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The need to make wind and solar energy numbers right

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ABSTRACT

The latest comment by G. Wagner, T. Kåberger, S. Olai, M. Oppenheimer, K. Rittenhouse & T. Sterner of title "*Energy policy: Push renewables to spur carbon pricing*" published on Nature September 3, 2015 (Ref.[1]) reveals once more the lack of any understanding of the actual limitations and opportunities of the "*fancy*" renewable energy sources to reduce the use of carbon and hydrocarbon fuels. This lack of understanding is very well exemplified by the caption "*Solar energy provides 50% of electricity in Germany when the sun is out and demand is low*" below the image of a residential installation of photovoltaic solar panels, in a paperexclusively focused on wind and solar, that are wrongly claimed to be effective and cheap as these are not now and will never be. The paper show the need to make the renewable energy number correct, as it may be understood by taking into account basic energy availability and conversion principles plus having a look at the energy statistic without covering both eyes.

MAKING THE NUMBER OF SOLAR AND WIND ENERGY CORRECT

The major issue of wind and solar energy are the actual production and the quality of this supply and the costs of the installation per unit energy production.

With reference to the actual production of electricity vs. their cost, wind is still presently quite expensive, while solar is outrageously expensive. The production of wind energy may largely fluctuate no matter which is the energy demand due to the variability of the source. The solar energy production is even more troublesome, as the variability is even larger. The specific power of wind and solar installations, especially solar, is then extremely low, and very large installed capacities usually translate in minimal energy production.

These two renewable energy sources cannot live alone, but must be integrated with other renewable energy sources, as biomass/biofuels, waste or hydraulic, as well as with the traditional carbon and hydrocarbon fuels, and possibly nuclear energy. A timely balance in between demand and supply requires a proper consideration of all the energy sources with all their plus and minuses without any preconception. Without this understanding, there is the opportunity of nominally introducing more wind and solar energy while consuming about the same carbon and hydrocarbon fuels.

Carbon and hydrocarbon fuelled power stations may work quite well at design loads. However, the fuel energy conversion efficiency drastically reduces working part load and during the start-up/shut-down of the facilities, especially the larger ones, that also limit the life of the power plants.

Integration of heat production and hot water with electricity production from combustion fuels may

drastically raise the efficiency of the fuel energy usage, as the power plants may then work very well to radically reduce the fuel energy needed for heating, air conditioning or processing heat. The combined production of electricity, heat and hot water may increase the combustion fuel conversion efficiency well above the values that the individual production would permit. Cogeneration plants may deliver more than 75% energy efficiency, compared with at the best a 30-40% for other power plants, that in some case may be even much less than that.

The price of the "*fancy*" renewable energy sources, namely solar and wind is still very far from being "*affordable*" or "*sustainable*", and very far from being competitive with other renewables as for example biomass, biofuels and waste, that even if minimally supported by the renewable energy advocates, are actually already the present and the most reasonable future.

If on a global scale the perception of the actual costs of an energy solution vs. the other may be hiding by taxation and subsidies, the simple case of a single family home or even a small farm or rural community may serve very well. If we do consider a domestic wind turbine installation to power a single house with 10 kW, this device may cost "*50,000 to 80,000 $ (or more)*" according to the partisan wind energy industry (Ref.[2]). The actual cost may then be even more than 160,000 $ without any subsidy and including all the parts needed. How this solution compares with a combustion fuel electricity generation? Very badly, as we may spend two order of magnitude less to get much more, as we may have the electricity needed (and eventually heat or hot water) without over sizing and no matter if it is a windy day.

That a generator based on an internal combustion engine may cost much less to deliver much more, the electricity needed in addition to process heat and eventually sanitary water, was very well understood by good engineers and genuine environmentalists back in the 1970s. The Total Energy Module (TOT.E.M.), built by using a FIAT 127 passenger car engine was proposed to serve the needs of heat and electricity in the developing countries. Especially if fuelled with biofuels locally produced, similar installations may certainly be better than everything else especially for remote areas.

Apart from the cost, while wind is actually producing a small percentage of the electricity absorbed by the grid, but the percentage of solar electricity is even smaller. The statement "*Solar energy provides 50% of electricity in Germany when the sun is out and demand is low*" is wrong and misleading, as discussed below by considering actual statistics.

