

## RESEARCH ARTICLE

### CLIMATE CHANGE: BIGGEST PD GAME EVER, DRIVEN BY ENERGY (N = 193)

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#### ABSTRACT

This Time is very tight for halting climate change. The COP21 project is not enough, according to the new theory of abrupt climate change. Major meltdowns of ice in Greenland and Antarctica would threaten large coastal cities around the globe, like for instance New York, London and Singapore as well as Shanghai. The discovery of several so-called tipping points substantiate the Hawking warming about irreversibility.

#### INTRODUCTION

The well-known *Prisoners' Dilemma* game or *PD game* for short offers a standard model of the problematic of promises: respect them or renege upon them. As social interaction is often based upon cooperation, the PD games lies at the heart of social life: cooperation against defection (Dutta, 1999). The Paris Treaty from 2015 – COP21 Agreement – is an example of PD gaming. Will the promises about decarbonisation from 2020 to 2075 be held or not? Given that states are sovereign under public international law (PIL), the signing governments cannot be forced by an outside to respect the promises made. It is all voluntary agreement, which may be reneged upon by governments, if the costs of decarbonisation appear too heavy for them each individually or simply advantageous for each one to continue with fossil fuels. The COP Treaty also falls under the model of a common pool regime (CPR). CPRs are based upon agreements and promises among a group of actors or players concerning the regulation of the use of a common resource, typically in scarce supply. According to the famous Elinor Ostrom analysis (1990), CPR are voluntary and rely upon self-policing. She focussed upon domestic CPRs mainly, and downplayed too much the indirect role of the state. But we find CPRs in international relations, where there is no third party Umpire who can play the role of Hobbes' illuminating judge with the sword:

Now, will the COP21 work as the CPR that saves mankind? Or will governments abstain from opportunistic behaviour, reneging upon their promises? Probably NOT.

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Why? Because the value of the game is tremendously important, namely energy.

#### THE ANTHROPOSCENE PERIOD: Likely End of Mankind?

Scholars now say we face a new period in the history of human beings on Earth, the anthropocene replacing the holocene period. It would be characterised by mankind's domination over Nature, resulting in a quite new climate and ecological degradation. Yet, one could retort that it is now Nature that shrinks the degrees of freedom of men and women, making them victims of Nature's unpredictability and violence. In this perspective, the holocene period antedating the anthropocene beginning around 1700, lasted for thousands of years. How long will the anthropocene period last? The COP21 Accords were based on a belief that time was available for a slow decarbonisation, managing global warming at around + 2 degrees Celsius, stabilising climate sometime 2076 - the carbon budget approach. These beliefs are now partially outdated.

#### Abrupt Climate Change Theory

Recently launched, climate and earth scientists now focus upon so-called tipping points as well as the great variability in temperature increases over the entire globe. The dramatic changes in the Arctic have made researchers focus upon the melting of the ice at the poles and Greenland and its repercussions for global weather and the huge methane holdings in the permafrost from Alaska to Siberia, both on land and in ocean.

- a) **Tipping point 1:** Arctic Sea ice; Expected to disappear around 2020, it will not increase sea levels dramatically due to the equivalence between ice and water. But this will affect global oceans streams as well as global weather yet streams.
- b) **Tipping point 2:** Greenland ice; Uncertainty when it will be gone – some say 1940, this will raise sea levels some 6 meters. Major city areas will inundated: Miami, Rio de Janeiro, Venice, Kairo-Alexandria, Mumbai, Hanoi, Shanghai, Tokyo and Singapore, for instance. It would further deteriorate oceans conveyor belt and the slow the global yet stream.
- c) **Tipping point 3:** Antarctica ice mass; this enormous mass of ice and glaciers would be finished by some 100-500 years, rising sea levels some 60-70 meters. Mankind stand to loose a lot of land all over the planet Earth – a true catastrophe.
- d) **Tipping point 4:** constant heat increase with draught and potable water scarcity. This would reuce food availability and lead to millions of climate refugees from vulnerable low level coastline countries and poor nations along the equator.
- e) **Tipping point 5:** Methane emissions from the melting permafrost. This threat is so huge that mankind would never survive such a major release of a very potent GHG.

The idea of so-called tipping points is that it make concrete the Hawking notion of irreversibility.

