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Halting Global Warming

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Abstract:Global warming must now be given more attention, by international organization (UNFCCC, G20), national governments and the public at large. We face Stephen Hawking's dire warning about irreversibility, but more important is the recent accumulation of evidence in support of global warming theory (GWT). Economist N. Stern (2007), declaring climate change the biggest external effect in human history, asks now: "What are we waiting for? (Stern, 2015).Reply: the COP23 of the United Nations' UNFCCC to take real action and initiate activities that reduce CO2 emission.
Key Words: Decarbonisation, COP21 Treaty GOAL I, II, III, CO2-temperature, solar power parks, coordination failures: implementation gap and defection in Ocean PD games.

I. Introduction

Interstate coordination has been successful in the so-called COP21 Treaty by the UNFCCC in Paris 2015, having more than 190 signatories and ratified by more than 55 states. It is thus valid Public International Law, obliging the member states of the UN to start decarbonizing. It was a great achievement in states' collaboration to reach this Treaty after so many years of meetings – transaction cost heavy.

However, goals are more ideas, wishes, plans, etc. - about future development, i.e. hopes in the minds of governments and the public. Now comes the implementation stage, where means have to be elaborated that really promotes the goals. This is for the fall meeting of the UNFCCC, the COP23 in Bonn. The COP21 objectives are:

- GOAL I: halting the increases in CO2:s definitely by 2020;
- GOAL II:reducing by 2030 CO2 emissions by 30-40 per cent in relation the 2005 baseline;
- GOAL III: full decarbonisation by 2070-80, or at least a very large reduction in the use of fossil fuels.

Today, things stand as follows with regard to these key GOALS I, II and III, namely that a minority fulfills GOAL I, no country fulfills GOAL II and certainly not GOAL III.

The direct target of this unique form of grand scale government coordination is the immense increase in energy consumption of fossil fuels the recent 30 years. The indirect target of the UNFCCC is the equally sharp rise in greenhouse gases, especially CO2 emissions. Table shows the total energy consumption in 2015, which increased only by 1 per cent in 2016.

Table 1 shows what has to change in the course of 10-12 years. The part of fossil fuels must be pushed back about 30 per cent, to be replaced by renewables and atomic power. The elimination preferred is to take away coal.

Table 1. Energy consumption 2015 (Million Tons of oil equivalent)

	Total	%
Fossil fuels	11306,4	86,0
Oil	4331,3	32,9
Natural Gas	3135,2	23,8
Coal	3839,9	29,2
Renewables	1257,8	9,6
Hydroelectric	892,9	6,8
Others	364,9	2,8
Nuclear power	583,1	4,4

Total	13147,3	100,0

Source: Source: BP Statistical Review of World Energy 2016

This is the global picture. Each country has its energy profile that varies much between countries, as some rely almost to 100 per cent upon fossil fuels whereas a few others are below 50 per cent. Many very poor countries rely much upon wood coal.

II. The Co2 Emissions and Climate Change

One may attempt to calculate exactly how increases in greenhouse gases impact upon temperature augmentations. Take the case of CO2s, where a most complicated mathematical formula is employed:

(1) $T = Tc + Tn$, whereT is temperature, Tc is the cumulative net contribution to temperature from CO2 and Tn the normal temperature;

But when it comes to methane, it is not known whether the tundra will melt and release enormous amounts. But methane does not stay in the atmosphere long, like CO2s. For the other greenhouse gases, there is no similar calculation as for the CO2s: If humans could eat less meat from cows, it would mean a great improvement, as more than a billion cows emit methane. Food from chicken should replace beef meat and burgers. The general formula reads:

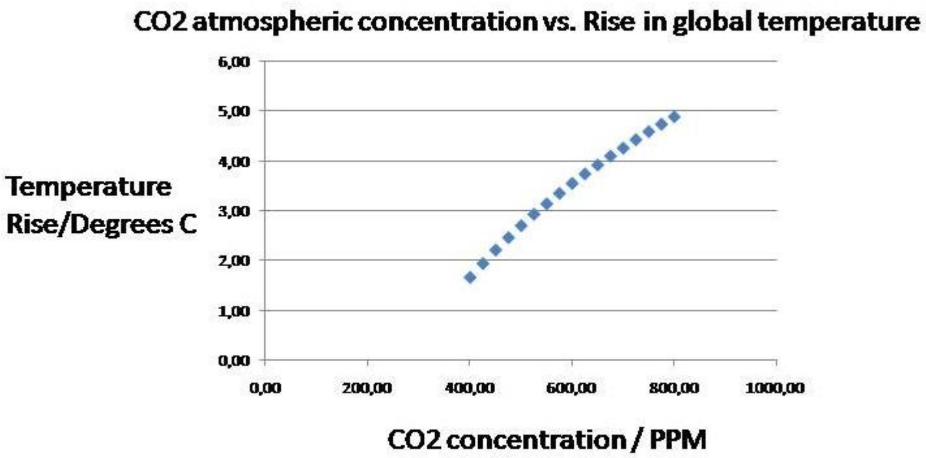
(2) $dT = \lambda * dF$, where 'dT' is the change in the Earth's average surface temperature, 'λ' is the climate sensitivity, usually with degrees Celsius per Watts per square meter (°C/[W/m2]), and 'dF' is the radiative forcing.

To get the calculations going, we start from lambda between 0.54 and 1.2, but let's take the average = 0.87. Thus, we have the formula (Myhre el al, 1998):

Formula: 0.87 x 5.35 x ln(C/280).

Figure 1 shows how CO2 emissions may raise temperature to 4-5 degrees, which would be Hawking's worst case scenario.

FIGURE 1. CO2s and temperature rise in CELCIUS



No one knows where the critical temperature rise occurs, i.e. from which Celsius degree global warming becomes "irreversible", to use Stephen Hawking's expression. It could be as low as + 2Celsius or as high as +5 Celsius.

III. GLOBAL WARMING THEORY(GWT): Structure and Evidence

The most recent addition to GWT is Stephen Hawking's ominous prediction about irreversibility. GWT has been known for some 200 years, but never harboring such dramatic hypotheses. French mathematician Joseph Fourier discovered global warming in the early 19th century looking at its contribution to warming a too *cool* planet Earth. But the negative theory was developed by Swedish chemist Arrhenius around 1895, focusing on the risk of *overheating* the planet Earth. He calculated that a doubling of CO2 ppm would be conducive to a 5 degree increase in global average temperature, which is not too far off the worst case scenario for the 21rst century, according to UN expertise now. Not until Stephen Schneider published Global Warming in 1989 did the theory receive wide attention with his journal Climate Change, no doubt strengthened by the work of Keeling in measuring CO2 ppm globally. Moreover, techniques for viewing the CO2 layer were developed, increasing the attention to climate change. Now, the UN reacted with creating a few bodies to look into the changes going on, one of which was the COP framework. One may say that GWT comprises a number of hypotheses with one theoretical core model in the natural sciences, and that it thus is well integrated in a web of beliefs.

Evidence: a) Melting of polar ice massively: b) Retraction of glaciers globally; c) Huge land losses along the costs (Bangladesh);; d) Too high temperatures for men and women to work outside (South Asia); e) Food production decline (Africa); f) Fish harvest decrease (Atlantic ocean, Pacific Ocean); g) Droughts and starvation (South Asia); h) Lack of fresh water supply (Latin America); i0 Drying up of rivers, affecting electricity supply (Latin America, South Asia, East Asia); j) Ocean acidification and species extinction (Australia); k) Highly volatile climate with giant forest fires, storms, rainfall and tornados with tremendous damages (America, Sri Lanka, China, Australia)); l) Deforestation and desertification (Africa, Indonesia, South Asia).

The theory of GWT in the social sciences is much contested and less developed, reflecting the differences of opinion in Skeptical Science against Science CO2 on their respective websites.

Iv. Policy Implementation: Grand Management Tasks

The contribution of the social sciences to GWT may be divided into two very different parts.

a) Part One: Negation of GWT

Some social scientists have argued forcefully that GWT in particular and environmentalism in general is mere politics. Unfounded, GWT and environmentalism is in reality an attack upon the system prevailing, i.e. the capitalist market economy with all its injustices and exploitation. Aaron Wildavsky (1997) saw GWT as "Mother of all environment scares". Julian Simon (2002) rejected the thesis that natural resources were becoming scarce in a general ecology crisis. And B. Lomborg (2003, 2007) carried the message further asserting the global environment faced few problems and that we should also "COOL It". I believe that this message is now outdated.