Having a look at some real numbers for this world energy, for example the data published by the International Energy Agency, Ref.[3], that we repropose in Figure 1,the actual share of total primary energy supply in Germany (year 2012) is almost 80% carbon and hydrocarbon fuels, then nuclear 8.2%, hydro 0.6%, biofuels/waste 8.9% and finally geothermal/solar/wind only 2.3%.

The trend since 1972 certainly evidencesa local growth of solar and wind energy contributions. However, this growth should not overshadow the similarly growing contributions by other renewables, as biofuels/waste, nor the still undiscussed predominance of carbon and hydrocarbon fuels energy supply.

In terms of only electricity, the contribution by solar photovoltaic, solar thermal and wind for the grid of Germany (2012 data), interconnected to the other European countriesfor the best synergy, are respectively 4.19%, 0.00% and 8.05% for a total of 12.24%, certainly much better numbers but still very far from the claims of overwhelming contribution of 50% by only solar. Possibly the authors of[1] consider the option of supplying energy to the grid may be during a summer night when all the Germans are in Italy or abroad on vacation and the factories are closed, may be only forgetting the fact that there is no sun during the night.

Worldwide, the energy mix is obviously much worse than for Germany. Worldwide average, the total energy supply shares are 31.4% oil, 29.0% coal, 21.3% natural gas, 10% biofuels and waste, 4.8% nuclear, 2.4% hydro and only 1.1% for geothermal, wind, solar and others. In terms of electricity, the contribution by solar photovoltaic, solar thermal and wind worldwide (2012 data) increase, but they are still respectively 0.43%, 0.02% and 2.29% for a total of 2.73%.

