Journal of Economics Bibliography
www.kspjournals.org
Volume 4 March 2017 Issue 1

"What are we Wauting for?" Professor Stern Bypasses the *Juggernaut* Links in Climate Change

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Abstract. Professor N. Stern had had an enormous influence on global warming policy debates. In his 2007 book, he stated the dangerous problem for mankind clearly. And now he comes back with a new book 2016, expressing his frustration about the developments with the UNFCCC and UNEP. The message is: Time is short for policy-making stabilising Planet Earth's climate and thus its overall environment. However, there is an answer to Stern's worry. "What are we waiting for?" in his 2016 book. The COP21 Treaty was possible after years of heavy transaction costs, because it contains the Stern Promise,, i.e. a Super Fund of $100 billion yearly for supporting the giant energy transformation involved in the COP objective of decarbonisation in this century. The COP project stets up *global gaming* where governments will play their rational strategies including opportunism with guile. Reducing emissions are linked with energy consumption, which is linked with country affluence. Mixing up climate stabilisation with general social development goals (SDG), as economist Sachs suggests, would be a serious mistake, Phycisist Hawkins' recommendation to leave the Earth for some new place in the Universe is but a fairy tale due to lack of energy. Emmissions are linked with energy that is linked with affluence. And all people have the same drive when it comes to money.
Keywords. Emissions, Energy, Affluence, Stern, Sachs, Juggernaut, Super Fund.
JEL. N70, O13, P28.

1. Introduction

The basic forms of energy for the globalisation period and its societies, rich or poor, comprise; i) fossil fuels: coal, oil, natural gas, ii) shale oil and gas: shale rock, iii) traditional renewables; charcoal, peat, waste, iv) modern renewables: solar, wind, geothermal, v) nuclear power: Fission or fusion.

Some of these sources of energy result in the emission of gases when consumed, the greenhouse gases (4-7 kinds), of which the CO2:s constitute the largest bulk, although also methane is highly relevant in the globalised world due to the melting tundra and ice pockets under the oceans. Thus, we arrive at the crucial links, outlined in the well-known Kaya identity model; CO2:s = GDP per capita X population X energy intensity of GDP X carbon intensity of energy (Kaya & Yokuburi, 1997): The Juggernaut links are as follows: (1) economic development or growth – energy consumption, (2) energy demand – greenhouse gases, (3) greenhouse gases – global warming at degrees X.

The exact nature of these links is not fully known today, constituting one of the most important areas of new inquiries in the natural and social sciences. It is globalisation that puts (1), (2) and (3) at the forefront, because the world economy has grown at large average rate since 1945, acceleration actually in the last 35 years with the awakening of giants like China, India, South Korea, Indonesia, Brazil and Mexico, *inter alia*.

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Not only may all forms of energy be measured, but all these measures are translatable into each other – a major scientific achievement. One may employ some standard sources on energy consumption and what is immediately obvious is the very huge numbers involved – see Figure 1.

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
	13147,3	100,0

Source: BP Statistical Review of World Energy (2016)

Examining Figure 1, one understands the size of the immense task of decarbonisation. Complete decarbonisation would mean the elimination of the energy consumption of fossil fuels and traditional renewables like wood coal. This is a herculean task, impossible simply. But the mix of energy usage will change during this century towards more of carbon neutral energy sources, but not as quickly as the COP21 project promises,

2. COP21 Process in Three Steps: Decarbonisation

The governments of the world have finally come around to accept that climate change is not a positive for mankind and Planet Earth. No one knows with certainty how dangerous global warming may be or what are the driving mechanisms behind it, as well as the possibilities or probabilities of positive and negative feedback lopes. The COP21 covers 3 stages of decarbonisation: i) Phase One up to 2020: halting of the growth of emissions typical of the entire industrial era; 2) Phase Two up to 2030: reducing the CO2 emissions by 40 %; 3) Phase Three up to 2080; more or less elimination the CO 2 emissions.

The task of the social sciences and economics is to inquire into the implementation of these goals as well as help devise management strategies that are conducive to the realisation of these goals, Energy will be, I submit, the crucial variable in these COP21 unfolding games, Why is energy so important for globalisation and the Earth's ecology ?

3. The Global Links

When calling for decarbonisation of economies in the widest sense, the COP21 envisages that decarbonisation can be maximised with the constraint of continued economic development or growth. But is it really true?

Hitherto GDP and energy per capita have been most strongly connected. See Figure 1. And GDP and GHG or CO2:s have also been strongly linked – see Figure 2. But the COP21 process claims we can have declining GHC:s and augmenting GDP? True? It all depends upon an immense evolution of energy consumption.

Figure 1 shows that the richer a country the more energy their inhabitants use, This entails that total energy consumption will be a straight function of affluence. Most of this energy comes from the burning of fossil fuels, as shown in Table 1.

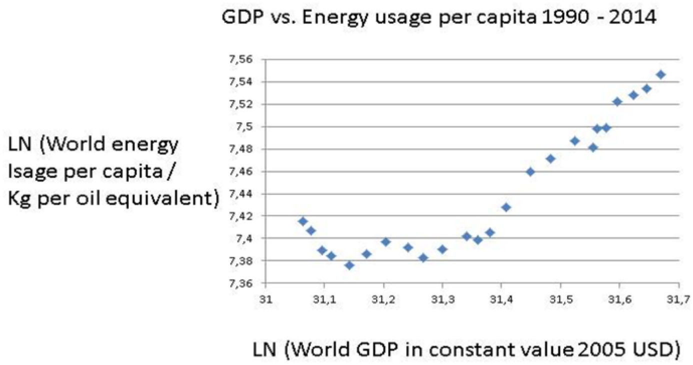


Figure 1. *First global link: Affluence and energy; GDP - Energy per capita:* $y = 0{,}26x$, $R^2 = 0{,}81$

The stylised projection for energy consumption in the globalised world speaks of unbelievably increases in the next decades to come, responding to the hopes for high economic growth in emerging economies and decent rates in mature ones. The objection to these predictions is simply that they fall outside of the COP21 approach that now starts.

There is much talk about moving towards GDP growth with little or no increase in carbon energy. From a micro point of view this is feasible, but hardly from a macro point of view, including the total aggregates for the globe. India for example cannot do without coal or even charcoal (Ramesch, 2015). Consider some of these stylised projections in Appendix 1.

