The Live Monitoring of Carbon Emissions for Sustainable International Trade and Exchange

Lee E. J. Styger#1

Tiger Bay Consulting Pty Ltd, P.O.Box 20991, World Square, Sydney 2002, Australia

1 lee@leestyger.com - www.leestyger.com

***Abstract* — There is growing hypothesis that, following the current economic crisis, carbon trading will kick start the stock markets once again and that carbon is a new "commodity" albeit now being traded in a traditional way.**

This carries several disadvantages; the most pressing being that "if you can't measure it then you cannot improve it", rendering any audit meaningless as a real improvement measure and resulting in the view that carbon trading is merely another form of taxation.

This paper will discuss the options of live monitoring and recording of trade waste resources and offer a framework for viable trading of tangible commodities such as carbon. Furthermore, the paper will offer insight into how Australian companies can lead the world in the technology critical deliver viable resource commodity trading.

I. Introduction

There is a growing hypothesis that, post the current economic crisis, carbon trading will kick start the stock markets once again as surely as tulip bulbs and dot coms have done in the past. The proposition is that carbon is a new "commodity", albeit now being traded in a traditional way.

Unlike pork bellies, orange juice and the myriad of other physical (i.e. something that you can see, touch and, importantly, measure) commodities being traded currently, the proposed method of trading carbon will be based on a theoretical availability (measure), not a tangible measure of availability.

This change in practice (from physical measure to theoretical measure in the case of carbon) carries several disadvantages, the most pressing being that "if you cannot measure it, you cannot improve it." Furthermore, experience suggests that it is not out of the question to expect that companies will shut down sections of plant and management will ensure that "everyone is working with the guards and safety equipment correctly in place" when and if an audit is conducted. Yet, as soon as the audit has been completed, the facility returns to its previous methods of operations (i.e. the audit and actions are meaningless as a real improvement measure.) Finally, to be viable, sufficient qualified auditors need to be commissioned and deployed if any meaningful impact is to be realised.

II. Hypothesis Moving Forward

There is sufficient doubt and, indeed, enough quantitative and qualitative evidence to suggest that a theoretically-based model of carbon trading is little more than an exercise in taxation; likewise the model is based on the assumption that large companies will pollute more than small companies, whereas it is equally feasible to expect that there will be many cases of large low-polluters and as many cases of small high-polluters.

As the CPRS/ETS moves forward and carbon permits are sold or provided to exempt industries (all now being debated), there will be a need to provide reliable and verifiable data on the performance of those holding licenses/permits to emit carbon dioxide emissions, plus other greenhouse gases (GHG) - e.g; methane, sulphur oxides, nitrogen oxides, etc.. The current audit paradigm of sampling and analysis on a weekly/monthly/quarterly/yearly basis will not satisfy the market where carbon permit residuals will be given a value in the market to be on-sold to those industries/emitters who, for example, have exceeded their permit conditions.

For permits to be traded in the market, up to date information will be required so that investors in and brokers of permit residuals will have confidence that the amount remaining in permit residuals has been validated. The optimum method to ensure this is by online continuous monitoring so that a complete history of the permit life is available instantly for independent audit. For the convenience of data management and recording, a centralised database should be established that provides to the market, an up to date, "real time", value of the permit residual that will then allow meaningful exchange between buyers and sellers of permit residuals.

The current methods of intermittent or periodic sampling and lab analysis will not provide a clear profile of the performance of the permit holder for any regulatory processes or for trading of residual permits. A major problem with this audit method is that a "snap shot" of the profile is the only data available which statistically would prove difficult to justify as representative of total emissions, when online real time data provides a detailed assessment of the performance of the permit holder. The experience gained from early attempts in Europe to meet initial GHG targets showed the sharp reduction in carbon prices was caused by companies/countries failing to meet permit conditions - a factor that would have been alerted to stakeholders if detailed emissions monitoring had been in place. There is a high risk to the price of carbon being maintained, let alone increase, as permit numbers are reduced over time if the residuals being traded in the marketplace are reduced in value due to uncertainty in the actual amount left in credit on the permit at a particular point in time.

