Original Paper

Global Warming: Chaotic Climate Changes with Chaotic Social Repercussions

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Abstract

Chaotic events and developments stemming from climate change now affect social systems and the household economy, globally. Thus, the growing deoxygenation will force people to move. See level rise will crush whole Island States in the Pacific and seize huge land portions elsewhere. Violent storms are conducive to mudslides that like extremely forceful forest fires kill numerous people. Entire cities may present a considerable health risk for ordinary citizens. The COP21 project of the UNFCCC starts its implementation of its decarbonisation goals I, II and III in 2020, but will countries like the economically successful nations on the Asian continent really comply. Or is continued economic growth still priority number One, as the enquiry into their plans indicates here?

Keywords

energy demand, de-carbonisation, the COP21 goal I, II, and III, Asian miracles, solar parks, defection in PD game

1. Introduction

Behind the entire debate about the greenhouse emissions (GHG), there is the global question of energy demand and supply. Its relevance is especially high for the Asian continent, where global economic output has skyrocketed at the same time as population growth remains high. Energy demand in the coming decades will be enormous in Asia, as poor people try to change their situation and the new middle classes strive for even more of affluence as well as the newly rich billionaires and millionaires throw themselves into conspicuous consumption.

However, the governments of the countries of the world have promised global de-carbonisation of energy consumption in a broad sense during this century where now fossil fuels deliver around 90 per cent of energy supply. An impossible policy promise?

Figure 1 shows the stylized projections about energy supply and they are not in agreement with the COP21 promise of global de-carbonisation to stop rising CO2 emissions and other GHG emissions too.

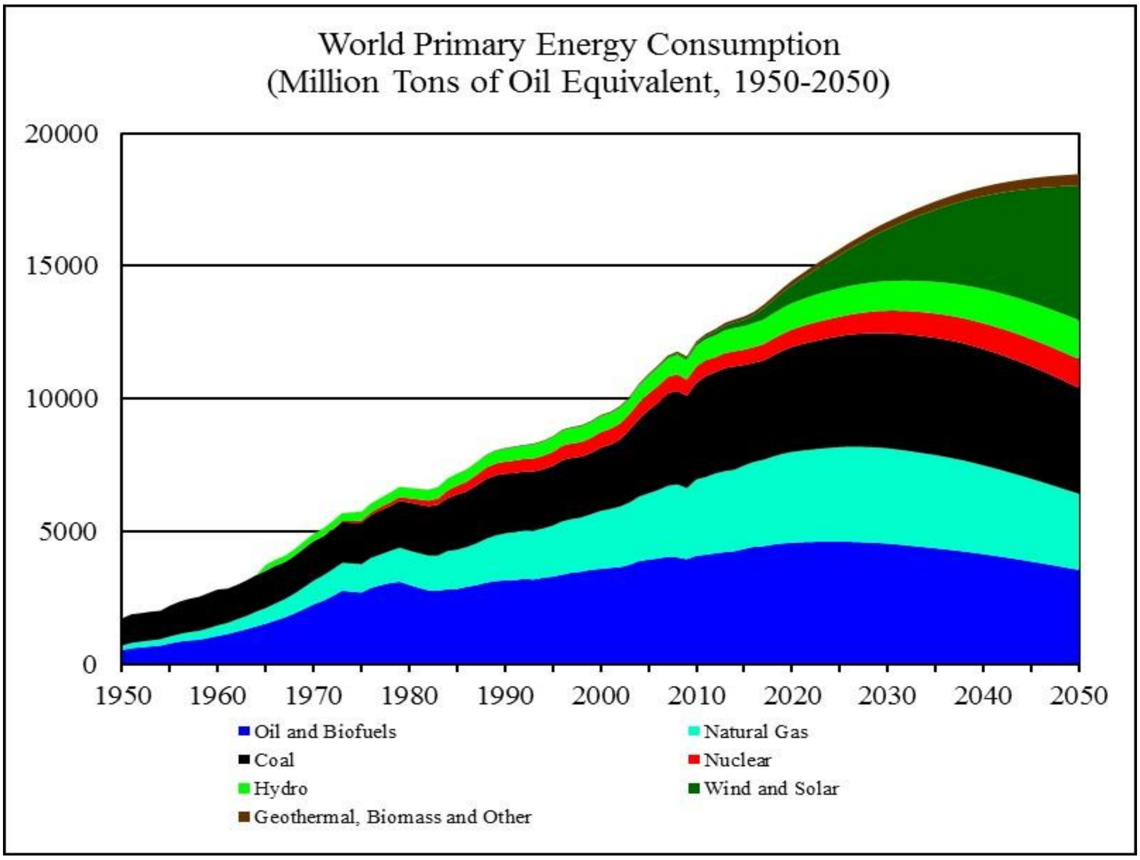

Figure 1. Global Energy Supply

Source: https://seekingalpha.com/article/4083393-world-energy-2017minus-2050-annual-report

Thus, the countries in the world have formed a Common Pool Regime (CPR) to save the atmosphere from more GHGs, focusing only upon the CO2s. The global decarbonisation plan in the COP21 Treaty includes:

i) Stall the rise if CO2s by 2020 (GOAL I);

ii) Decreasing the CO2s by 30-40% by 2030 (GOAL II);

iii) More or less full decarbonisation by around 2075 (GOAL III);

iv) Decentralised implementation under international oversight, financial support and technical assistance.

These are enormous goals, as only one country—Uruguay—is near GOAL I and GOAL II. Can they be implemented? Will the Asian miracle economies implement them or will they renege in this giant *ocean PD game* (Prisoner's dilemma)? Only Japan has decreasing CO2 curves today.

2. Emissions and Energy: Asia

The Asian continent is the largest GHG emitter of all continents on Planet Earth. The cost is clear, as the Asian Development Bank states about one of its most vibrant parts:

Southeast Asia is also becoming a larger contributor to global GHG emissions, with the fastest growth in carbon dioxide emissions in the world between. … Deforestation and land degradation have been driving most of the emissions to date. ... Given the region's vulnerability to climate change, curtailing global emissions growth should be a priority consideration, to which the region can make an important contribution (ADB, 2015: Foreword).

The ADB calls for anti-global warming policies, recommending carbon capture and sequestration. This technique would allow for continued high economic growth, but it is neither safe nor least expensive, as solar power parks offer a better technique, given much sun on this continent. Figure 1 displays the huge augmentation in CO2s in Asia. Note also the big contribution by maritime and airborne transportation.

