1.0. Introduction

An ‘Artic Katabatic Wind’, one of many rumbling inexorably southward, educes effervescence and ebullition of methane into the atmosphere at increasing and alarming rates to form a sinuous umbrella now enveloping most of the Northern Hemisphere.

Emissions of Arctic stockpiles of frozen methane clathrate accumulated in massive quantities over millennia, as permafrost on the Arctic tundra and on ocean beds along continental shelves of Alaska, Canada, Greenland and Siberia, are occurring at alarming rates\textsuperscript{14,16,17}. The accelerated atmospheric accumulation of carbon dioxide and methane, both major Greenhouse gases, will exacerbate global warming and could present unprecedented challenges to current and future civilisations\textsuperscript{10}. The two anomalous climatic processes are occurring much earlier than expected.

So, how did we, the World’s extant \textit{Homō sapiēns}, the ‘wise human’, precipitate this global challenge?

The key events happened over past eons and others ensued during our recent history.

The Scottish Chemist, Joseph Black, discovered the existence of \textit{carbon dioxide} (CO\textsubscript{2}) in June 1754, when a gas heavier than air quenched the flames of a candle burning in an experimental jar\textsuperscript{12}. Alexander von Humboldt, born in Berlin, Prussia, in 1769, became the ‘\textit{greatest scientific traveller who ever lived}\textsuperscript{19’}, according to his friend Charles Darwin\textsuperscript{19}. Humboldt, following extensive studies on climate, ecology and geography in the Orinoco Basin, Venezuela, established climate observatories throughout Europe to found scientific research on global warming. Humboldt, himself, believed even then that accumulating carbon dioxide would alter the World’s climate. Joseph Priestly discovered ‘\textit{dephlogisticated air’}, in 1774\textsuperscript{19}, which, thankfully, was renamed \textit{oxygen} (O\textsubscript{2}) by Antoine Lavoisier, in Paris, in 1789\textsuperscript{5,15}. Concurrently, Alexandro Volta, in 1776, discovered \textit{methane} (CH\textsubscript{4}) in marsh gases of Lake Maggiore, Italy/Switzerland. Thereafter, discoveries of other atmospheric gases, and their possible role in climate change\textsuperscript{1}, occurred in rapid succession during the late 1800s.

Concurrently, James Watt of Glasgow, Scotland, in a commercial perspective, changed the efficacy of, and then mobilised steam engines, thereby promulgating the nascent Industrial Revolution, based entirely on coal combustion. Thereafter, Watt and Matthew Boulton, in 1775, formed the very successful company of Boulton and Watt. Subsequent events furthered the Industrial Revolution in England and thereafter incrementally throughout the World. Stoked steam furnaces multiplied in the 1800s and, in greater part, replaced by combustion engines throughout the 19\textsuperscript{th} and 20\textsuperscript{th} centuries.

Today, we realise air \textit{per se} is a composite of nitrogen (N\textsubscript{2}, 78\%), oxygen (O\textsubscript{2}, 21\%), argon (Ar, 0.93\%), carbon dioxide (CO\textsubscript{2}, 0.035\%) and some 90 trace gases. Air also holds variable amounts of water (H\textsubscript{2}O) in the form of vapour. Space exploration emphasises that our atmosphere comprises a very thin, delicate veil around Earth, extending only 97 kilometers toward the vacuum of space, with 50\% of breathable air prevailing within 5.6 kilometers of the surface (Fig. 1). Our atmosphere, in scale perspective, comprises an extremely delicate, thin sheet of porous plastic wrapped around a basketball. This tenuous element of thin fluid is highly susceptible to our ravaging industrial activities.
1.1. The Goal

Events of the past 260 years have led scientists to realize that human activities have contributed substantially toward global warming and thereby established tangible needs to understand, appreciate and foster our natural environment. Throughout the World, the United Nations, concerned Governments, insightful businesses and collectives of increasingly active environmentalists are addressing and working together to resolve this crucial responsibility.

This is co-responsibility, beyond individualism, beyond partisanship. It’s time to recognise, confront and cope with these challenges, to bring the World to its senses by linking our efforts to implement innovative and synergistic measures to mitigate our past actions, to bring change through our concerted efforts. On this basis, alone, I do not agree with the Report’s abstract notions.

