Renewable Energy Technologies and Carbonless Anthropogenic Global Warming (CAGW)

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Abstract. Several world governments are now formulating policies that introduce massive increases of renewable technologies without a detailed Environmental Analysis. This happens, in spite of the fact that most of the “renewable” technologies harvest energy from large, global scale, naturally existing, warming and cooling Earth systems (see note 4 at the end of this document). This is likely happening because we have been conditioned to think only in terms of CO$_2$ as a direct danger to our global environment. Since the renewable technologies do not produce CO$_2$ during their operation, then it has been assumed that an Environmental Analysis is not necessary.

But increase in CO$_2$ – an otherwise necessary plant food molecule – is avoided only because of its unique ability to cause some warming - proportional to its presence in our atmosphere. This means that it is this small extrawarming that we want to avoid if possible, not the CO$_2$ itself. Furthermore, this “CO$_2$ warming” seems to be only one of several anthropogenic contributors to the “undesirable warming”. Are there other contributors to anthropogenic global warming which we have neglected? This is what this study suggests that is happening with regards to a massive deployment of renewables. The conclusions suggest that there are additional Carbonless Anthropogenic Global Warming (CAGW) processes which we have neglected to consider and which increase our Global Heat Flux Density, and hence temperature. Some of these heat fluxes likely result from the hasty introduction of renewable technologies, without a complete environmental analysis. Another heat source is the total energy that humanity is generating with all technologies. Most of it ends up as heat in our atmosphere.

A preliminary study has been conducted on the three popular renewable energy technologies: - hydro, solar and wind, to identify and possibly quantify if extraction and harvesting of energy from nature impacts locally and hence globally the heat flux density, thus altering the temperature, of the Earth system.

It has been noted that so far, environmental scientists have been dealing with measuring, averaging and projecting global temperatures. But variability of these temperatures results from variabilities in the density of incoming and outgoing heat fluxes. This thermodynamic analysis focuses on these heat fluxes along with conservation of energy for our Global Earth system.

This study suggests, that while all three of these renewable technologies mitigate the direct production and release of CO$_2$; solar panels are likely causing increasing rates of incoming heat intake, which results in extra heat added to the Earth system. Wind turbines are likely causing decreasing rates of heat dissipation or cooling, which also increases the heat energy retained by the Earth system. Hydro does not involve global heat fluxes and seems to be thermally neutral. Consequently, two out of the three renewable technologies – solar and wind - seem to be causing an increased global heat flux density and hence temperature. These temperature increases are independent and additional to any CO$_2$ warming.

The positive feedback of the water vapor in our atmosphere amplifies further such small warmings, in a similar way that the small anthropogenic warming of CO$_2$ is amplified to cause AGW even though it represents only 2% of the GHG’s in our atmosphere. In this case the warming has been named Carbonless Anthropogenic Global Warming (CAGW). Preliminary evidence suggests that Earth warming due to (CAGW) might be more significant than the warming saved from the lack of CO$_2$ emissions, due to the deployment of renewable technologies. It is concluded
therefore, that these two renewable technologies should be subjected to an “in depth” simulation and analysis prior to their significant deployment for baseload electricity production.

Introduction

People have often thought there is not upper limit to the power we can get from renewable technologies. The sun, wind gusts and breezes don’t seem likely to run out the same way oil wells might run dry. In this regard, several governments are now striving to formulate policies that deploy renewable energy technologies, mainly hydro, solar and wind, as the backbone for their baseload production of electricity. This deployment is thought to mitigate Anthropogenic Global Warming (AGW).

The law of physics for the Conservation of Energy, clearly tells us that renewable technologies must be tapping in, and harvesting energy from, naturally existing energy fluxes. These energy fluxes cross the boundary of our system Earth. All three of these renewable technologies mitigate the direct production and releases of CO₂. However, this study suggests that one of them – solar—is also tapping into the incoming radiant heat flux from the Sun, and we want to know if this is increasing the rates of incoming heat intake. The second – wind –is also tapping on the outgoing (cooling) energy flux. We want to know if it is causing decreasing rates of energy dissipation or cooling, which will also increase slightly the heat retained by the Earth system. The third – hydro -- does not use fluxes that cross the boundary of our system. It seems to be thermally neutral, as it uses the potential energy of the water, instead of the incoming or outgoing energy fluxes. Consequently, two of the three renewable technologies might cause a mild increase in global heat flux density and hence temperature. This phenomenon we call Carbonless Anthropogenic Global Warming (CAGW).