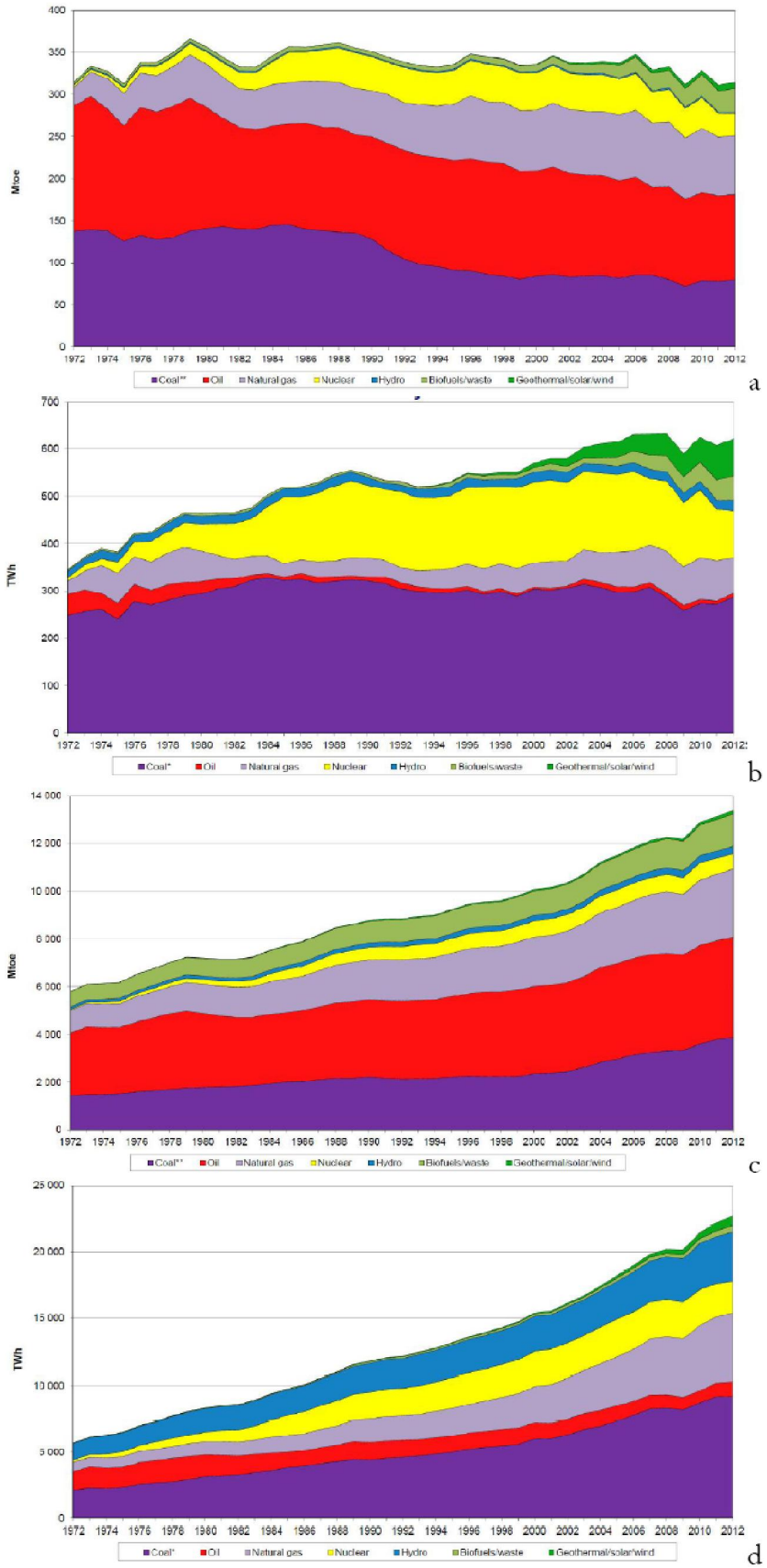

Figure 1 : Shares of total primary energy supply (In Mtoe) and electricity generation (in TWh) in Germany (a,b) and the world (c,d), 2012 data. Images are from[3]