*Everyone needs to ‘recognize the problem, to understand the science, to work together to implement key solutions, and to apply both grass roots and innovative technology for offsetting climate change.*

2.0. Root Cause of Climate Anomalies

Greenhouse gases (GHGs) - CO₂, CH₄, N₂O, CFCs and HCFCs – absorb and emit infra-red radiation, thereby effectively retaining heat within Earth’s atmosphere and causally in the oceans. These gases vary in their respective lifespans and their abilities to warm the atmosphere. For instance, CO₂ has a half-life of 200 years, whereas that of CH₄ is only 10 to 12 years. Yet, because of CH₄’s chemical structure, its 20- to 25-times more active than CO₂ as a greenhouse gas. N₂O has a half-life of 120-190 years, and is 200 times more active than CO₂. Sulphur hexafluoride (SF₆) though has a half-life of 32,000 years and is 25,000 times more active; fortunately, its industrial usage is limited.
Pragmatically, what do we know about the sources and effects of these gases on climate change?

2.1. Carbon dioxide

Thermal combustion of coal, gas, oil or wood each form carbon dioxide (CO₂) as a waste product. Consequently, CO₂, because of its relatively long life span, has been accumulating in Earth's atmosphere since the onset of the Industrial Revolution in the early 1750s. Quantification of CO₂ accrual since 1958, in the form of the Keeling Curve, depicts a sharp rise from 1958 to the present day, as detected at Mount Mauna Loa, Hawaii, in the Northern Hemisphere (Fig. 2A). In fact, based on analyses of air samples trapped in ice cores, CO₂ accrual started about 1740 (not shown). Mean CO₂ concentrations, on increasing exponentially, exceeded 400 parts per million (400.05 ppm) for the first time in March 2015, and attained 403.26 ppm in April 2015, on seasonally corrected values (Fig. 2A).

Importantly, analyses of samples taken at Mauna Loa depict highly repeatable, seasonal rhythms, with peaks occurring in May/June of every year that reflect a combination of natural and human activities (Fig. 2B). These data attest to the accuracy and repeatability of the underlying measurements. Scientifically, these data are irrefutable in testifying to a 46% increase in CO₂ concentrations.

Similarly, atmospheric CO₂ concentrations are accumulating in the Southern Hemisphere, although the monthly averages are slightly lower and seasonal variations are attenuated, consistent with less forestation and human activities in the Southern Hemisphere (Fig. 3). The minor difference in CO₂ concentrations between the Northern and Southern Hemispheres indicates the gas traverses the equatorial region and equilibrates in the high latitudes of Antarctica.

Recent studies based on direct evidence and modelling by computer-based simulations are consistent with such projections. CO₂ emissions emanating from major sources (e.g. China) equilibrate throughout the Northern Hemisphere and flow across into the Southern Hemisphere with relatively minimal delays.

Today, acquisition of further data is accruing from >10 climate stations distributed World-wide, to obtain better quantitative insights into the various climatic processes.

These very high CO₂ concentrations are increasing at levels consistent with a 2ºC rise or more of global warming occurring within the near future, as expected by IPCC’s 5th Assessment (2013, 2014).

2.2 Methane Emissions

Methane emissions from previously frozen permafrost in sub-Arctic tundra and sub-sea regions of estuarine outflows, frozen methane clathrate along coastal shelves and oceanic rifts of the Siberian Sea have risen substantially during the past eight years. In addition, data collected at the Barrow Station, Point Barrow, Alaska, portray a considerable rise in CH₄ emissions, to reach peaks of 1,820 ppb and even 2,800 ppb in recent summer months (Figs. 6). Terminal extensions of the Gulf Stream have brought warm tongues into the Arctic Ocean and destabilized frozen permafrost and methane clathrate along the Siberian seaboard and oceanic shelf. Likewise, warm currents passing through the Bering Strait have affected methane clathrate sequestered on shallow shelves of the Siberian Sea and Arctic Ocean. Arctic methane emissions equal in amount the total methane emissions of the entire globe, and therefore require serious attention in future assessments of climate change.

These emissions have resulted in large veils of methane clouds drifting southward over Canada and the USA, raising the spectre of heated Arctic air raising temperatures of the lower Gulf Stream Current, and thereby instigating a feed-back loop on further warming of the Siberian Sea and Arctic Ocean. The effects could cause rapid and total Arctic deglaciation and oceanic ebullition/sublimation of permafrost and methane clathrate, of multiple terrestrial and oceanic sites.