The methodology used in this preliminary study, applies accepted thermodynamic laws of physics directly to the total Earth System. It attempts to identify and quantify possible direct alterations to the global heat flux density, caused by the extraction and harvesting of energy by the renewable technologies. The goal has been to determine if there is a need to develop an overall thermodynamic simulator for the Earth’s heat flux system. Such a model does not exist today [11] and its development will require significant time and resources. Research, so far, has been limited to anthropogenic global warming (AGW) that is caused by our emissions of CO₂ [7]. However, we have not considered yet, how significant might be the amount of Carbonless Anthropogenic Global Warming (CAGW), in terms of direct alterations caused to incoming or outgoing heat fluxes by the various CO₂ mitigating projects. Working only with temperatures does not tell us where the heat is coming from or where it is going to. Neither is it providing much information on the details on the variability of the natural heat flux density. Therefore, in this study we are focusing directly on the heat fluxes and their density variation.

The topic of CAGW has not been pursued yet, because it is expected that any warming computed will likely be small. However, it has been observed that nature has the tendency to amplify small thermal fluctuations, caused naturally or by anthropogenic activities. For instance, a small increase in temperature due to anthropogenic CO₂, is amplified 50 times or 5,000 % by the positive feedback of the water moisture in the atmosphere [7], [see also note 5], and causes AGW. The amount of water vapor contained in the Earth’s atmosphere, is a strong GHG that doubles its density for every 100C increase of the atmospheric temperature. Small temperature increases are the signal that triggers this large positive feedback of water vapor.

it is therefore suggested that the water vapor feedback will also amplify any small temperature changes in the atmosphere, regardless of the source of the initial “trigger” for warming or cooling. If so, we will likely have a similar amplification of any small temperature change, caused by any possible interference or efficiency change in the incoming or outgoing heat fluxes. When a renewable technology interferes and extracts energy in a manner that may affect the globe’s overall thermal or cooling efficiency, any interference and any temperature amplification begin to reach a level that matters. Therefore, this study focuses in identifying and quantifying what form of energy is harvested by each one of the renewable technologies and how this harvesting of energy impacts
the overall efficiency of the Earth’s vast heating and/or cooling systems. We want to know the impact of our energy harvesting and conversion processes on the Earth’s incoming and outgoing heat fluxes.

Hydroelectric Plants

Hydro-electric power conversion seems to be neutral to the total heat flux of the Earth system in the “production of electricity”. It does not harvest directly heat from the Earth’s global heating or cooling systems and energy fluxes are not crossing the outer boundary of our system Earth. Hydro harvests water’s potential energy, converts it into kinetic energy and then with turbines produces electrical energy. The consumption of which results in some heat production. Approximately, the same amount of energy (heat) would have been produced if the hydro dam and turbines did not exist. The same amount of potential energy would have been converted into heat, kinetic energy and sound energy naturally, by the flow of water in the streams and rivers.

Thermodynamic Analysis of Solar Panels- PV Converters

The incoming energy from the Sun is transferred by radiative heat, mostly in the visible spectrum, that is not impeded by the greenhouse gases, GHG. It travels fast, with the speed of light, and on average: 20% is absorbed by the atmosphere, 50% is absorbed by the Earth’s surface, and the remaining 30% is reflected unimpeded out to space again in the visible spectrum [5& 6].

At any location on the Earth’s surface, without the presence of solar panels, an averaged incoming solar energy of 342 Wm-2 [6] will be disposed of as follows: about 70 Wm-2 or 20% will be absorbed by the atmosphere, about 168 Wm-2 or 50% will be absorbed by the Earth’s surface, and about 104 Wm-2 or 30% will be reflected back out to space in the visible spectrum unimpeded by GHG. We are using average reflection because the variation of the Earth’s reflectivity, also called albedo and whiteness, varies with the colour characteristics of the earth’s surface.

When we place a solar panel on the surface of the Earth, we are actually introducing a darker surface which increases the absorption rate closer to that of a “Black Body”. Such absorption in the extreme is 80%, and reflection is reduced to close to 0%. The atmosphere still absorbs 20%. This means that the introduction of the solar panel lowers the Earth system’s “albedo” and dissipates less energy in the visible spectrum, which is reflected unimpeded by GHG’s. As a result, the Earth ends up absorbing up to 50% or 104 Wm-2 more heat than normally in the area covered by solar panels. This extra heat flux can only be dissipated in the infra-red spectrum, which is impeded by GHG, thus contributing to a Carbonless Anthropogenic version of Global Warming (CAGW).

