME)

Ever since the activities of the Club of Rome (Meadows et al. study of 1972 on the limits to growth) brought the problem of sustainable development in a world with limited resources into the limelight, the accent of discussions and studies was on the exhaustibility of resources. Especially exhaustibility of conventional (fossil) energy resources was a heatedly discussed topic. It has been proven, however, that this problem was exaggerated; life time of oil and gas remained essentially the same from the time of my student years till today. This is due to both exploration and exploitation of new and “unconventional” oil and gas resources (tar sands, deep sea fields, arctic fields, fracking) as well as efficiency increase. These energies remain exhaustible, but there is enough fossil energy, also nuclear, for the next generations, however, at rising cost. And there is an increasing fight for the resources. Though there remains a serious problem, the attention has shifted to the environmental impact of energy use.

Presently the primary energy consumption amounts to about 13,9 Gtoe/a, with about linearly rising tendency, at least for the next decades (Fig.2). The uneven world-wide distribution, which means unequal availability, of primary energy is shown in Fig.3. Especially in emerging economies and less-developed countries (China, India, Brazil, Indonesia, etc.) there is a great backlog demand in energy, otherwise the living standards for the masses cannot be improved. In general, the population increase in these countries is high which means that the need for more energy will continue, regardless of the announced measures at the Paris Agreement of 2015 on climate change.

