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Global Warming Problems and Solutions

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Abstract **– Satelite data show significant average global temperature rise in the last decades. For the previous periods, we have only proxy data with great uncertainties. Hundreds of nonlinearly interacting parameters control climate.**

To base our strategy on only one parameter - CO_2 - is very short sighted. There are other greenhouse gases. Other main variables are solar radiation changes, World Ocean impact, winds, volcanic activity, etc., which are independent from man's influence.

Renewable resources are viewed as method to reduce CO_2 emission. Calculations show that we can cover only 10 – 20% of our current energy needs using renewable resources.

We do not understand climate change mechanisms, and we do not have reliable techniques to reduce CO_2 emission and we do not have energy sources to cover our increasing needs.

Keywords: **climate change, carbon dioxide, renewable resources, bioenergy**

INTRODUCTION

For the last 50+ years we have more or less reliable data for the average global temperature estimation. These data are based on measurements of dense net of metrological stations and satellite measurements. Previous estimates can be characterized only as proxy data. Going back on time scale the uncertainties of global temperature estimates are rapidly increasing.

According to the NRC (National Research Council, Washington), 2006 /1/ (Fig.1.):

a) There is a high level of confidence that the global average temperature during the last few decades was warmer than any comparable period during the last 400 years.
b) Present evidence suggests that temperatures at many, but not all, individual locations were higher during the past 25 years than any period of comparable length since A.D. 900. However, uncertainties associated with this statement increase substantially backward in time.
c) Very little confidence can be assigned to estimates of hemisphere average or global average temperature prior to A.D. 900 due to limited data coverage and challenges in analyzing older data.

Proxy data show that global temperature changes are not homogeneous in time and, if looked at as a stochastic processes, not ergotic, but rather cyclic with period about 110 – 120 thousand years. At the maximums of cycle the temperature was much higher than in the last century (Fig.2, /2/). Human influence during these cycles was negligent. After the short maximums, there were long periods of very low temperature.

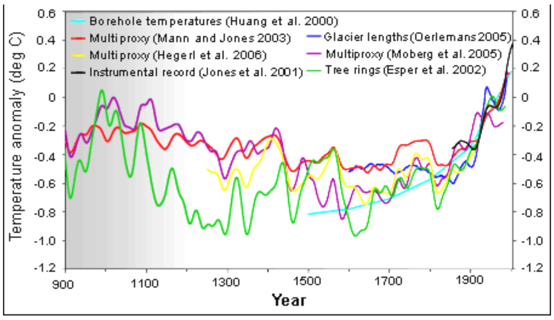

Fig.1. Average global surface temperature for the last 2000 years /1/.

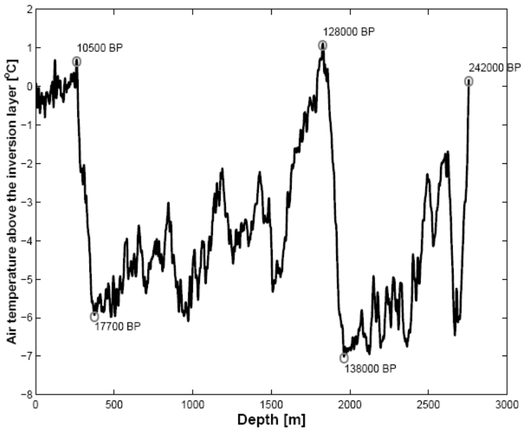

Fig. 2. Temperature changes during the last 240 000 years (data from ice core records drilled at station Vostok, Antarctica /2/. The horizontal axis gives the depth along the drilled ice core; increasing depth corresponds to an earlier era; the present-day era is on the left; BP=years before present)

Climate is controlled by hundreds (or may be thousands) of nonlinearly interacting parameters, and we do not have models, which can be used for climate change forecasts. Climate change forcing parameters include solar radiation changes, World Ocean impact due to changing flow patterns, Earth axis changes, volcanic activities, etc. Humans can regulate none of these influences.

GREENHOUSE GASES

The greenhouse effect is the process in which the emission of infrared radiation by the atmosphere warms a planet's surface. The greenhouse effect was discovered by Joseph Fourier and quantitatively investigated by Svante Arrhenius in 1896.