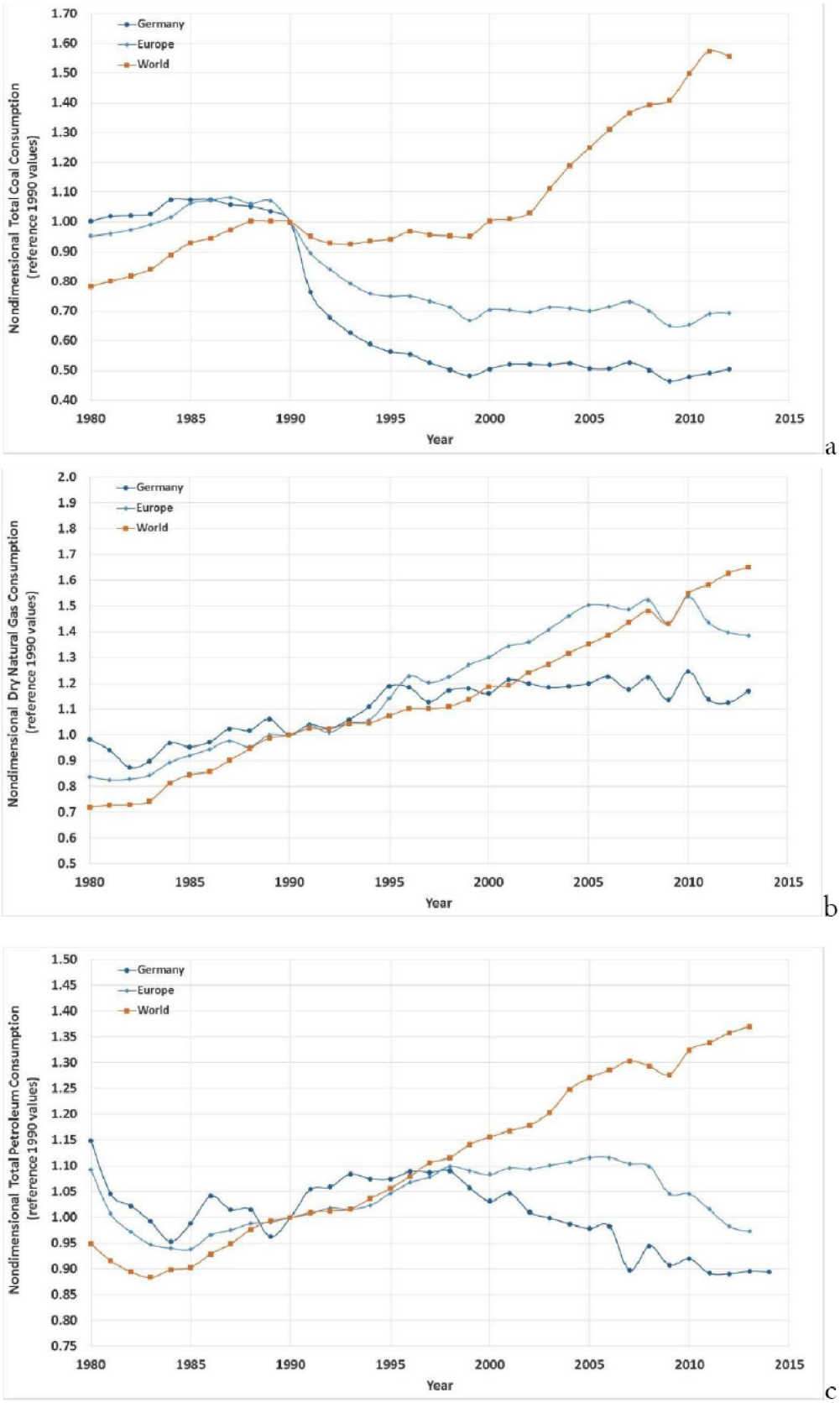

Figure 2 : a) Total Coal Consumption, b) Dry Natural Gas Consumption and c) Total Petroleum Consumption all normalised vs. the values of 1990 for Germany, Europe and the World. Data are from[4]

In addition to the energy data, it may be interesting to consider also the consumption of carbon and hydrocarbon fuels, for Germany, in Europe, and Worldwide, from the U.S. Energy Information Administration, Ref.[4]. The values of Total Coal Consumption, Dry Natural Gas Consumption and Total Petroleum Consumption all normalised vs. the values of 1990. The consumption of carbon and hydrocarbon fuels is sharply rising worldwide in every component over the full window, but especially since the start of this century. The coal consumption has not been reducing in Germany,or in Europe, over this century. The natural gas consumption has been about stable in Germany and actually increasing in Europe over this century. The petroleum consumption is the only parameter reducing both in Germany and Europe. This result is consistent with the total primary energy reduction in Germany over this century, Figure 1.a.

If really interested in renewables, or in the possible reduction of the carbon and hydrocarbon fuel consumption growing almost everywhere in the world and certainly globally growing, what we do learn from the world statistic is that biofuels and waste, more than the "*fancy*", and only politically correct, solar and wind, may be the right direction to move, together with the more efficient and rational use of all the energy sources including the carbon and hydrocarbon fuels. Cogeneration, energy savings, design of better devices delivering superior fuels conversion efficiencies,reduction of energy loss, and finally integration of all the energy sources without prejudices may certainly be a better shot to deliver what we do need with what we do have.

As commented by the German press, Ref.[5], the push above reasonable of wind and solar has basically succeeded in only reducing the electricity consumption of the local poor. Germans already pay the highest electricity prices in Europe, but rising prices are always on the horizon. In 2013, Germans were forced to pay €20 billion for electricity from solar and wind having a market price of just over €3 billion. Because of the needed back-up of solar and wind by conventional carbon and hydrocarbon fuel plants operated irrationally, for same amount of electricity produced the actual carbon dioxide emission, if of real interest to any one, did not reduced at all[5].

Germany's antagonistic and careless expansion of wind and solar power thus translates in a heavy price tag for consumers, with the costs falling disproportionately on the poor.

CONCLUSIONS

Wind and solar are certainly two interesting contributors to the world energy mix. However, they cannot replace the other energy sources. Overrating their relevance, magnifying the potentials while minimising the downfalls, this is the very wrong way to move towards a world supposed to use less carbon and hydrocarbon fuels but while permitting all the mankind to achieve the same opportunities of the rich countries. The noble quest of changing the leadership of the world with the pathetic excuse of transforming the weather paying carbon taxes, trading carbon credits or building wind and solar photovoltaic farms does not seem that noble and in the direction of producing benefits for all the mankind. As global warming got missed since the end of last century and all the predicted signs of the catastrophic global warming are still very far from materialize in anything measured, hopefully things will change.

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