Climate Change: on Nature's and Social System's Determinism

Author's Details:
[(1)]Jan-Erik Lane [(2)]Florent Dieterlen
[(1)]Jan-Erik Lane, Fellow with Public Policy Institute, BELGRADE; Address: 10 Charles Humbert, 1205 Geneva; 559 A, 3rd Floor, Thuya Street, 9th Quarter, Yangon. Myanmar.
[(2)]Florent Dieterlen is independent scholar, Geneva.

Abstract:
The great fear for the future is that the global warming process already started starts displaying signs of irreversibility - determinism. One can distinguish between two kinds of deterministic processes, that of Nature and socio-economic determinism. If GHGs or CO2s are allowed to increase so much that temperature rises 5 degrees Celsius or more, then we have nature's determinism, probably eliminating the conditions for advanced life. Socio-economic determinism models how human activity or social systems are driven by unstoppable forces like individual needs and power or the trend of capitalistic economy. Perhaps the COP23 fails to start the implementation of COP21 Treaty due to the enormous demand for cheap energy in the global economy and national societies?

Keywords: *Global warming as irreversible process, natural determinism against socio-economic determinism, degrees of freedom in global coordination against climate change.*

!. INTRODUCTION

The just released major research report - USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I – documents in detail the damages from climate change, in the US and around the world. Should global warming reaches the point of no return with temperatures perhaps plus 4-6 degrees Celsius higher, then the present calamities will be magnified and could reinforce each other, like heat fueling storms, reinforced by see level rise: a) Melting of polar ice massively: b) Retraction of glaciers globally; c) Huge land losses along the costs (Bangladesh);; d) Too high temperatures for men and women to work outside (South Asia); e) Food production decline (Africa); f) Fish harvest decrease (Atlantic ocean, Pacific Ocean); g) Droughts and starvation (South Asia); h) Lack of fresh water supply (Latin America); i0 Drying up of rivers, affecting electricity supply (Latin America, South Asia, East Asia); j) Ocean acidification and species extinction (Australia); k) Highly volatile climate with giant forest fires, storms, rainfall and tornados as well as mudslides with tremendous damages (Caribbean, Mexico, North America, Sri Lanka, Vietnam, China, Australia)); l) Deforestation and desertification (Latin America, Africa, Indonesia, South Asia). The majot difference from now on will be the scope and range of these climate calamities. If worse comes to worse, global heat streams like the Gulf Stream and the Atlantic Current may be affected, changing weather in the Northern and Southern hemispheres.

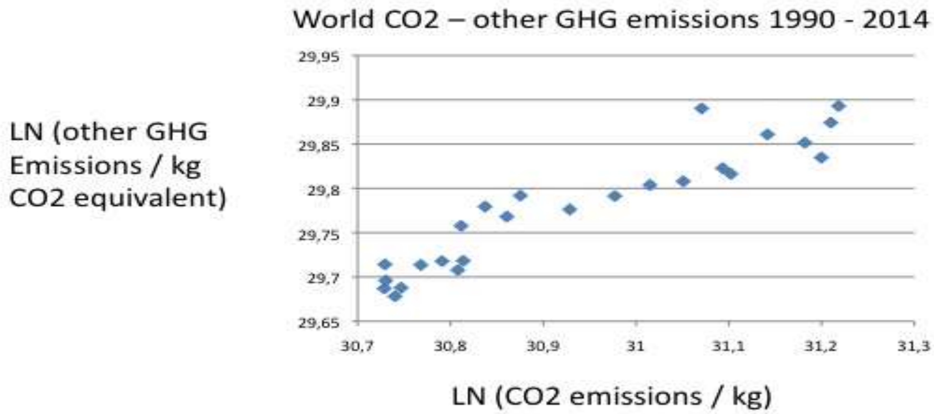
The problem of determinism is a fascinating one, comprising two entirely different kinds of determinism, viz. nature's determinism on the one hand and social determinism on the other hand. Hawking is reflecting upon natural determinism, the global warming process becoming unstoppable. Strong determinism is to be found in the scientific ideals of classical mechanics and physics, modelled on the image of the movement of billiard balls. Today, strong determinism has to compete with probabilities modelling and even chaos theory in the natural sciences.