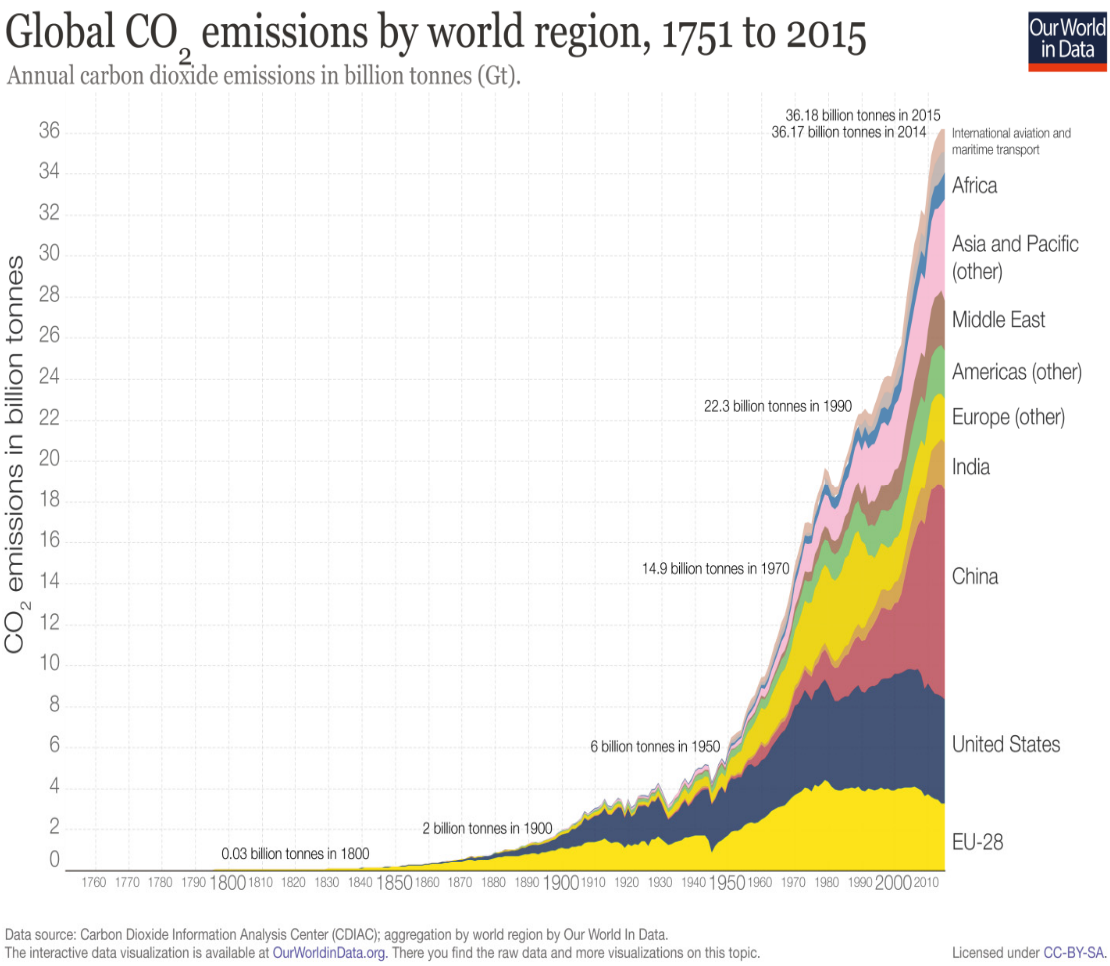

Figure 2. Global CO_2 Emissions by World Region, 1751-2015

The greenhouse gases (GHG) have anthropogenic sources, being linked with socio-economic development or economic growth via the consumption of energy, especially the burning of fossil fuels, use of cement and the emission of methane from landsinks, cows, microbes, etc. The UNFCCC has focused on halting CO2s and decreasing them in a gigantic decarbonisation policy globally in this century.

Since 1970, global energy consumption has more than tripped. And the share of Asia has increased phenomenally. The Asian economic miracle started in Japan after the Second War, spread to the four miracles—Taiwan, South Korea, Hong Kong and Singapore—only to include mainland China since 1980, in order to further widening to South East Asia and South Asia plusKazakhstan as well as the Middle East oil and gas tycoons (Figure 2). Now Asia has more than 50% of all energy consumption and it is more than 80 percent fossil fuels, globally. In several Asian countries, fossil fuels make up 90 percent of energy consumption.

This economic revolution has made Asia harbor the set of factories of the world, thus increasing quickly affluence and wealth as well as succeeding in diminishing poverty. But energy transformation requires huge changes in Asia, like the elimination of coal as soon as possible.

3. CO_2 Emissions in Asian: The Defection Risk

Below we look at the GDP and CO2 links in a few major Asian economies in order to position hem with regard to the fulfilment of the COP21 objectives.

3.1 China: 20% More Energy up to 2030

China has expressed support for COP21, especially when smog hits Beijing. But its economic expansion endeavours remain unchanged, not least over Asia with the New Silk Road. Alarming information now arrives that China, the biggest emitter of CO2s, will not succeed to halt its curve for CO2s due to hydro power shortages. Instead, it counts upon some 3 percent increases the nearest 1-2 years—see Figure 3.

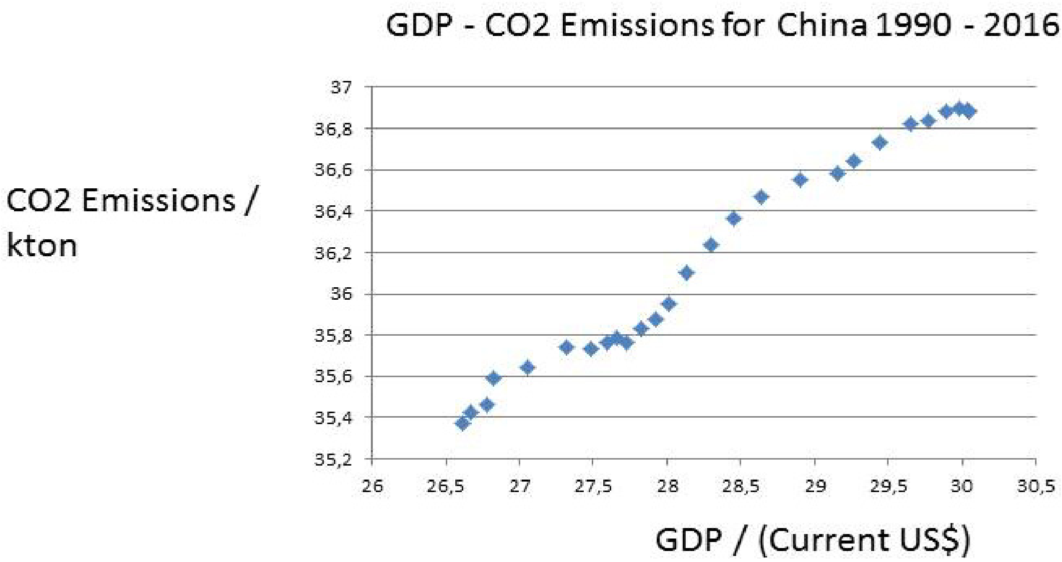

Figure 3. China: GDP and CO2s: y=0,46x, R^2=0,98

Will China renege upon both GOALI, halting the increase in CO2s, and GOAL II, reducing CO2s by some 30 percent in 10 years? Promises and intensions are one thing, defect, but real life developments are another matter. All countries in this CPR can at any time renege, the US has already done being not willing to pay to the Super Fund.