b) Part Two: COP21 Problems in the Future

Through the cop21 Treaty, some 190 countries have self-obliged themselves to decarbonisation in this century. It is to be done in steps: GOAL I, II and III. But how? Can such an enormous set of tasks really be accomplished, a total energy transformation where energy consumption is vital to human needs and the global economy? Two model humans, men and women, deny that the fulfilment of COP21 is feasible. Both refer to the rationality of human behavior, albeit in very different ways.

i) Bounded rationality

The most influential social scientist ever, Max Weber from Freiburg and Heidelberg, stated in a famous passage the following about means and ends in human behavior:

"Any thoughtful reflection on the last elements of meaningful human activity is first of all bound to the categories of 'ends' and 'means'". (Weber, 1922).Weber regarded the Western civilization as basically founded upon means-end rationality, or technical calculation, in both state and market. Herbert Simon developed his bounded rationality theory by emphasizing the cognitive limitations of men and women. He devoted much of his scholarship to criticize the relevance of the neo-classical decision-making model in economics to private management and public administration (Simon, 1996). In government and big firms, decisions could not meet all the requirements of full or completely comprehensive rationality. Instead, decision-making just "muddles through", as C. Lindblom states, following H. Simon. Not all means were known, not all their probabilities could be stated, and not all goals were taken into account – bounded rationality, i.e. incomplete marginal decision-making.

Wildavsky took up marginalism or incrementalism, applying it first to budget making and then to policy implementation. When the national government decides about policies, how can regional or local governments implement these? Due to cognitive limitations and the rapidly changing situation, regional and local governments may reject the means and ends of the national government, and try other implementation themselves (Pressman and Wildavsky, 1973, 1984). Policy identity would entirely lose due to space and time.

The same warning – *Wildavsky's hiatus* – applies to the implementation of the COP21 Treaty goals I, II and III.

ii) Game theory: defection

In game theory, we are back to the assumption of full rationality in behavior, meaning complete information and transitive preferences. In reality, the implementation of COP21 Treaty is interaction between the member states in this club, a common pool regime (CPR). The threat to this global CPR is reneging, which one big partner already has done. Turkey may follow suit and perhaps also Australia. The relevant game is the PD game (prisoner's dilemma):

India
ComplyRenege

		India: Comply	India: Renege
US (Trump)	Comply	-10, -10	-40, 0
	Renege	0, -30	-20,-20

If the US and India comply, they both pay 10 billion $ for instance for energy transformation. Reneging is better, as each would pay 0. But when both defect, the costs of damages from climate change increases. The paradoxical outcome is the Nash equilibrium: -20, -20, although it is rational foolishness. The governments should coordinate upon Pareto optimality: -10, -10, but this requires promises, which will be cheated upon, as Hobbes emphasized already 1651.

It has been suggested that voluntary cooperation leads to the Pareto optimal outcome when the game is played several time, sequentially repeated (Axelrod, 1984). Thus, a replay three times could give -30, -30 instead of defection: -60, -60. This insight formed a basis for Elinor Ostrom's (1990) theory of CPRs, handling externalities by means of non-state intervention. However, Axelrod's solution holds only for infinite games, but all CPR are finite. The sub game perfect Nash equilibrium to a repeated PD game in finite form is: defection – *the principle of backwards induction*.

Thus, one may safely conclude that the entire COP21 goals implementation harbors lots of reneging opportunities, from funding to planning and execution as well as management. The only remedy is selective incentives, meaning that countries complying receive financial assistance – side payments. This is the real reason of the Super Fund. What, more precisely, is involved in a major comprehensive energy transformation, from fossils to for instance solar parks?

IV. Cop21 Energy Transformation: A Model Example

Consider now Table 1, using the giant solar power station in Morocco as the benchmark – How many would be needed to replace the energy cut in fossil fuels and maintain the same energy amount, for a few selected countries with big CO2 emissions?

Table 1. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II: Global scene (Note: Average of 250 - 300 days of sunshine used for all entries except Australia, Indonesia, and Mexico, where 300 - 350 was used).

Nation	CO2 reduction pledge / % of 2005 emissions	Number of gigantic solar plants needed (Ouarzazate)	Gigantic plants needed for 40 % reduction
United States	26 - 28[i]	2100	3200
China	none[ii]	0	3300

EU28	41 - 42	2300	2300
India	none[ii]	0	600
Japan	26	460	700
Brazil	43	180	170
Indonesia	29	120	170
Canada	30	230	300
Mexico	25	120	200
Australia	26 – 28	130	190
Russia	none[iii]	0	940
World	N/A	N/A	16000

If countries rely to some extent upon wind or geo-thermal power or atomic power, the number in Table 1 will be reduced. The key question is: Can so much solar power be constructed in some 10 years? Thus, the COP23 should decide to embark upon an energy transformation of this colossal size.