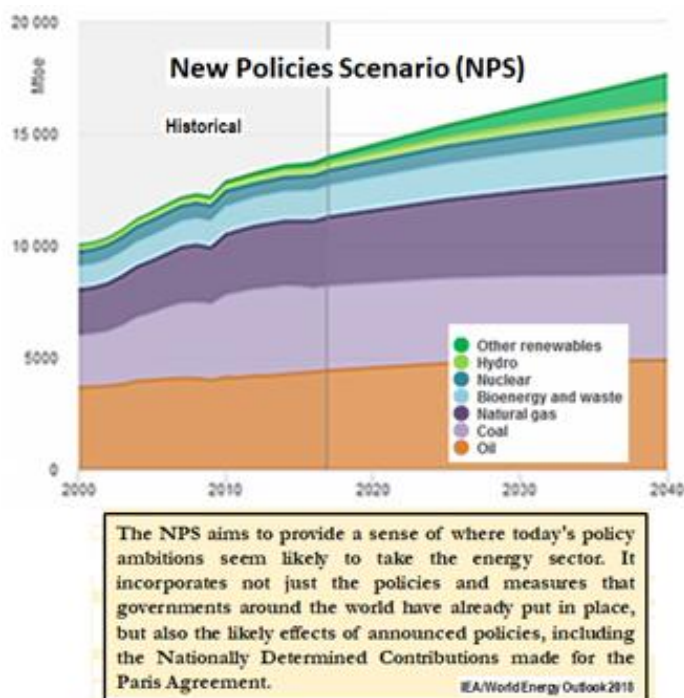


Fig. 2 World-wide primary energy consumption

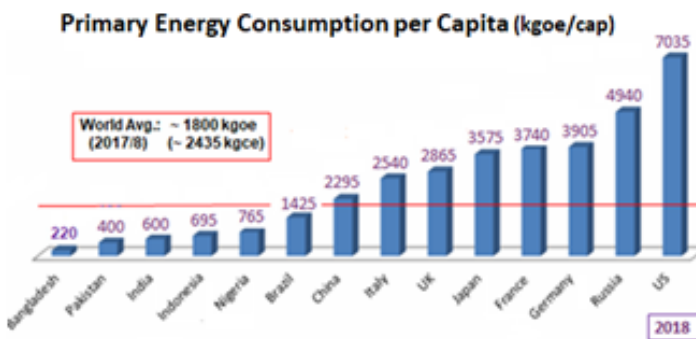


Fig. 3 Primary energy consumption per capita

Our world energy system is based on fossil fuels (about 82 % of primary energy consumption, non-commercial energy not counted; about 64 % of electricity). Usage (i.e. burning) of fossil fuels is accompanied with substantial harmful emissions on a local, regional and global level. Many of the toxic emissions can be drastically reduced (at some cost). The global problem is the emission of greenhouse gases (especially CO<sub>2</sub>, methane, nitrous oxide, chlorofluorocarbons and hydrocarbons). About 3/4 of the global warming is due to CO<sub>2</sub> (about 65 % related to the energy sector, viz. use of fossil fuels, industrial processes). The dramatic consequences of global warming (more frequent and powerful natural events like hurricanes, droughts, floods; shifting of climate zones; melting of glaciers and arctic ice; etc.) have been described in depth elsewhere, as well as the possibility of “tipping points” which would mean an irreversible change of climate. It is debated whether melting of Greenland ice, Arctic and Antarctic ice, large scale thawing of permafrost regions, disappearance of tropical rain forests can already be regarded as indicators of tipping points. With the Fridays for Future movement, a worldwide demonstration against climate change and for measures to prevent it, this topic is presently on the news headlines. It seems to be the understanding of the movement that the capitalistic economic systems is responsible for this disaster. In this context one should remind that the anticipation of the long-term catastrophic consequences of the capitalistic system on man and nature has already been expressed 1875 by Karl Marx in his Critique of the Gotha Programme (Appendix A).

The “culprit list” of major emitters has drastically changed in the last decade. No longer the old industrialized countries are dominating, but emerging economies are in the upper ranks now. Especially China and India with their immense economic growth are now number 1 and 3 of the CO<sub>2</sub> emitters (Fig.4).

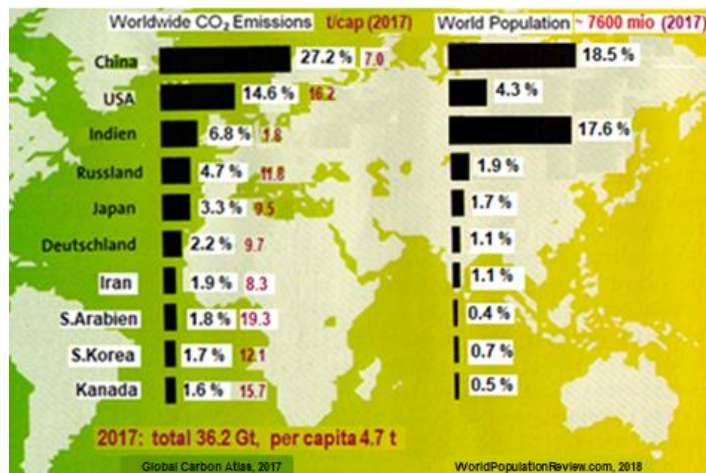


Fig. 4 CO<sub>2</sub> emissions and world population

However, what is mostly overlooked is the fact that on a per capita basis these countries are still emitting (much) less than the industrialized countries. Moreover, it has to be taken into account that these emerging countries started their industrialization much later, and their historic contribution to the CO<sub>2</sub> content in the atmosphere is much less. The problem of global warming has been acknowledged by most nations, and a number of international agreements have been made, starting from the Kyoto protocol in 1997 (after preparatory conferences in Rio 1992 and in Berlin 1995). At the Paris Climate Summit of 2015 “binding” agreements have been reached how to limit global warming to below 2 K (if possible 1.5 K) over the pre-industrial level. Among others it was decided that a climate fund shall be established to support poorer countries in counter-measures against global warming. E.g. between 2020 and 2050, 100 bill. \$/a shall be paid by the industrialized nations; from 2026 on, this sum shall be increased. From an objective and “fair” point of view, these measures are eyewash. In the Appendix B, an example is given how “fair” CO<sub>2</sub> budgeting could look like. A big setback was the announcement of the present US administration to drop out of the Paris Accord.

