GLOBAL JOURNAL OF ADVANCED ENGINEERING TECHNOLOGIES AND SCIENCES

GLOBAL WARMING: AVOIDING HAWKING'S IRREVERSIBILITY

By Jan-Erik Lane*

* Fellow at the Public Policy Institute, Belgrade

Address: 10 Charles Humbert, 1205 Geneva; 559 A, 3rd Floor, Thuya Street, 9th Quarter, Yangon. Myanmar

ABSTRACT

When the UNFCCC meets again in Bonn for the COP23 in the fall with Fiji as host, the focus should be upon the GOAL II in the COP21 Treaty: decarbonisation with 30-40 per cent of 2005 levels until 2030. Several countries now meet the GOAL I of halting the rise in CO2 emissions. And the rest should be asked and helped to do so. But the GOAL II is a very big challenge. It can only be fulfilled with massive investments in solar panel parks.

KEYWORDS: Decarbonisation and the UNFCCC, the COP21 GOALS, renewables, global warming dangers, Ouarzazate size solar parks.

INTRODUCTION

What international governance in the UNFCCC project aims at together with global state coordination is to engage in decarbonisation while securing economic development. The COP21 objectives are: GOAL I: Halt CO2 increases by 2018-2020; some countries already have done so, but far from all; GOAL II: Reduce CO2 emissions by 30-40 per cent, depending on how counts, by 2030 – an immense challenge; GOAL III: Complete decarbonisation by 2070-75.

As world star physicist Stephen Hawkins recently remarked: global warming is close to becoming irreversible. The theory of global warming could not be more relevant for mankind, as irreversibility entails human extinction. French mathematician Joseph Fourier discovered global warming in the early 19th century, but the theory was developed by Swedish chemist Arrhenius around 1895. 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.

Yet, it was not until Stephen Schneider published <u>Global Warming</u> in 1989 that the theory started to receive wide attention, 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. The economists jumped in besides the natural scientists, worried about the future costs of this transformation of the atmosphere. On the one hand, Kaya and associates presented in 1997 a model that explained CO2:s with energy and energy intensity of GDP. On the other hand, Stern called global warming the largest externality in human history, calling for international governance in order to stem the growth of greenhouse gases. Stern outlined in 2007 a number of activities aimed at reducing CO2 emissions, promising also a Super Fund to channel money from rich advanced nations to poor countries and developing economies. As little has been done through the UN system of meetings and agencies – transaction costs - up to date, Stern 2015 asked: "What are we waiting for?", neglecting his promise of the Super Fund (Ramesh, 2015).

DANGERS FROM ANTHROPOGENIC CLIMATE CHANGE

Considering the probable damages from global warming, it is astonishing that global warming theory has not been better recognized or even conceptually developed or empirically corroborated. There will be sooner or later:
   a)   Huge land losses along the costs;
   b)   Too high temperatures for men and women to work outside;
   c)   Food production decline;
   d)   Fish harvest decrease;
   e)   Droughts and starvation;
   f)   Lack of fresh water supply;
   g)   Drying up of rivers, affecting electricity supply;
   h)   Ocean acidification and species extinction;
   i)   Highly volatile climate with storms, rainfall and tornados with tremendous damages;
   j)   Deforestation and desertification.

This list is far from complete or exhaustive. One could even mention worse outcomes, like the transformations of warm and cold currents in the oceans – Gulf Stream, North Atlantic Current for example. What one may underline is that so far no known negative feedback has been found that could stem global warming naturally. We seem to have mainly only positive feedbacks, meaning outcomes reinforce each other in the same direction. The situation in the Amazons and Borneo is basically "lost", and Siberian forests threatened.

ENERGY-ENVIRONMENT CONUNDRUM

Basically, roughly 90 per cent of all energy consumption comes from non-renewables. The COP21 call for decarbonisation involves a sharp reduction of fossil fuels up until 2030 in order to stabilize climate change with a 30-40 decrease in CO_2 emissions. First, we see that CO_2 emissions are closely connected with energy consumption, globally speaking. And the projections for energy augmentation in the 21st century are enormous (EIA, BP, IEA).