### Irreversibility: Its entailment

When S. Hawking suggested that climate change was irreversible, he was met with sharp criticism. The notion of an irreversible process of change comes from the theory of scientific laws of nature with their universality and empirical necessity. If global warmin is unstoppable or inevitable, then the survival of the human race is at stake. The only way to reduce the speed of climate change, avoiding inevitability, is to stop pumping GHGs into the atmosphere. This requires inter alia:

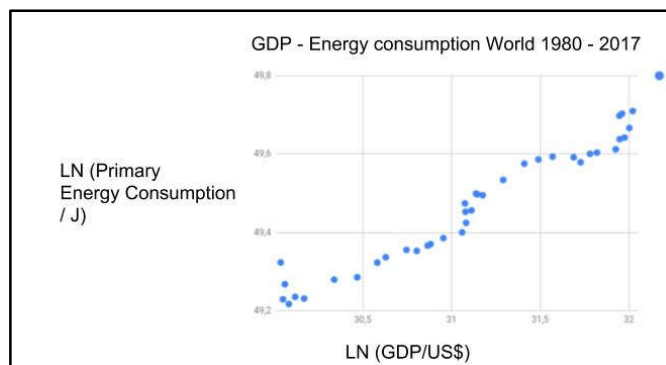
- Immediate stop to coal and charcoal in poor countries;
- Replacing fossil fuel enegy with solar panel parks of the Moroccan Quarzazate kind;
- Initiate now large scale geo-engineering experiments to suck up CO<sub>2</sub>s or sequesterate CO<sub>2</sub>s.

Will these measures be taken by the UNFCCC or the G20 group of nations? Probably not. Why? Because of the ocean PD game involved. What matters to all countries and governments is access to energy, the culprit of the anthropocene period. Hawking irreversibility is *practically* sure, as massive decarbonisation is highly improbable.

### Energy

The public and private sectors demand lots of energy to produce their goods and services. Energy, or the capacity to do work potentially or actually, is key in economic growth for enterprises and financula institutions in rich countries. And energy is absolutely essential in socio-econmic development in poor nations. But energy supply drives the emissions of GHGs, as energy consumption results in GHG emissions as long as fossil fuels dominate supply. Figure 1 shows most recent data

about the iron link between GDP, or economic output, and energy consumption, globally.

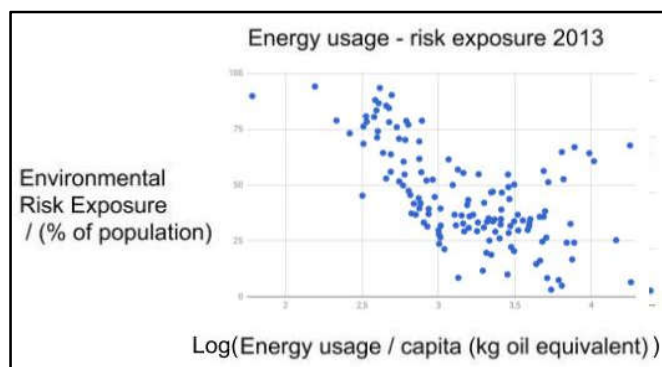


Note: R<sup>2</sup> = 0.951

Sources: BP Statistical Review of World Energy World Bank Data Indicators

**Figure 1. Gdp and energy**

The central position of economic growth in rich countries and of socio-economic development in poor countries is much in consonance with basic human drives as well as with the logic of vibrant capitalism in the global market economy. Governments and politicians cherish economic growth, because it makes more policy-making possible. Look at the evidence about the positive effects of energy in the figures below, linking energy consumption with human development indicators. The living conditions in the poor countries in Latin America, Africa and Asia as well as the Pacific reflects the low level of energy employed. This basic fact determines life opportunities in a most dramatic fashion. The low access to energy has consequences for the environment and the life situation of people, including health, schooling, work, food and potable water. For instance, African countries are poor because they have too little energy. Thus, they have much less GHGs than Asia. Yet, they need the COP project of the UNFCCC to renew their energy sources and move from fossil fuels and traditional renewables to solar power. Hydro power depends upon water availability that shrinks with global warming. African energy deficit is conducive to a dire environment with enormous damages and risks. Consider the following global figures. Figure 2 shows how low energy leads to an unsafe environmental.