There are numerous studies how global warming could be avoided by employing technical means. The often-discussed possibility to accomplish that by change of the living style of the people is pure fiction. The majority of mankind can contribute nothing; they have to struggle to survive. And the well-to-do will by no means (with very few exceptions) change their way of life. But solutions are technically possible. Fig.5 shows results of older studies which compared the reference scenario (business as usual with a resulting temperature increase of 7 K) with the 450 ppm scenario (2 K increase). The latter requires a reduction of CO<sub>2</sub> emissions from 2020 on down to zero around 2050. It is shown that by various measures, there can be a reduction of nearly 14 Gt CO<sub>2</sub>/a by 2030 at moderate cost of below 9 400 bill. \$, i.e. less than 1 000 bill. \$/a (for comparison: the total cost of the wars in Iraq and Afghanistan surpass 5 000 bill. \$). The interesting result of the studies is that the major contribution comes from efficiency increase, both at power plants but especially in the end use sector. What is not included is the enormous potential which lies in the reduction of road transport in favour of rail transport, improvement of public transportation systems and hydrogen (or hydrogen-based liquids) as fuels for the automotive sector. More recent data covering the time span from 2010 to 2019, however, show a disastrous trend of the CO<sub>2</sub> emissions. They are significantly higher than for the reference scenario.

Considering both the imminent inertia associated with changes in an energy system and especially the financial interests and the economic/political power of the energy industrial complex (oil and gas monopolies), this can be interpreted as a clear sign that climate change is inevitable.

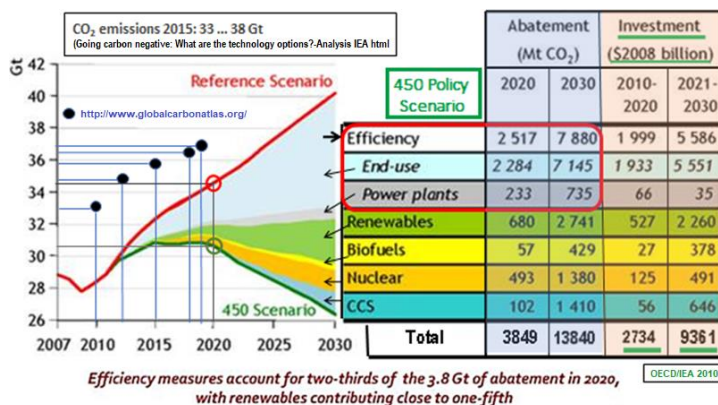


Fig. 5 Abatement of energy related CO<sub>2</sub> emissions

In the frame of the E3-scheme, methods have been developed and studies carried out to find “optimum” solutions for economic/ecological policies. Energetic-economic and exergetic-economic studies are carried out especially on local and regional levels (for technical systems, individual industries or parts thereof, communities, regions, nations). Upon analysis of the respective system, a cost function (objective function) is generated and linear or non-linear optimization is employed to obtain optimum solutions. There are also attempts to include environmental aspects in such investigations. The big problem which arises is how to account for the environmental cost of energy use. There is no data base for the internalization of external cost. And, of course, there are substantial controversies on how to measure the cost of environmental damage and damage to human health. Even the relatively simple question of cost for avoided CO<sub>2</sub> emissions is disputed.

#### 4. ENERGY - ECONOMY - ECOLOGY - (Population)EXPLOSION - EDUCATION (E5-SCHEME)

The unequal primary energy consumption is a problem in itself, because the least developed countries need more energy to develop their countries, and the population explosion primarily in these countries aggravates the problem. There have been suggestions to invest in education in order to bring the population growth to a lower figure. It is a historic fact that in most industrialized countries the number of children per family significantly went down in the course of development. Thus, an expanded E5-scheme has been discussed.

Putting emphasis on education looks convincing at a first glance, but it misses the decisive point. It is clear that education towards a responsible energy/environment consciousness is necessary. Education is especially necessary to meet the requirements of competitive industry/economy. But the solution to the population explosion problem is to provide reasonably paid jobs in the industrial and service sector and sufficient own farm land needed for self-sufficiency of small farmers. The former is the main problem in established and emerging industrialized countries. E.g., in China and India well over 10 million jobs have to be created annually for the upcoming young generation. But in countries where for a foreseeable long time there is no chance to establish an industrial basis with sufficient jobs for the growing population (countries in Africa, Latin America, Asia, notably also the emerging economic giant India), the latter aspect is decisive to enable decent living conditions for a large part of the rural

population. Besides land reform, this comprises reasonable prices for agricultural products needed for small farmers to survive (not subsidies for farm industries), and above all a functioning social security system (health & unemployment insurance, retirement payment), see Fig.6.

