International Journal of Research in Humanities and Social Studies
Volume 3, Issue 1, January 2016, PP 1-17
ISSN 2394-6288 (Print) & ISSN 2394-6296 (Online)

THE COP21 AGREEMENT: Greenhouse Gases and the GDP

Jan-Erik Lane

fellow with Public Policy Institute in Belgrade, 10 Charles Humbert, 1205 Geneva

ABSTRACT

The global agreement from the COP21 meeting will put immediate pressures upon countries to plan for the 2018-2020 cap on augmentation of the emission of greenhouse gases (GHG). The +2, or even hopefully +1,5 goal requires that the increase in the emission of greenhouse gases is halted and reversed during the 2020s into a trend of decreases yearly throughout this century. But we must ask how about the implications for politically relevant goal of economic development, especially for the developing countries. Economist Jeffrey Sachs has stated publicly that decarbonisation would reduce economic growth, at least in the short run, before new technologies can be put to use on a massive scale. This paper examines the macro link between the increase in country GDP and the evolution of GHG emissions for a set of key nations for the period 1990-2014. The conclusion is that decarbonisation will prove very difficult for several countries, especially for countries relying almost exclusively on fossil fuels.

Keywords: GHG, GDP, decarbonisation, energy types, global warming: +1, 5, +2, +2. 7, +4, +6, developing countries, advanced countries, halting emission growth, reducing emissions, country energy sources.

INTRODUCTION

The governments, the IGO:s and NGO:s and other experts on climate change will hear that halting or reducing the emission of GHG:s must involve costs. There are simply not enough alternative energy sources or innovations to draw upon, at the moment. Some countries will ask for special delays, others will call for economic assistance or compensation and some may even decide to promise but later renege. What is involved in

this trade-off between reduction of greenhouse gases on the one hand and economic development or growth on the other hand? This article portrays this connection by means of figures on key countries. The closer the link between GDP and emissions is, the more painful or costly will the transition to a reduction of emissions be.

METHOD AND DATA

This paper employs two sets of data. On the hand, the country GHG emissions have been taken from two sources: World Resources Institute, EU Joint Research Centre Emission and UN Framework Convention on Climate Change. On the other hand, country GDP numbers are available in the following sources: World Bank and OECD. Combining these data sources and transforming the enormous figures by the LN allows us to put up emissions growth against GDP growth for the last 20 years. This allows for the identification of the standard link between economic development and emissions, while also finding a few countries that have succeeded to halt if not also reverse the trend towards more and more emissions. The emission of GHG:s and the rates of GDP development have one element in common, namely the use of energy. Countries that have not succeeded in halting emissions are extremely reliant upon fossil fuels, especially coal. Yet, the use of certain renewables does not always lead to reductions in aggregate country emissions.

The global warming process is already on and proceeds seemingly unstoppably, involving *inter alia* larger climate swings, deforestation, desertification, ocean acidification and rising sea levels. One does not really know whether it is an irreversible transformation of Planet Earth, or where it could be stopped: + 1, 5, +2, + 2, 7, +4, +6, or would end in a global catastrophe. We look at the last two

Address for correspondence:

janeklane@gmail.com

decades when the debate about climate change really got momentum as the evidence has multiplied about a dangerous process of global warming.

GREENHOUSE GASES: Tiny but Effective

Greenhouse gases (GHG) contribute to the so-called greenhouse effect, which boils down to continuous overall warming of the Planet Earth. Atmospheric gases trap electromagnetic radiation from the sun that would otherwise have been reflected back out into space. These greenhouse gases include: methane, nitrous oxide, carbon dioxide, hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulphur hexafluoride (SF6). But these gases make up only a small fraction of the gases of the atmosphere. Figure 1 shows the actual situation with these tiny GHG:s.

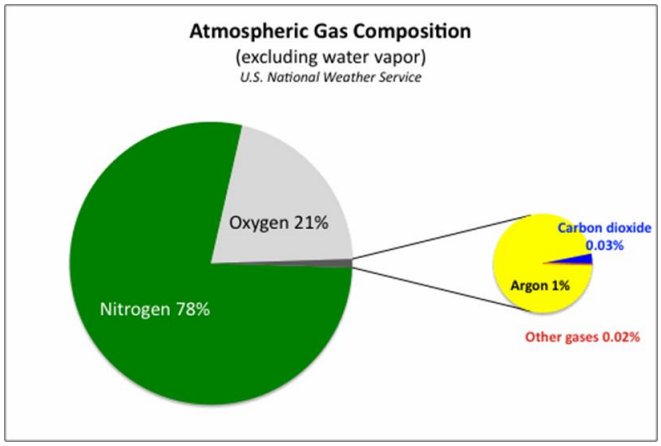


Figure1.

The composition of the atmosphere comprises basically nitrogen and oxygen with merely 0.05 per cent carbon dioxide and other GHG:s. Can these tiny particles really bring future disaster to mankind? Answer: YES!

20 per cent of the greenhouse effect is attributed directly to carbon dioxide with 5 per cent to the remaining 6 greenhouse gases. 75 per cent of the greenhouse effect is thought to be due to naturally-occurring water vapour and clouds. Some greenhouse gases are produced in natural processes, like forest fires, animal manure and respiration, or volcanic eruptions. However, the majority of new greenhouse gases are produced from industrial processes with huge energy consumption as well as energy production. We quote:

"The four largest human sources of U.S. greenhouse gases in 2009 were energy, non-fuel use of fossil fuels, natural gas production, and cement manufacture, in descending order. Non-fuel, greenhouse gas-producing applications of fuels include industrial production like asphalt, lubricants, waxes and other. Emissions related to cement manufacture happen when limestone (calcium carbonate) is reacted with silica to make clinker, the lumps ground to make cement." (http://burnanenergyjournal.com/the-connection-between-greenhouse-gases-climate-change-and-global-warming/)

RELEVANCE OF ENERGY SOURCES

Fighting global warming involves reflecting upon several measures, as with the CAP21 conference in Paris, including:

- Slowing population growth
- Changing agricultural production modes
- Water recycling and waste treatment
- Ocean protection
- Changes in energy consumption: "decarbonisation"
- Stopping deforestation and protecting rain forests.

Although energy is far from the only source of greenhouse gases, it is the single largest one. Energy use crops up in all forms of activities most often with an economic element: industry, transportation – land, sea, air, housing and commerce as well as food production and agriculture (APPENDIX 1)

How important energy consumption is for daily life domestically appears from the Figure 2 below (http://www.auroras.eu/sensore-di-assorbimento-corrente-un-sensore-wireless-per-il-risparmio-energetico/).

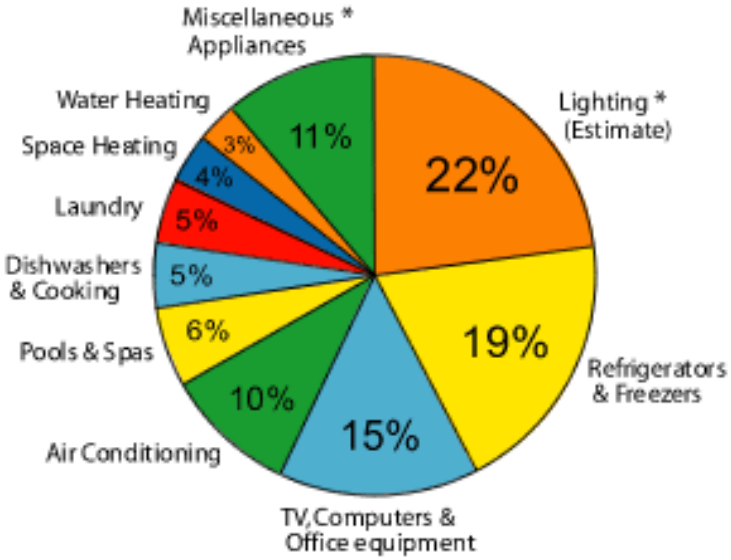


Figure2.