If these predictions, and there are several like these, become true, the COP21 will fail miserably, because this predicted fenergy uture entails more of carbonisation.

People who argue for more and more energy put their hope for decarbonisation with the uncoupling of GDP and HG:s or CO2:s. However, the present evidence does not at all support this claim – see Figure 2. It shows that total GHC:s follow GDP. As the more affluent the country, the more CO2:s or GHG:s.

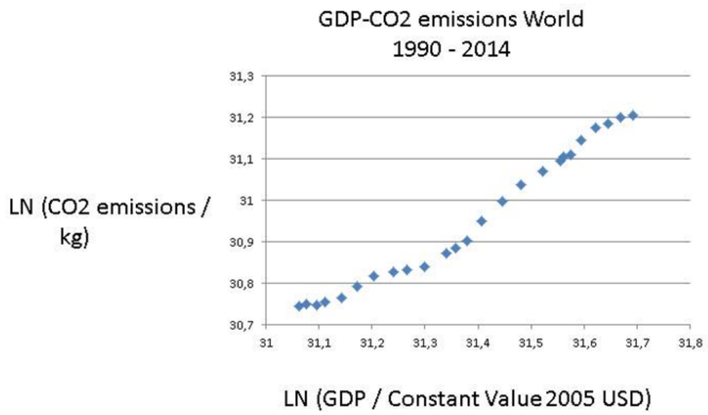


Figure 2. *Second global link: Affluence and emissions: Global GDP-CO2 link:* $y = 0{,}80x + 5{,}96$; $R^2 = 0{,}97$ *(N = 59)*

4. COP21 is not SDG:s

Star economist J. Sachs states about SDG (sustainable development goals) that it should be tightly coupled with fighting climate change:

> "… the SDGs need the identification of new critical pathways to sustainability. Moving to a low-carbon energy system, for example, will need an intricate global interplay of research and development, public investments in infrastructure (such as high-voltage direct current transmission grids for long-distance power transmission), private investments in renewable power

> generation, and new strategies for regulation and urban design. The task is phenomenally complex."

But Sachs does not inform us how something so "phenomenally complex" is to come about,, Of course, but what is the likelihood that a carbon tax can be put in place (where, how much) as well as how large is the probability that planning works? Only wishful thinking! Sachs realizes the gap between desirability and feasibility, but he confronts the gap by almost religious make beliefs, saying:

> "The SDGs will therefore need the unprecedented mobilisation of global knowledge operating across many sectors and regions. Governments, international institutions, private business, academia, and civil society will need to work together to identify the critical pathways to success, in ways that combine technical expertise and democratic representation. Global problem-solving Networks for sustainable development -in energy, food, urbanisation, climate resilience, and other sectors- will therefore become crucial new institutions in the years ahead."(10)

What is at stake for most people who understand the risks with climate change is not the desirability of sustainability, whatever it could mean, but simply: How to promote decarbonisation so that real life outcomes come about?

One may come up with a wish list for how to save the Planet, but how likely is it that governments can or will embark upon them? The problem is the enormous size of energy transformation, the immense costs involved and the gaming strategies of the players involved. Proposals for a turn to huge solar and wind plants, for massive carbon sequestration, for huge carbon sucking schemes, for total elimination of coal, for the electrification of billion cars, for giving up cow meat, etc., are launched from time to time. But however important such innovations are, they cannot realistically solve the energy-emission conundrum in the short time frame of COP21. How is all the *new* demands for electricity to be supplied? Who pays for huge wind and solar plants, requiring lots of land? And what to do when the sun does not shine or the wind is calm? If all the cars drive on electricity, where does it come from?

Decarbonisation is decentralized policy-making and implementation. Let us examine the situation of a few key countries. Can they manage to fulfil the COP21 objectives? Is it probable, given their energy mix and energy-emission trend?

5. Country Incentives

5.1. India: Coal – stone or wood –cannot be replaced

India is one of greatest polluters on the planet, and they are heading for the number 1 position, if the projection about population growth and economic development come true. The overall environment in South Asia is fragile by massive littering as well as recurrent droughts.

Energy consumption in India is planned to augment over the coming decade, as the ambition is to provide electricity to the whole population. Some 300 million people are today without electric power, and the population of India is growing fast. Mass povertyis the only outcome of this imbalance between total energy and total population, where India is heading for becoming the largest country in the world soon, population wise. Public intellectual and former minister Ramesh (11) states that India has no alternative but to build more coal fired energy plants. Thus, we may expect that Figure 3 will show more of an upward trend in the decade to come, violating already Goal I.

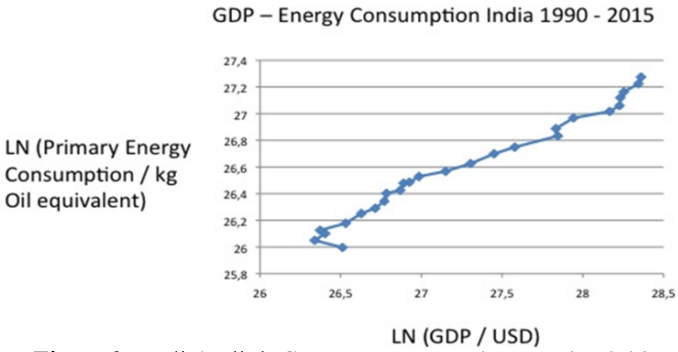


Figure 3. *India's link GDP-energy: y = 0,55x ;R² = 0,98*

Besides burning lots of fossil fuels, Indian housholds rely much upon wood coal in its various forms, such as charcoal, peat and dung. Wood coal is detrimental to people and the environment. As wood coal releases CO2:s, the use of biomass is typically defended by the argument that it also stores CO2, meaning that the use of biomass would be basically carbon neutral. However, this argument completely bypasses that wood coal in poor nations is conducive to deforestation and desertification, which is what happens on a large scale in India.

Figure 6 shows the constant increase in emissions. India will certainly appeal to the fairness problematic, namely per capita against aggregate emissions. India actually has one of the smallest numbers for energy per capita, although it produces much energy totally. The country is more negative than China to cut GHG emissions, as it is in an earlier stage of industrialization and urbanization, the "take-off" stage (12). Figure 4 shows the close connection between carbon emissions and GDP for this giant nation.