But how about the social sciences? Is global warming inevitable, as a few deterministic theories in the social sciences speak of? Or does mankind face a real choice, as the UNFCCC hopes with its 2016 Paris Treaty on debardonisation?

2. NATURE'S DETERMINISM: Climate Change Irreversibility

Although Nature is resilient, it can only absorb so much of greenhouse gases (GHG). There are several types of GHGs, but the UNFCCC has concentrated upon the carbon dioxide particles (CO2s). They are considered responsible for the human induced temperature rise that is global warming. Figure 1 depicts the recent strong increases in GHCs and CO2s, causing the climate change phenomenon.

Figure 1. Greenhouse gases 1990 - 2014: CO2 and other GHGs



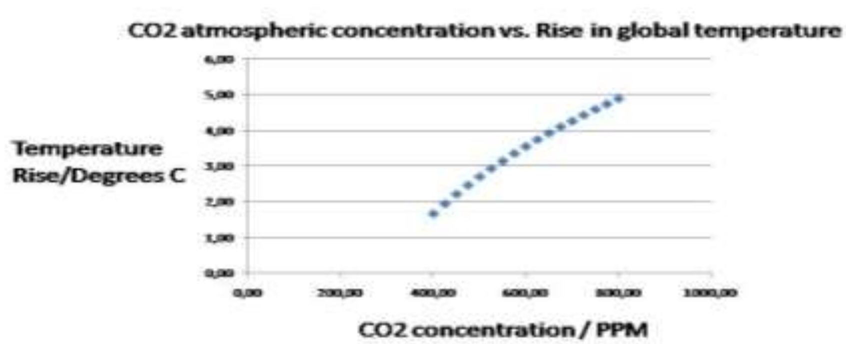
CO2s constitute the largest part of the GHCs. They are now stalling, not increasing any longer glonally. However, methane emissions are now becoming more frequent and important for global warming. Finally, we have the Nitrous Oxide and very small amounts of F-gases.

Methane and F-gases are more powerful in preventing sun radiation to exit the Planet, but they are not as long lasting as the CO2s. The oceans swallow much CO2s, but this leads to acidification. It appears now that the increase in CO2s has been halted, globally, whereas GHGs continue to advance due to augmenting methane emissions from the melting permafrost, among other things. Halting the growth in CO2s is not enough for avoiding the negative effects of climate change, as they must shrink considerably according to the decarbonisaton goals of the UNFCCC.

The logic of global warming is that the more of GHGs, the higher the probability of climate change goes. At what point global warming becomes deterministic is open to debate, where some scholars argue that we are far from the point of irreversibility, while others like Hawking and Neil deGrasse Tyson affirm a clear risk of irreversibility in the future..

One may attempt to calculate exactly how increases in greenhouse gases impact upon temperature augmentations. Take the case of CO2s, where a most complicated mathematical formula is employed: $T = Tc + Tn$, where T is temperature, Tc is the cumulative net contribution to temperature from CO2 and Tn the normal temperature. Moreover, the general formula reads: $dT = \lambda * dF$, where ‘dT’ is the change in the Earth’s average surface temperature, ‘λ’ is the climate sensitivity, usually with degrees Celsius per Watts per square meter (°C/[W/m2]), and ‘dF’ is the radiative forcing. To get the calculations going, we start from lambda between 0.54 and 1.2, but let's take the average = 0.87. Thus, we have the formula (Myhre el al, 1998): Formula: $0.87 \times 5.35 \times \ln(C/280)$. Figure 2 shows how CO2 emissions may raise temperature to 4-5 degrees, which would be Hawking’s worst case scenario.

FIGURE 2. CO2s and temperature rise in Celsius



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

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. Table 1 shows that methane is growing faster than CO2.The international data sources on greenhouse gases render CO2 numbers much more accurately and timely than methane and overall GHG numbers.