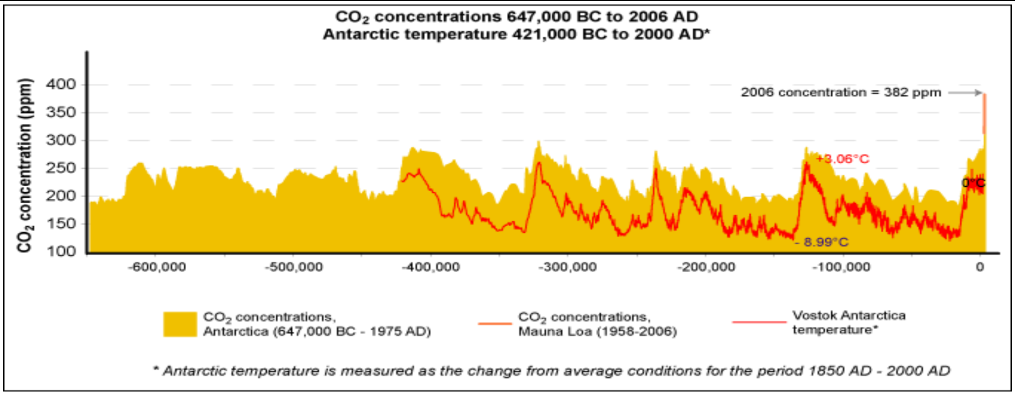

Fig.3. Correlation of the Antarctic temperature and carbon dioxide concentration /3/

There is strong evidence of the correlation between CO_2 concentration in the atmosphere and global temperature /Fig.3/. What is the cause and what is the consequence?

Humans are currently putting about 8 billion tons of CO_2 into the atmosphere annually.

From the other side, there are about 40,000 billion tons of CO_2 dissolved in seawater and captured in the biomass. The human contribution is negligible relatively to what is available from natural sources. As the seawater is warmed, it releases billion quantities of CO_2 in the atmosphere. As it cools, it absorbs CO_2. During the warmer interglacial periods CO_2 releases from the oceans would dominate. Warmer water cannot hold as much CO_2 as cold water, a fact well known from Henry's Law. The warming seawater causes the CO_2 increase.

Why are we are considering only CO_2 as the main reason for temperature increase? What about the impact of other greenhouse gases?

The relative importance of different infrared absorbers is confused by the overlap between the spectral lines of different gases. As a result, the absorption due to one gas cannot be thought of as independent of the presence of other gases. There are some approximate estimates /4/:

Water vapor	36% effect
Carbon dioxide	9% effect
Ozone	3% effect
Methane	no estimate, increasing concern (from cattle, biodegradation, etc.);
Nitrous oxide	no exact estimate (about 3% from N fertilizers are released into the atmosphere);
ClF carbons	no estimate (to be avoided; they are all man made and banned).

Greenhouse effect is only one of the forcing factors. Earth is a complex system.

„By a complex system I mean one in which the elements of the system interact among themselves, such that any modification we make to the system will produce results that we cannot predict in advance. And for that matter, who believes that the complex system of our atmosphere behaves in such a simple and predictable way that if we reduce one component, carbon dioxide, we will therefore reliably reduce temperature? ... And furthermore, who believes that the climate can be stabilized when it has never been stable throughout the earth's history? We can only entertain such an idea if we don't really understand what a complex system is. We're like the blonde who returned the scarf because it was too tight." (Michael Crichton, /5/).

However, the strategy of reducing CO_2 emission and reducing fossil fuel usage is a sensible approach.

What can we do in this direction other than saving energy saving?

CARBON DIOXIDE CAPTURE AND STORAGE (CCS)

Huge efforts are made to find ways how to capture and store CO_2 released by industrial processes, mainly heat and electricity generation generating plants.

CCS is a 3-step process, which includes:

1. Capturing the CO_2 from power plants and other industrial sources;
2. Transporting the CO_2 (if possible, by pipelines);
3. Storing the CO_2 in geological sites such as deep saline formations, or depleted oil and gas fields, or deep see.