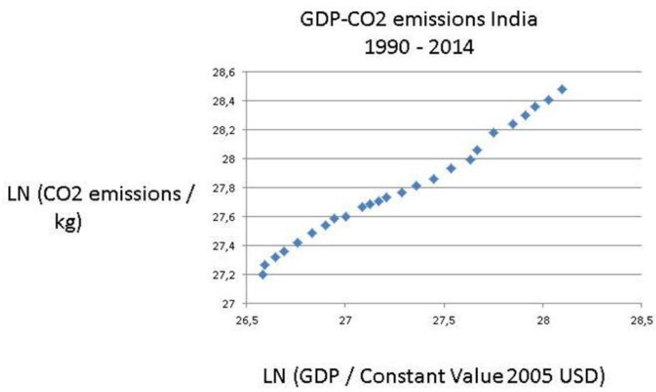


Figure 4. *India: Link between GDP and CO2:s: y = 0,77x + 6,79; R² = 0,99*

India needs cheap energy for its industries, transportation and heating as well as electrification. From where will it come? India has water power and nuclear energy, but relies most upon coal, oil and gas as power source. It has strong ambitions for the future expansion of energy, but how is it to be generated, the world asks. In its energy mix traditional renewables – wood, charcoal and dung - play a bigger role than in for instance China. Figure 5 shows its present energy mix.

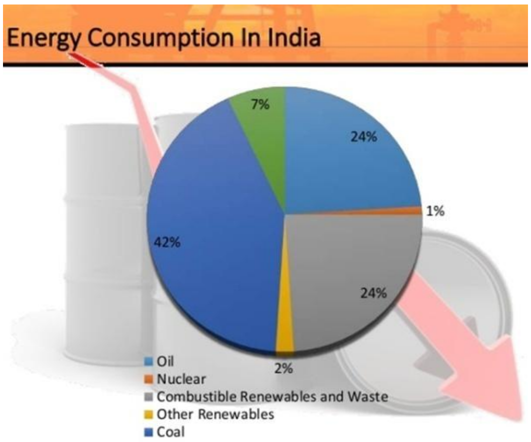


Figure 5. *Energy mix in India 2014*

India is heavily dependent upon stone and wood coal as well as oil and natural gas. To change this pattern towards modern renewables will take a long time and require massive financial assistance from the Super Fund. Since India is a federal state, the management tasks will be complex and involve conflicts between the powerful states. India cannot comply with the COP21 objectives. Energy transformation is slow and requires capital as well as policy-making. India's need for energy is overwhelming.

Global warming constitutes a major Negative for India, as water shortages limit hydro power and the melting of glaciers make water access unpredictable. In addition, the plains of India become too hot to do farming upon.

5.2. China: Decarbonisation + carbonisation = little change in GHG:s

It holds true that China is taking several steps in the direction of decarbonisation, especially reducing the consumption of coal. Thus, atomic power stations are built and massive investments in solar and wind power occur. Yet, at the same time, China is pushing ahead with its socio-economic development towards modernisation and post-modernity, employing market incenyives (13). New and bigger cars are sold, new autostradas are built, new airports are put up and urban developments are spawling with skyscrapers – all taking lots of cement. What does it add up to? Reply: need of energy.

In a uniquely rapid economic development over a few decades, China has moved from the Third World to the First World with stunningly new giant cities cropping up and modern infrastructure being introduced to its old cities. With economic growth rates hovering around 10 per cent, China is no longer a poor nation. The trick has been to employ market incentives, resorting to a massive mobilisation of energy, partly imported from Australia among others. Figure 6 has the colossal step forward towards a mature economy.

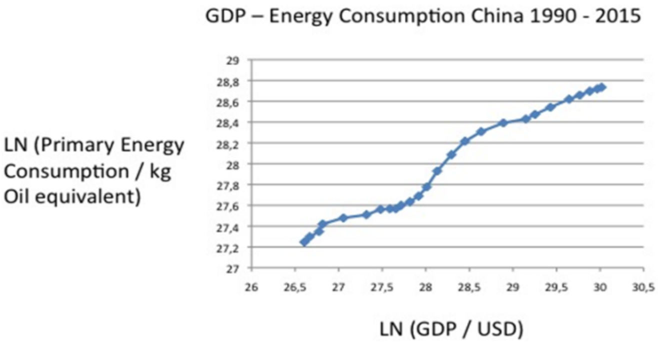


Figure 6. *Energy and GDP in China: $y = 0{,}46x$; $R^2 = 0{,}97$*

China has multiplied its energy usage several times over, drawing upon internal and external resources, mainly fossil fuels. It used to rely upon internal oil and natural gas, but now it is a major global importer. Its exports are gigantic to the US and the EU, and it is tying other Third World countries into patterns of cooperation, or some would say dominance economically, like African nations and Pakistan. However, the price is not only overall environmental deterioration but also the world's largest CO2 emissions (Figure 7).

A few nations do not depend upon any foreign assistance, because they are highly developed technologically and can draw upon own substantial financial resources. One may find that the emissions of GHG:s follows economic development closely in many countries. The basic explanation is population growth and GDP growth – more people and higher life style demands. Take the case of China, whose CO2 emissions are the largest in the world, totally speaking. China was a Third World country up until yesterday.

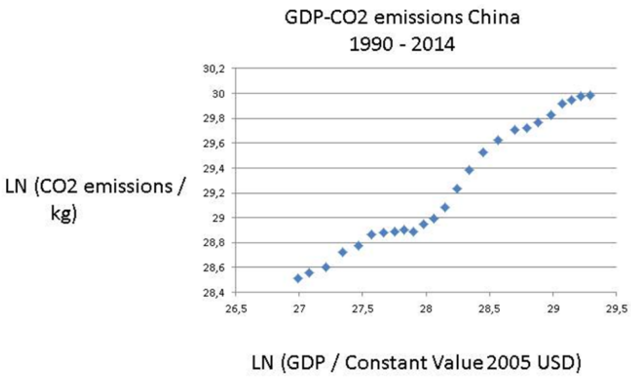


Figure 7. *China: GDP-CO2 link: y = 0,70x; R² = 0,97*

The sharp increase in CO2:s in China reflects not only the immensely rapid industrialization and urbanization of the last 30 years, but also its problematic energy mix with around 90 per cent of energy consumption coming from fossil fuels.The energy consumption mix in China is different from that of India, as wood coal is not used much. Figure 8 has the energy mix.