There is no doubt regarding the global imperative to improve the current ecological situation. However, if meaningful and lasting benefits are to be manifest, then a more robust solution to future trading of resource commodities such as carbon, methane, heat etc. is needed.

It is proposed that a holistic system of continual, live monitoring of waste resources should be adopted as the global standard. As such, these tangibly measured commodities can be traded in exactly the same way as any other commodity in an open free market. As seasons change and demands change, clearly the amount of available un-used resource fluctuates, thus creating the fluctuations in demand and price of the remaining resources and thereby generating the supply and demand dynamic necessary in economics.

III. Other Pollutants and/or un-captured resources

GHG emissions are principally listed as the following compounds:

- Carbon dioxide
- Methane
- Sulphur
- Nitrogen oxides

A final value of CO2 (equivalent) is derived incorporating the separate contributions from the listed gas compounds. Referencing the National Greenhouse & Energy Reporting (NGER) Act 2007 and associated documents from the Australian Greenhouse Office, values are provided for assessing emissions of GHG in order to determine tonnes/year volumes. These would be expected to form the basis of many carbon permits that will be issued to industries. Given the timing of the start of CPRS, there is little likelihood that there will be time to assess yearly emissions from future permit holders using continuous monitoring. Hence the above process as discussed will likely be used to quantify permits once they are sold to emitters. However, license or permit compliance and verification of residual permits will require a rigorous audit process. It should be noted that online monitoring technology of the listed gas compounds is available.

IV. Monitoring Standards

The challenges of meaningful monitoring and trading of emissions goes well beyond ISO 14001. Whereas the family of ISO standards provide a framework for continuos improvement and corporately responsible behaviour, they do not necessarily deliver a consistent benchmark at the higher level. For example, the main issue for onsite automated continuous monitoring is to ensure the sample taken for analysis is representative of the emissions stream being monitored. This involves airflow rate (cubic metre/second), gas concentrations (ppm or milligram/cubic metre), air temperature and pressure, moisture content, etc.. All these factors can be analysed by a range of systems currently available. However, the establishment and maintenance of a reliable and repeatable sampling system is vital for field mounted online systems. Here the sampling system needs to follow such measures as isokinetic sampling (Duguid).

The use of various online monitoring systems should be subjected to Standard Reference Methods & Materials (SRMs) as supplied by agencies such as the US National Bureau of Standards (NBS). There are some 40,000 Standard Reference Materials supplied via the NBS that can be resourced for verification, calibration, etc., and are usually endorsed by ASTM.

V. Challenges of a Live Monitoring System

If one accepts the premise of a live monitoring system, then a number of key factors need to be overcome in order to establish a viable, global technology platform. The key factors include:

- Connectivity
- Standards
- Data repository
- Reliability
- Consensus

Figure 1 illustrates the interdependent nature of the five key factors for environmental and fiscal sustainability.

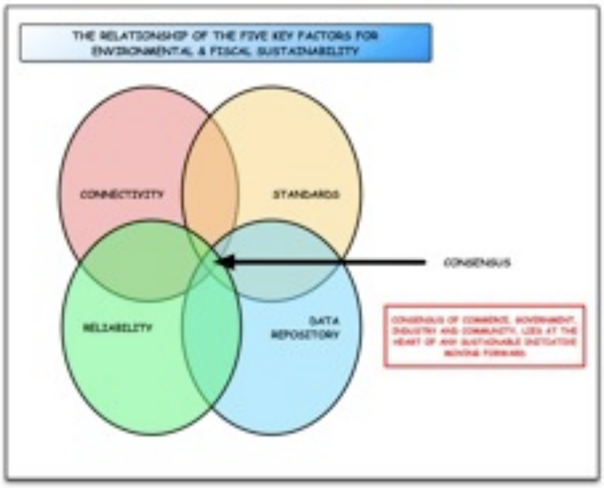

Figure 1 Relationship of the Five Key Factors for Environmental and Fiscal Sustainability

A. Connectivity

Connectivity of any industrial system is difficult. Factors such as common exchange protocols between devices, cable runs, uninterrupted power supplies, systems management, calibration etc. are common. However, the connectivity of a national or international system will undoubtedly generate significantly greater challenges. For example, within the Australian context one of the greatest challenges will be the development of robust technological infrastructure that will operate reliably over considerable distances and in remote rural areas where “normal” power and service levels are impractical and traditional cable runs impossibly expensive to install and maintain.