TABLE 1. GHC minus CO2s

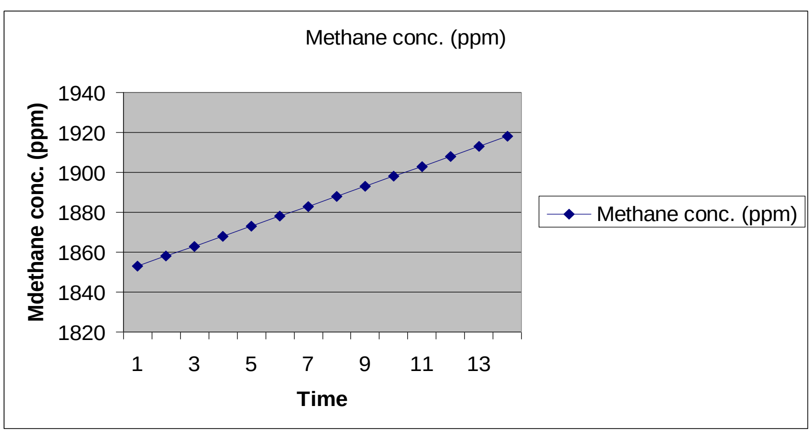
Year GHG other than CO2 / Tton

1990	15,56
1995	15,20
2000	14,74
2005	17,20
2010	17,05
2011	18,47
2012	18,97

Source: EDGARv4.2FT2012, European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Emission Database for Global Atmospheric Research (EDGAR), release version 4.2

We shall use the methane concentration curve from mid-2013 to beginning of 2017 issued by NOAA ESRL https://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/ , gently suggested by .Dlugokencky and Kuniyuki. The most important contribution to the recent rise of methane concentration is mainly due to the increase in activity by microbes, mainly in the tropics. This 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 (Diagram 1).

Diagram 1. Future increase in methan emissions



Moving now and up to 2030, according to the COP21's GOAL II for decarbonisation would eliminate Hawking infamous irreversibility Time has come for halting and reducing CO2 emissions by real implementation and not utopian dreams of a sustainable economy (Sachs, 2015). There is nothing to wait for any longer (Stern, 2015), as the COP23 must set up the promised Super Fund. No time for politicking in the UN any longer (Conca, 2015; Vogler, 2016). Yet, could socio-economic determinism drive mankind to take proper action according to the COP21 Treaty?

3. SOCIO-ECONOMIC DETERMINISM

Energy constitutes the basics in the anthropogenic greenhouse gases emissions. It generates not only survival but also affluence and wealth, being vital to both poor and rich countries. If energy consumption is reduced, there will be global economic recessions and mass poverty as well as unemployment. But Planet Earth consumes too much energy from one major source: burning fossil fuels. All forms of energy be measured, and 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 immensely huge numbers involved – see Table 2.

Table 2. Energy consumption 2015 (Million Tons of oil equivalent)

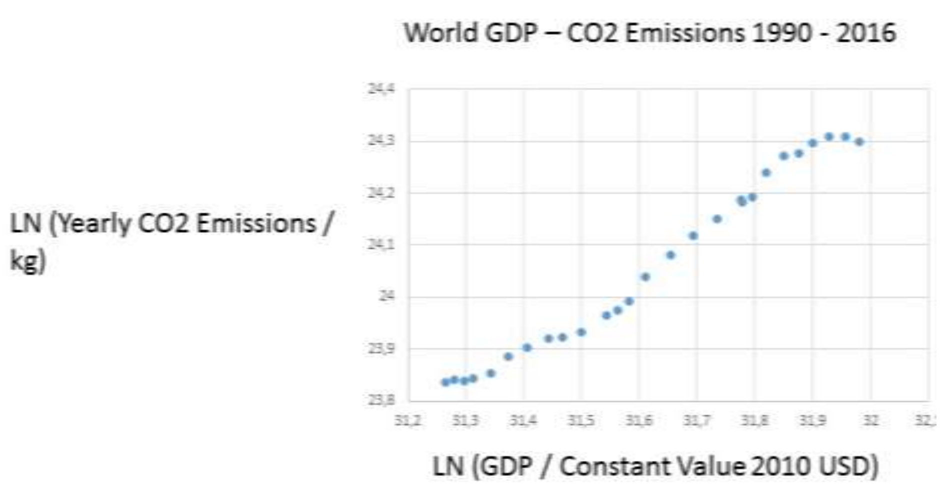
	Total	%
Fossil fuels	11306,4	86,0
Oil	4331,3	32,9
Natural Gas	3135,2	23,8
Coal	3839,9	29,2
Renewables	1257,8	9,6
Hydroelectric	892,9	6,8
Others	364,9	2,8
Nuclear power	583,1	4,4
Total	13147,3	100,0