China invests in both nuclear power and modern renewables. Yet, it has magnificent economic ambitions over the next decades:

i) Airports and own constructed aircraft;

ii) Largest air traffic in the world;

iii) Biggest car market in the world;

iv) More SUVs and ever larger engines;

v) The New Silk Road: infra structure expansion into Central Asia, Pakistan and the Middle East.

Air and sea transportation adds much to CO2 emissions. Even if electrical cars are launched massively in China, one must ask where the electricity comes from. Coal?

China expanding outward meets first Kazakhstan when building the new highway to Turkey, an enormous project with CO2 consequences.

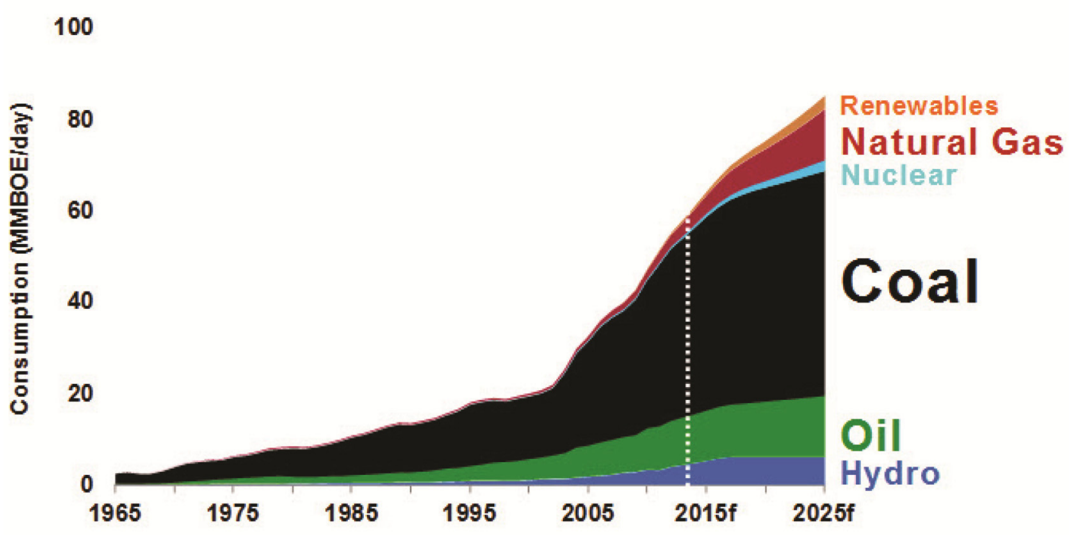

Figure 4. China's Future Energy Mix

Figure 4 send a vision of a future that is not the same as that of the COP21 project.

3.2 Kazakhstan: Oil and Gas

Here, we have a nation very much occupied with the catch-up strategy, as its exit from the Soviet Union worked like a "take-off" stage. It wants to copy the Asian miracles, moving to affluence in a few decades, using its immense fossil energy resources (Figure 5). But this picture of over 90% fossil fuels is very far from the obligations under the COP21 Treaty.

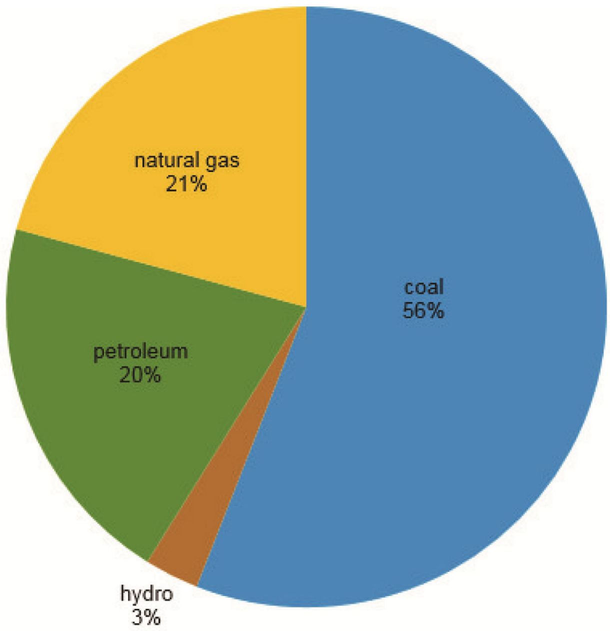

Figure 5. Energy Mix

Kazakhstan's energy consumption leads to enormous emissions. The stunning economic development, including the great project of a modern Silk Roan from China to Turkey through Kazakhstan implies that the CO21 goals cannot be accomplished here. Catch-up strategy and huge infrastructure trump climate change. Countries with no hydro power often display increasing trends for emissions. Kazahkstan employs its vast fossil fuel resources for energy consumpton besides exporting a lot. But it has to start energy transformation towards renewables.

3.3 Turkey: Imported Energy

Turkey has never been politically stable, neither today nor historically speaking. The Ottoman Empire was an example of oriental despotism, namely *sultanismus*. When the Young Turks set up modern Turkey, they failed to stabilize the country with a permanent constitution. The many constitutional changes reflect not only *coup d'état*, but also a weak tradition of the *Rechtsstaat*. Economically, things are entirely different, as Turkey is one of giants of the global economy, especially important with connections to the West and dominance in Turkestan.

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 6 supports this picture of Turkey as an energy consuming giant.

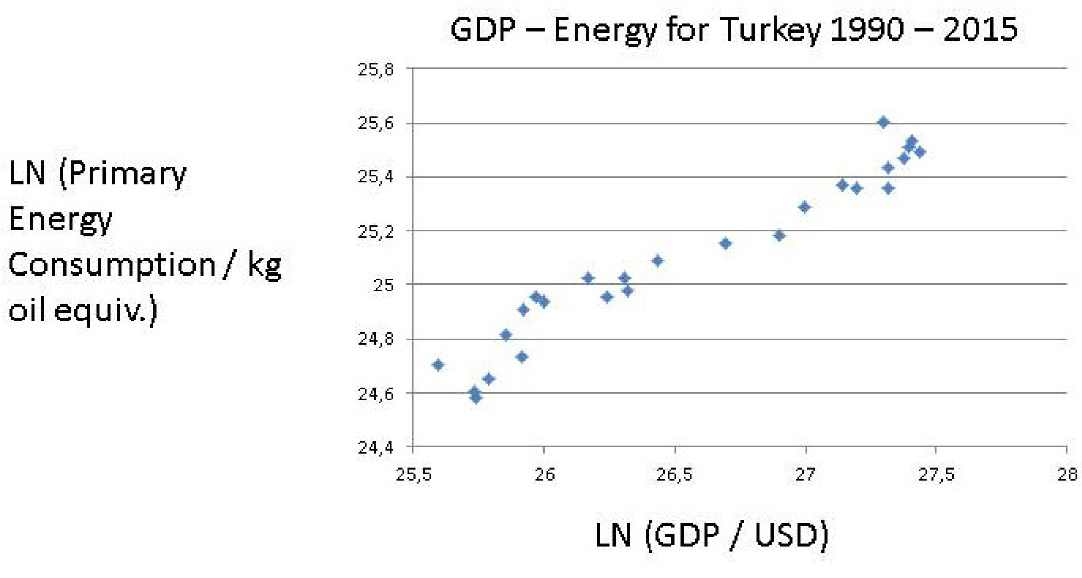

Figure 6. Turkey: Energy-GDP Link

Strong economic development is combined with heavy energy-emissions increase. Oil and gas are imported from the East. Only hydro power is a large internal source of energy. Wind energy has become fashionable, but solar energy would be an ideal solution. Figure 7 displays the still heavy reliance of Turkey on fossil fuels, mostly imported. Decarbonisation according to the COP21 Treaty implies that Turkey must change drastically, as it now depend at 90% on fossil fuels.