B. Standards

Manageable standards will need to be written and adhered to if a fully interactive system is to become operational. These standards will need to go far beyond the current national and international technical standards presently employed within the technology and environmental sectors and of themselves, will need to take into consideration sustainability and overall environmental footprints during rollout.

C. Data Repository

If a national or international system is developed then the data generated by the live monitoring devices will need to be housed and managed somewhere. Of itself, this aspect of the system will represent a significant infrastructure project. However, aligning the data to the standards and indeed maintaining relevant connectivity are likely to represent significant challenges well above those typically associated with more traditional product life management (PLM) or enterprise resource management (ERP) systems. Particularly, real time data concerning the availability of waste resources will need to transfer seamlessly into standard financial institutional trading systems at the same time it transfers into standard government monitoring and taxation systems.

D. Reliability

One of the greatest challenges moving forward will be developing reliable technology that requires the minimum of maintenance and monitoring, otherwise it will defeat the objective of live continual measurement. Importantly, the level of reliability will generate the correct level of confidence within the market and thereby contribute to sustainability.

E. Consensus

If carbon trading is to have any sustainable effect on the environment then it has to be undertaken in a technically viable and transparent manner that simple theoretical sampling cannot ever achieve. However, a significant level of consensus is necessary if change is to be brought about and a "win-win" achieved within the industrial, financial and ecological points of reference.

Individually or indeed collectively, the challenges highlighted above are manageable within current commercial platforms. The greatest barrier to effective live monitoring, measuring and trading of waste resources is that of the stake-holders reaching a consensus, in time, on the method, platform and, importantly, need for such a system.

Unfortunately, offering robust solutions to overcome the politicising of all interested parties is outside the scope of this work.

VI. Discussion of potential carbon sinks

Carbon sinks are currently considered the most likely way to sequester carbon emissions off major facilities such as power stations, and other industrial processes (e.g; steel mills, cement works, etc..) where coal or oil firing is used in the process. The carbon sinks typically being considered from these processes are based on the burial of CO2 within geological structures able to bear the sequestration process, or discharged into the ocean. Another process, popular with the general public, is to provide reforestation programs or the development of particular agricultural industries to take up atmospheric CO2.

Both these processes would rely on the value that they would apply to carbon credits where they are acting as sinks or users of CO2.

There are other processes in various stages of R&D such as algae systems that have the potential to generate a biofuel from the assimilation of CO2 during photosynthesis.

The measurement of CO2 into compounds such as calcium carbonate for sequestration would be able to be monitored and verified, however the take-up of CO2 by plantations or reforestation is difficult to quantify. While the business plans being developed by promoters of plantation systems incorporate the value of their carbon uptake in the carbon trading market (i.e; carbon emitters would pay them to establish plantations, etc.), there must be a well defined and verifiable monitoring program, otherwise the contract between emitter and carbon sink provider may not be sustainable. Essentially the ability of reforestation or plantations to take up CO2 at known rates may be questioned over time, as there is currently a paucity of data available other than default factors for carbon uptake by various plants during their stages of growth.

VII. An Australian Case Study

Recently, it has become necessary to monitor waste outlets at the point of discharge to ensure that any solutions that could have a negative impact on the system and environment can be detected instantly and contained.

Sydney Water needed to monitor trade waste customers at the point of the customers discharge into the sewer system. Typically however, most monitoring systems had failed in such environments because the high level of suspended solids often found in these environments caused blockages and equipment failure.