Quantitatively, a dark solar panel increases the energy absorbed by the Earth system from the average of 168 Wm-2 to as much as 254 Wm-2, an approximate increase of 50% to the Earth’s average normal surface absorption. This increases by up to 50%, the incoming heat flux density, increases the Earth’s average temperature, and hence the amount of extra heat that will need to be dissipated by the Earth’s natural cooling systems. Such warming becomes worse in northern climates, where the surface is covered with “white” snow 4 to 5 months per year. Deploying dark colour solar panels, in this case, decreases locally the Earth’s albedo and heat retention becomes higher.

Considering a typical PV conversion efficiency of 15%, for every 1kW of electricity produced, PV solar panel surfaces cause at least an additional 4 to 5kW increased heat absorption by the Earth system. This corresponds to a direct heat increase of at least 4 to 5 times the electrical energy produced. This may be insignificant until we consider the positive feedback and hence amplification of heat by the water vapor. In this case the resulting amplification of the warming becomes quite significant.

In conclusion, it is suggested that deploying a few solar panels may not pose a problem; however, a massive deployment of solar panels (PV), which continuously add extra heat to the Earth system, may cause a relatively significant warming to our globe, relative to what it saves from the avoidance of CO₂ releases in the production of electricity. Manufacturers of solar panels could
consider the benefits of producing lighter coloured PV solar panels, which would reflect light at wavelengths not used for electricity production.

**Thermodynamic Analysis of Wind Turbines**

The 50% of the energy absorbed by the Earth’s surface and the 20% absorbed by the atmosphere are both heat fluxes which are received normally from the sun, as shown in Part 3.0 above. Both these heat fluxes are converted into heat and other energy forms which automatically activate the following five slower heat transfer mechanisms:

The dissipating radiation heat transfer is in the infra-red spectrum. Although it travels with the speed of light, it interacts with, and hence it is impeded by, the presence of water vapor, CO₂ and other greenhouse gases (GHG). All GHG molecules exchange radiation from and to all directions. Consequently, the outward heat flux speed of the dissipating energy is slowed down considerably - see note 1 before the references. This slowed down radiative heat transfer mode delays the heat in the atmosphere and provides the time and opportunity for action by the other four even slower heat transfer mechanisms of:
- Evaporation of water and the formation of a convective vapor
- Convection where the vapor, GHG’s and warmer air rise and cooler air descends
- Conduction between surfaces and air molecules and amongst air molecules themselves, and
- Dispersion between risen hot molecules and cold air in the upper troposphere.

![Figure 1. Heat Fluxes in an Atmospheric Heat Pump.](image)

The incoming energy comes into the Earth’s surface with the speed of light during the shorter period of time of daylight, and the outgoing energy dissipates from the Earth’s surface slowly but continuously during both day and night times. This takes place in all locations and all Meridians as the Earth rotates. The difference in duration and heat flux density, between incoming and outgoing energy, increases the surface heat flux density, and hence temperature during day time, and decreases it during evenings and nights. This provides us with cool crisp mornings and warmer afternoons.

The higher is the presence of H₂O moisture and other GHG’s in the atmosphere, the slower becomes the dissipating heat flux by IR radiation, and the surface becomes warmer. Furthermore, the higher the Earth’s surface temperature is, the more active become the slow surface cooling processes of evaporation, conduction, convection and dispersion. These slow processes exist mostly in the troposphere and they are not impeded by the presence of GHG. They contribute to the Global Circulation System by converting some heat energy into other forms of energy such as kinetic...
energy, potential energy and enthalpy of vaporization, all of which rise and are eventually converted into infra-red radiation, called “outgoing long wave radiation (OLR)”, and dissipate.

This description suggests that our Global Circulation System likely includes some naturally occurring atmospheric heat pumps that take heat and vapor enthalpy energy from the warm surface of the Earth and send it to the upper cooler troposphere where it is dissipated to space via (OLR) – (see note 2 before the references).