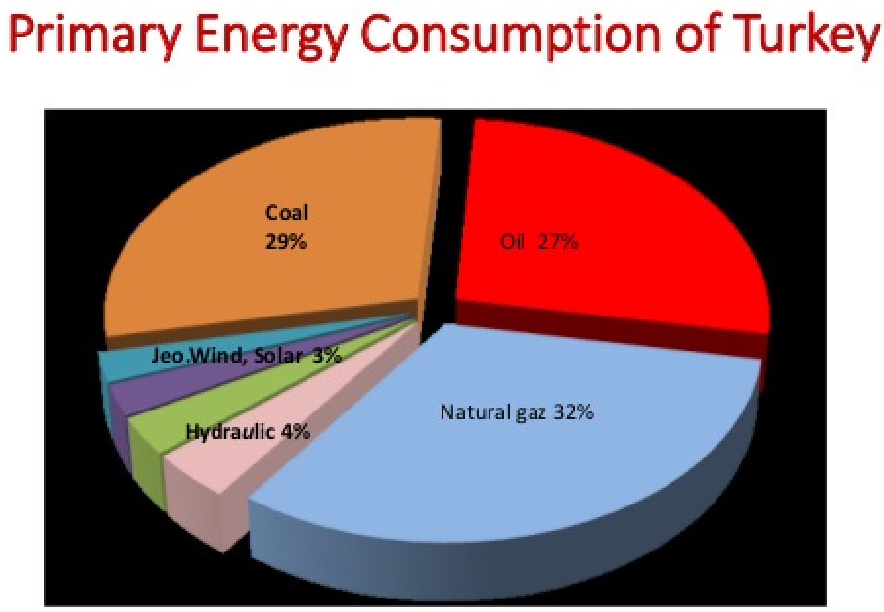

Figure 7. Energy Mix in Turkey

Source: https://www.slideshare.net/omerfarukgurses/world-energy-outlook-2015-presentation

Turkey, Iran and Kazakhstan pursue the "catch-up" strategy in relation to the advanced capitalist countries (Barro, 1991; Barro & Sala-i-Martin, 1992, 1995). They are not very eagre to take on the burden for global decarbonisation, especially if it hurts their economic development. They would demand compensation from the promised Super Fund, as Turkey has now threatened to regene upon its COP21 promises.

3.4 Iran: Need of Solar Power

Countries may rely upon petroleum and gas mainly—see Iran. CO2 emissions have generally followed economic development in the giant carbon rich countries. In Iran though, there seems to be a planning out recently, perhaps due to the international sanctions against its economy. Iran has made considerable economic advances, despite international sanctions, but it's CO2: shas also increased much (Figure 8).

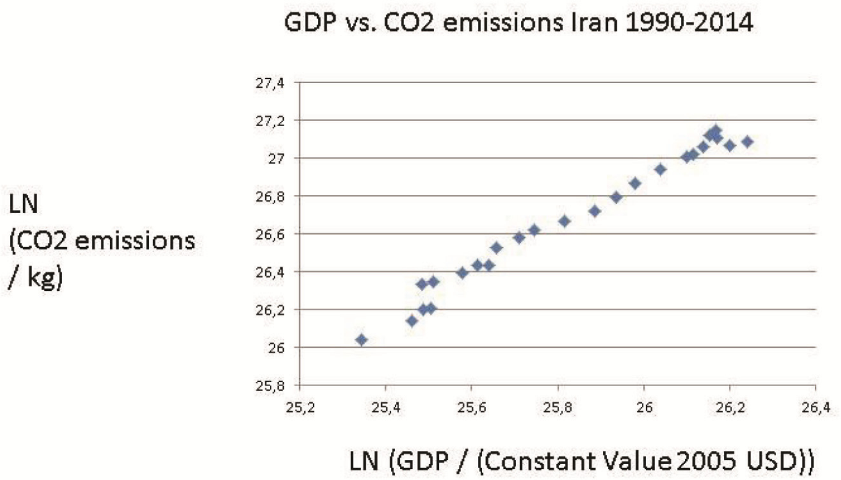

Figure 8. Iran: GDP-CO2 Link (y=1,22x-4,91; R^2=0,98)

Iran is together with Russia and Qatar the largest owner of natural gas deposits, but also Turkmenistan and Uzbekistan have enormous gas reserves. But despite using coal in very small amounts, its CO2 emissions are high. Natural gas pollute less than oil and coal, but if released unburned it is very dangerous as a greenhouse gas. Iran relies upon its enormous resources of gas and oil (Figure 9) to support the "take-off" of its economy (Rostow, 1960).

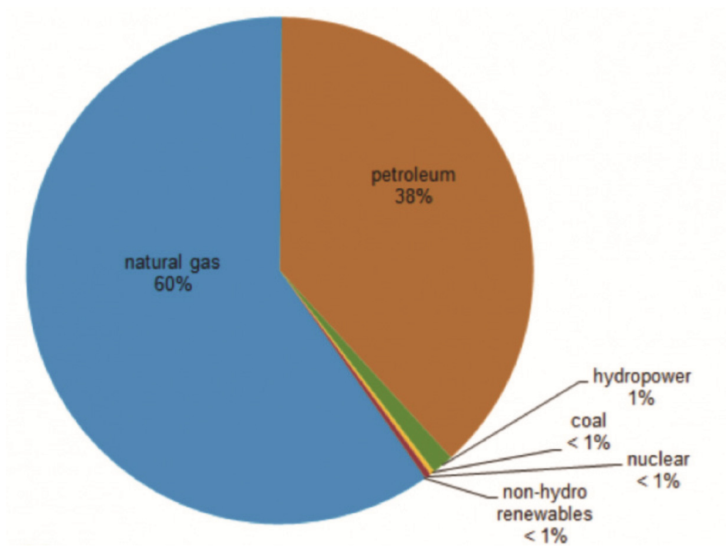

Figure 9. Iran: Energy Mix

Iran is far from the goals of the COP21 Treaty, relying to 95% upon fossil fuels. It face difficulties with all three major objectives of the UNFCCC: GOAL I, II and III. Iran needs foreign exchange to pay for all its imports of goods and services. Using nuclear power at home and exporting more oil and gas would no doubt be profitable for the country. And it would also help Iran with the COP21 goals achievement. Solar power parks are the best solution.

3.5 India: Super Fund Hope

Its Rostov take-off point in time would 1990, when Nehru's economic regime was abandoned for free market economics. Unleashing the dormant giant of India has led to enormous economic expansion and growth in CO2s—see Figure 10.