The energy question concerns how all these vital activities in our economic and social systems like the family are to be furnished from a few sources of energy. Figure 3 displays these sources and their relative weights.

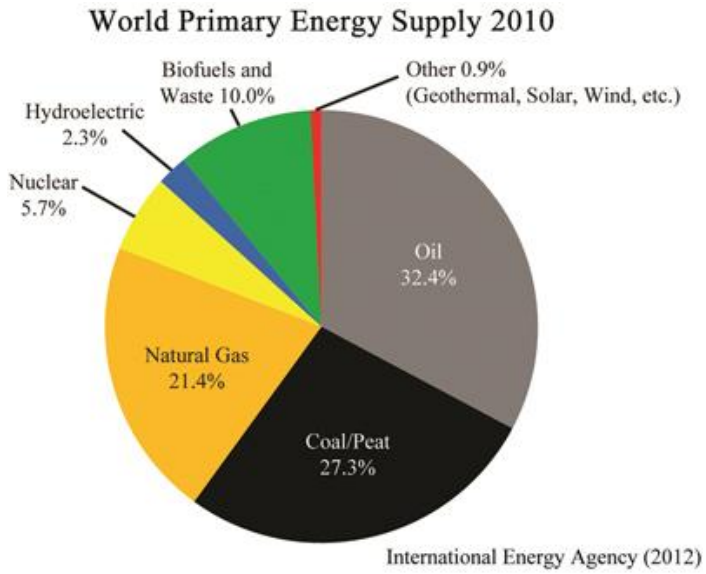


Figure3.

Globally speaking, more than 80 per cent of the energy consumed daily is derived from the burning of fossil fuels. How fast can this be changed and what could be the economic costs of decarbonisation? Countries can attempt to meet their obligations in the COP21 Agreement by decarbonisation, lower economic growth or more energy efficiency. New technology and innovations will be crucial, not only in small scale endeavours but used massively. We wish to find out below is how countries vary in terms of their energy consumption.

Jeffrey Sachs: Decarbonisation and Economic Development

Sachs has launched a coherent call for the world to move towards *sustainable* development, based on decarbonisation of the energy systems of countries (http://jeffsachs.org/2015/08/sustainable-development-for-humanitys-future/). He has correctly emphasized the close link between economic development or growth and the massive use of fossil fuels as energy sources during the last 20 years, resulting in the enormous expansion of GHG emissions. The Figure 4 displays this link.

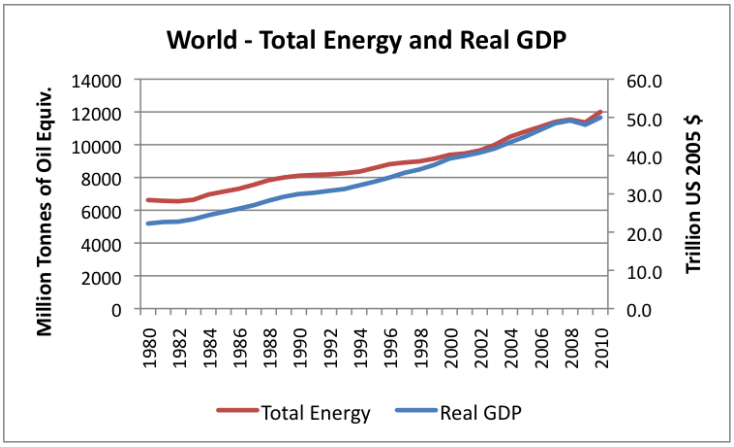


Figure4. Growth in world energy consumption (based on BP data) and growth in world real GDP

However, given this close link between GDP and energy consumption, how can the countries of the world achieve decarbonisation without hampering economic development or growth? What is the country link between GDP and GHG emissions? It depends upon the nation in question!

VERY STRONG LINK: GDP-GHG

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 emissions are the largest in the world, totally speaking (Figure 5).

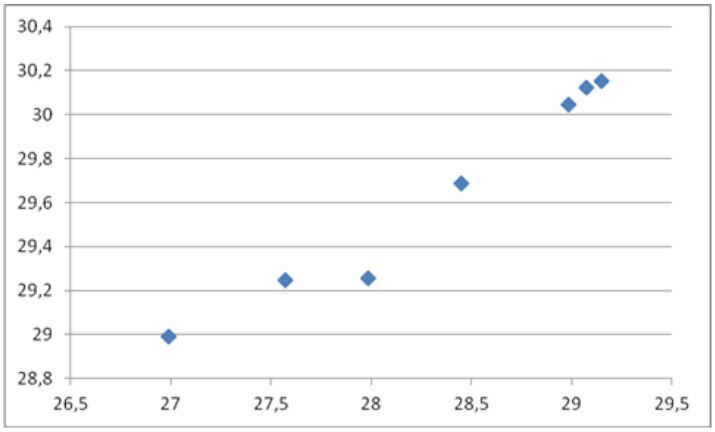


Figure5. *China: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Note: *GHG = y-axis, GDP = x-axis*

The sharp increase in GHG:s in China reflects not only the immensely rapid industrialization and urbanization of the last 30 years, but also its problematic energy mix (Figure 6).

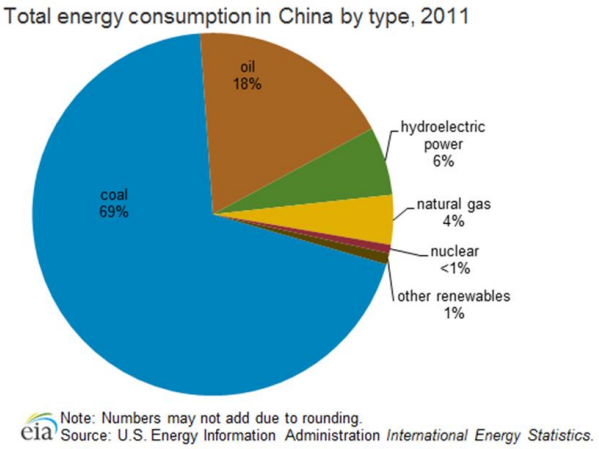


Figure 6.

Almost 70 per cent of the energy consumption comes from the burning of coal with an additional 20 per cent from other fossil fuels. The role of nuclear, hydro and other renewable energy sources is very small indeed. This makes China very vulnerable to demands for cutting GHG emissions: other energy sources or massive installation of highly improved filters?

It should be pointed out that several small countries have much higher emissions per capita than China. This raises the enormously difficult problematic of fair cuts of emissions. Should the largest polluters per capita cut most or the biggest aggregate polluters? At COP21 this issue was resolved by the creation of a super fund to assist energy transition and environment protection in developing counties, as proposed by economist Stren (2007)

India will certainly appeal to the same problematic, namely per capita or aggregate emissions. The country is even more negative than China to cut GHG emissions, as it is in an earlier stage of industrialization and urbanization. Figure 7 shows the close connection between emissions and GDP for this giant nation.