HydroSentinel is a continuous live monitoring technology, developed by Envirodyne Group Pty Ltd. The HydroSentinel technology was developed to overcome the challenging environments experienced by organisations such as Sydney Water. The technology addresses the problems typically associated with manual "snapshot" sampling and analysis by continually monitors for pH, ORP (oxidation reduction potential), conductivity, temperature and the presence of hydrogen sulphide gas in the pump station wet-well.

The technology data links through a telemetry system and provides data to the clients through a simple web interface. Should contaminant levels register outside of the pre-sets of the technology, the system automatically collects a sample and notifies the responsible person via SMS, email or voice alerts. Provision is also made to return the system to fail safe by automatically closing down valves etc. if required.

As such, the technology delivers a duplex arrangement where it not only monitors the condition of the waste resource but also provides a fail-safe to avoid contamination or pollution once an alarm is raised.

It is possible that HydroSentinel technology could offer a "model" system for potential future live monitoring and trading technology, insofar as it provides a closed loop duplex approach to environmental systems configuration.

VIII. Correlation of Live Monitoring Data with Theoretical Models

In one of the current uses of online monitoring by HydroSentinel, correlation has been shown between various parameters being monitored where one or more are in breach of a set range, indicating a change in the properties of a sewerage stream being monitored for industrial waste discharges. In the correlation of actual vs theoretical results, data for gasses is still limited because most applications have been in actual events where auditing was required to ensure compliance. Calibration and cross checking with reference methods have been performed as part of the ongoing maintenance of systems. In these cases, it is usual to find certain parameters being monitored require their analyzing apparatus to be calibrated at different frequencies - i.e, some instruments are more stable than others, and drift can be a function of the other compounds in the stream being monitored due to contamination factors, etc.. The design and installation of an online automated monitoring system must take into account these variables and their impact factored in to provide reliable results.

IX. Benefiting from a Duplex System

The basic principle of six sigma demonstrates that no system can be 100% effective, regardless of how well the system is configured and how diligent the organisation is. Put simply, it is likely that accidents will occur in environmental monitoring and containment, but it is how they are addressed that will eventually be the differentiator between good shareholder return and corporate liability litigation cases.

Fundamentally, it is not acceptable to adopt a "dilution solution" or indeed a licensed discharge policy if serious and sustainable environmental responsibility is to become manifest. Containment, via automatic fail-safe protocols, must be incorporated into any system and the contained waste converted into safe resources.

This is fundamentally the argument against theoretical statistical measuring because at the end of the day, the waste is still transferred to the environment and the polluter simply pays the appropriate levy (tax) – no improvement has actually been made in an environmental or corporate responsibility sense.

X. Rationalisation and Creating Momentum

Currently, there are a myriad of technical solutions typically being rolled out on an isolated, project-by-project basis. There is little doubt that the environmental monitoring sector will see significant rationalisation in the next few years as market forces apply and consolidation of markets takes place. If consensus can be reached regarding live, continual monitoring of waste resources then a program of incentivised rollout should be considered and, at the same time, real commodity trading encouraged.

XI. Conclusions

Whether tulip bulbs or dot coms, the great economic growths of the "new new thing" have crashed with remarkable speed and severity, when the real lack of substance has been realised and investors lose confidence. Without substance, there it every likelihood that a purely theoretical model of carbon trading will fare the same. It is far better to adopt a strategy of live continuous monitoring of waste resources that provides a tangible link to resource availability, thereby delivering a real transaction in the marketplace like any other commodity. Furthermore, it is far better to incorporate duplex systems that can contain any potential discharge and thereby protect the environment.

Overall, the greatest challenge to sustainability is not technical, nor indeed institutional, but rather that of consensus of all interested parties. Unless a consensus can be reached, we face years of further green wash and burdensome taxation that will have no effect on improving the environment and a negative effect on business sustainability.

XII. Further Work

Recommendations for further work include:

- Mapping the infrastructure requirements for a fully integrated live monitoring protocol
- Mapping the core technology availability with a view to incorporating key aspects into any standards
- Developing robust standards
- Bringing together financial, industrial and government stake-holders to develop a workable model for trading

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