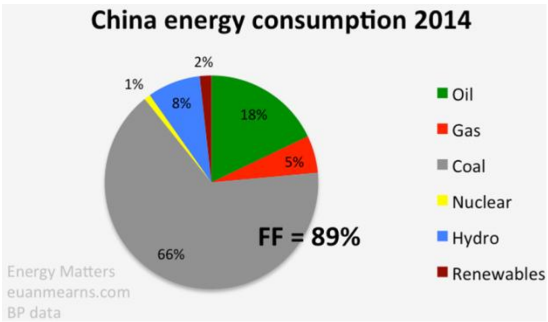


Figure 8. *China's energy mix*

It may be underlines that these data in Figure 8 underestimate the share of atomic and renewable power, but it provides an indication of how much China must change to comply with the COP21 goals. Water power is fully utilised, meaning that atomic, solar and wind power must be the future energy sources. In any case, China is not on route to achieve the COP21 goals.

5.3. Indonesia: Taking off stage trumps environmentalism

Indonesia has rapidly moved up as a major consumer of energy in the early 21rst decade., refelcting growimh political stability and a strong effort to catch-up with the other Asian miracles. It has definitely passed its "take-off" stage (Rustow, 1960), but interestingly itsenormous consumption of energy has not been accompanied by high economic growth in most recent years (Figure 9).

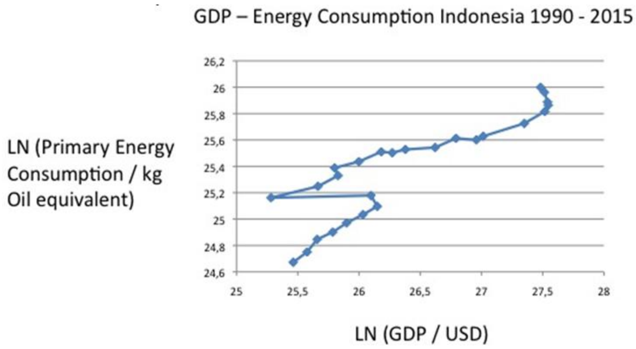


Figure 9. *Indonesia: y = 0,46x ;R² = 0,79*

The inward and upward sloping curve for Indonesia must be of concern to the elite in the country, because Indonesia has become a major contributor to CO2 emissions. If economic growth stalls due to inflation, then how to defend the enormous emissions?

The bad CO2 emissions stem partly from the cutting and burning of rain forests and adjacent land on Kalimantan and Sumatra, which the government is to weak to control. The illegal fires affect other neighbouring countries but little is done to stop them. The search for more land for agriculture, especially soya planations, drives the externality. Emissions even outpace energy consumption. These rain forests are bound to disappear, as the Indonesian state does not have the capacity or even willingness to police these huge areas.

One may guess correctly that countries that try hard to "*catch-up*" will have increasing emissions. This was true of India. Let us look at three more examples, like e.g. giant Indonesia – now the fourth largest emitter of GHG:s in the world (Figure 10).

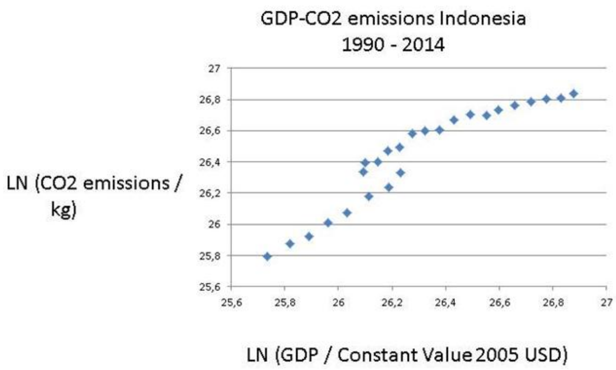


Figure 10. *Indonesia: GDP-CO2 link: y = 0,95x + 1,58; R² = 0,89*

Indonesia is a coming giant, both economically and sadly in terms of pollution. Figure 10 reminds of the upward trend for China and India. However, matters are even worse for Indonesia, as the burning of the rain forest on Kalimantan and Sumatra augments the GHG emissions very much. Only 4 per cent comes from hydro power with 70 per cent from fossil fuels and the remaining 27 per cent from biomass, which alas also pollutes (Figure 11).

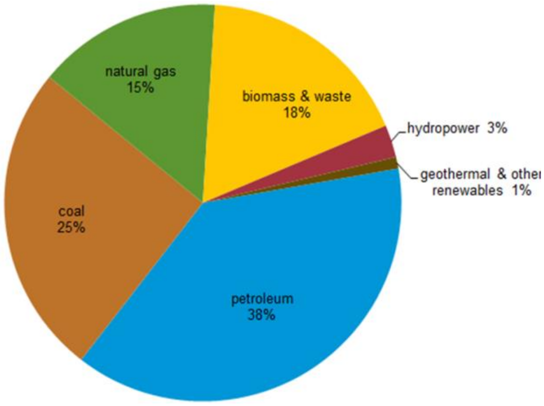


Figure 11. *Indonesia's energy mix*

The reliance on fossil fuels and wood coal is too heavy in Indonesia in order to fulfil the COP21 objective

5.4. South Korea: "Catch-up" strategy is endless

A major industrial country in East Asia is South Korea with an advanced economy and large population. It deviates from the pattern of mature economies to display a slowing down in the CO2:s (Figure 12).