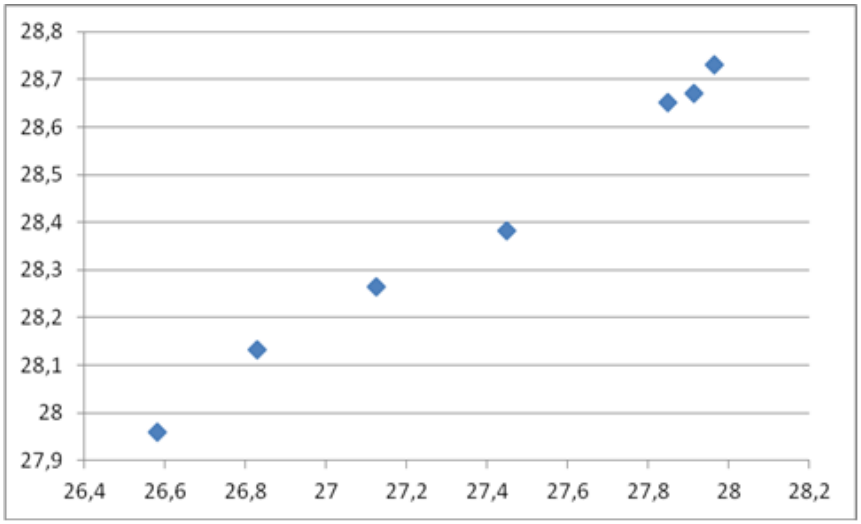


Figure7. *INDIA: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Note: *GHG = y-axis, GDP = x-axis*

India needs cheap energy for its industries, transportation and heating (Figure 7) as well as electrfication. 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. India actually has one of smallest numbers for energy per capita, although it produces much energy totally. Figure 8 shows its energy mix where renewables play a bigger role than in China.

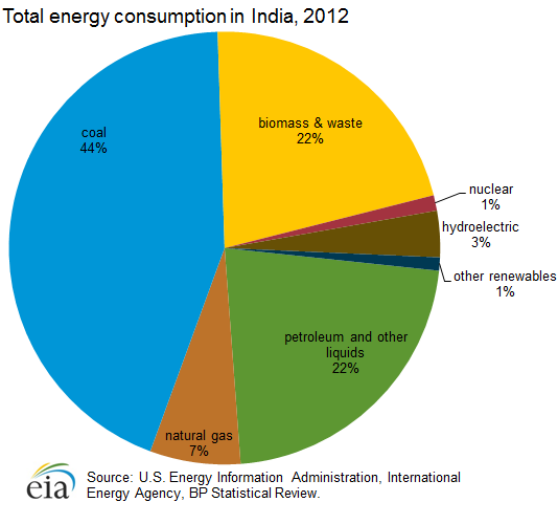


Figure8.

India needs especially electricity, as 300 million inhabitants lack access to it. The country is heavily dependent upon fossil fuels (70 per cent), although to a less extent than China. Electricity can be generated by hydro power and nuclear power, both of which India employs. Yet, global warming

reduces the capacity of hydro power and nuclear power meets with political resistance. Interestingly, India uses much biomass and waste for electricity production, which does not always reduce GHG emissions. India's energy policy will be closely watched by other governments and NGO:s after 2018.

One may find a close link between GDP and emissions also in countries with an advanced economy. See Figure 9 for South Korea.

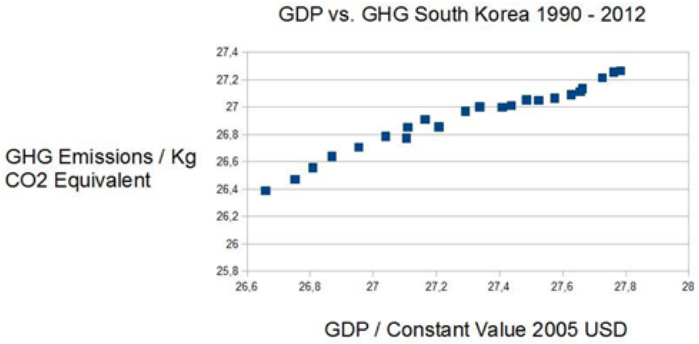


Figure9. *South Korea: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

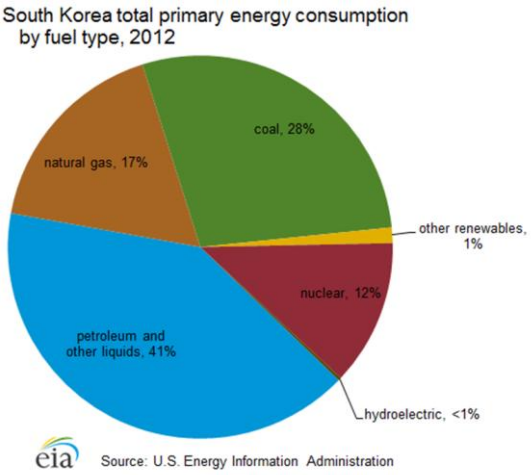


Figure10.

Lacking much hydro power, South Korea has turned to fossil fuels for energy purposes, almost up to 90 per cent (Figure 10). It differs from China only in the reliance upon nuclear power, where the country is a world leader in plant constructions. Reducing its hefty GHG emissions, South Korea will have to rely more upon renewable energy sources, as well as reducing coal and oil for imported gas or LNGs.

The above three countries are giant polluters in terms of GHGs. China and South Korea uses mainly fossil fuels for energy consumption, whereas India also employs renewables and hydro power, lacking in the other two. Yet, the burning of renewables like biomass and waste for electricity generation also leads to GHG emissions. Only nuclear and hydro constitute emissions neutral energy (Figure 11).

Specific Energy, Energy Density & CO2

Fuel	Specific Energy kj/g	Density KWH/gal	Chemical Formula	lbs CO2/gal
Propane	50.4	26.8	C3H8	13
Ethanol	29.7	24.7	C2H5OH	13
Gasoline	46.5	36.6	C7H16	20
Diesel	45.8	40.6	C12H26	22
Biodiesel	39.6	35.0	C18H32O2	19
Methane	55.8	27.0	CH4	3
Oil	47.9	40.5	C14H30	20
Wood	14.9	11.3	approx weight	9
Coal	30.2	22.9	approx weight	19
Hydrogen	141.9	10.1	H2	0

Source: DOE, Stanford University, College of the Desert, & Green Econometrics research

Figure11. *Types of Energy and Emissions*

Only hydrogen is carbon neutral, according to Figure 11. Ethanol and renewables like wood or biodiesel are not.

NOT SO STRONG LINK

The picture of a very close link between GDP and emission of GHG:s that is to be found with the three giants in Asia does not necessarily hold for all countries. Let us look at a few countries where this link is weaker, starting with Canada that has halted the expansion of GHG:s (Figure 12).