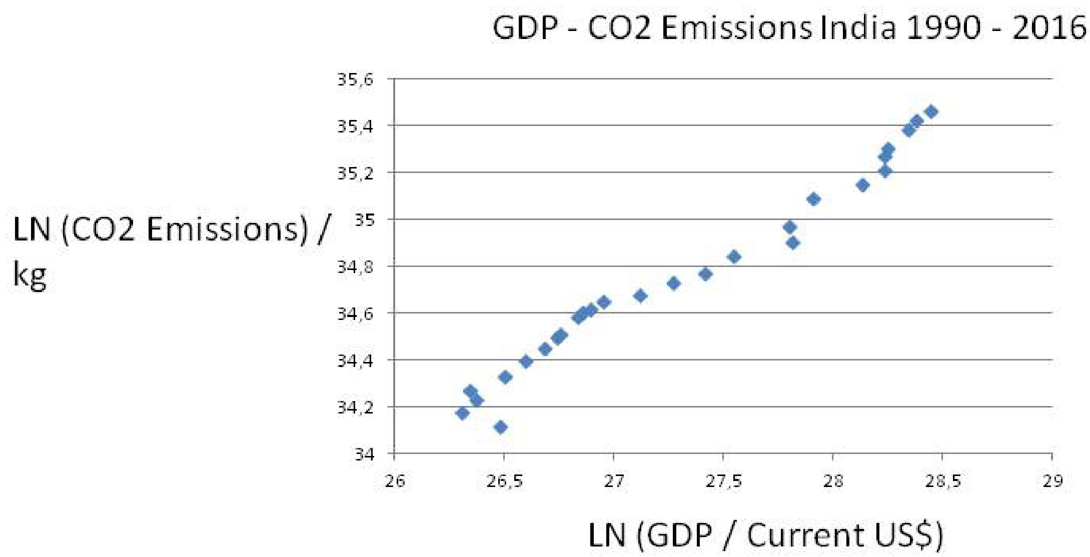

Figure 10. India: GDP and CO2

India takes the position that any reduction its economic growth due to the fulfillment of global decarbonisation must be compensated by the West. Moreover, the Super Fund should be employed for the energy transformation that is necessary for India to comply with GOAL 1 and GOAL 2.

Ramesh (2015) insists that India cannot alone uplift its million poor without coal power. In addition, families in India rely much upon wood and charcoal—traditional renewables. The country is investing in nuclear power and modern renewables. However, its hydro power suffers from water scarcity—a positive feedback loop from climate change.

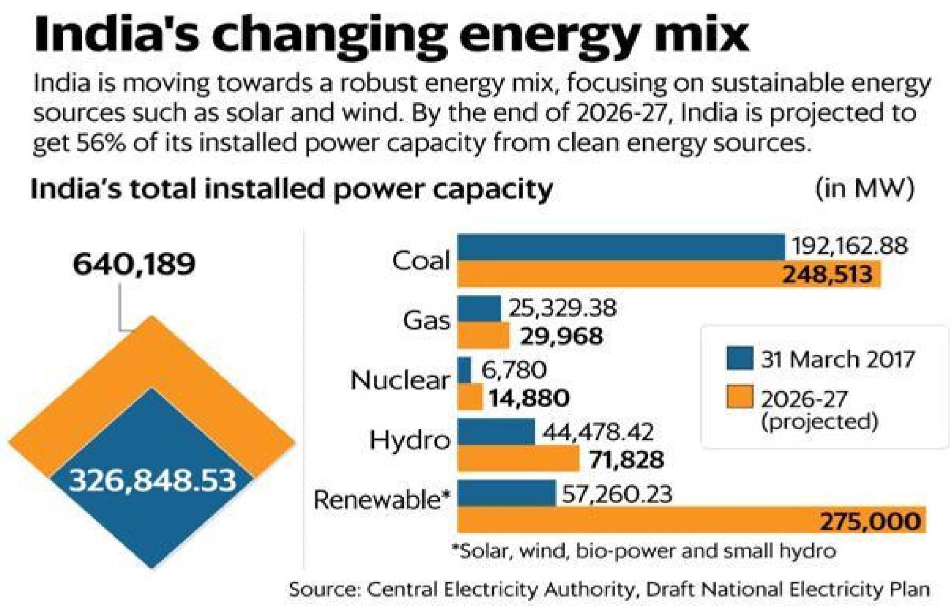

Figure 11. India's Planned Energy Mix (Excluding Transport)

India says that it will renege, if no massive support from the Super Fund. Its future plans, according to Figure 11, comprise a 20% energy increase. And it must reduce coal more to comply with COP21. Renewables in India consist of much wood coal.

3.6 South Korea: From Nuclear to LNG

South Korea is today a member of the club of First Advanced Economies, the OECD. From dismal poverty, it has pursued a spectacularly successful catch-up strategy, making it a global leader in technology and car production. The transformation is all the remarkable, as the country possess few internal power resources. Thus, it has relied upon imported fossil fuels, with the result in Figure 12, huge CO2 emissions.

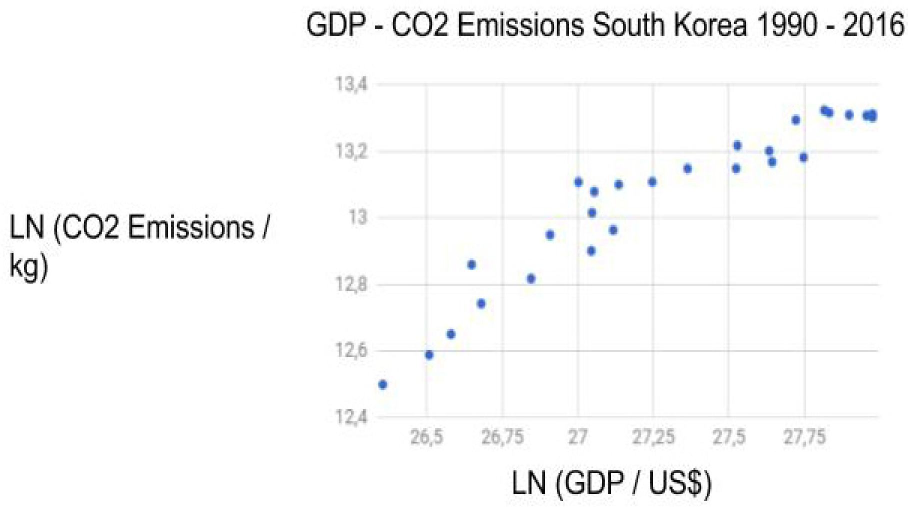

Figure 12. South Korea

To come to grips with its enormous GHG emissions, South Korea has attempted to reduce its coal dependency. Thus, it engaged upon a most ambition nuclear program, as its force is the largest power source in the world. South Korea with its advanced technology can build new and better as well as safer atomic power plants, also constructing them abroad. But the new president hesitates about nuclear power, like the European governments, and has launched a new energy strategy based massively upon natural gas (LNG), imported mainly from Australia and Indonesia. But it will still result in CO2 emissions higher than GOAL II in CO21. And international maritime transportation is a major source of CO2s.