In conjunction with radiative heat transfer, these atmospheric heat pumps are convective and hence they can transfer heat and other forms of energy, regardless of the presence of GHG’s. They work as vertical, small scale Hadley circulation systems as shown in Figure 1.0. The mechanisms shown in Fig. 1 are as follows:

a) Cold dry air is denser and heavier than the rest of the air in the atmosphere and descends towards the Earth’s surface. This downward, clockwise in the northern hemisphere, spiral Coriolis motion forms a High Pressure system on the Earth’s surface. It is counterclockwise in the southern hemisphere.

b) Warm moist air is lighter than the air in the atmosphere and rises almost isothermally-see Note 3 before the references- in an opposite spiral Coriolis motion carrying along with it warm air and H$_2$O vapor. This deep convective rising spiral motion creates a low pressure system on the surface of the Earth that enhances the production and accumulation of more water vapor, and it gains enough kinetic energy to reach the upper troposphere.

c) When warm air and H$_2$O vapor reach the upper troposphere, they are subjected to Dispersion by high elevation cold currents, such as the Jet Stream, condense the water in the air [7 & 8] and the enthalpy heat is dissipated by OLR (outgoing longwave radiation). Ionized particles from cosmic radiation provide the cloud seeding process that results in cloud formation in the upper Troposphere. Note that at this high elevation the density of the atmosphere (and all GHG molecules) is much lower. Also the water vapor condenses into clouds and removes 96% of the GHG effectiveness. All these contribute to OLR accelerating in its outward path, starting above 6 to 7 km altitude.

d) Along the surface of the Earth, the Potential Energy existing between High pressure and Low pressure systems is converted into Kinetic Energy of the air, causing the resulting wind to move from the high pressure area towards the low pressure area. On its way the wind removes heat and H$_2$O vapor from the surface and feeds them into the low pressure system where they rise and dissipate.

e) These atmospheric heat pumps travel and collect moisture and heat along the Earth’s surface continuously, usually from South-West to North-East. As they move, they find new areas containing heat and water moisture which will be removed. As long as the supply of H$_2$O moisture continues, a Low Pressure system intensifies and removes more heat from the surface and delivers it to progressively higher altitudes, all dependent on the intensity and vertical momentum of the low pressure system.

f) Under the right atmospheric conditions, H$_2$O vapor becomes the fuel of gales, storms and hurricanes. It appears that all these lows, and in general the existence of every convection heat pump in global circulation, serve to help cool the Earth’s surface and the atmosphere[17]. This concept is also reinforced by the correlation between the elevations of cloud formations and storm intensity. There are also many correlations observed between “Heat Flux Density” and “Wind Speed”[10, 11, 12, 17].

g) Every gram of cloud mass provides a confirmation that enthalpy energy was removed from the Earth’s surface and dissipated at higher altitudes. The higher the energy content of the weather system, the higher becomes the altitude, where condensation and heat transfer to OLR take place more efficiently. The sum of this energy would include not only the kinetic energies of the air but also the enthalpy of vaporization of water, the kinetic and potential energy of the vapor, and its heat content on arrival at its point of condensation.

h) Confirmation is also provided by observations suggesting that wind speed is not a happenstance. When the heat flux density increases, the pressure gradient also increases
and the wind intensifies to remove the extra heat present. Weather reports and forecasts in all countries [13, 14, 15] provide clear evidence that between high pressure and low-pressure systems, the wind intensity always increases in the afternoon and evening in proportion to the amount of heat accumulated [17]. Trade winds, offshore winds and onshore winds always seem to intensify in the afternoon and die at night. Surface wind appears to be an integral part of the Earth’s cooling process, since it likely forms a section of an Atmospheric Cooling Pump along the Earth’s surface, as shown in Figure 1. Moisture is the fuel of storms, and energy is removed by storms in proportion to the heat flux density present. Most of the hurricanes happen in the summer and fall when the heat flux density is highest, due to the accumulation of summer heat in the Northern hemisphere. Similar observations can be made in the Southern hemisphere.

Figure 2. [13] Harvesting enthalpy of vaporization from the wind causes condensation & turbulence.

The energy that wind turbines harvest and convert into electrical energy includes not only the kinetic energy of the wind but also, the enthalpy of vaporization of the moisture present (see figure 2) and the heat absorbed by the wind as it travels along the earth’s surface. In the absence of being harvested by wind turbines, most of these forms of energy would normally rise to the upper troposphere, by a Low Pressure system, where they would be converted into heat (infrared radiation) and dissipated by the OLR.

Figure 2 clearly shows the interference that result from harvesting the kinetic energy and especially the enthalpy energy from the wind. In addition to the energy that is converted into electricity, the resulting turbulence and condensation retain some of the dissipating energy on the Earth’s surface; thereby, impeding one of the Earth’s natural cooling processes. This retention of energy increases the heat flux density on the surface. The impeded heat must now be dissipated again by the Earth’s natural cooling processes.