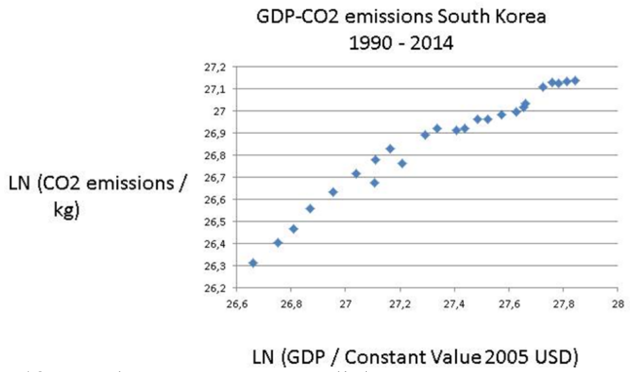


Figure 12. *South Korea: GDP-CO2 link: $y = 0{,}65x + 9{,}19$; $R^2 = 0{,}96$*

Lacking much hydro power, South Korea has turned to fossil fuels for energy purposes, almost up to 90 per cent. Now, it builds nuclear plants, but South Korea needs to move aggressively into solar power to reverse trends. It differs from China only in the reliance upon nuclear power, where the country is a world leader in plant constructions. Reducing its GHG emissions, South Korea will have to rely much more upon modern renewable energy sources, as well as reducing coal and oil for imported gas or LNGs. Its appetite for energy is not slowing down (Figure 13)

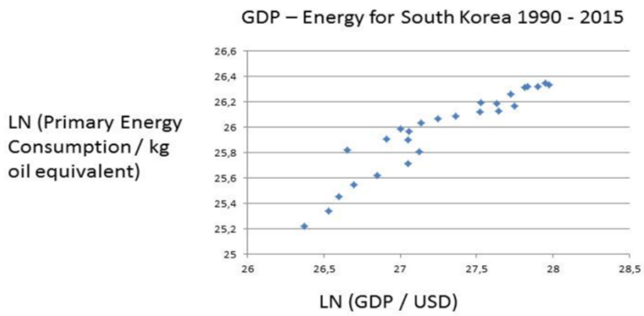


Figure 13. *GDP-energy for South Korea: $y = 0{,}622x$; $R^2 = 0{,}88$*

South Korea is of course a mature economy, but it still pursues an aggressive catch-up strategy with strong claims in electronics and nuclear power technology besides shipping and car industry (Figure 14).

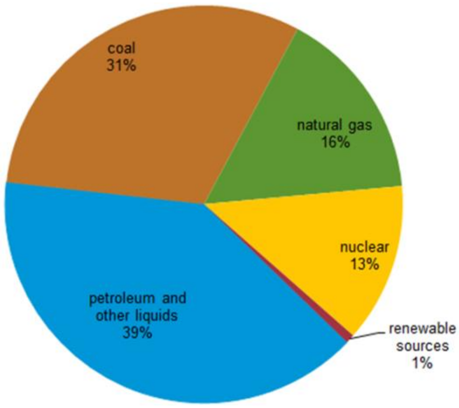


Figure 14. *South Korea total primary energy consumption by fuel type, 2014.*

South Korea is hardly on track for implementing decarbonisation, despite its impressive atomic program. Perhaps the availability of sun shine is not sufficient in South Korea for a major investment in solar plants. South Korea is ultimately driven by the catch-up strategy (Barro, 1991, 1993, 1995).

5.5. Brazil: Too much hydro power destroys th Amazons

Brazil has for a long time been in the forefront of environmental concerns. On the one hand, it has paved the way for an alternative to the oil dominance in transportation by developing a domestic biomass industry on large scale. The ethanol is derived from immense sugar plantations and it has reduced oil dependency, especially when international petrol prices have skyrocketed. On the other, there is the constant worry that Brazilian governments are ineffective in protecting the lungs of the Planet Earth, the giant rain forest in the Amazons.

First, we may establish that Brazil produces much CO2:s, and this as a function its economic development (Figure 15).

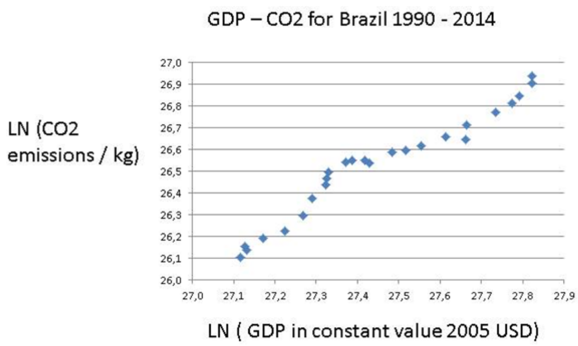


Figure 15. *GDP-CO2 in Brazil: $y = 1{,}02x$; $R^2 = 0{,}95$*

The trend in Brazil for CO2:s is like in Argentina up and up. When the burning of the rain forest is added, then Brazil is one of the largest CO2 emitter in the world. The country may reply that its energy mix and its huge forests decrease CO2:s by consuming carbon (Figure 16).

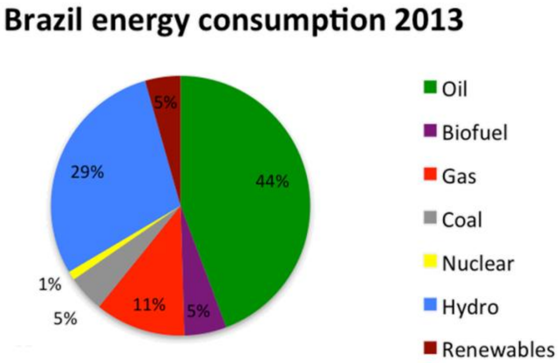


Figure 16. *Energy mix of Brazil*

Hydroelectric power is massive in Brazil and capacity has grown steadily since 1965. However, hydro production has been down owing to late and light rains. Brazil is one of the few countries in the world where liquid bio-fuel production is significant: ethanol. Gas production in Brazil is significant, but Brazil has very little of coal production. In 2006, the discovery of vast oil resources in the sub-salt strata of the Santos Basin promised petroleum bonanza, but deep water and sub-salt setting has posed technical challenges and high costs. Brazil has 3 nuclear reactors, but nuclear provides 1% of primary energy.

One can hardly say that it will easy for Brazil to live up to its COP21 commitments, despite its comparatively low dependence upon fossil fuels. Its large hydro power supply is vulnerable to droughts, as rivers dry up. And then one must add the political difficulties in managing the oil and gas reserves properly in giant enterprise Petrobas. The huge Mato Grosso could be used for renewable energy generation, wind and solar power.