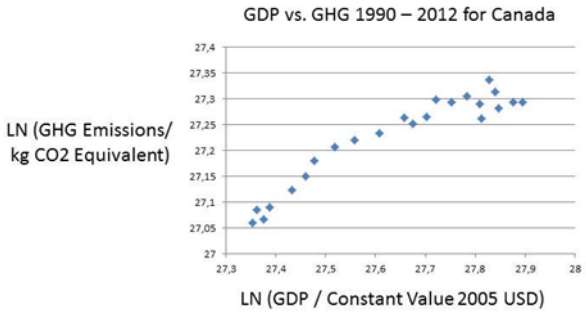


Figure12. *Canada: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Although Canda is a major emitter of GHG:s as well as one of the world's largets fossil fuel producer – oil sands, it had managed to stem the increase in emissions for the most recent years, i.e. halting the augmentation. Figure 13 may be invoked to explain this, showing a very mixed energy consumption pattern.

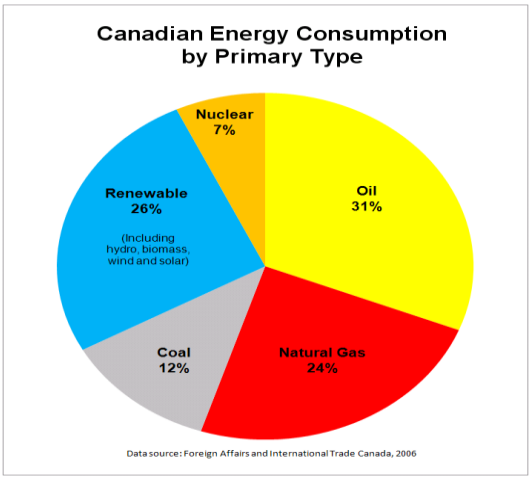


Figure13.

Canada has a strong advantage compared with for instance China and India in thatit has access to lots of hydro power and natural gas. The burning of coal is as low as 12 per cent, but oil still makes up almost a third of energy consumption.

Let us look at the ethanol country *par preference*: Brazil. Figure 14 shows a considerable drop in total emissions, but it is followed by huge increases that tend to flatten out.

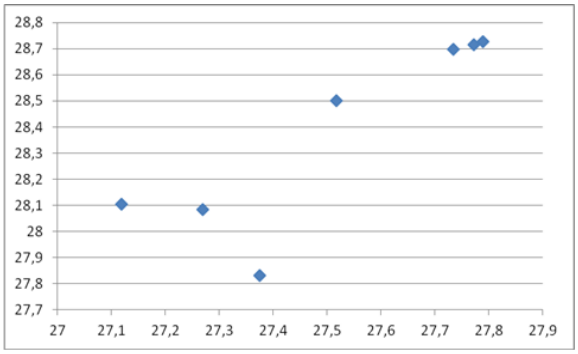


Figure14. *BRAZIL: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Note: *GHG = y-axis, GDP = x-axis*

Brazil employs the most biomass in the world, but the emissions stay at a high level, which is a reminder that renewables may also have GHG:s. One advantage for Brazil is the large component of hydro power, but the overall picture for the largest Latin American country is not wholly promising when it comes to reduction of emissions. Global warming reduces the potential of hydro power, and Brazil has very little nuclear power (Figure 15).

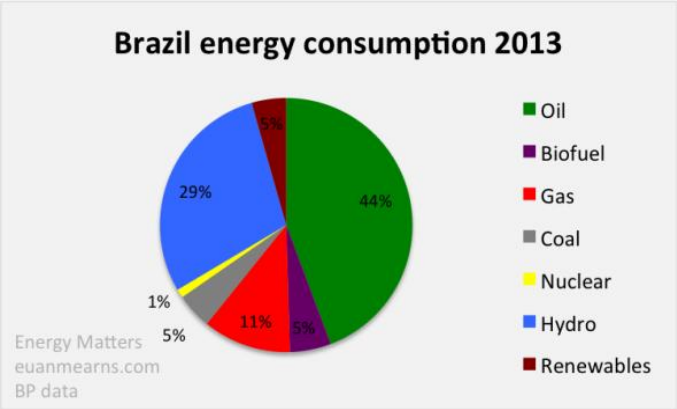


Figure15.

The Russian picture is split, with two series of estimates, both placing the country as a major polluter of GHG: s (Figure 16**).**

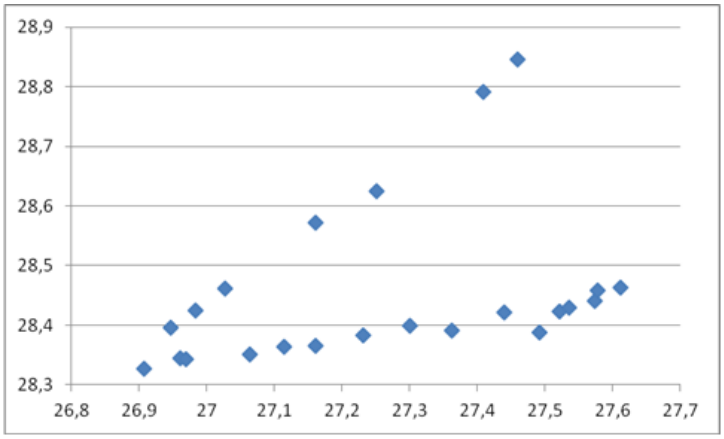


Figure16. *Russia: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Note: *GHG = y-axis, GDP = x-axis*

The shifts in the data in Figure 16 may be due to the on-going deindustrialization process connected with the fall of the Soviet Union. In any case, Russia is extremely dependent upon fossil fuels – up to 90 per cent, especially natural gas (Figure 17).

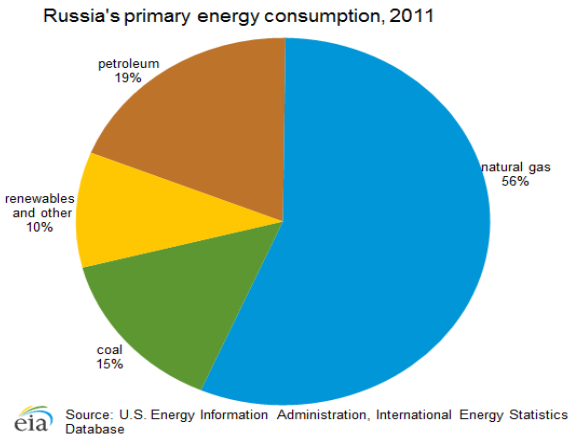


Figure17.

Russia will hardly be very active in promoting major reductions in GHG:s, as it has only so much hydro and nuclear power, relying upon fossil fuels, especially gas.

WEAK LINK

For most countries hold that their emission of GHG:s increases, as well as augments with the GDP. However, there are a few notable exceptions of decreases that are worth mentioning. We start with the US (Figure 18).

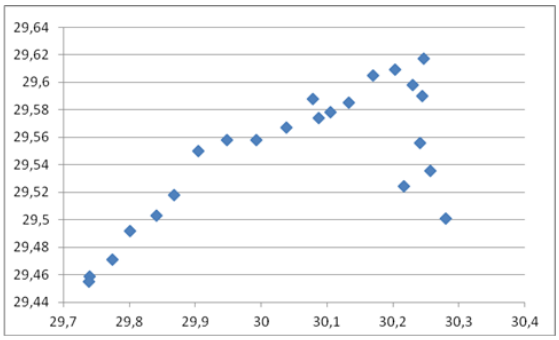


Figure18. *USA: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Note: *GHG = y-axis, GDP = x-axis*

Recently, the level of GHG emission has been reduced significantly in the US. It reflects no doubt the economic crisis that began 2007, but the US remains the second largest polluter in the world, reflecting that it cannot draw upon a mixed bag of energies (Figure 19). Per capita GHG:s is of course very high for the USA. As the economy now starts to accelerate, emissions are bound to go up again.