This is typical "end of pipe" approach. First we create difficulties, after that we heroically fight them. This technology needs immense additional energy, materials, and infrastructure; the total environmental effect will be negative.

ALTERNATIVE ENERGY SOURCES

Nuclear energy sources (uranium) are limited and sooner or later will end. The potential of nuclear fusion energy is huge, but we have not still tamed it. Despite massive efforts we do not have technology for use of nuclear fusion energy production.

Hydroelectric power stations are widely used technology, but have limited resources and strong negative impact on the environment.

Tidal, solar and wind energy are not without their environmental impacts. Being irregular, they make poor and inefficient use of electrical transmission facilities, and, if they grow sufficiently large, will probably demand pumped hydroelectric as a palliative for intermittency. That will require construction of vast, environmentally destructive hydroelectric projects involving the diversion of rivers from natural watercourses and water storage in artificial reservoirs /6/.

Biofuel is seen as a very promising resource, much hope is put on it, and it is classified as renewable.

Strictly speaking, there are no totally renewable resources. History has a rather sad record. Why there are no woods anymore in Mesopotamia after bronze axe was invented? Where are the woods of Europe - Greece, Belgium, Italy, England, Sweden, etc. after the first industrial revolution? Why are there deserts where grass was growing?

Renewable recourses are renewable only if we use them cleverly and sparingly and take a huge amount of effort to restore them. Restoration also needs energy. Accordingly with the third law of thermodynamics restoration process must increase entropy which means that there cannot be totally renewable resources.

Biofuel has many controversial problems. Three classes of biofuel can be considered.

First generation. Biofuel can be made from naturally available biomass: plants, animals and their by-products (garden waste and crop residues, outputs from industry, agriculture, forestry and households, for example straw, timber, manure, rice husks, sewage and food waste). These resources cannot give a comprehensive solution to energy needs.

Second generation. Agricultural products specifically grown for biofuel production: corn, switch grass, soybeans (United States); rapeseed, wheat, sugar beet (Europe); sugar cane (Brazil); palm oil, miscanthus (South-East Asia); sorghum and cassava (China); jatropha (India); hemp.

Would you be prepared to use agricultural products to fuel your car when hundreds of millions of people are starving?

Third generation biofuels - algae fuel, also called oilgae. Algae are low-input/high-yield feedstock (about 30 times more effective by hectare than the second-generation biofuel). However, vast territories must be acquired to cover energy needs. The United States Department of Energy estimated that, if algae fuel replaced all the petroleum fuel in the United States, it would require 38,849 square kilometers (larger than Maryland).

There are a lot of other current issues with biofuel production and use: the "food vs. fuel" debate (are we going to use food resources for energy needs when millions of people are starving), carbon emissions level reduction in many cases is questionable, fertilizers release nitrous oxide which can increase greenhouse effect, deforestation and soil erosion, impact on water resources, human rights issues, biofuel prices, energy balance and efficiency.

Let us consider only some of these questions.

How much land is available to grow biofuel, and how much we have? We are cultivating now about 12.10^6 hectares of land; we have on Earth about $250 – 300.10^6$ hectares possibly additionally usable for growing biofuels (about the size of Argentina), but at least 290.10^6 hectares of land must be used to meet 10% need of energy demands in 2030 /7/.

How much water is needed to grow biofuel and how much we have? We have the total annual flow down of all World's rivers about 14 000 km^3 to cover 50% of energy demands by 2050. We need an extra 4 000 to 12 000 km^3 of water annually for growing biofuel crops /8/.

Fertilizers. About 3 to 5% of the nitrogen used as fertilizer ends up in atmosphere as nitrous oxide. It is enough to negate the cut in CO_2 emission made by replacing fossil fuel (it depends from the crops grown – ethanol from sugar cane can give a positive environmental effect, biodiesel from rapeseed came up as worse and gives negative effect) /9/.