Brazil's plan of building some 30 dams in the Amazons is completely at odds with global ambitions behind the UNFCCC, UNEP and the COP21 project. It would give the country massive amounts of energy for a short time span, some of which could be exported with profit. In the long run, the policy is self-defeating, as it would increase CO_2 emissions and could stumble on water shortages. Dams require lots of cement that give CO_2:s. And the land over spilling water kills the rain forest just like logging and agriculture.

One may speculate about the policy reason for Brazil's plan to go for much more hydro power. The country already exports electricity. Figure 16 shows the close link between economic development and energy in Brazil.

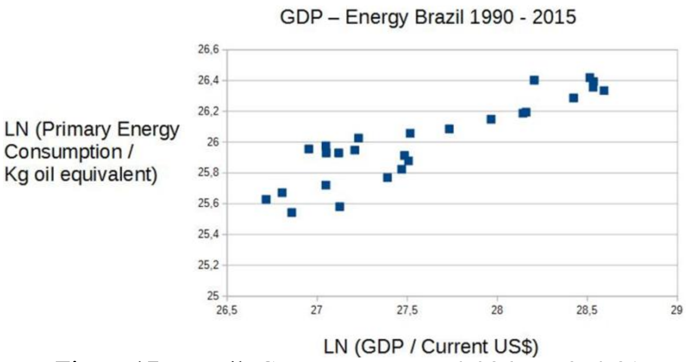


Figure 17. *Brazil: GDP+energy: y = 0.386 x; R2=0.81*

The majority of the political elite may believe that transforming the Amazons will secure future high GDP growth, but it is an erroneous belief, neglecting the environmental effects that may be very costly. If water levels go down in the many rivers in the Amazons delta, then the cement barrages are worthless.

5.6. Japan: No alternatives to fossil fuels

Japan has a huge energy consumption, but it hovers from year to year, reflecting not only the stagnation of the economy but also the occurrence of natural disasters. Japan has been forced to increase fossil fuel imports to compensate for the close down of several nuclear plants (Figure 18).

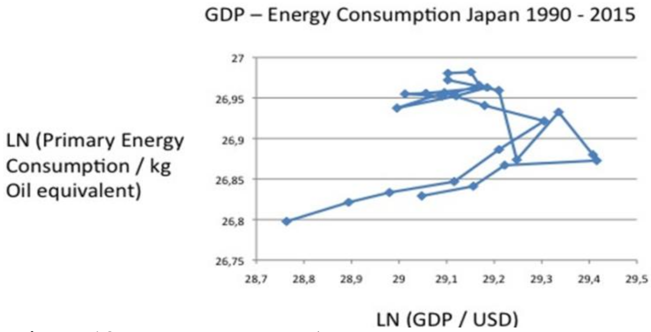


Figure 18. *Japan energy and GDP: y = 0,092x ; R² = 0,056*

It is hardly a daring guess that the nuclear plant disaster in Japan together with the decision to close most such power plants has further increased emissions, as the country now relies upon fossil fuels much more. Governments make plans, but they may not hold for unforeseen developments. Japan is today more dependent upon fossil fuels than earlier due to the debacle with its nuclear energy program. Is really solar, wind or atomic power realistic in Japan on the scale needed for massive decarbonisation? When forced, governments renege, i.e. they will turn back to the fossil fuels, as for them economic growth trumps the environment. After all, nations are brutally egoistic, at least according to standard teachings in international relations.

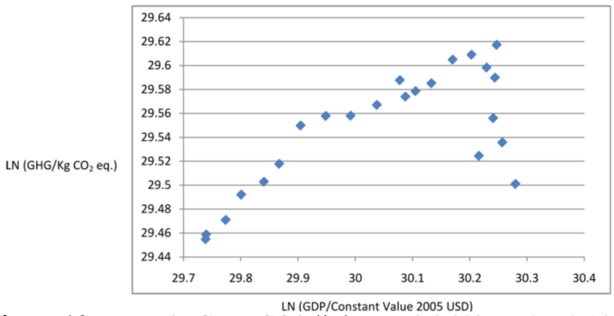


Figure 19. *Japan's GDP-CO2 link: y = 0.2648x; R² = 0.194.*

With an extremely high standard of living, based on the consumption of very much electricity, Japan will have to increase its energy use. And it cannot rely upon domestic sources or renewables. Figure 20 rightly projects increased use of fossil fuels in Japan, which goes against the COP21 goals.

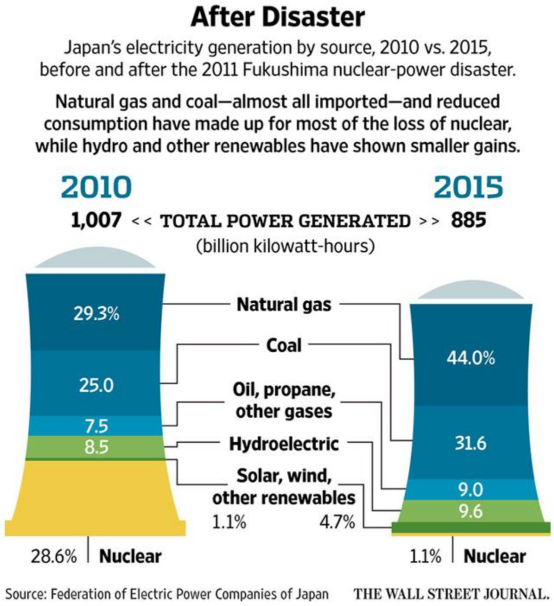


Figure 20. *Energy min in Japan*

5.7. Mexico: Burning oil is cheap and effective

One would expect to find huge CO2 emissions in this large emerging economy with lots of oil production. Countries like the Gulf States have massive CO2:s because they drill and refine oil and natural gas. For Mexico holds the following situation (Figure 21).