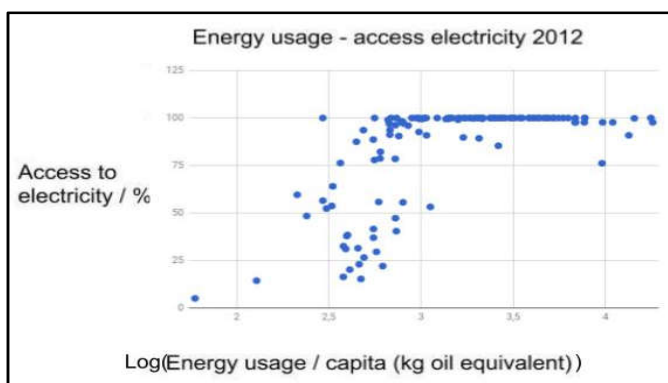


Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/inde>)

**Figure 2. Energy and environmental risk exposure**

Low energy use leads to poverty, malnutrition, deceases, lack of potable water, insufficient sanitation, etc. Typical of many Latin American, African and Asian nations is the lack of stable

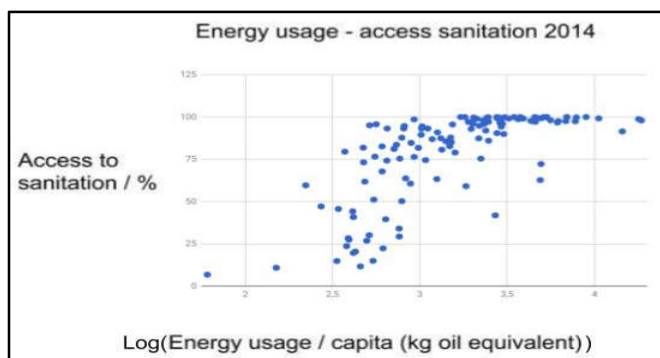
electricity, which hampers everything and reduces environmental viability. Figure 3 has the global picture.



Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/inde>)

**Figure 3. Energy and electricity access**

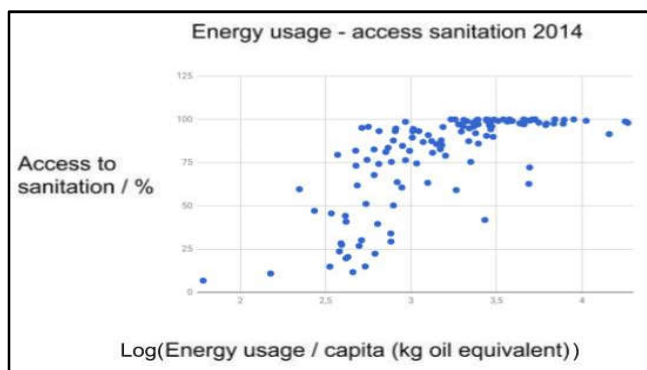
The access to safe and stable electricity is crucial for health, schools, food, water, etc. Figure 4 links energy with proper sanitation.



Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/index>)

**Figure 4. Sanitation and energy**

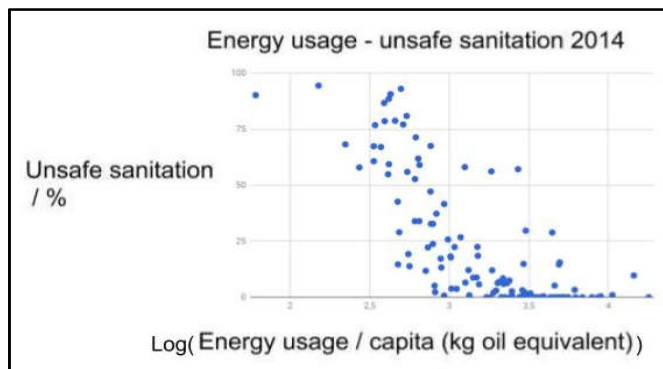
Especially, the rapidly growing African, Latin American and Asian mega-cities lack entirely proper sewage plants. Thus, dirty water is put into the big rivers where other cities downstream take their potable water. The access to safe and stable electricity is crucial for health, schools, food, water, etc. Figure 4 links energy with proper sanitation.



Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/inde>)

**Figure 4. Sanitation and energy**

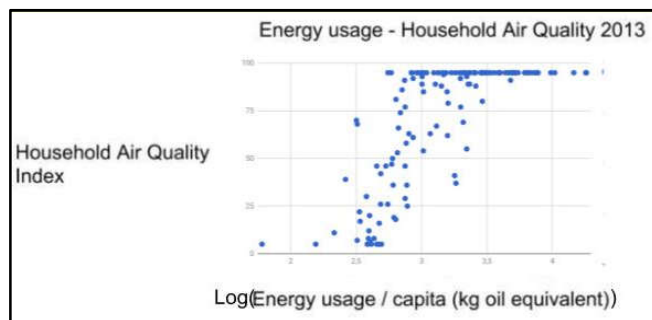
Figure 5 underscores the necessity of more energy in poor countries for proper sanitation, without which the life of humans is "salle".



Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/inde>)

**Figure 5. Energy and unsafe sanitation**

Air quality too depends upon energy access (Figure 6).



Source: Environmental Performance Index, Yale University, <https://epi.envirocenter.yale>. IEA Statistics © OECD/IEA 2014 (<http://www.iea.org/stats/inde>)

**Figure 6. Energy and air quality**

Typical of many poor nations – Latin America, Africa, Asia - is the lack of predictable access to safe electricity, which hampers work and reduces environmental viability. The access to safe electricity is, it must be emphasized, absolutely central for health, schools, food, potable water, etc. Given the lack of enough energy in poor countries, being conducive to the above bad living conditions, one understands the hopes of the poor countries for help with energy transformation, leading to better access to just energy!. Given the above evidence about the positive consequences of energy for quality of life and life opportunities, one understand the position of the Third World at the Paris meeting that decarbonisation must be combined with great economic assistance to make fundamental energy transformation. The result was the promise of a giant Super Fund, but it is only a promise.

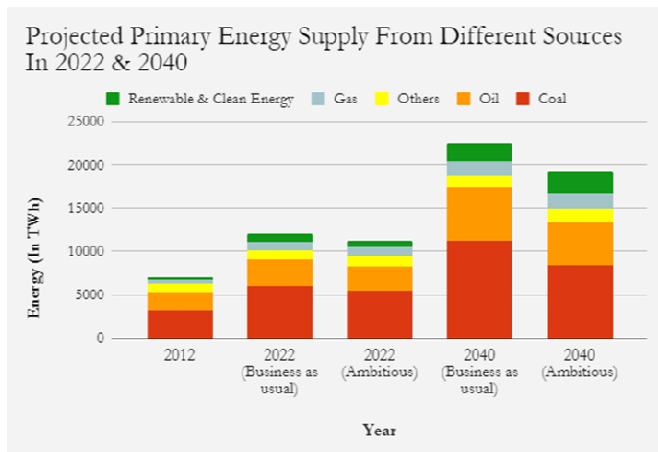
**Energy Projection for three Giants**

The decarbonisation goal of COP21 requires the support of the big countries in the world. But do they really aim at decarbonisation? We look at three examples here.

**India**

In Indian energy policies, it is emphasized that developmental goals take precedence over climate change considerations.

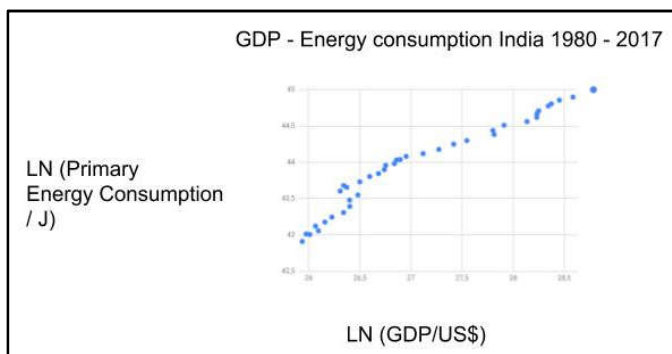
Thus, all Indian household must have access to electricity and only sustained rapid economic growth can reduce poverty. India has a “take-off” economy that delivers affluence for the first time since independence. But it is based on fossil fuels. India looks into other sources of energy, as long as socio-economic development is not hindered. Figure 7 shows the main features of India’s future planning.



Source: <https://scroll.in/article/843981/indias-new-energy-policy-draft-projects-coal-fired-capacity-will-double-by-2040-is-that-feasible>

Figure 7. India’s energy future

India has rapidly become a major CO2 emitter due to its high growth rates since 1990. It uses lots of coal, stone or wood. Charcoal is bad for households and results in forest destruction. India tries to broaden its energy supply to modern renewables, like solar, wind and hydro power. Yet, it will remain stuck with fossil fuels for decades. It needs assistance from the COP21 project, especially for solar power parks. Building more dams is very risky, as global warming reduces water assets. Figure 7 indicates the India cannot meet its COP21 promises, as Ramesh (2015) underlines. India shows the same close link between GDP and energy consumption (Figure 8).