Source: BP Statistical Review of World Energy 2016

Table 2 holds the answer to why CO2 and GHG emissions have become the global headache number 1. Energy for humans and their social systems come to an average of 90% from burning fossil fuels: stone and wood coal, oil and gas. And people do that all over the world, though to very different degrees from 100% to less than 50% of all energy consumption, because it is necessary for affluence and survival. The enormous expansion in the energy consumption of fossil fuels has allowed the world to take on many new inhabitants, as well as reducing poverty in the Third World and much enhancing affluence and wealth in the First world.

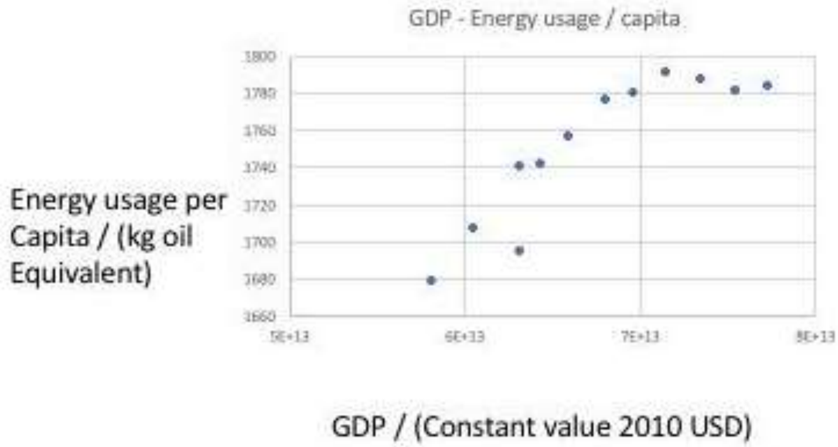
First, we underline that CO2 emissions are closely connected with energy consumption, globally speaking. And the projections for future energy augmentation in the 21st century are enormous, especially for Asia (EIA, BP, IEA). Figure 2 shows how things have developed since 1990.

FIGURE 2. Global GDP-CO2 link: $y = 0{,}7498x$, $R^2 = 0{,}9801$



Second, we show in Figure 3 that GDP increase with the augmentation of energy per capita. Decarbonisation is the promise to undo these dismal links by making GDP and energy consumption rely upon carbon neutral energy resources, like modern renewables and atomic energy.

FIGURE 3. GDP against energy per person, 2005-2016



Source: World Bank Data Indicators, data.worldbank.org
BP Statistical Review of World Energy 2017

The *energy-emissions conundrum entails*: GDP growth being unstoppable requires massive amounts of energy that results in GHC:s. The only way out of this dilemma is that renewables become so large and effective in a short period of time that decarbonisation becomes feasible, in accordance with the three goals of COP21 Treaty.

Decarbonisation puts pressure on countries. Not only do they have engage in a fundamental energy transformation, but they are also supposed to contribute to the so-called Super Fund. It will assist poor and emerging economies with a yearly budget of some 100 billion $. Both the energy changes and the funding set up an ocean prisoners' dilemma game where defection will be very temptation. Governments may renege upon their obligations in several ways, with delays or refusal to pay. If self-seeking dominates the implementation of the COP21 Treatr\y, social determinism may push mankind to the limit where nature's determinism takes over, i.e. the point of irreversibility.

Most nations plan to increase their energy supply in the coming decades, at the same time as they have to comply with decarbonisation. Since energy is so vital for socio-economic development and economic growth, countries that fail to do both may engage in reneging. Managing the decarbonisation process according to the COP21 Treaty involves an enormous set of challenges, both technologically and funding-wise. One may mention:

a) The logic of the PD game will show up time and again during the whole decarbonisation process. When countries have difficulties meeting their obligations they defect with impunity. Small countries are tempted by the N-1 problematic, meaning that their defection does not count for much. On the other hand, big nations are tempted by the 1/N problematic, meaning that they have to share with others their costly contributions to the common good. Only the management of selective incentives can halt reneging.

b) The coming COP23 conference must start setting up the administrative machinery for implementing the COP21 goals. It will be very difficult, given the promise of a yearly support of 100 million $ to poor and emerging economies. All kinds of opportunistic strategies are relevant: black-mailing, cheating with information, corruption, embezzlement, - all forms of PD defection. At the end of the day, socio-economic development and economic growth trump environmentalism, most of the time. Halting climate change will be acceptable to several countries, if it does not reduce economic affluence.