Solar power investments will have to take many things into account: energy mix, climate, access to land, energy storage facilities, etc. They are preferable to nuclear power, which pushes the pollution problem into the distant future with other kinds of dangers. Wind power is accused to being detrimental to bird life, like in Israel's Golan Heights. Geo-thermal power comes from volcanic power and sites. Let us look at the American scene in Table 2.

Table 2. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II: American scene (Note: Average of 250 - 300 days of sunshine per year was used for Canada, 300 – 350 for the others).

Nation	Co2 reduction pledge / % of 2005 emissions	Number of gigantic solar plants needed (Ouarzazate)	Gigantic plants needed for 40 % reduction
Canada	30	230	300
Mexico	25	120	200
Argentina	none[ii]	0	80
Peru	none[ii]	0	15
Uruguay	none[ii]	0	3
Chile	35	25	30

It has been researched has much a climate of Canadian type impacts upon solar power efficiency. In any case, Canada will need backs ups for its many solar power parks, like gas power stations. Mexico has a very favourable situation for solar power, but will need financing from the Super Fund, promised in COP21 Treaty. In Latin America, solar power is the future, especially as water shortages may be expected. Chile can manage their quota, but Argentine needs the Super Fund for sure. Table 3 has the data for the African scene with a few key countries, poor or medium income.

Table 3. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II: African scene (Note: Average of 300 - 350 days of sunshine per year was used).

Nation	Co2 reduction pledge / % of 2005 emissions	Number of gigantic solar plants needed (Ouarzazate)	Gigantic plants needed for 40 % reduction
Algeria	7 - 22[iv]	8	50
Egypt	none[ii]	0	80
Senegal	5 - 21	0,3	3
Ivory Coast	28-36[iv]	2	3
Ghana	15 – 45[iv]	1	3
Angola	35 – 50[iv]	6	7

Kenya	30[iv]	3	4
Botswana	17[iv]	1	2
Zambia	25 – 47[iv]	0,7	1
South Africa	none[ii]	0	190

Since Africa is poor, it does not use much energy like fossil fuels, except Maghreb as well as Egypt plus much polluting South Africa, which countries must make the energy transition as quickly as possible. The rest of Africa uses either wood coal, leading to deforestation, or water power. They can increase solar power without problems when helped financially.

Table 4 shows the number of huge solar parks necessary for a few Asian countries. The numbers are staggering, but can be fulfilled, if turned into the number ONE priority. Some of the poor nations need external financing and technical assistance.

Table 4. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II. Asian scene (Note: Average of 250 - 300 days of sunshine was used for Kazakhstan, 300 - 350 days of sunshine per year for the others).

Nation	**Co2 reduction pledge / % of 2005 emissions**	**Number of gigantic solar plants needed (Ouarzazate)**	**Gigantic plants needed for 40 % reduction**
Saudi Arabia	none[ii]	0	150
Iran	4 – 12[iv]	22	220
Kazakhstan	none[ii]	0	100
Turkey	21	60	120
Thailand	20 - 25[iv]	50	110
Malaysia	none[ii]	0	80
Pakistan	none[ii]	0	60
Bangladesh	3,45	2	18

Finally, we come to the European scene (Table 5), where also great investments are needed, especially as nuclear power is reduced significantly and electrical cars will replace petrol ones, to a large extent.

Table 5. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II: European scene (Note: Average of 250 - 300 days of sunshine per year was used)