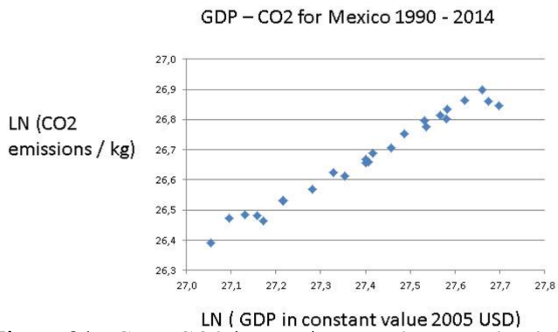


Figure 21. *GDP-CO2 in Mexico: y = 0,77x; R^2 = 0,98*

The close link between economic development and CO2 is discernible in the data, but the emissions growth seems to stagnate in the last years. This is of course a promising sign, whether it is the start of a COP21 inspired 40% reduction in CO2:s remains to be seen. I doubt so, but let us enquire into the energy mix of this huge country that is of enormous economic importance to both North and South America (Figure 22).

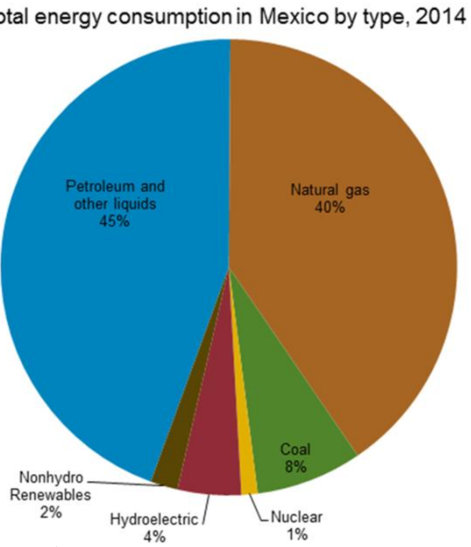


Figure 22. *Energy mix for Mexico*

Few countries are so deependent upon fossil fuels as Mexico. One find the same patter with some of the Gulf States. The Mexican government must start now to reduce this dependency, by for instance eliminating coal and bringing down petroleum, instead betting upon solar, wind and nuclear power. Mexico will face severe difficulties with the 40% reduction target in COP21. It has a fast growing population with many in poverty and an expanding industry sucking electricity. Can economic growth and decarbonisation go together here?

Mexico employs fossil fuels for rapid economic development. Actually, the country had its take-off stage decades ago (Rustow, 1960). But eonomic development has been volatile often. Now Mexico is an emerging economy with a clear catch-up strategy (Barro, 1991, 1993, 1995). But its link between GDP and energy, portrayed in Figure 23 is too dependent upon oil and gas. Why not solar energy?

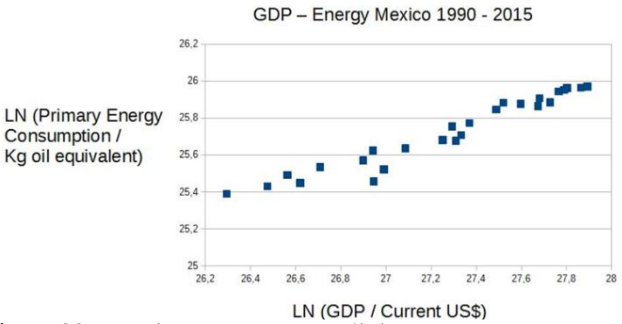


Figure 23. *Mexico's GDP-energy link: y = 0.399x; R2=0.945*

It is true that Mexico has started many solar power plants, more than e.g. Argentina, but will the country also close than plants for fossil fuels?

6. The Methane Threat

Methane could cause even more worry for Stern. It is a potent greenhouse gas that, pound for pound, traps more than 80 times as much heat in our atmosphere than carbon dioxide. Sudden increases in this greenhouse gas have been reported, with fear of methane emissions coming from the permafrost. In addition to methane, oil and gas operations release volatile organic compounds (VOCs) into the air which contribute to coughing, wheezing, asthmaattacks, and cancer. Because carbon dioxide persists so long in the atmosphere, the level of atmospheric CO2 will affect the Earth's climate for centuries, if not longer. By contrast, the level of atmospheric methane affects today's climate, but it does not last nearly as long. So methane is mainly important for controlling the peak temperature that global warming ultimately reaches. If we want to keep global warming close to 2 degrees Celsius, the globally agreed-upon climate goal, methane concentrations must go down. And because methane has so many sources, it is difficult to control.

The oil and gas industry leaks millions of tons of methane pollution and toxic chemicals into the air that harm peoples' health and speed up climate change. These industrial leaks are like an invisible oil spill happening every day. Oil and gas companies can use infrared cameras to track methane leaks and plug them - or capture excess methane. Oil and gas companies should plug leaks from oil and gas wells. In agriculture with cows, scientists are experimenting with ways to get cows to burp less. Researchers have fed cattle things like infused flaxseed, decreassing methane emissions. Crop scientists are developing new genetically engineered rice varieties not transfering as much methane from flooded paddies into the atmosphere. But if methans gets loose from the tundra, then global warming will be unstoppable.

7. Conclusion

The answer to Stern's question: "What are we waiting for?", is his idea of a Super Fund that will pay for the incredible energy transformation, implied in the decarbonisation objective of COP21. Who will pay? When faced with enormous costs and difficulties of implementing the 3 goals of decarbonisation in poor and emerging economies, the mature economies will renege. To be sure, we will see many promising energy projects, funded by the World Bank and other agencies, but the impact will be marginal. As long as the governments in the rich countries do not clarify how Stern's Super Fund would really operate, no poor and emerging countries have incentives to take on the immense costs of decarbonisation. Look at Turkey for instance.

Turkey has become a heavy-weight in the Asia Minor thanks to a rapid economic development of the country with huge population. Figure 24 supports this picture of Turkey as no longer a poor developing country. Comparing the picture for Turkey with that of "catch-up" nations, one may state that Turkey has the typical GDP-GHG link, despite lots of hydro power. Strong economic development is combined with heavy emissions increase. Since the world organisations - the UN, WB and IMF - opt for more of economic growth, one must ask whether emissions growth really can be halted.