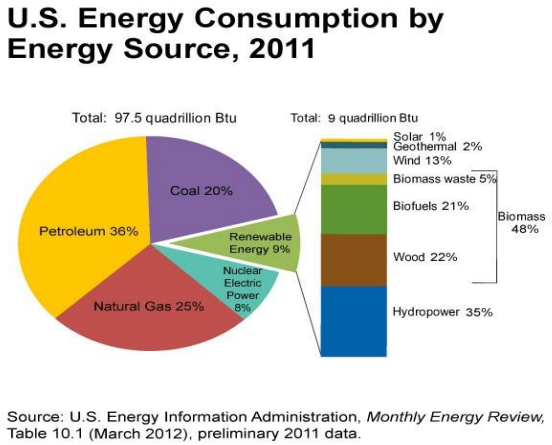


Figure19.

The US is heavily dependent upon fossil fuels, or some 89 per cent comes there from. What is changing is the more and more of energy is produced within the US and no longer imported from outside – the *shake oil and gas* revolution. Further reduction of GHG:s will meet with firm resistance from the Republican House of Congress, which may oppose the COP21 Agreement. The advent of shale oil and gas has changed the entire energy markets, lowering the price of oil most substantially. This implies not only that there will be no Hubbert peak oil for the world, but also that switching to renewable energy source will be extremely expensive, relatively speaking.

Another interesting country is the largest EU economy, namely Germany. Figure 20 shows a marked decrease in GHG emissions.

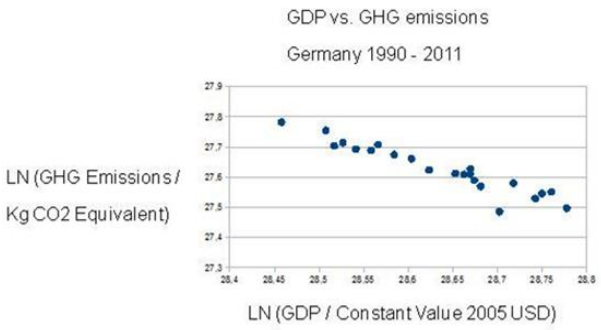


Figure20. *GERMANY: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

The German data shows a consistent decreasing trend, which is not to be found with many countries, if at all. How come this German exceptionalism? Germany needs massive amounts of energy, but it decided to phase out nuclear power. Can really the domestic employment of renewables satisfy this gigantic demand (Figure 21)?

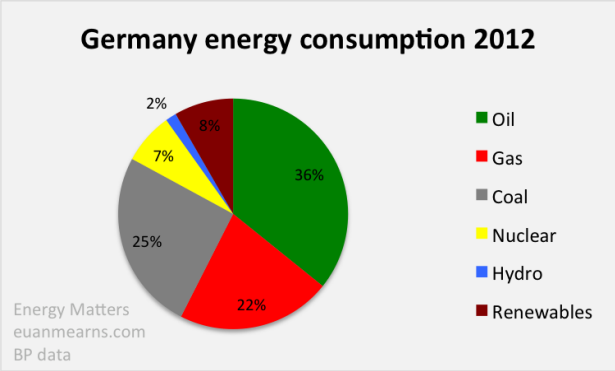


Figure21.

It is true that nuclear power and renewables has made it possible for Germany to decrease its GHG:s, but the country is still dependent upon fossil fuels, especially coal and oil. What will happen with the nuclear power stations are phased out in 2022 is that most likely the GHG emissions will start going up again. To replace nuclear power with solar and wind power will be difficult to say the least. Already, Germany uses more coal from Columbia and gas from Russia.

Japan has a rather similar situation in that it will no longer rely much upon nuclear power. Its emissions have gone done recently, but seem to be on the rise again (Figure 22).

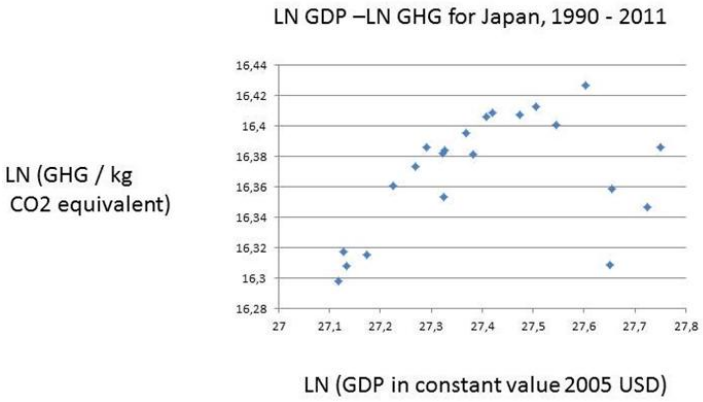


Figure22. *JAPAN: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

The decrease in emissions for Japan reflects the country's post-industrial developments. Production sites have been moved out of Japan with heavy investments in other Asian countries as well as the EU and the US. Yet, Japan will still need massive amounts of energy (Figure 23). After the Fukushima disaster, it operates only 1 nuclear power station.

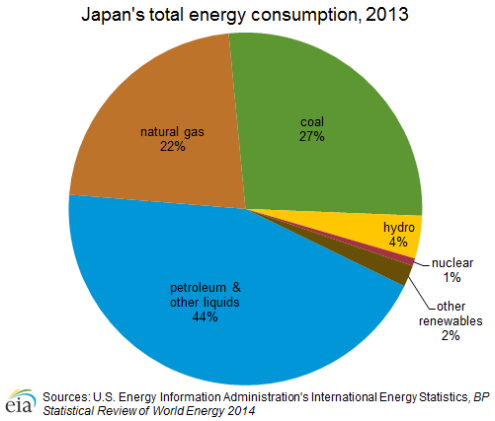


Figure23.

As Figure 23 shows, Japan is very dependent upon fossil fuels for generating electricity and transportation, especially when nuclear power is no longer a major option with one nuclear power plant operating now in Japan.

THE GREEN STATES

Some countries applaud themselves for a positive energy policy, i.e. a policy that leads to decreases in emissions. But is it really true? Look first at Singapore in Figure 24.

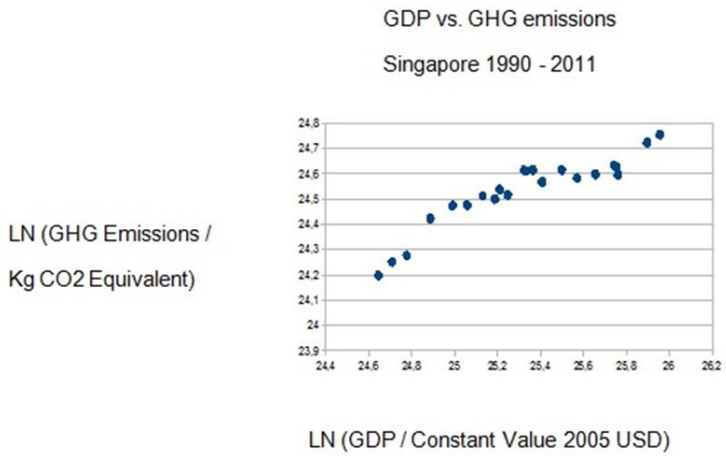


Figure24. *SINGAPORE: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Despite its official statements about being a *GREEN* city, emissions have been going up steadily in Singapore. The GHG:s is very high if related to per capita. Its energy mix is only oil and natural gas, imported from abroad (Figure 24). Singapore needs lots of electricity to bolster its advanced life style (air conditioning, total waste water cleaning, etc).