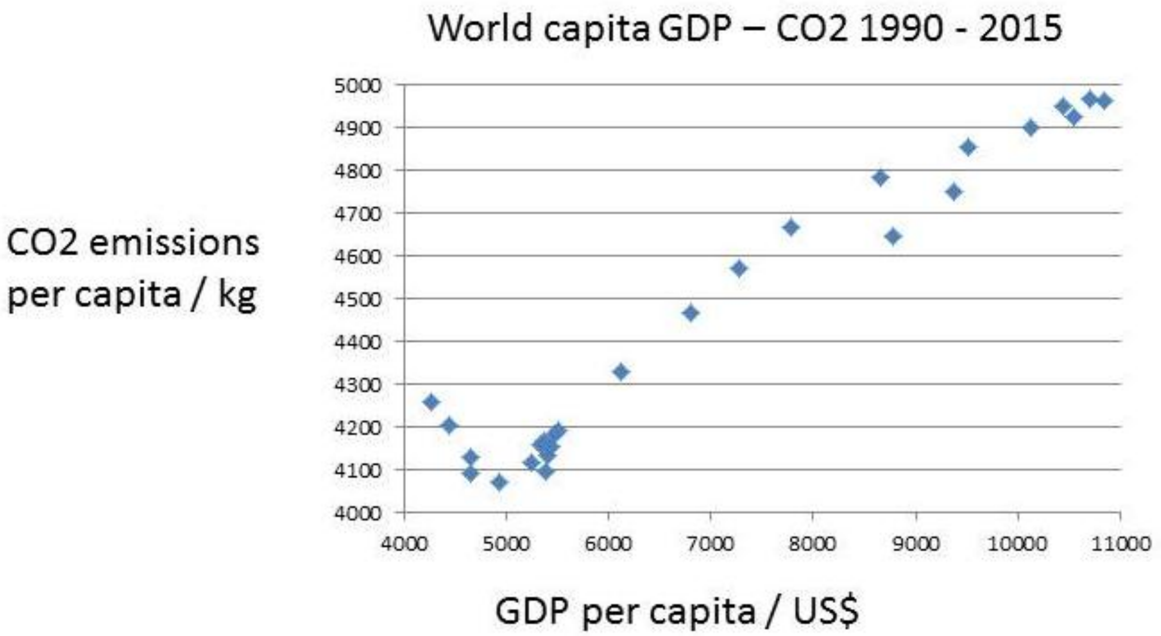
Nation	**Co2 reduction pledge / % of 2005 emissions**	**Number of gigantic solar plants needed (Ouarzazate)**	**Gigantic plants needed for 40 % reduction**
Germany	49[v]	550	450
France	37[v]	210	220
Italy	35[v]	230	270
Sweden	42[v]	30	30

The United States has pulled out of the deal
1 No absolute target
1 Pledge is above current level, no reduction
1 Upper limit dependent on receiving financial support
1 EU joint pledge of 40 % compared to 1990

V. Affluence and Emissions

If energy consumption is the key to understanding CO2 emissions (Kaya and Yokobury, 1998), then what drives the enormous demand for energy globally? Reply, the human drive for affluence, need satisfaction and wealth. Figure 2 shows the two trends going together: GDP per capita growth (affluence per person) and CO2 emissions per capita from 1990 to 2015 – longitudinal analysis.

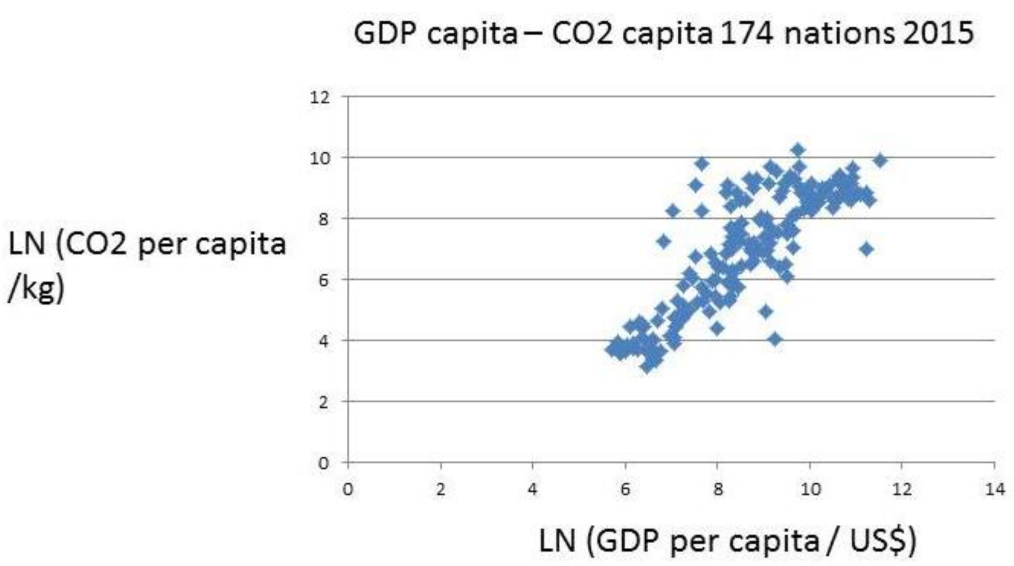
FIGURE 2. 1990-2015: Per capita affluence and CO2s: y = 0,15x; R^2 = 0, 95



Sources: World Bank Data Indicators, data.worldbank.org; EU CO2 Data Base EDGAR, edgar.jrc.ec.europa.eu

The same relation between economic affluence and CO2s hold for the world difference in GDP per capita in 2015- cross-sectional analysis in Figure 3.