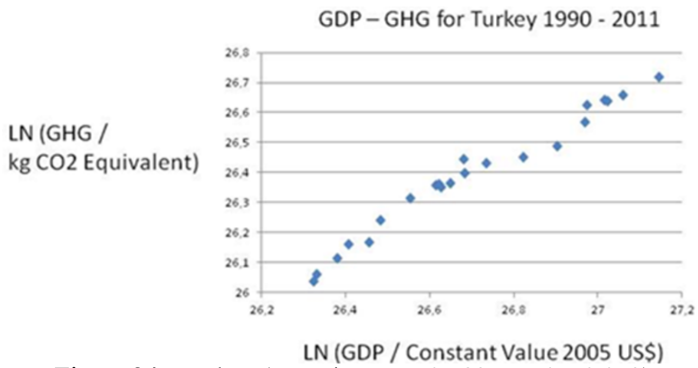


Figure 24. *Turkey (Equation: Y = 0,7837x; R² = 0,972)*

Thus, Turkey has become a heavy-weight in the Asia Minor thanks to a rapid economic development of the country with huge population. Figure 25 supports this picture of Turkey as no longer a developing country.

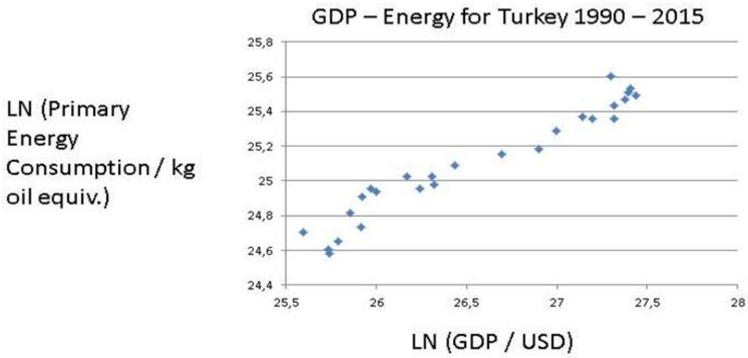


Figure 25. *Turkey: energy-GDP link*

Comparing the picture for Turkey with that of France and Germany, one may state that Turkey has the most typical curves. Strong economic development is combined with heavy emissions increase. Since the world organisations – the UN, WB and IMF – opt for more of economic growth, one must ask whether emissions growth really can be halted.

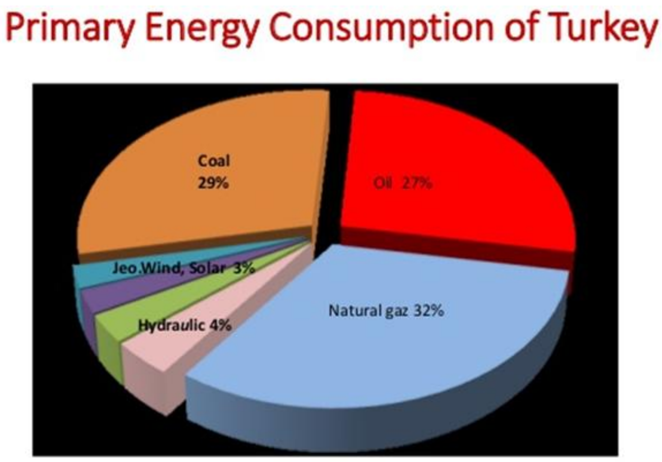


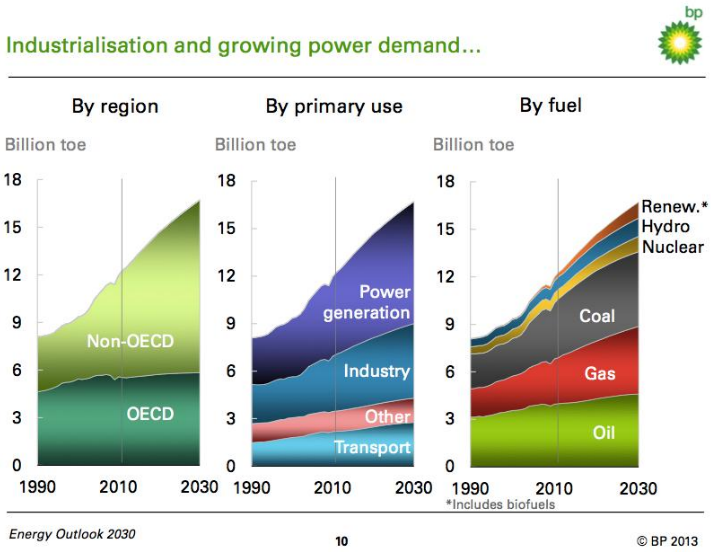
Figure 26. *Turkey'senergy mix*

Turkey, aiming at a major political and economic role in relation to both the EU and the huge Turkistan, is in a process of rapid economic expansion with huge energy needs. As it relies to almost 90 per cent on fossil fuels, it will have to start a major energy transformation in order to comply with the COP21 goals. It will be difficult, especially now when Turkey is not politicallystable. Its renewables are too small simply.

The above countries are responsible for a huge part of the CO2 emissions. As they pursue their ”catch-up” strategy in relation to the advanced capitalist countries, they are not very eagre to take on the burden for global decarbonisation, especially if it hurts economic development. They would demand compensation from the promised Super Fund.

Appendix

App. 1. Energy predictions



App. 2.

The best model of carbon emissions to this day is the so-called Kaya model. It reads as follows in its standard equation version – *Kaya's identity*:

(E1) 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 is 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),

in a stochastic form with a residual variance, all to be estimated on most recently available data from some 59 countries. I make two empirical estimations of this probabilistic Kaya model, one longitudinal for 1990-2014 as well as one cross-sectional for 2014. I make an empirical estimation of this probabilistic Kaya model - the longitudinal test for 1990-2014, World data 1990 - 2015:

(E4) Ln CO2 = 0,62*LN Population + 1,28*LN(GDP/Capita) + 0,96*LN(Energy/GDP); $R2 = .90$.

In a stochastic form with a residual variance, all to be estimated on data from some 59 countries, I make an empirical estimation of this probabilistic Kaya model - the cross-sectional test for 2014:

(E5) k1= 0,68, k2=0,85, k3=0,95, k4=0,25; $R2 = .80$.

Note: LN CO2 = k1*LN (GDP/Capita) +k2*(dummy for Energy Intensity) + k3*(LN Population) + k4*(dummy for Fossil Fuels/all) Dummy for fossils 1 if more than 80 % fossil fuels; k4 not significantly proven to be non-zero, all others are. (N = 59).

These two tests of the Kaya model shows that the key factors in anthropogenic climate change are the size of the economy, energy consumption and the carbon content of energy.

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