Note: R2=0.94  
Sources: BP Statistical Review of World Energy World Bank Data Indicators

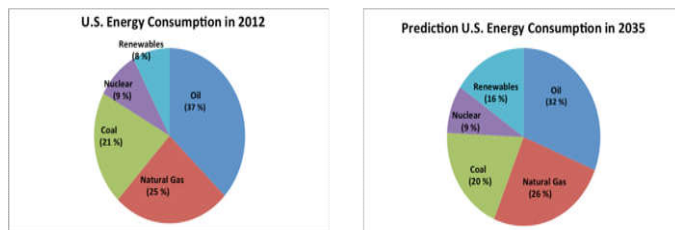
Figure 8. GDP and energy in India

Given this close connection between GDP and energy consumption in India, the risk is of course that further socio-economic developments will increase GHG emissions. India is hardly on the decarbonisation road.

**USA**

The US has reduced its CO2 emissions during the last years, mainly by a shift to natural gas. Actually, several mature

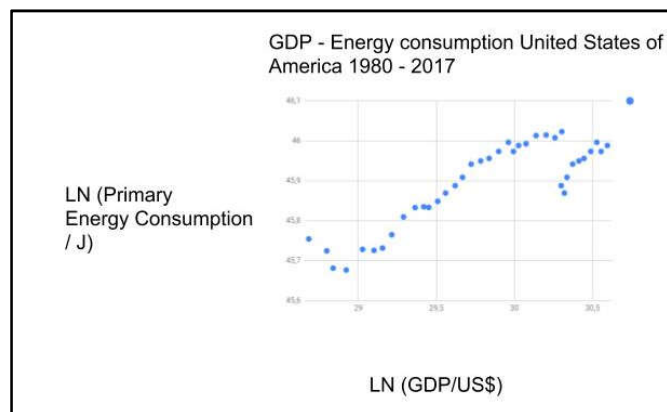
economies have been able to halt the rise of CO2 emissions, either by more energy efficiency or a shift to natural gas or renewables. Figure 9 captures some features in US energy plans.



Source: <https://www.e-education.psu.edu/egee102/node/1930>

Figure 9. US energy future

Although the Figure 9 predicts a doubling of renewable energy, the dependency upon fossil fuels, including coal energy, will not be much reduced. We are talking here about relative numbers, but if the US increases total amount of energy supply – fracking!, then there may even be more fossil fuels. The reduction in CO2s during recent years seems to be coming at a reduced rate. The hope is for economic growth without energy increases, but we are not there yet. And most countries demand more energy for the future.



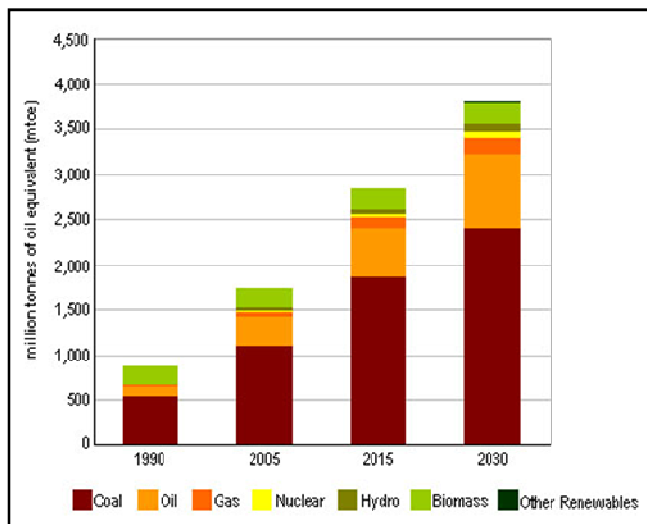
Note: R2 = 0.77  
Sources: BP Statistical Review of World Energy World Bank Data Indicators

Figure 10. GDP and energy for the USA

Although the link between GDP and energy consumption is less tight for the USA than India, reflecting that economic growth in advanced countries can be achieved without energy increase, it is still the case that the US is not on the road towards major decarbonisation.