**(Population) Explosion:** increase of energy consumption & environmental pollution  
 Ever growing world population causes increased energy demand:  
 More people need  
 - more energy, to maintain their standard of living  
 - much more energy, to improve their standard of living  
 As a consequence:  
 - increased CO<sub>2</sub> and other emissions  
 - food, water, employment problems  
**Education:** education towards energy/environmental consciousness  
 educated people needed to run economy  
 Better education suggested as solution to the problem:  
 higher education – (better paid) jobs – higher living standard –  
 reduction of birth rate (1 child family)  
**Necessary, but not sufficient:**  
 - reasonably paid jobs needed  
 - sufficient own farm land needed for self-sufficiency  
 - reasonable prices for agricultural products needed for farmers to survive (not subsidies for farm industries)  
 - functioning social security systems needed (health & unemployment insurance, retirement payment, ... )  
 → **Socio-economic infrastructure needed** ←

Fig. 6 Population explosion and education

**5. ENERGY - ECONOMY - ECOLOGY - (Population)EXPLOSION-EDUCATION-EQUALITY - EXPLOITATION (E7-SCHEME)**

We have seen that the “traditionally” discussed interrelationship energy-economy-environment is far from providing a general overview on the societal/political situation. A more complete picture can be obtained by taking into account the important role of population explosion and education. And in this context the necessity of a good enough socio-economic infrastructure became evident. Moreover, history of mankind has shown that the underlying problems in this context are the system-inherent phenomena of inequality/exploitation. Therefore, we obtain a fairly good picture of the situation by an E7-scheme (Fig.7).

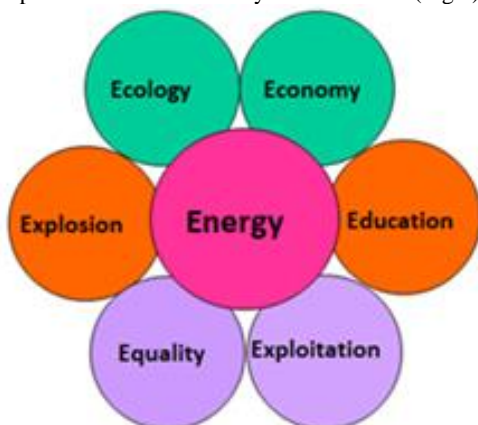


Fig. 7 The E7-scheme

Besides the serious problems associated with the rising need for energy, reinforced by the rapid population growth, the major problems are the maldistribution of means to provide decent living conditions for the large majority of mankind, and the exploitation of the many poor by the few rich.

(In)equality and exploitation exist in families/small communities, in big societies; between nations and groups of nations. Lacking equality or full-scale discrimination are related to sex, age, race, colour, religion/ideology, physical or mental disabilities. In general, weak minorities have always been and still are subject to discrimination. There is world-wide discrimination of women (lower wages, subject to physical abuse, poorer health conditions), children (child labour, physical abuse), disabled persons. There are over 65 million refugees (whether fleeing from war, economic disaster, etc., whether inland refugees or migrating refugees) who live to a large extent under miserable conditions. These facts demonstrate the economic/social disparities, on local, regional, national and international level.

The inequality among nations is illustrated in Figs.8 and 9. On a nominal basis, four emerging nations have entered the top ten list. On a PPP basis, China has already surpassed the USA and India is on place three before Japan and Germany. On a per capita basis, however, China and India rank only as 73<sup>rd</sup> and 142<sup>nd</sup>, even on PPP.