The LNG option may also appear attractive to Japan, hesitant about the use of atomic power.

3.7 Japan: Energy Uncertainty

The Fukushima atomic power plant disaster changed energy policy in Japan, with an almost %-stop of nuclear plants. But what to use in Japan? See a plan in Figure 13.

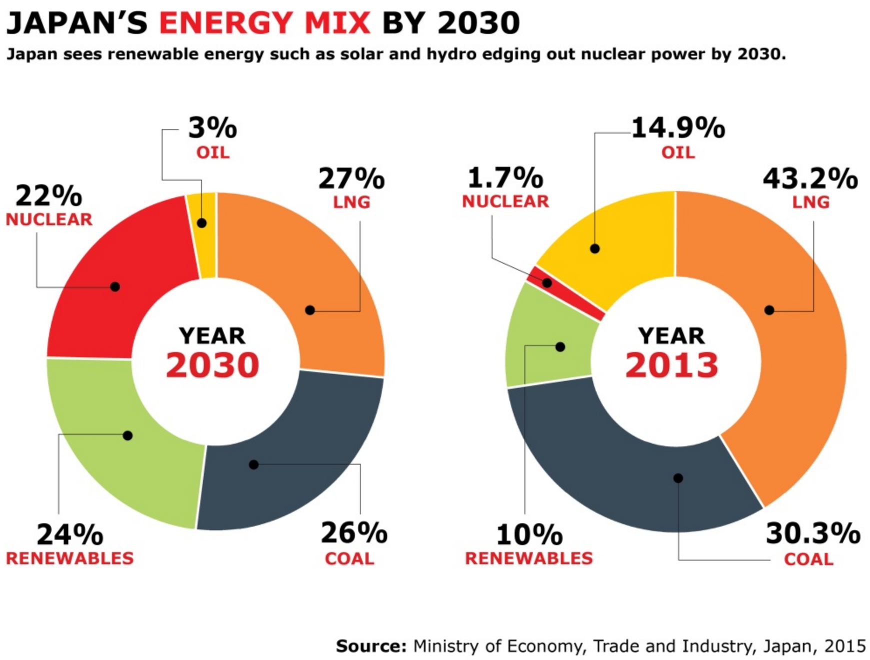

Figure 13. Japan's Future Energy Mix

This plan relies upon a big return to nuclear power, as there aresafer models now. But is it politically realistic? If not, Japan must increase imports of fossil fuels, and renege upon COP21.

3.8 Saudi Arabia, UAE, Kuwait and Qatar: Top Energy Per Capita

The Middle East is almost all fossil fuels, consumption as well as production. This has allowed the Gulf States to enjoy the highest living standards in the world—see Figure 17. These states consume energy at levels not seen elsewhere. But they promise decarbonisaion, or the construction of entirely new green cities.

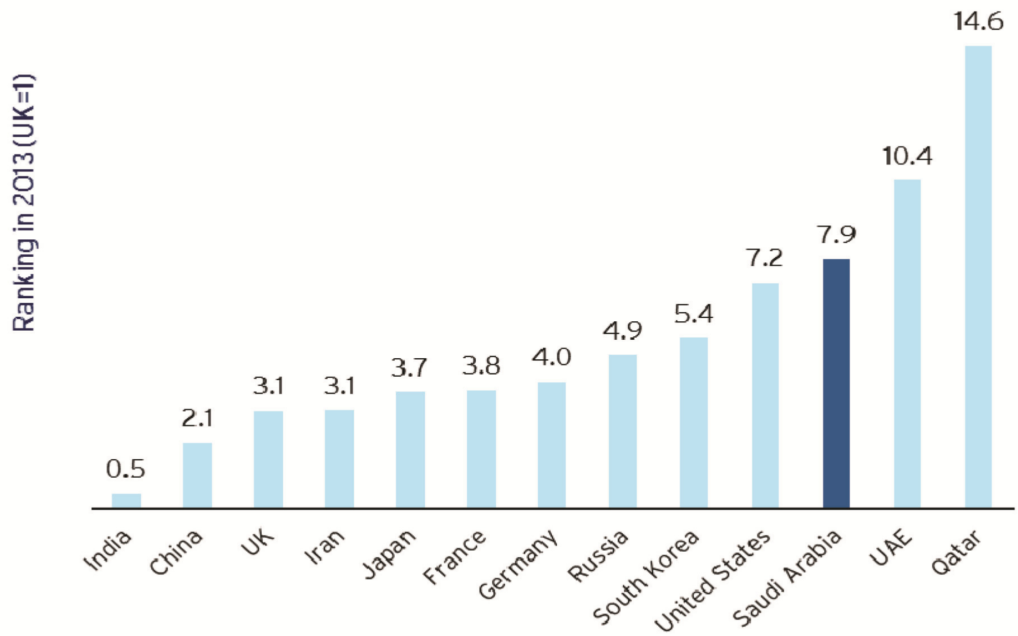

Figure 14. Energy Consumption in the Gulf

Decarbonisation is feasible in the Gulf, and the remedy is of course solar power. But will it happen on the scale required by COP21?

3.9 Indonesia

One may guess correctly that countries that try hard to "*catch-up*" will have increasing emissions. This was true of China and India. Let us look at three more examples, e.g., giant Indonesia—now the fourth largest emitter of CO2: s in the world (Figure 15).

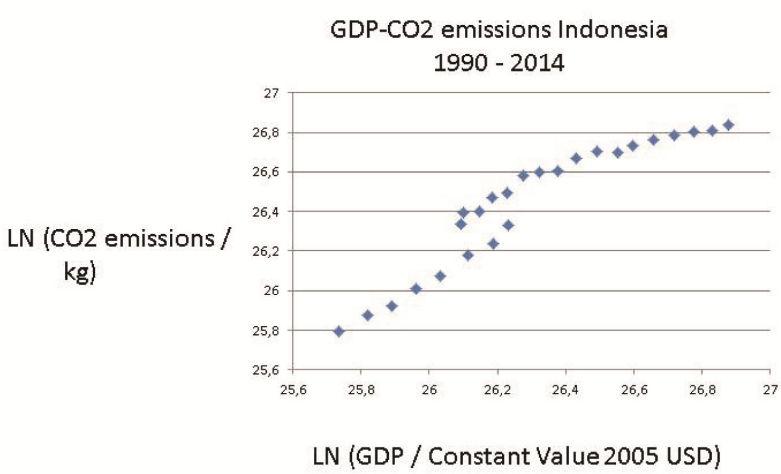

Figure 15. Indonesia's Link GDP-CO2: y=0,95x+1,58; R^2=0,89

Indonesia is a coming giant, both economically and sadly in terms of pollution. Figure 15 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. Figure 16 presents the energy mix for this huge country in terms of population and territory.