CONCLUSIONS

- We do not know the mechanisms of the Earth's climate change.
- It is not clear if CO_2 emission is the main and only cause for the recent global warming or it is the consequence of temperature increase.
- We do not have feasible technological solutions to decrease CO_2 emission into atmosphere.
- Available alternative energy technologies have serious drawbacks and can provide only negligible percentage if compared with the total energy consumption.
- Biofuel cannot solve our increasing energy demand problems, we simply do not have enough bio resources to keep up existing and growing the Earth's population at the comfort level we are used to in the "developed countries".
- Principally new energy technologies must be developed as soon as possible.

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Iljo Dreijers. Globālās sasilšanas problēmas un risinājumi

Dati uzrāda ievērojamu vidējās globālās temperatūras palielināšanos pēdējos gadu desmitos. Šī tendence izraisa bažas. Par iepriekšējiem periodiem mums ir tikai aptuveni (*proxy*), visai neskaidri dati. Mēs zinām, ka Zeme ir pārdzīvojusi vairākus Ledus periodus un vairākus periodus ar augstu temperatūru. Klimatu kontrolē simtiem nelineāri savstarpēji saistītu parametru, un nav zināms, kā varētu prognozēt klimata izmaiņas nākotnē.

Balstīt stratēģiju tikai uz vienu parametru – CO_2 – ir ļoti tuvredzīgi. Eksistē arī citas siltumnīcas efekta gāzes. Ūdens tvaiku, metāna, slāpekļa oksīdu ietekme ir lielāka nekā CO_2 ietekme. Nav ticamu modeļu CO_2 un ūdens tvaiku apritei. Nav skaidrs, vai CO_2 koncentrācijas pieaugums ir cēlonis vai sekas globālajam vidējās temperatūras kāpumam. Bez tam ir vesela rinda no cilvēces neatkarīgu faktoru, kuri iespaido klimatu, piemēram, saules radiācija, pasaules okeāna ietekme, vēji, vulkāni u.c. CO_2 izplūdes samazināšana atmosfērā ir visnotaļ atbalstāma stratēģija. Taču šobrīd nav pieejamas tehnoloģijas, ar kuru palīdzību to varētu realizēt. Atjaunojamos resursus (piemēram, biodegvielu) uzskata kā iespēju samazināt CO_2 emisiju. Aprēķini rāda, ka šie resursi šodien var nodrošināt tikai 10 – 20% no pašreizējā enerģijas patēriņa.

Secinājums. Mēs nesaprotam klimata izmaiņu mehāniku, mums šobrīd nav tehnoloģiju, kas varētu būtiski samazināt CO_2 emisiju un nav enerģijas avotu, kuri varētu apmierināt arvien pieaugošo enerģētisko resursu pieprasījumu.

Ило Дрейер. Глобальное потепление - проблемы и способы решения

Данные свидетельствуют, что за последние десятилетия значительно повысилась средняя глобальная температура. Это вызывает серьезную обеспокоенность. О предыдущих периодах мы имеем только приблизительные данные с большой неопределенностью. Однако мы знаем, что на нашей планете были продолжительные ледниковые периоды и времена с весьма высокой температурой. Климат земли управляется сотнями нелинейно-связанных параметров, и мы не имеем моделей, которые могли бы прогнозировать дальнейшее развитие климата в будущем. Наша стратегия основана только на одном параметре – CO_2 – что является очень недальновидным подходом. Нет уверенности в том, является ли повышение концентрации CO_2 следствием или причиной роста средней глобальной температуры. Имеется целый ряд других тепличных газов. Например, влияние водяных паров, метана, окислов азота больше, чем влияние CO_2. Нет надежных моделей оборота CO_2 и водяных паров в окружающей среде. Кроме того, существует много факторов, не зависящих от человечества – солнечная радиация, влияние мирового океана, ветры, вулканы, и.т.д. Возобновляемые ресурсы рассматриваются как возможность сократить выбросы CO_2. Расчеты показывают, что эти ресурсы могут обеспечить только 10-20% от сегодняшнего потребления энергоресурсов.

Выводы. Мы не понимаем механизмы изменения климата. На сегодняшний день у нас нет технологических решений для ограничения выбросов CO_2 и нет доступных новых источников энергии для обеспечения растущих потребностей.