FIGURE 3. 2015: Affluence and CO2s per capita:y = 1,11x; R^2 = 0, 69



Sources: World Bank Data Indicators, data.worldbank.org; EU CO2 Data Base EDGAR, edgar.jrc.ec.europa.eu

VI. Implementation Or Management Tasks Ahead

The COP23 meeting in the fall in Bonn faces the enormous challenge of making its goals, especially GOAL I and GOAL II operational. This involves setting a joint international-national management or implementation center to engage in planning:

a) What incentives to employ for decarbonisation?
b) How to phase out coal as soon as possible?
c) How to stop the use of wood coal in poor countries?
d) How to replace fossils with a mix of renewables like solar and wind power plus geo-thermal power as well as maybe atomic energy?
e) How is the construction of facilities be organized?
f) The Super Fund: funding, budgeting, oversight?
g) How will international governance cooperate with national policy-making, implementation and markets?
h) Can the global supply of renewable power installations be enough to meet an enormous increase of demand?
i) How to control goal attainment and honesty in performance with minimization of embezzlement and other forms of cheating?

We are back to H. Simon's bounded rationality. To implement or manage such a global revolution must be done in a piecemeal fashion, trial and learning, mistakes and redoing. But the UNFCCC must stop talking and start doing CO2 reduction.

VII. Conclusion

Ramesh (2015) says that India cannot abstain from fossils, even stone coal or wood coal, unless massive support is forthcoming. To restrain reneging upon the COP21 Agreement, there must be selective incentives from the promised Super Fund to assist poor and emerging economies like South Asia, Indonesia and Brazil. The COP23 must start the operative stage of decarbonisation, as it is an enormous set of management tasks, internationally, nationally and locally. The only viable solution to the problem of halting climate change is massive investments in new solar power parks plus the turn to electrical vehicles.

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NOTES

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Appendix I.

The so-called Kaya model runs is the best one to understand affluence—energy-emissions. It runs as follows:

(E 1) Kaya's identity projects future carbon emissions on changes in Population (in *billions*), economic activity as GDP per capita (in *thousands of $US(1990) / person year*), energy intensity in *Watt years / dollar*, and carbon intensity of energy as *Gton C as* CO_2 *per TeraWatt year*."
(http://climatemodels.uchicago.edu/kaya/kaya.doc.html). Concerning the equation (E 1), it may seem premature to speak of a law or identity that explains carbon emissions completely, as if the Kaya identity were a deterministic natural law. It will not explain all the variation, as there is bound to be other factors that impact, at least to some extent. Thus, it is more proper to formulate it as a stochastic *law-like* proposition, where coefficients will be estimate using various data sets, without any assumption about stable universal parameters. Thus, we have this equation format for the Kaya probabilistic law-like proposition, as follows:(E2) Multiple

Regression: $Y = a + b_1X_1 {}^{+} b_2X_2 + b_3X_3 + ... + b_tX_t + u$. Note: Y = the variable that you are trying to predict (dependent variable); X = the variable that you are using to predict Y (independent variable); a = the intercept; b = the slope; u = the regression residual.

Note: http://www.investopedia.com/terms/r/regression.asp#ixzz4Mg4Eyugw. Thus, using the Kaya model for empirical research on global warming, the following anthropogenic conditions would affect positively carbon emissions: (E3) CO2:s = F(GDP/capita, Population, Energy intensity, Carbon intensity). An empirical estimation of this probabilistic Kaya model with a *longitudinal* test for 1990-2014, i.e. World data 1990 – 2015, gives:: (E4) Ln CO2 = 0,62*LN Population + 1,28*LN(GDP/Capita) + 0,96*LN(Energy/GDP); R2 = .90.Energy means power and consequently affluence and wealth. It is hotly desired by men and women in today's world, as Figure 4 entails.

Figure 4. Energy consumption per capita globally