Quantitatively, Jacobson [14] and Keith [15] have computed the performance of wind turbines, while focusing on their specific areas of interest. Based on values they computed, the “atmospheric efficiency” with which a wind turbine converts the wind’s kinetic energy into electricity is approximately 50%. This means that 1kW of electricity produced by a wind turbine corresponds to 2 kW of kinetic energy harvested from one of the Earth’s natural cooling processes. However, as figure 2 demonstrates, wind turbines absorb not only kinetic energy from the wind, they also absorb enthalpy of vaporization. The total amount of energy harvested from, and the interference caused to, the Earth’s cooling system depends also on the ratio of enthalpy energy to kinetic energy contained in the wind. Typically, at 150°C the ratio of enthalpy energy to kinetic energy of a windswept gram of vapor moisture may be at least 4 times. This yields a combined increase of at least 6 times the energy flux (of the non-dissipated heat) that is kept on the surface of the Earth, to the energy harvested by the wind turbine, and converted into electricity.

Again if we factor in the amplification due to the positive feedback of water moisture in the atmosphere to a small increase in temperature, the resulting Carbonless Anthropogenic Global Warming (CAGW) becomes extremely important. Consequently, deploying a few wind turbines may not pose a problem; however, an exponential increase in the deployment of wind turbines may cause an increase in heat flux density, and hence warming to our globe. Such warming could be
significant relative to what is saved from the avoidance of CO₂ releases by using renewables. Some scientists think that the warming is perhaps bigger than the impact of doubling CO₂” [15]. This study, with the inclusion of the enthalpy of vaporization, suggests that the CAGW adds significantly more heat and contributes to global warming.

Conclusions

Hydro power proves to be a true, so called, green technology with which we can produce electricity. However, the other two appear less credible. The difference between them is that solar panels increase the intake of the Earth’s incoming energy, resulting in increased warming. Wind turbines appear to reduce the natural cooling rate of the Earth’s energy dissipation, which also results in increased warming. Both these technologies are thought to mitigate some of the Earth’s warming through the reduction of CO₂ emissions. However, this thermodynamic review suggests that both, solar and wind technologies, likely result in an increased net heat flux density for the Earth system. These increases might arguably be small; however, the large amplification factor, when we consider the effect of the water moisture’s positive feedback, signal caution and concern for extensive deployment for both of these technologies.

The above conclusions were based on manual computations and they contain some approximations that may increase uncertainties. Also, all the variant amplification factors may not have been considered and included in our computations. For instance, amplification due to water vapor, assumes that there is an infinite amount of water available and ready to evaporate anywhere on the Earth, whenever the atmospheric temperature rises. Furthermore, the difference in the extrapolated heat profiles, between AGW and CAGW has not being factored in. This study however has provided sufficient theoretical, conceptual, practical and methodological innovations needed for the development of a thermodynamic simulator for the Earth System. This will be needed to analyse and quantify in greater detail the combined total contribution to Earth warming from both, net CO₂ savings and carbonless anthropogenic global warming (CAGW). Answers to these questions are needed urgently as they will facilitate policy implications, of Global relevance, that will eliminate the risk of a collective action in the deployment of renewable technologies, that may result in wasting resources and time during a period that we need to conserve both.

Notes

1. The Lapse Rate tells us that the temperature of the Troposphere decreases with altitude. Also, the equations of heat transfer tell us that heat transfer fluxes exists only from warmer surfaces and masses towards cooler ones. Hence the GHGs effect is the slowing down (impede) only the OLR heat flux’s outward speed.
2. In the upper troposphere the water vapor condenses and removes its significant contribution to the effectiveness of the greenhouse gases. Also, the density of the atmosphere, and hence of the inventory of other GHG molecules, is reduced with altitude; thereby, allowing the OLR flux to accelerate, as it rises.
3. In a rising Low, during expansion no significant cooling is taking place since the enthalpy of vaporization is used to expand the gas almost isothermally as the pressure and density decrease.
4. See basic law of Physics titled “Conservation of Energy”.
5. The GHG in our atmosphere are made approximately by 96% water moisture molecules and almost 4% of CO₂ molecules. Other GHG molecules are also present but their quantities are negligible at present. From the 4% of CO₂ only half, 2% of GHG, is anthropogenic. The other half, 2% of GHG, occurs naturally.

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