Projections indicate these events, exacerbated by the substantial GHG effect of methane alone, could lead the World into a 6ºC rise in atmospheric temperatures within a few decades, rather than centuries, with cascades of secondary deleterious effects on climate change and on present and future civilisation.
2.3. The Conundrum

In New Zealand, higher atmospheric temperatures causing severe droughts and extreme storms would affect agricultural production and deleterious losses of international exports. Few tourists would visit our shores due to the blight on our ‘clean green’ image and also high transportation costs.

Our politicians and citizens cannot turn collective blind eyes or bury our heads in the sand. We need willing leaders and hands to take action in seeking measures for countering or better still circumventing future actions of climate change.

We can become instead a disruptor nation by seeking, developing and implementing technologies that will ameliorate global warming, while establishing novel export markets for boosting New Zealand’s economy. We can accept responsibility and forge a pathway forward.

3.0 Renewable and Clean Technologies

The objectives are to develop and implement clean technologies and renewable energy programmes by introducing innovative concepts, to minimize the use of fossil fuels. The following are examples:

3.1. Developing a hydrogen economy

Electrophoresis splits water, $\text{H}_2\text{O}$, into its components, hydrogen ($\text{H}_2$) and oxygen ($\text{O}_2$), and both gases have subsequent applications. Renewable energy resources - marine turbines, wave turbines, wind turbines and PV solar energy - could provide the required electricity, especially during periods of low demand and ample power resource. $\text{H}_2$, a versatile form of energy, can be stored as a liquid in tanks or in underground caverns or else distributed for other applications, in particular to power heavy transport vehicles.

Combustion of $\text{H}_2$ with air ($\text{O}_2$) yields water, $\text{H}_2\text{O}$, and energy, so it’s almost completely clean technology. Moreover, distribution of $\text{H}_2$ internationally benefits countries poor in natural energy resources (e.g. Japan, who’s presently entering contracts for purchasing $\text{H}_2$ internationally as a power resource while waiting decisions regarding re-instatement of their nuclear power stations). The $\text{H}_2$ can supplement distributed natural gas to 5% (v/v) content without incurring detrimental effects.

The respective energy generators, tidal, wave, wind, solar, can gain substantial economic benefits, while avoiding combustion of fossil fuels and accruing ‘valuable’ carbon credits.


3.2. Hydrogen vehicles

Incentivise public buses and commercial bus lines and freight vehicles to convert to clean hydrogen fuel cells for short and long-distance travel and haulage.

California has been testing and evolving hydrogen buses on its ‘HyRoad Project’ since 2006. The present fleet of twelve buses are equipped with 120-kW fuel cells. The buses have travelled ~435,000 km. The vehicles are quiet, fuel efficient by comparison to diesel-powered buses, and emit only water from their exhausts. Each bus in the HyRoad project will travel 58,000 kilometers per year, while reducing carbon emissions by 44 metric tons when using methane as a source of fuel, or 103 metric tons when using hydrogen generated by renewable energy - wave, wind, tidal and/or solar power.

Further, Louisville, Kentucky, USA, has founded city ‘Zero Bus’, fleet operating on electricity.

See: http://earthtechling.com/2012/05/hydrogen-powered-buses-take-hyroad-in-california/
http://earthtechling.com/2015/01/louisville-all-electric-zero-bus-fleet-launches/
3.3. Ground-source, geothermal heat pumps

The invention of geothermal heat pumps in 1852 by William Thompson (later became Lord Kelvin) comprised the beginning of the ‘Heat Multiplier’, and, although a brilliant invention, it attracted scarce attention in Britain, already a coal-rich society. However, today there are 100,000s of these devices throughout the World. In the USA, geothermal heat pumps collectively generate >940 MW, equivalent in output to a major power station.

Geothermal heat pumps transfer heat from one source to another, analogous to air-air-heat pumps. The heat usually is sourced from the ground, which affords a constant temperature (15ºC to 16ºC), a feature that enables optimal engineering and efficiency of the system. Operating efficiencies (COP, Coefficient of Performance) are ~5.0 to 6.0 depending on the design, about 20% to 30% better than modern, air-to-air heat pumps. This translates to ‘one unit of electrical energy needed to drive the heat exchanger, provides five to six units of heat’ for distribution in home or business.

4.0 Conclusions

In New Zealand, our electrical energy derives from ~75% renewable power, at present hydroelectric, geothermal or wind. It is possible, given our natural resources, to generate 100% of New Zealand’s electricity from renewable and sustainable resources. Indeed, Scotland has set its target to achieving 100% renewable electrical energy by 2020.