4. DEGREES OF FREEDOM

We are not yet at the point of irreversibility, meaning there are still a few degrees of freedom for government policy-making and international governance. The plans of the UNFCCC must be implemented by all nations: Goal I: halting CO2 growth, Goal II: reducing CO2s until 2030 and Goal III: near complete decarbonisation by 2075.

Among the alternatives of action in decarbonisation, one may mention: atomic power, b) carbon capture, c) biomass, d) wind power, e) geo-thermal power and f) solar power. How big changes are needed if countries would rely upon solar power parks? Let us offer a model example, based only upon solar power parks.

Consider now Table 3, using the giant solar power station in Morocco as the benchmark – How many would be needed to replace the energy cut in fossil fuels and maintain the same energy amount, for a few selected countries with big CO2 emissions?

Table 3. Number of Ouarzazate plants necessary in 2030 for COP21's GOAL II: (Note: Average of 250 - 300 days of sunshine used for all entries except Australia, Indonesia, and Mexico, where 300 - 350 was used).

Nation	**Co2 reduction pledge / % of 2005 emissions**	**Number of gigantic solar plants needed (Ouarzazate)**	**Gigantic plants needed for 40 % reduction**
United States	26 - 28[i]	2100	3200
China	none[ii]	0	3300
EU28	41 - 42	2300	2300
India	none[ii]	0	600
Japan	26	460	700
Brazil	43	180	170
Indonesia	29	120	170
Canada	30	230	300
Mexico	25	120	200
Australia	26 – 28	130	190
Russia	none[iii]	0	940
Canada	30	230	300
Mexico	25	120	200
France	37[v]	210	220
Italy	35[v]	230	270
Sweden	42[v]	30	30
Argentina	none[ii]	0	80
Uruguay	none[ii]	0	3
Chile	35	25	30
World	N/A	N/A	16000

Notes:

1) The United States has pulled out of the deal; 2) No absolute target; 3) Pledge is above current level, no reduction; 4) Upper limit dependent on receiving financial support; 5) EU joint pledge of 40 % compared to 1990

If countries rely much upon water or geo-thermal power or atomic power, the number in Table 1 will be reduced. Table 1 displays the dependency upon fossil fuels that may go over 90%in some countries. Each country energy predicament is both situation dependent and path dependent, reflecting natural resources and past policies/

The key question is: Can so much solar power be constructed in some 10 years? If not, Hawking may be right. Thus, the COP23 should decide to embark upon an energy transformation of this colossal size.

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

It has been researched has much a climate of Canadian type impacts upon solar power efficiency. In any case, Canada will need backups for its many solar power parks, like gas power stations. Mexico has a very favourable situation for solar power, but will need financing from the Super Fund, promised in COP21 Treaty. In Latin America, solar power is the future, especially as water shortages from the Andes may be expected. Chile can manage their quota, but Argentine needs the Super Fund for sure. Uruguay has the best number globally, relying upon water and biomass.

Table 4 has the data for the African and Asian scene with a few key countries, poor or medium income..

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

Nation	Co2 reduction pledge / % of 2005 emissions	Number of gigantic solar plants needed (Ouarzazate)	Gigantic plants needed for 40 % reduction
Algeria	7 - 22[iv]	8	50
Egypt	none[ii]	0	80
Senegal	5 - 21	0,3	3
Ivory Coast	28-36[iv]	2	3
Ghana	15 – 45[iv]	1	3
Angola	35 – 50[iv]	6	7
Kenya	30[iv]	3	4
Botswana	17[iv]	1	2
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

Notes:

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Since Africa is poor, it does not use much energy like fossil fuels, except Maghreb as well as Egypt plus much polluting South Africa, which countries must make the energy transition as quickly as possible. The rest of Africa uses either wood coal, leading to deforestation, or water power. They can increase solar power without problems when helped financially. For a few Asian countries, the numbers are staggering, but can be fulfilled, if turned into the number ONE priority. Some of the poor nations need external financing and technical assistance.