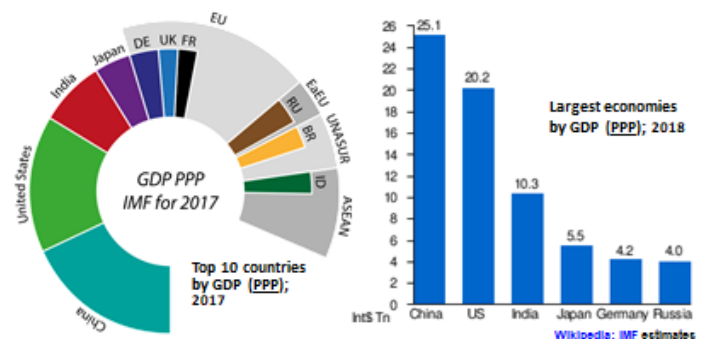


Fig. 8 Largest economies by PPP

Country	Population (10 <sup>6</sup> )	GDP (10 <sup>12</sup> \$, PPP)	GDP/cap (\$, PPP)	GDP (10 <sup>12</sup> \$)	GDP/cap (\$)
China	1 395	23.2	14 100	12.1	8 600
USA	325	19.4	59 500	19.4	59 500
India	1 290	9.5	7 200	2.6	2 000
Japan	127	5.4	42 700	4.9	38 400
Germany	83	4.2	50 200	3.8	44 800
Russia	145	4.0	27 900	1.5	11 000
Brazil	208	3.2	15 500	2.1	9 900
World	7 650	126.7	16 800	80.0	14 600

IMF (2017)  
 GDP: market value of all output (goods & services) produced within a country in one year by all enterprises; gross national income  
 GNP: market value of all output (goods & services) produced in a country in one year by the national enterprises, plus inflow of income from their outside investments, minus outflow of income of foreign investments

Fig. 9 Disparity of wealth among largest economies

The wealth of nations is dramatically unequal. However, there is a clear shift of economic power from the West to the East, from the old colonial/capitalistic nations to former colonies/ semi-colonies (Fig.10). The economic decline of Europe already started in the post-World War I era, that of the USA around 1960/70. The rise of Asia was dominated in the 1960s and 1970s by Japan. From the 1980s and 1990s on, India and

especially China are responsible for the rising economic power of Asia (to a lesser extent also South Korea, Indonesia, Taiwan). It seems that China and India are on the way to become the dominant economic nations as they have been for centuries in the pre-colonial/pre-capitalist times.

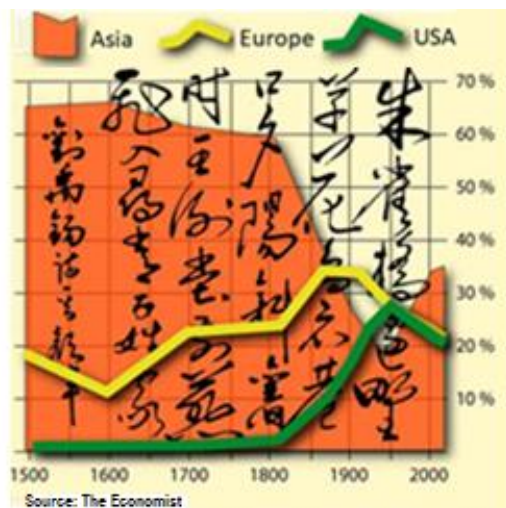


Fig. 10 Shift of economic power from Europe/USA to Asia

Figure 11 gives an ideal-typical description of inequalities and exploitation within selected nations; it shows an extreme maldistribution of wealth. The income and wealth gap between the (super)rich and the poor is enormous. Both in highly industrialized traditional capitalistic countries, as well as in emerging nations, regardless whether they have a capitalistic or socialist system, the wealth is concentrated at the upper 10 %, (2/3 to 3/4 of the national wealth), notably the top 1 % (1/3 to 1/2 of the wealth). Poverty is wide-spread and increasing. In industrialized nations, poverty is usually defined as income below the subsistence level, which means need for state support. In emerging and developing