FIGURE 1. Global GDP-CO2 link: $y = 0,4092x + 25,03$, $R^2 = 0,987$ (N =26)
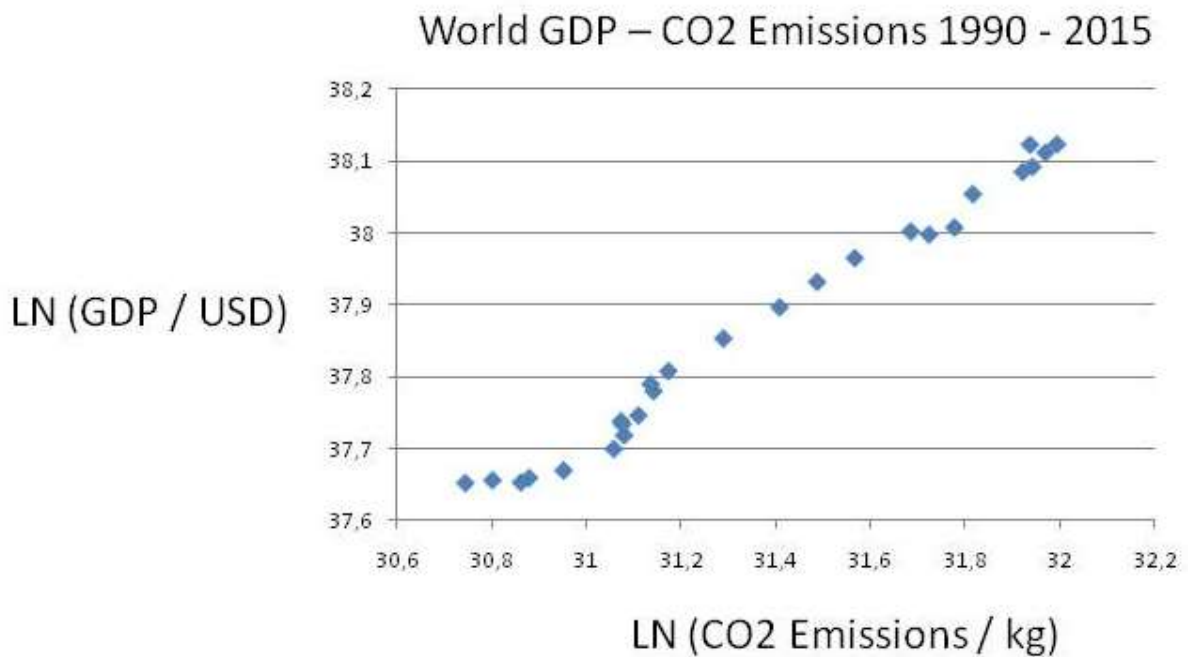
The findings show that total GHG:s or CO2:s go with larger total GDP, i.e. GDP per person * population. Decarbonisation is the policy promise to undo these inks by making GDP and energy consumption rely upon carbon neutral energy resources, like modern renewables and atomic energy. Thus, the upward sloping curves must be reversed but still slope outward. As, total energy consumed rises, so CO2:s increase. Secondly, energy means power and consequently affluence and wealth. It is hotly desired by men and women in today's world, as Figure 2 entails.

Figure 2. Energy consumption per capita globally

GDP vs. Energy usage per capita 1990 - 2014
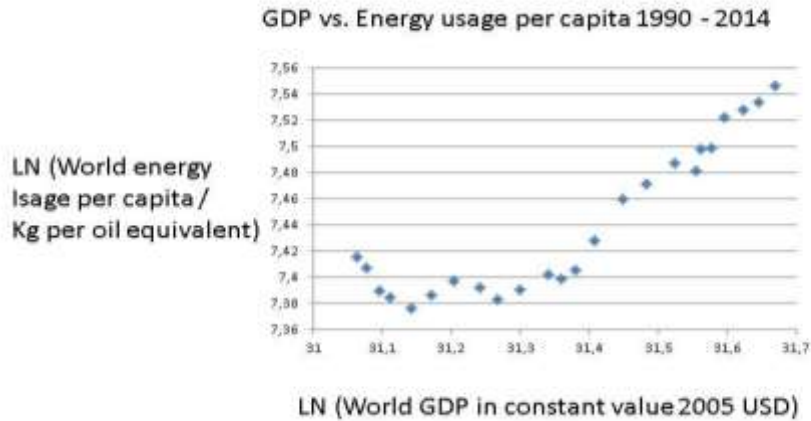
With such a demand for energy, resulting in sharply rising CO2:s per capita, how is mankind to avoid the horrendous consequences of climate change? One solution is the vast economic depression with strong cut backs in energy consumption, but no governments will deliberately chose this alternative, as it entails mass poverty and starvation deaths.