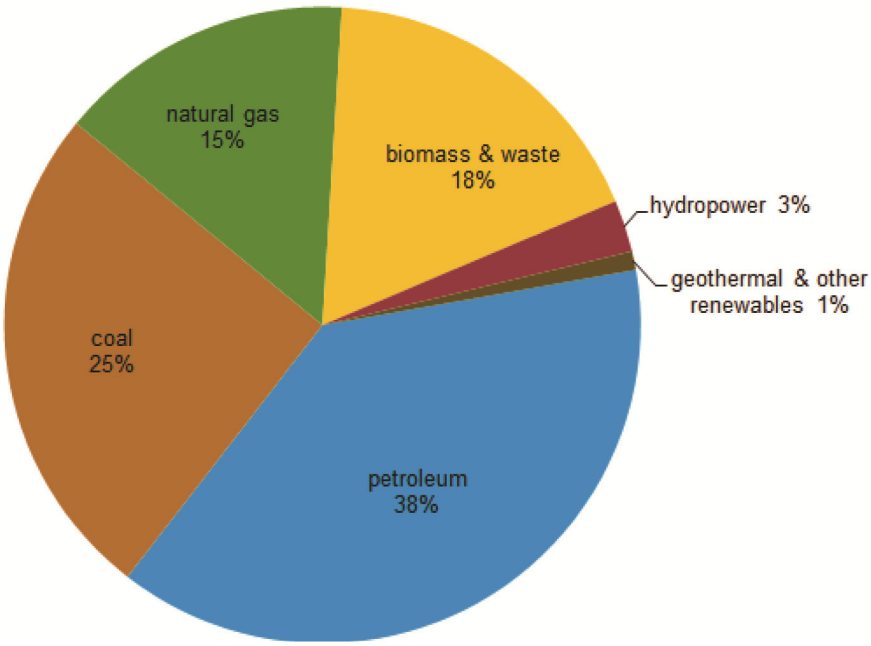

Figure 16. Indonesia Total Primary Energy Consumption, 2013

Only 4 per cent comes from hydro power with almost 80 per cent from fossil fuels and the remaining from biomass, which alas also pollutes.

Indonesia cannot control the illegal burning and cutting down of its rain forest. Thus, it is a very major contributor to global warming.

4. Evolving Methane Threat

There are several greenhouse gases, but the two biggest are the CO2s and methane. The UNFCCC has concentrated upon halting and reducing carbon dioxide, but now we are about to face a methane threat. We shall use the methane concentration curve from mid-2013 to beginning of 2017 by NOAA ESRL (https://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/), as suggested by Dlugokencky and Kuniyuki. Why mid 2013? It is the last maximum of the second derivative before 2017. Since then, the curve is approximately linear, and we will derive its equation hereunder.

We start with a linear approximation, the simplest approximation that can be found, because it is a mean between two extreme scenarios: 1) Another plateau like during the years 1999-2006 (probably due to an enhancement in methane transport insulation in ex-USSR after 1991, Pearce), unlikely for the following reasons. 2) Any decrease in methane concentration is very unlikely; as the main sources (in decreasing importance order) generally increase:

a) Agriculture emissions increase with the increase of population, the increase in meat diet in developing countries and the temperature increasing the metabolism of microbes in rice agriculture.

b) Wetlands emissions do not diminish, as the microbial chemical activity will increase with temperature for many years.

c) Fossil fuel production and use does not diminish, and was underestimated by industry (Fred Pearce, http://e360.yale.edu/features/methane_riddle_what_is_causing_the_rise_in_emissions).

d) Biomass burning does not diminish, as the primary forest diminishes in the tropics, leading also to a decrease in animal, vegetal and cultural (Indigenous People) diversities and an increase in biosphere entropy.

e) Other natural emissions, like from the melting permafrost.

The most important contribution to the recent rise of methane concentration is mainly due to the increase in activity by microbes, present in points a), b) and d) mainly in the tropics. This study suggests the positive feedback of the chemical increase of activity of microbes is starting now, yielding a quasi-exponential curve in the near future, or at least a steeper curve.

We will simulate the hypothetical solution of a transition (bifurcation) between 2 steady-states; with an S-shaped function (which approximates the bifurcation between 2 steady-states) multiplied (to have continuity) by the linear approximation. We shall approximate the S-shape curve by a transitory (5 years) exponential curve in continuity with the linear approximation. The present (November 2017) quasi-linear curve starts mid 2013 (2013.5) and its ordinate is approximately 1813 ppb. We will use as a last value at start of 2017 (2017), and the function is approximately 1846 ppb.a straightforward calculation gives the slope: it is approximately 10 ppb/year. Therefore the equation for the future curve if there is no vicious circle (positive feedback) is: (1) $y=10\ (t-2013.5)+1813$, where t is the time when one wants to know the CH_4 concentration and y is the future CH_4 concentration in ppb. From this equation, one can estimate the approximate the temperature rise due by methane, by applying to y the formula (1), and multiply it by 25.

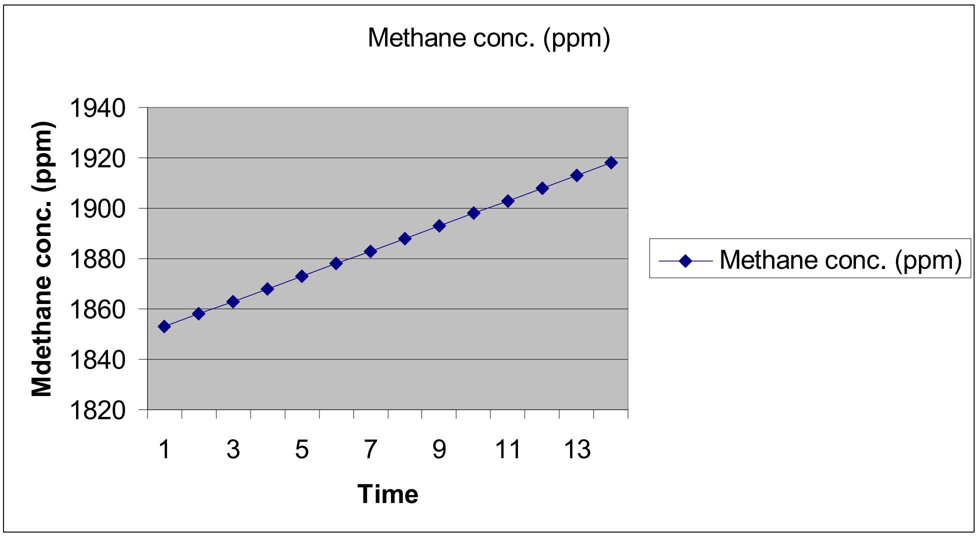

Figure 17. Projected Increase in Methane (Dieterlen)

Management Strategies for Decarbonisation

The UNFCCC suggests a decentralized management strategy for decarbonisation. Reflecting the enormous differences in available energy resources in the member states of COP21 Treaty, each government must develop a strategy for achieving Goal I, Goal II and Goal III. The COP 24 in Poland 2018 may wish to concentrate upon the following measures start credible decarbonisation:

1) Phasing out coal power plants; convincing a few countries like India and Australia not to build new ones;
2) Replace wood coal with natural gas—small or large scale, stopping deforestation and the use of charcoal in households in poor nations, giving them free small gas ovens;
3) Turn some countries away from massive dam constructions towards solar power parks, like Brazil and India, as the environmental damages are too big;
4) Help some countries maintain their huge forests: Brazil, Indonesia, Malaysia, Russia, Congo, India, etc.;
5) Abstain from expensive and unsafe carbon sequestration techniques in favour of electricity: solar power and electrical vehicles.
6) The promise of financial support—Super Fund—has to be clarified about both funding and budgeting. A management structure has to be introduced for oversight of the entire decarbonisation process. As the emission of methane increases, the reduction of CO2s is all the more important, if irreversibility is to be avoided with a margin.
7) The resort to atomic power plants is highly contested. Nuclear power gets safer and safer, but the problem of storing the used uranium has no solution yet, although Finland says it knows how. Old atomic plants could be made much safer in France and Germany for instance. Full

scale climate change would be worse than single nuclear disasters.