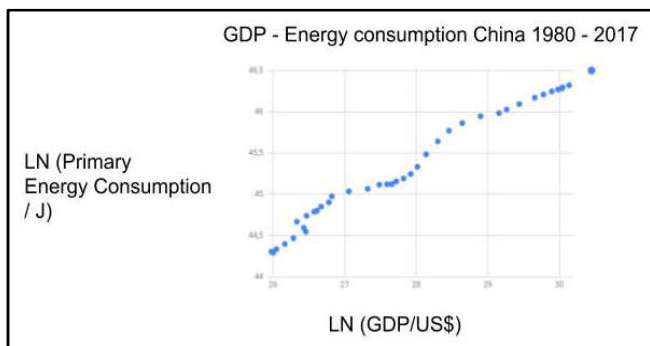
**China**

China now enters the First World, as it has long passed its “take-off” point in time around 1980 and has pursued a successful “catch-up” policy for a few decades. Its energy consumption, especially of fossil fuels, has skyrocketed with GDP, resulting in the largest CO2 emission globally. Figure 11 has a projection for China. Decarbonisation does not seem highly probable. Much hope was placed at a recent reduction in CO2s, but water shortages forced China to revert to coal in 2017 with attending augmentation of CO2s. China is investing in both renewables and atomic power, but it also plans for large energy increase in the coming decades with lots of energy consuming new projects.



[http://www.wrsc.org/attach\\_image/chinas-projected-energy-growth-fuel](http://www.wrsc.org/attach_image/chinas-projected-energy-growth-fuel)

Figure 11. Energy projection for China



Note: R2 = 0.98.

Sources: BP Statistical Review of World Energy World Bank Data Indicators

Figure 12. GDP and energy for China

Such a close connection between GDP and energy consumption in China implies that China must turn to renewables massively in order to comply with COP21 goals.

**Cooperation or defection in ocean games or ocean clubs**

The COP21 Treaty, or any other similar agreement, would have two parts:

- Reduction of CO2 emissions in a certain pace towards zero emissions at some future date;
- Contributions to the Super Fund yearly according to some scheme and time table.

Both these two actions concern first and foremost the countries in the G20 group of nations, responsible for 70 per cent of the total CO2 emissions. Small poor nations can be left aside, as they pollute little and cannot be required to pay into the Super Fund. Both i) and ii) are just promises, which the COP21 Secretariat or the UN cannot enforce, strictly speaking. When a country receives support the Super Fund, there is some leverage to force obedience. However, a big poor country may simply refuse decarbonisation, if no assistance is provided. Decarbonisation is costly in the short run for all countries, as they must replace existing energy plants with new, hopefully renewable energy resources. Contributing to the Super Fund is also costly in the short run. This sets up an interaction where a

government may be tempted to defect from its promises to decarbonise or pay to the Super Fund.

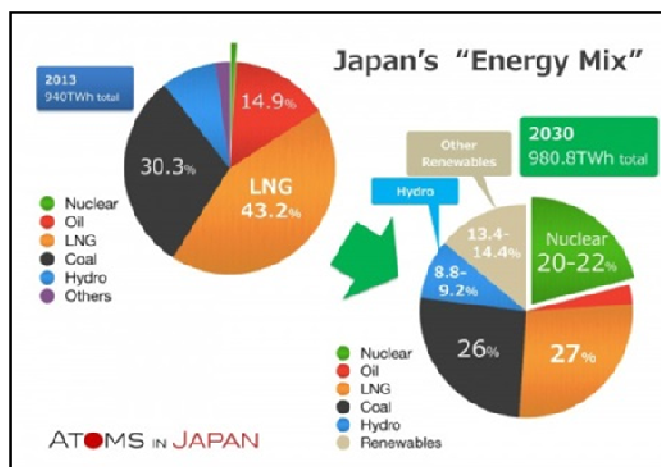
- A. Strategy of poor nations: the N-1 problematic. Poor or small nations will engage in opportunism with guile in order to avoid too large costs with the COP decarbonisation policy, pretending they matter very little for outcomes.
- B. Strategy of the rich country: the 1/N problematic. Large or rich countries will find sacrifices that cannot be internalised as meaningless gifts to others, who may not be trusted to cooperate. Thus, the US reneged because it did not want to pay for decarbonisation in India. The PD nature of interaction in a global CPR like the COP21 Treaty is fragile, to say the least. What is lacking is the instruments of control, as Hobbes pointed out already 1651 in his Leviathan, speaking of voluntary agreements or accords: "Covenants, without the sword, are but words, and of no strength to secure a man at all."