- USA:** top 1 % own 36 % of wealth, top 10 % own 75 %; lower 50 % own 0 %;  
 income of lower 50 % is 12 %  
 20 richest persons/families own more than lower half  
 ~ 16 % live in poverty (60 % criteria); millions lost homes in consequence of 2007/8 financial crisis
- Germany:** top 1 % own 33 % of wealth, top 10 % own 69 %; lower 50 % own 1 %;  
 income of lower 50 % is 21 %  
 ~ 15 % live in poverty (60 % criteria)  
 2000 – 2010: salaries of employed dropped by ~ 10 %;  
 income of self employed & companies increased by ~ 30 %;  
 taxes of companies decreased: 50 % (1990) -> 45 % (2000) -> 15 % (2009)
- India:** top 1 % own 52 % of wealth, top 10 % own 78 %; lower 50 % own 4 %;  
 income of lower 50 % is 4 %  
 wealth of 119 billionaires amounts to ~ 1/3 of the GNP (850 bill. \$)  
 ~ 50 % of population live in poverty (650 mio with < 2 \$/d, 400 mio with < 1.25 \$)
- China:** top 1 % own 34 % of wealth, top 10 % own 61 %; lower 50 % own 4 %;  
 income of lower 50 % is 15 %  
 ~1.4 % (~20 mio) live in poverty (< 3 \$/d)

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- Brazil:** 20 oligarch families own as much agricultural land as 3.3 mio small farmer families; 4.5 mio farmer families are landless
- Greece:** 200 oligarch families own 80 % of total wealth

Fig. 11 National distribution of wealth (typical examples)

countries, the subsistence level, as defined by UNO, is 2\$/day (poor) and 1.25 \$/day (extremely poor). Most impressive is the fact that an emerging country, China, with state-controlled mixed economy (strategic sectors under state control, rest market economy) has successfully defeated poverty. The remaining small amount of poverty shall be eliminated by 2021, with the goal of minimum income of 15 \$/day. A real success story!

In countries with strong agricultural sector, in general few feudal oligarch families own the largest part of the land. Brazil is a typical example. The example of Greece stands for the problems “peripheric” countries can/will suffer when exploited by strong economies. In this case it is the Germany-dominated European Union, especially the Euro zone with common currency, which became a disaster for the Greek population and Greece as a nation (tremendous public debt, extreme unemployment rate among young people, ruined social security system, sale/privatization of state assets). Interesting, but not surprising, the wealth of the tiny fraction of Greek oligarchs remained untouched, it even increased.

Wealth is transferred from bottom to top. It is hard to believe, but a fact, that even the poor and very poor can be further exploited (reduction of public services, increase of consumer prices and of “general” taxes (VAT), increase of working hours, reduction of wages, part time work, etc.), if they have not the possibility to fight back. And this becomes increasingly difficult with a permanent high unemployment rate and a large industrial reserve army.

Maybe the best illustration of the situation/status of the imperialistic period of capitalism, which is globally prevailing, and which generated and keeps increasing the economic/political/social instability, was given in a study of ETH Zurich on global corporate control nearly 10 years ago. At that time, the 147 biggest multinational/ transnational companies controlled more than 40 % of the gross social product of the world (national wealth). This is accomplished by cross-connections and mutual participations. Among those multinational corporations, about ¾ are banks, insurance and investment companies; the rest are real estate and energy companies. They dominate the world economy along with their governments. Though the study is some years old, the general trend of concentration goes on, and the global players remain essentially the same.

Of course, these global players belong to private persons, only very few are state-controlled. The data published by Oxfam on the concentration of wealth in the hands of few individuals reveal an absurd situation. In 2017, the 42 richest persons owned the same wealth as the lower half of the world population (3.8 bill.). In 2018, this was true for the 26 richest persons. Since years, the richest 1 % own more than the remaining 99 %. Economic and thus political power are in the hands of very few. And this power is exerted to increase the accumulation of wealth by increased exploitation of the world. If needed, military power supports economic power.