8) Massive construction of solar power and wind power plants in all countries, as well as stimulate small scale solar power; Solar power parks: 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 has the answer.

Table 1. Number of Ouarzazate Plants Necessary in 2030 for COP21's GOAL II (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
China	none[i]	0	3300
India	none[ii]	0	600
Japan	26	460	700
South Korea	37	260	280
Philippines	70	70	40
Turkey	21	60	120
Indonesia	29	120	170
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
Australia	26-28	130	190
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.

5. Climate Change and Chaos Theory

The most recent news about the severe negative impacts of global warming is an article in *Science* saying 1/4ths of the oceans have become oxygen empty—deoxygenation killing fishing and local people livelihood. Can the chaos approach help analysis these drastic changes and their consequences?

Chaos was discovered in the 60s by E. Lorenz, who was studying equations ("differential equations") applied to climate. He found a system of three such equations, coupled with a positive feedback and a negative feedback, which could not be predicted in the future.

When trying to predict the evolution, two starting conditions very close one to each other will have two very different evolutions. Even if the 2 initial conditions are infinitesimally close! That's why the "butterfly effect" started to be cited: if a small (infinitesimally) variation of weather (the "wind" produced by a butterfly) would imply a big variation in the weather far from there. In fact, this is wrong, because the Lorenz equations are too simple for climate, and are simply wrong for climate.

So chaos equations are useless to predict, even if climate is chaotic. But there are other coupled differential equations, which can help predict things in climate. They are simpler mathematically than chaos, but they have also at least a positive feedback and a negative feedback.

How do they predict? They are unstable for certain conditions (for example for methane above a given concentration), and we can calculate this instability. Therefore, we can know when the system (climate) will jump from one state to another. Practically, it can be: Earth temperature jumps form 17 degrees in 5 years to 20 degrees in 6 years. The positive feedback is necessary for the system to jump, and the negative feedback is necessary for the system to be stable when it doesn't jump.

The climatic system (a few climatic variables, as temperature, CO_2 and methane concentrations, and maybe one or 2 other variables) is modelled thanks to a method that transforms chronological data (e.g., monthly data) into those equations.

A stability analysis on a parameter (methane concentration, if we did not put methane as a variable but as a parameter), would see when the system gets unstable, if it does. Without methane, it didn't become unstable, but with methane, it likely becomes unstable.

One can show the system as arrows between the variables: each arrow showing if variable A increases or decreases, this affects variable B. This gives an image which shows how the system works, out from the equations directly, and out of the historical data also. One can be sure that the release of massive methane from the melting permafrost will force the Keeling curveupwards, perhaps with a *chaotic jump*. This may herald *Hawking irreversibility*.

The threat of a rise in methane emissions due to the melting of the permafrost must be related to the rising Keeling curve. All evidence points to a further advance in Figure 16: rising GHGs, the many positive feedback lopes, deoxygenation, melting ice, etc.

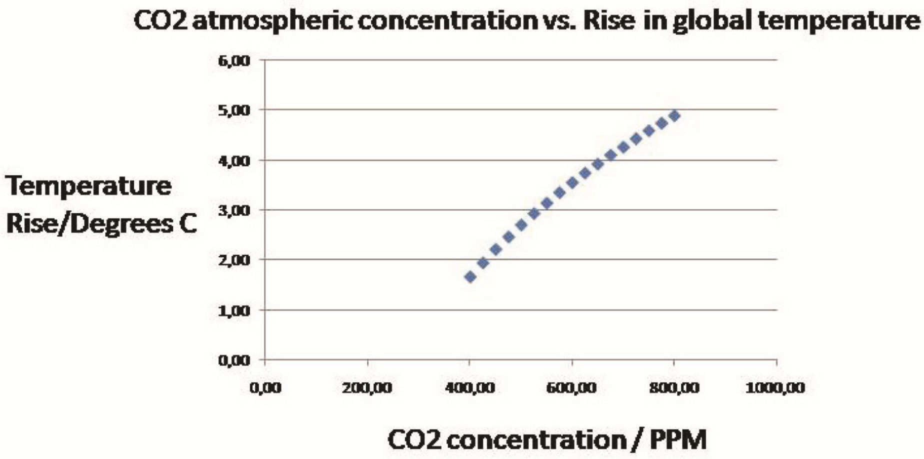

Figure 18. The Keeling Curve

Today, the Keeling curve stands at almost 408, but it could soon hit 420-430, which would make the plus 2 degrees objective unfeasible already before the implementation of COP21 begins.

6. Conclusion

The Asian economic miracle is going to run into mega pollution from GHGs. It would undo much of the immense advances the recent decades. Solar panel parks are the reply, and not carbon capture, suggested by the ADB.

Conca (2015) and Vogler (2016) have shown in inquiries into how he UN has handled the climate change that the Great Powers use the fragmented UN structure to delay real action against global warming. They move the key issue of global warming and decarbonisation around, from arena to arena, just to delay concrete measures. The question of climate change is mixed with general environmental protection or the idea of a new sustainable economy, often utopian proposals.

"What are we waiting for"? ask economist Stern (2015). Reply: G20 real action. The G20 group of nations is responsible for more than 3/3rds of the CO2 emissions. They do not face enormous transaction cost like the UNFCCC. They can act and not only make enquiries, like the IPCC. But they rely upon *resilience*: Let each country respond to climate change. Global warming leads to enormous externalities (Stern, 2007). It requires global policy responses, where only the G20 group can lead. They must pay for the costs they place upon others. It is in their own interests. But we have seen above that they have little readiness to fulfill the COP21 Treaty goals, eliminating coal, cutting down oil and gas. Instead, they plan for a 20-30% increase in energy consumption, especially on the Asian continent. The chaotic developments in climate change will be conducive to chaotic changes in social systems and economic activity, leading to massive people mobility. The Asian region has become dominant in the world economy. This has made Asian countries very vulnerable to the threat of global warming from the emissions of GHGs. Asian economies produce more than 50% of all CO2s, which is why they must be active in implementing the UN global de-carbonisation plan: COP21 Treaty. They have grandiose plans for much more energy, but where will this come from? The ADB suggest fossil fuels with carbon sequestration. It will not work. And the COP21 project is utopian like the idea of a sustainable economy (Sachs, 2015).

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