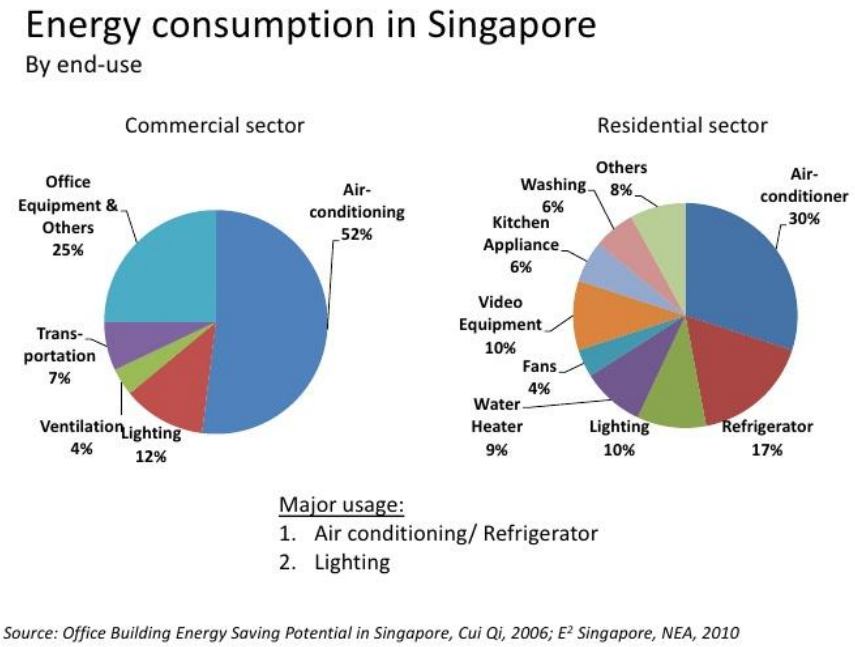


Figure24.

Why would this island state need too much energy, resulting in such an amount of emission of GHG:s? Reply: the need for fossil fuels to generate electricity and make transportation possible**.** Singapore has a hot climate and handles that with a complete use of air conditioners all over the pkace. It is also a huge hub for shipping and air travel. It is impossible to generate so much electricity without emissions when using fossils fuels. Singapore has a large oil refinery.

Consider now another GREEN state, the United Arab Emirates (Figure 25).

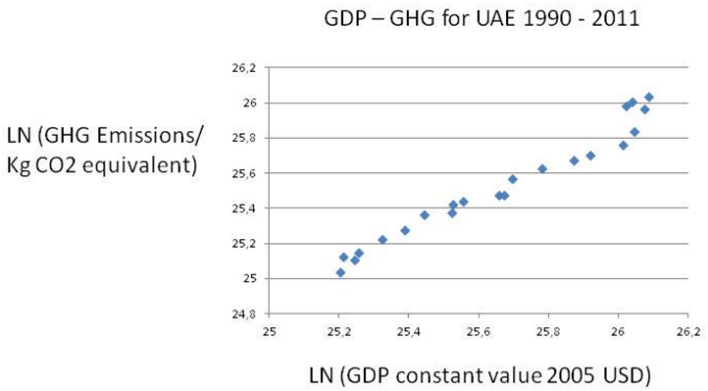


Figure25. *UNITED ARAB EMIRATES: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

The UAE have increased their emission of GHG sharply in relation the positive economic development of these emirates. They rely upon the fossil fuels of Abu Dhabi with immense oil resources. Like other Gulf States, the UAE boosts with building entirely GREEN sites, with energy from solar power and almost no waste. But it is based upon their enormous consumption of electricity generated out of burning oil and gas (Figure 26). The Gulf countries use lots of petrol, gas and electricity to uphold a stunningly high standard of living, which also results in extremely high levels of emissions per capita.

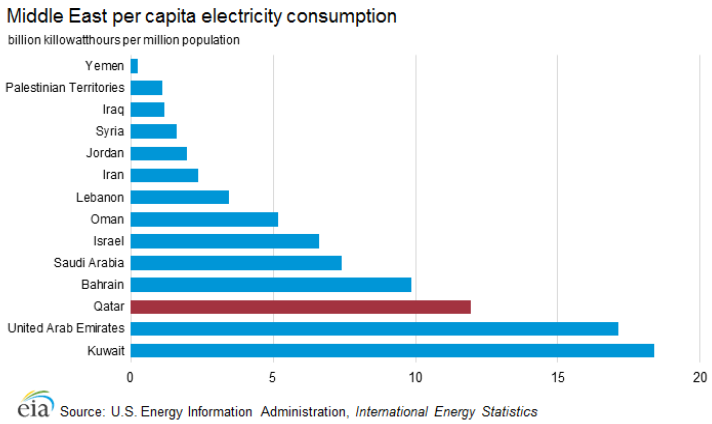


Figure26.

The standard image is that of a close link between GDP and emissions, like for the so-called super rich GREEN states. What is the situation in a few major developmental countries?

DEVELOPMENTAL COUNTRIES

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, like e.g. giant Indonesia – the fourth largest emitter of GHG:s in the world..

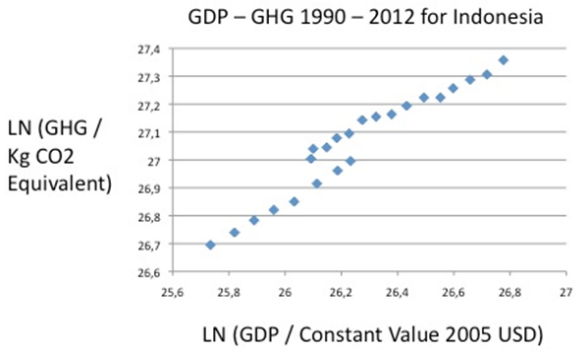


Figure27. *INDONESIA: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Indonesia is a coming giant, both economically and sadly in terms of pollution. Figure 27 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 augments the GHG emissions very much. Figure 28 presents the energy mix for this huge country in terms of population and territory.

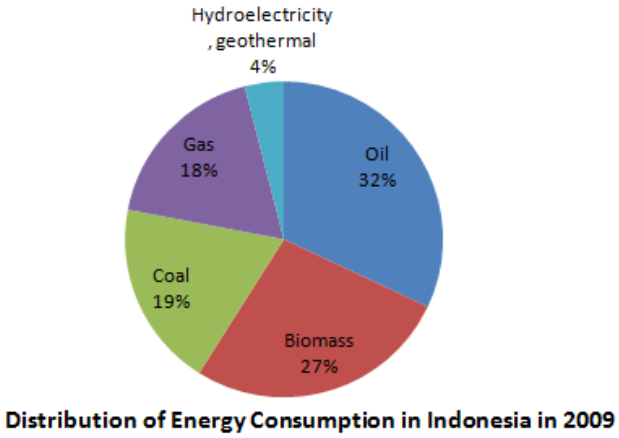


Figure28. *(http://missrifka.com/energy-issue/recent-energy-status-in-indonesia.html)*

Only 4 per cent comes from hydro power with 70 per cent from fossil fuels and the remaining 27 percentfrom biomass, which alas also pollutes.