The discussed economic situation reflects the development of the capitalistic/imperialistic system. It is based on the antagonistic contradiction between rich and poor, rulers and ruled, in general terms: exploiters and exploited. The ultimate consequences can be observed on a national and international level. On a national level, the exploitation of the bulk of the population and the distribution of wealth from bottom to top is the result of class warfare. This has been openly spoken out in an interview with the New York Times in 2006 by one of the richest men of the globe, Warren Buffet: “There’s class-warfare, all right, but it’s my class, the rich class, that’s making war, and we’re winning.” And in their Manifesto of the Communist Party of 1847, Karl Marx and Frederick Engels wrote: “The history of all hitherto existing society is the history of class struggles.” On the international level, there is struggle for domination/exploitation of the periphery by the imperialistic core countries through multinational monopolist corporations with the support of their governments. This is done by exertion of economic power and military power to open up markets for sales of goods, investment of capital, access to resources, exploitation of cheap labour.

## 6. CONCLUDING REMARKS

The question arises whether and how the existing situation, which is disastrous for a large part of mankind, can be overcome.

It is clear that (in any alternative to the capitalist system) the most advanced and efficient technologies (means of production, productive forces) have to be employed, but in a way that benefits the great majority, i.e. the relations of production (the political/economic/etc. superstructure) have to be appropriate. This means that the productive forces have to be utilized in a framework of overall social planning in the interest of the society as a whole and not by the competitive, aggressive, profit-oriented, non-social planning of individuals.

What is definitely necessary to accomplish a decent living for the masses are fair wages, i.e. distribution of the generated surplus value to the working class. In countries where agriculture is the basis for large parts of the population, land reform must allow small farmers acceptable living conditions. A number of measures must be taken to achieve these goals. In Fig.12, mandatory measures are listed.

- Land reform (agricultural sector)
- Fair wages (everywhere; distribution of surplus value)
- Basic commodities under "public" control, not under control of private capital
- Energy, water, public transportation
- Finance and insurance sector (heavy progressive income tax, inheritance tax, Tobin tax, high frequency trading tax, etc...)
- Education
- Information (electronic & print media)
- Social security (health care, unemployment, retirement)
- etc.

Fig. 12 Measures to resolve inequality problems

It would be required to establish transparency of all economic/political activities and control of bureaucracy. Ultimately, the establishment of "true" democracy would be necessary, as already expressed by Abraham Lincoln in his Gettysburg address of 1863 ("... and that government of the people, by the people, for the people, shall not perish from the earth."), and, of course, written down in the Communist Manifesto of 1847 by Karl Marx and Friedrich Engels. In the end it would mean no private property of means of production and resources, and no speculation with land.

It is evident that within the existing finance-market driven capitalistic/imperialistic system this cannot be accomplished. So the question arises: Can the existing finance-market-driven system be reformed? Are successive changes/improvements possible? Is an evolutionary transformation possible? Ultimately, is a peaceful transformation possible?

There are various theories/scenarios about the future development. Both bourgeois and Marxist economists and sociologists talk about dystopian scenarios. Such scenarios have also been considered already in the middle of the last century in the literature (Aldous Huxley (1932), George Orwell (1949), Ray Bradbury (1953) and in films, e.g. Soylent Green (1973)). The crisis of capitalism is evident. Bourgeois scientists talk about an overstretching and self-destruction of capitalism with dire consequences for the masses. They see no solution to reverse this trend (with the exception of a big war.) The Marxist/Leninist approach provides an alternative between decay and destruction, viz. the active/revolutionary overthrow of the existing system towards a socialist system. Rosa Luxemburg phrased this alternative as "barbarism or socialism".

There are extensive and intensive discussions among both bourgeois and Marxist economists. Many scenarios have been and are being developed how to save capitalism from self-destruction, how to transform capitalism peacefully and at the same time develop democracy in the society and introduce it into the monopolies. It seems that among the millions who are now demonstrating against climate change and for saving

our planet, the conviction is growing that these efforts may be fruitless in our neoliberal system, that the capitalistic/imperialistic system has to be overthrown forcefully. Therefore, I want to place at the end of this paper a photo of a banner shown at one of the world-wide Friday for Future demonstrations (Fig.13) where the slogan of the Copenhagen Climate Summit of 2009 "System change not climate change" is displayed. Though this picture has an optimistic approach, one has to keep in mind that history has proven that the capitalistic/imperialistic system will be defended by its beneficiaries by all means. So it is rather improbable that a "peaceful revolution" or the principle of Satyagraha can cause a system change. The present tendency is rather towards barbarism.