New Zealand must set landmark goals to contribute globally toward mitigating climate change?

Survival of the planet, as such, is likely to depend on all citizens of planet Earth pitching toward achieving this goal.

I wish to be heard on this important policy issue?

Kind regards,

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FIG. 2: CO₂ concentrations (ppm) in Earth’s atmosphere from 1958 to the present, expressed in mole fraction in dry air of samples collected on Mount Mauna Loa, Hawaii (3,400 meters). Record collection began in March 1958. Daily samples are analysed and then represented graphically by monthly means (Black lines), following adjustment for known anomalies in weather systems arriving at Mauna Loa. The data represent CO₂ added and removed from air by human activities and natural processes. Seasonal changes (Red lines) occur primarily due to differences in summer vegetative growth and human winter activities. [A] CO₂ concentrations have increased 46% since the beginning of the Industrial Revolution; i.e. 276 ppm (1740) versus the present level of 403.26 ppm ± 0.1 (April 2015). [B] Monthly variation depicted in detail. (Source: National Oceanic and Atmospheric Administration (NOAA), US Department of Commerce, USA. See: http://www.esrl.noaa.gov/gmd/ccgg/trends/)
FIG. 3: Atmospheric carbon dioxide concentrations occurring at the South Pole, Antarctica, and Mauna Loa, Hawaii (3,400 masl), at comparable altitudes above sea level (masl), verify major increases from 1960 through 2015. Data for Antarctica are commensurate with those (for Mauna Loa, but exhibit less seasonal variability consistent with the lack of vegetation and industrial activities. Other stations around the world report analogous increases in CO₂ concentrations. (Black: Mauna Loa, Hawaii, USA 3,400 masl); (Brown: South Pole, Antarctica; 2,810 masl) [Source: Modified after Charles D. Keeling’s Tyler Prize Lecture (2005).]


Fig. 4: Concentrations of CO₂, CH₄, N₂O, CFC-11, CFC-12, HCFC-22 and HFC-134a, collected and analysed by NOAA’s Global Network for airborne sample collection. Five greenhouse gases depict substantial increases in concentrations from 1977 through 2015, other than the phasing out of CFC-11 and CFC-12 by the Montreal Protocol. (Source: NOAA, US Department of Commerce, USA. http://www.esrl.noaa.gov/gmd/aggi/aggi.html)
Fig. 5: Cumulative data for CO₂ alone and CO₂ plus other GHGs, by comparison to NOAA’s AGGI Index. Samples collected from throughout the Atlantic Ocean, Pacific Ocean and Antarctic Oceans, and Antarctica. NOAA Earth System Research Laboratory, R/GMD, 325 Broadway, Boulder, CO 80305-3328

Fig. 6: Proxy data for atmospheric concentrations of CO₂ (ppm) and CH₄ (ppb) extending back 420,000 years BP, through four periods of glaciation. Significantly, atmospheric concentrations of methane reached a catastrophic level of 1,830 ppb in the summer of 2013 and even higher levels at 2,845 ppm in 2014. [Source: Light, M.P.R., Hensel, H. and Sam Carana (2014)]
FIG. 7: Methane ebullition in Fairbanks, Alaska. [A] A chunk of frozen methane clathrate burning. [B] Thawed methane clathrate re-frozen during ebullition (bubbling) to the surface of a lake. Thawing ice in the spring releases methane into the atmosphere. Due to global warming permafrost has melted and converted into millions of lakes emitting methane. [Source: National Geographic, Washington, DC, USA]
FIG. 8: Time-lapse images taken during CO₂ emissions from combustion of coal, oil and gas (fossil fuels) and their re-distribution to other regions and hemispheres of the World. These images reflect distribution of CO₂ at 9 ppm to 10 ppm during 2011 to 2012, a period of two years. Images represent 2011.01.04, 2012.01.03 and 2012.12.23, at upper, right-hand side of each globe) (Video: http://www.esrl.noaa.gov/gmd/ccgg/trends/ff.html; Source: OIADC, NOAA, US Department of Commerce, USA.


FIG. 9: Hydrogen-powered bus participating in the ‘HyRoad Project’ in California, USA. The project has been operating since 2006 and is being expanded substantially at present (See: Text). [Source: http://earthtechling.com/2012/05/hydrogen-powered-buses-take-hyroad-in-california/]

References