The same upward trend holds for another major developing country with huge population, namely Pakistan (Figure 29).

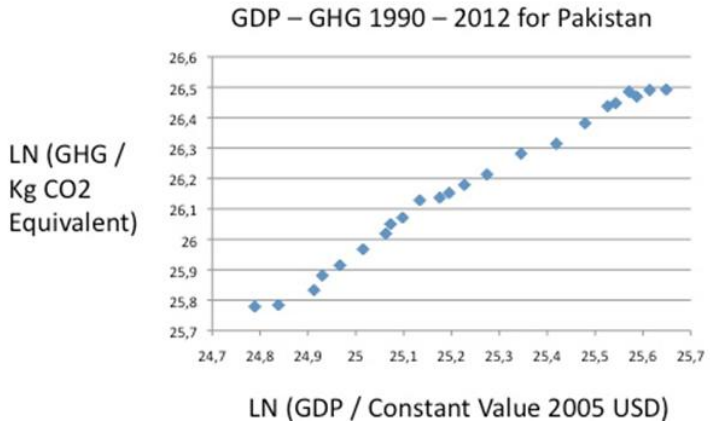


Figure29. *PAKISTAN: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

The amount of GHG emissions is high for Pakistan, viewed as aggregate. Pakistan is mainly reliant upon fossil fuels (Figure 30).

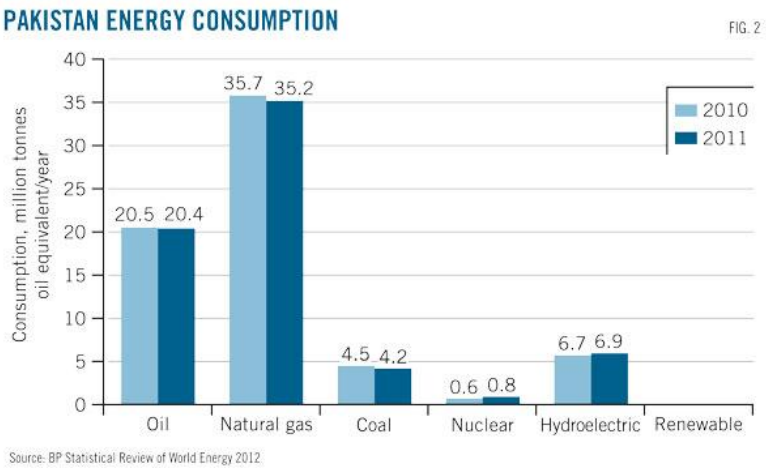


Figure30.

But Pakistan employs a considerable portion of hydropower – 13 per cent – and a minor portion of nuclear power. Looking at South Africa in Figure 30, it is the same trend.

Emissions are high, because South Africa uses a lot of coal to generate electricity (Figure 31). Decarbonisation will be difficult and costly.

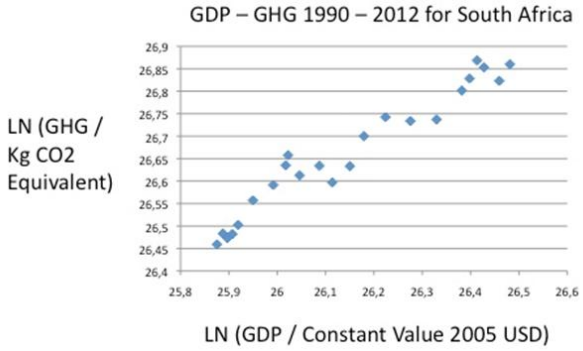


Figure31. *SOUTH AFRICA: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

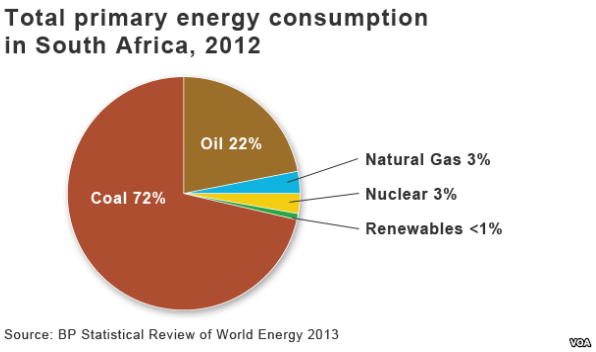


Figure31. *Energy consumption in RSA*

The reliance upon coal in this largest economy in Africa is stunningly high.

CONCLUSION

The overwhelming number of countries in the world displays the upward trend for the emission of GHG:s. A few has managed to halt this progression, linked closely to economic development. But very few have embarked on a path of credible path of diminishing these emissions. The great developing countries are still heavily dependent upon fossil fuels. It is true that hydro power and nuclear power are employed in some countries, but a significant increase in these power sources cannot be expected. Wind and solar power are still in infancy. Biomass has been resorted to on a large scale in a few countries, but it is not carbon neutral.

Ideally, a country would wish to start reducing its emissions of GHG:s without any major impact upon the GDP. This would require a policy mix of promoting energy efficiency, moving towards the use of renewables massively and cutting back upon fossil fuels. I have found one country that fits these conditions – Sweden (Figure 32).

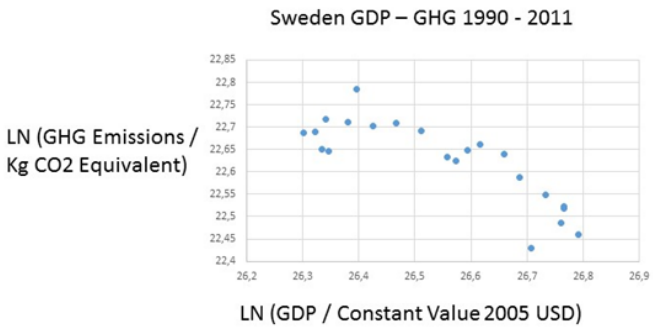


Figure32. *SWEDEN: LN (GHG / Kg CO2 eq and LN (GDP / Constant Value 2005 USD)*

Interestingly, Sweden has embarked upon a steady trend towards emissions reduction, while still experiencing economic growth. The answer may lie in its pattern of energy consumption (Figure 33),

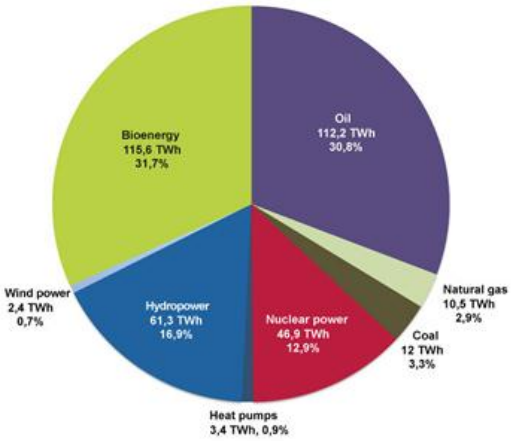


Figure33. *Energy Consumption in Sweden 2010*

Fossil fuels count for less than 50 per cent, and there is massive use of hydro and nuclear power besides some wind power. Bio-energy is almost of the size of oil. Together with efficiency measures, this would be the ideal situation, especially if solar power is added.