Fig. 13 Banner at Climate Change Demonstration

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## APPENDIX A: Springs of Wealth

Nearly 150 years ago, Karl Marx has clearly stated that there are only two springs of wealth, viz. human labour and nature. In a sense this means nature only, since human labour is an expression/a specific form of nature: "Die Arbeit ist nicht die Quelle alles Reichtums. Die Natur ist ebensoehr die Quelle der Gebrauchswerte (und aus solchen besteht doch wohl der sachliche Reichtum!) als die Arbeit, die selbst nur die Aeuferung einer Naturkraft ist, der menschlichen Arbeitskraft." [Labour is not the source of all wealth. Nature is just as much the source of use values (and it is surely of such that material wealth consists!) as labour, which itself is only the manifestation of a force of nature, human labour power." ] K. Marx, Critique of the Gotha Programme, 1875]

He and F. Engels concluded that the capitalistic system is ruining human beings and disturbing the metabolism between humans and nature due to excessive exploitation of human labour in the inherent thrive for accumulation of capital, i.e. profit maximization. At their time, capitalism was blooming, and thus the brutal exploitation of human labour was common place, but the irreversible exploitive destruction of nature was not yet in sight. However, they already observed the problems and anticipated the danger.

## APPENDIX B: Fair CO<sub>2</sub> Budgeting

As discussed at the Copenhagen Climate Change Conference in 2009, fair CO<sub>2</sub> budgeting is the basis of climate justice. A fair approach to distribute the cost for emissions would be, in accordance with the UN Human Rights Charter, that "emission rights" have to be based on the same amount per capita. The following assumptions are made for a rough estimate: a) Maximum temperature rise of 2 K (with 66 % probability), which limits the total CO<sub>2</sub> budget of the atmosphere to 2 900 Gt; b) Reduction of CO<sub>2</sub> emissions from about 2015 onward linearly to zero in 2050; c) The available budget till 2050 is estimated to be 1 100 Gt.

The "climate debt" and the cost for purchase of emission rights are estimated for China, USA, Germany. For the climate debt, the amount of CO<sub>2</sub> emissions between 1990 and 2009 is taken as reference (1990, reference year for the planned emission reductions; 2009, year when the estimate was made). For the cost to purchase emission rights from 2009 onward, the total CO<sub>2</sub> emissions of that year are used. A relatively moderate price (representing the abatement costs for CO<sub>2</sub> emissions) of 50 \$/t CO<sub>2</sub> is assumed. China (18.1 % of world population) has a total budget of 199 Gt and emitted 75 Gt in 1990-2009. Thus 124 Gt remain for > 2009. Data for USA (4.2 % of world population) are: 46 Gt total budget, 106 Gt emissions in 1990-2009, i.e. zero emission rights >2009. Germany (1.1 % of world population): 11.8 Gt total budget, 16 Gt emissions in 1990-2009, i.e. zero emission rights >2009 The respective dues for 2010 would be: China 387 G\$/a, USA 275 G\$/a, Germany 40 G\$/a. While China has no climate debts, these would amount to 3100 G\$ for USA and 210 G\$ for Germany. Assumptions can be modified (e.g. emissions before 1990, essentially caused by the industrialized nations, can be accounted for; preservation and creation of carbon sinks like reforestation can be considered) and updated figures can be used; but the applied principle of climate justice shows that the discussed climate funds to help endangered poor countries in the fight against climate change are ridiculously small, especially the envisioned contributions of the industrialized countries which have substantial climate debts.

In the last decade, emerging economies, especially China and India, have increased their CO<sub>2</sub> emissions considerably; their emission dues would respectively increase. Based on the described budgeting scheme, and with 2018 data, the following dues would arise for the 5 largest economies (sequence according to PPP) China:490 G\$/a, USA:265 G\$/a, India:125 G\$/a, Japan:60 G\$/a, Germany:40 G\$/a, Russia:85 G\$/a.