**Domestic policy concerns and international coordination**

A government may bind the state it represents to farreaching objectives like complete decarbonisation at an international reunion, but it is just a "scrap of paper". It matters really concerning safeguarding national interests, the government simply reneges. When water becomes scarce for Chinese energy dams. Then coal is resorted to again, with new CO2 augmentation. Domestic politics play a major role in energy policy besides international accords. Here are three examples

**a) Japan's dilemma**

After the Fukushima disaster, Japan closed 50 of its 52 reactors. The country relies much upon the import of various energy resources. Will Japanese politics allow a return to nuclear power or will Japan like South Korea rely massively upon LNG from Australia? One possible scenario is outlined in Figure 13.



Source: <http://www.world-nuclear-news.org/NP-Plan-sets-out-Japans-energy-mix-for-2030-0306154.html>

Figure 13. Energy plan for Japan

**Germany & France: nuclear distrust**

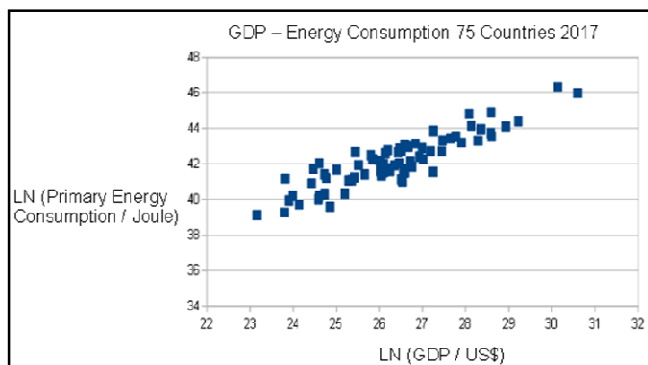
Despite all propaganda about so-called *Energiwende*, Germany remain much dependent upon fossil fuels.

**Table 1. Number of Ouarzazate plants for 40 per cent reduction of CO<sub>2</sub> in some giant countries (Note: Average of 250 - 300 days of sunshine used for all entries except Australia, Indonesia, and Mexico, where 300 - 350 was used)**

Nation	Co <sub>2</sub> reduction pledge / % of 2005 emissions	Number of gigantic solar plants needed (Ouarzazate)	Gigantic plants needed for 40 % reduction
United States	26 - 28 <sup>i</sup>	2100	3200
China	none <sup>i</sup>	0	3300
EU28	41 - 42	2300	2300
India	none <sup>ii</sup>	0	600
Japan	26	460	700
Brazil	43	180	170
Indonesia	29	120	170
Australia	26 - 28	130	190
Russia	none <sup>i</sup>	0	940
Germany	49 <sup>i</sup>	550	450
France	37 <sup>v</sup>	210	220
Sweden	42 <sup>v</sup>	30	30
World	N/A	N/A	16000

Note: 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.

High grade coal is imported from Russia and Colombia to add to its own low grade and dirtier coal, besides all the natural gas from Gazprom. At the same time, nuclear power are closing – all up to 2022. France is also closing nuclear plants, despite the fact that they could be used longer and made safer. Both countries should turn to solar power – see Table 1, but may be expected to burn biomass or biotrash, which emits CO<sub>2</sub> inter alia.



Sources: BP Statistical Review of World Energy World Bank Data Indicators  
Note: R<sup>2</sup>=0.8

**Figure 14. GDP and energy for the globe 2017**

**Swedish folly:** Sweden used to be lucky with energy resources, relying upon its many rivers and modern high tech with very safe nuclear power stations. However since 2000, it now abandons nuclear power at astronomical costs, relying instead upon the import of biomass or biotrash. CO<sub>2</sub>s now increase for Sweden.

### Summing up

Climate change is much more lethal than a nuclear power plant accident.

### Conclusion

The prospects for decarbonisation halting climate change seems grim, especially if abrupt climate change theory is correct. The crux of the matter is energy, which still comes with a high carbon intensity in most countries. Energy is the capacity to do work, which is the foundation of affluence. Figure 14 brings this fact out clearly for 2017. As long as economic growth pushes up energy consumption with a very *high carbon intensity*, there is no hope of putting a stop to global warming, which will only result in positive feedback loops – tipping points as they are called. The consequences – economic, social, political – will be simply catastrophic – sea level rise, storms and draught with incredible heat. Stern's (2007, 2015) voice remains unanswered or even heard by the decision-makers globally.

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