THE COP21: Implementation of GOAL II
Let us first focus upon what this hoped for reduction of fossil fuels implies for the augmentation of renewable energy consumption, here solar power. The use of atomic power is highly contested, some countries closing reactors while others construct new and hopefully safer ones. I here bypass wind power and thermal power for the sake of simplicity in calculations.

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? If not, Hawkins may be right. 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, 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 4. 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 |

Is there space to build all these solar parks, one may ask. But many many small houses with solar roofs will also do well. Public buildings and company offices may be run on solar power from their roofs! Innovation is needed everwhere.

CONCLUSION

As the Keeling curve continues its relentless rise (Earth CO2), we must take Hawkins warning about irreversibility seriously. Moving now and up to 2030, according to the COP21's GOAL II for decarbonisation eliminates irreversibility. The solution is solar power parks of Ouarzazate type size. Above is a calculation of what is needed in many countries around the world, taking into account the insights of the research into GDP-energy-emission links. Time has come for halting and reducing CO2 emissions by real implementation and not utopian dreams of a sustainable economy (Sachs, 2015). There is nothing to wait for any longer (Stern, 2015), as the COP23 must set of the promised Super Fund. No time for politicking in the UN any longer (Conca, 2015; Vogler, 2016).

REFERENCES
SOURCES

Solar power
Paris 2015: Tracking country climate pledges. Carbon Brief, https://www.carbonbrief.org/paris-2015-tracking-country-climate-pledges

EDGAR v 4.3.2, European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Emission Database for Global Atmospheric Research (EDGAR), release version 4.3.2. http://edgar.jrc.ec.europe.eu, 2016 forthcoming

CO2 Emission Reduction With Solar
http://www.solarmango.com/in/tools/solar-carbon-emission-reduction

GDP sources:
World Bank national accounts data - data.worldbank.org
OECD National Accounts data files

GHG and energy sources:
World Resources Institute CAIT Climate Data Explorer - cait.wri.org
EU Joint Research Centre Emission Database for Global Atmospheric
Research - http://edgar.jrc.ec.europa.eu/overview.php
UN Framework Convention on Climate Change -
http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3814.php
International Energy Agency. Paris.
Energy Information Administration. Washington, DC.
BP Energy Outlook 2016.
EU Emissions Database for Global Research EDGAR,
http://edgar.jrc.ec.europa.eu/
World Bank Data Indicators, data.worldbank.org
British Petroleum Statistical Review of World Energy 2016.

LITERATURE
[1] "Arrhenius, Svante August" in Chambers's Encyclopædia. London: George Newnes, 1961, Vol. 1.
[2] Barry, B. (1982) "The Tradition of Spontaneous Order", in Literature of Liberty. Vol. V, No. 2, pp. 7-58. Arlington, VA: Institute for Humane Studies.
[3] Conka, K. (2015) Un Unfinished Foundation. The United Nations and Global Environmental Governance. Oxford: OUP.
[4] Dutta, P.L. (1999) Strategies and games. Cambridge, MA: MIT Press.
[5] Hayek, F.A. (1991) The Fatal Conceit: The Errors of Socialism. Chicago: The University of Chicago Press.
[6] Kaya, Y., and Yokoburi, K. (1997) Environment, energy, and economy: Strategies for sustainability. Tokyo: United Nations University Press.

[7] Ramesh, J. (2015) Green Signals: Ecology, Growth and Democracy in India (2015). Oxford : Oxford University Press.
[8] Sachs, J.D. (2015) The Age of Sustainable Development. New York: Columbia University Press.
[9] Stern, N. (2007) The Economics of Climate Change. Oxford: OUP.
[10] Stern, N. (2015) What are we waiting for? Cambridge, MA: MIT Press.
[11] Vogler, J. (2016) Climate Change in World Politics. Basingstoke: MacmillanPalgrave

APPENDIX I.

The so-called Kaya model 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 CO₂ 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).

I make an empirical estimation of this probabilistic Kaya model with a *longitudinal* test for 1990-2014, i.e. World data 1990 - 2015: (E4) Ln CO2 = 0,62*LN Population + 1,28*LN(GDP/Capita) + 0,96*LN(Energy/GDP); R2 = .90.

NOTES

[i] The United States has pulled out of the deal

[ii] No absolute target

[iii] Pledge is above current level, no reduction

[iv] Upper limit dependent on receiving financial support

[v] EU joint pledge of 40 % compared to 1990