Yet, not even for Sweden is the future clearly bright. As it will face out its nuclear power and it cannot increase its hydro power, it will be forced to rely upon biomass and oil during the next decade. Wind power does not give much electricity, though important but marginal.

When discussing the major objective of halting global warming at +2, in order to avoid +4 or catastrophically +6, a lot of measures are mentioned: carbon sequestration, carbon tax, support for new technologies and innovations, huge solar plants, massive wind power stations, wave energy, etc. But people forget that energy consumption is steadily going up, as global population increases and the quest for a high level life style is shared by more and more millions of people. What is gained on one side – decarbonisation, energy efficiency, small scale solar and wind power – may simply be cancelled out by what is lost on the other side: dismantling of nuclear power, expansion of car transportation, SUV:s, etc.

To Sum Up: Returning to Sachs, one can only say that decarbonisation will be hard to come by, especially for countries with little hydro or nuclear power. When the requirements of sustainable development collide with conventional economic growth, something has to give. It is not likely that decarbonisation will trump economic development, at least not enough to avoid + 2, 7, +4 or +6 scenarios. He states: "Economic development, social inclusion, and environmental sustainability are the three tenets underpinning the forthcoming post-2015 development agenda, a once in a generation opportunity to put mankind on the path to a sustainable growth model."

A forceful move towards sustainable economic development would have to wait major innovations in energy consumption and they must prove economical too. The COP21 Agreement lacks completely information about how the major objective of +1,5 should be implemented, both technologically and legally. Strangely enough, the COP21 Treaty does not speak of *filtering* CO2 in all the coal plants!

It is true that both GHG:s and CO2:s have increased a little in 2015, but it is not enough for the objectives of the COP21 approach. The coal sector is diminishing for the natural gas sector. But the transport emissions keeps going up, as more cars enter and bigger ones too. Some countries decrease, whereas others increase.

SOURCES

GDP:

World Bank national accounts data - data.worldbank.org

OECD National Accounts Data Files

GHG:

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

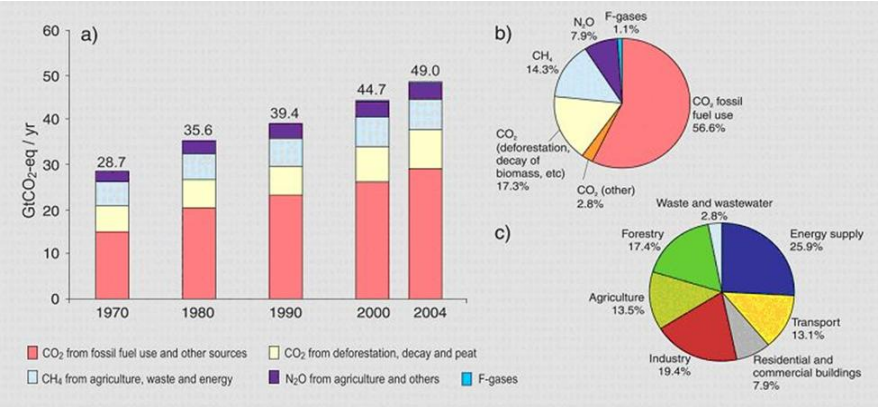
UN Framework Convention on Climate Change -

http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3814.php

Sachs, J. (August 10th, 2015) "Sustainable Development for Humanity's Future" (http://jeffsachs.org/2015/08/sustainable-development-for-humanitys-future/)

International Energy Agency (IEA). Paris.

Energy Information Administration (EIA). Washington, DC.



Appendix1. *Global atmospheric concentrations of four greenhouse gases. From the IPCC 2007 4th Assessment Report*

REFERENCES

Akpan, G. E. (2012). Electricity consumption. Carbon Emissions and Economic Growth in Nigeria, 2(4), 292–306.

Alam, M. J., Begum, I. A., Buysse, J., Rahman, S., & Van Huylenbroeck, G. (2011). Dynamic modeling of causal relationship between energy consumption, CO2 emissions and economic growth in India. Renewable and Sustainable Energy Reviews, 15(6), 3243–3251.

Alkhathlan, K., & Javid, M. (2013). Energy consumption, carbon emissions and economic growth in Saudi Arabia: An aggregate and disaggregate analysis. Energy Policy, 62(2013), 1525–1532.

Ang, J. B. (2008). Economic development, pollutant emissions and energy consumption Malaysia. Journal of Policy Modeling, 30(2), 271–278.

Arouri, M. E. H., Ben Youssef, A., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. Energy Policy, 45(2012), 342–349.

Bloch, H., Rafiq, S., & Salim, R. (2012). Coal consumption, CO2 emission and economic growth in China: Empirical evidence and policy responses. Energy Economics, 34(2), 518–528.

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37(3), 1156–1164.

Jahangir Alam, M., Ara Begum, I., Buysse, J., & Van Huylenbroeck, G. (2012). Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. Energy Policy, 45(2012), 217–225.

Kaygusuz, K. (2009). Energy and environmental issues relating to greenhouse gas emissions for sustainable development in Turkey. Renewable and Sustainable Energy Reviews, 13(1), 253–270.

Khan, M. A., Khan, M. Z., Zaman, K., Khan, M. M., & Zahoor,H. (2013). Causal links between greenhouse gas emissions, economic growth and energy consumption in Pakistan: A fatal disorder of society. Renewable and Sustainable Energy Reviews, 25(2013), 166–176.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. Journal of Energy and Development, 3(2), 401–403.

Lotfalipour, M. R., Falahi, M. A., & Ashena, M. (2010). Economic growth, CO2 emissions, and fossil fuels consumption in Iran. Energy, 35(12), 5115–5120.

Menyah, K., & Wolde-Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. Energy Economics, 32(6), 1374–1382.

Ozturk, I., & Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14(9), 3220–3225.

PACJA (Pan African Climate Justice Alliance). (2009). The economic cost of climate change in Africa.

Soytas, U., Sari, R., & Ewing, B. T. (2007). Energy consumption, income, and carbon Emissions in the United States. Ecological Economics, 62(3), 482–489.

Wolde-Rufael, Y. (2006). Electricity consumption and economic growth: A time series experience for 17 African countries. Energy Policy, 34(10), 1106–1114.

Xepapadeas, A. (2005). Economic growth and the environment. In K. G. Ma¨ler, J. R. Vincent (Eds.), Handbook of environmental economics (Vol. 3, pp. 1219–1271).

Zhang, X.-P., & Cheng, X.-M. (2009). Energy consumption, carbon emissions, and economic growth in China. Ecological Economics, 68(10), 2706–2712.

AUTHOR'S BIOGRAPHY

Jan-Erik Lane, has taught politics and economics at many universities around the world. He has been member of many editorial boards of political and social science journals. He has published some 400 books and articles. In 1996 (and 2009), he received the Humboldt Award by the Humboldt Stiftung, receiving also a Lady Davis Fellowship at the Hebrew University in 2006 and also 2012, as well as honorary medals from Kairo University and the University of Qatar. He is a permanent resident in the Republic of Geneva and lives part-time in Myanmar. He has been full professor in 3 universities and visiting professor at many more. He is now a fellow with the Public Policy Institute in Belgrade.