5. DECARBONISATION SRATEGIES

The UNFCCC suggests a decentralized management strategy for decarbonisation. Reflecting the enormous differences in available energy resources in the member states of COP21 Treaty, as outlines in the Table 3 and Table 4 above, each government must develop a strategy for achieving Goal I, Goal II and Goal III, but under international governance oversight and hopefully economic support and technological assistance. The COP may wish to concentrate upon the following measures start credible decarbonisation:

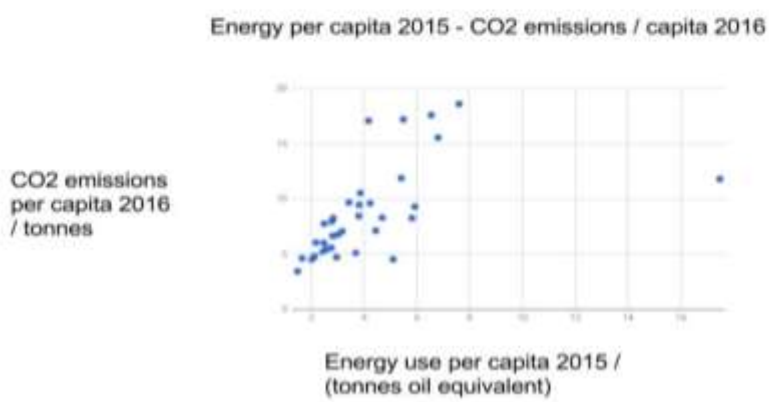
1) Phasing out coal power plants; convincing a few countries like India and Australia not to build new ones;
2) Replace wood coal with natural gas – small or large scale, stopping deforestation and the use of charcoal in households in poor nations;
3) Stimulate the innovations in nuclear power, so that safe atomic may be utilized; there is no need to dismantle atomic power stations in Western Europe;
4) Massive construction of solar power and wind power plants in all countries, as well as stimulate small scale solar power;
5) Turn some countries away from massive dam constructions towards solar power parks, like Brazil and India, as the environmental damages are too big;
6) Help some countries maintain their forests;
7) Abstain from expensive and unsafe carbon sequestration techniques in favour of electricity: solar power and electrical vehicles.

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.

6. CONCLUSION

At the forthcoming UNFCCC meeting in Bonn, the willingness of the COP21Treaty members to engage in sharp decarbonisation will be tested. They constitute a common pool club where each member country face the dilemma in Figure 5: more energy gives higher economic growth but also more CO2s. If countries continue to prioritize fossil fuels induced socio-economic development, they will defect in this ocean PD game and bring about irreversibility.

Figure 5. Energy and CO2s per capita



Sources: EU CO2 Database EDGAR: Co2 and GHG emissions of all world countries, http://edgar.jrc.ec.europa.eu/booklet2017/CO2_and_GHG_emissions_of_all_world_countries_booklet_online.pdf

World Bank Data indicators, http://data.worldbank.org

REFERENCES

SOURCES: ***Solar power***

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

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

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

GDP sources:

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

GHG and energy sources:

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

Literature

i. *Conka, K. (2015) Un Unfinished Foundation. The United Nations and Global Environmental Governance. Oxford: OUP.*
ii. *Kaya, Y., and Yokoburi, K. (1997) Environment, energy, and economy: Strategies for sustainability. Tokyo: United Nations University Press.*
iii. *Ostrom, E. (1990) Governing the Commons. Cambridge: Cambridge U.P.*
iv. *Ramesh, J. (2015) Green Signals: Ecology, Growth and Democracy in India (2015). Oxford : Oxford University Press.*
v. *Sachs, J.D. (2015) The Age of Sustainable Development. New York: Columbia University Press.*
vi. *Stern, N. (2007) The Economics of Climate Change. Oxford: OUP.*
vii. *Stern, N. (2015) What are we waiting for? Cambridge, MA: MIT Press.*
viii. *Vogler, J. (2016) Climate Change in World Politics. Basingstoke: MacmillanPalgrave*
ix. *USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp., doi: 10.7930/J0J964J6.*

NOTES

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