Submission to Climate Change Authority Options.

By Murray Scott

Effectiveness of Emission Reduction Incentive Programs

Enforceable regulation (eg vehicle emission standards) and compliance bonds (eg for rehabilitation of minesites and gasfields) is necessary to preserve heath and amenity standards.

To optimise security of emission reductions however the burden of the necessary individual and corporate behaviour change, there is little alternative to the immediacy of market pricing mechanisms.

Question C6 asks:

> "The Authority proposes assessing policies primarily on their cost effectiveness, environmental effectiveness and equity. Are these principles appropriate? Are there any other principles that should be applied, and if so, why?"

I consider these principles appropriate but incomplete. Additional principles relating to the security of policy effectiveness that should also be considered include:

- criteria and timescale for review of effectiveness of policy
- insecurity of contract fulfilment for proposed long term measures, eg carbon capture and storage, minesite and gasfield rehabilitation, aquifer recharge, carbon sequestration by agricultural and rangeland fire practices
- insecurity of government policy commitment eg. repeal of carbon tax
- vulnerability of regulation to corporate legal challenge eg. under FTA ISDS clauses
- insecurity of dependance on uncontrolled external factors eg. market fluctuations
- reliability and performance of partners eg. in overseas offset purchase schemes

Effectiveness of Greenhouse Emission Reduction Incentives depends on Electoral Funding Reform.

Question C9 :

> "What lessons can be learned from Australia and overseas on the effectiveness of mandatory carbon pricing, and its interaction with other climate policies?"
>
> and

Question C10 :

> "How does mandatory carbon pricing perform against the principles of cost effectiveness, environmental effectiveness and equity? Which type of pricing scheme is likely to be more effective, and why?"

The primary lesson from Australia's ETS, Carbon Tax and Direct Action plans, which would have applied to any other incentive scheme, is that effectiveness under any of those criteria depends on assuring a stable investment environment for greenhouse gas reduction measures. Confidence in the long-term durability of these investment environments was sabotaged by cynical Parliamentary games and open hostility to climate action, reinforced by well-funded vested interest lobbying. Even investment finance and technological assistance schemes are vulnerable to such sabotage. Any incentive scheme must therefore be secured by a transparent multi-party agreement from which it would be politically difficult for any party to renegue. The political influence of vested interest lobbying, primarily from fossil-fuel extraction and consuming industries, is thus the greatest obstacle to effectiveness of emission reduction schemes.

Measures to strengthen Parliamentary implementation of durable emission reduction measures depend on public understanding and support at a level which is robust against scare campaigns and refuses to tolerate derailing of climate action by vested interests. Before that can assured it is essential to establish in State and Federal Parliaments, a transparent electoral funding and donation disclosure environment.

My Personal Renewable Energy Experience and Outlook for Battery Storage.

Owning my own home and having the means to invest in a 3.8kW solar photovoltaic system I am in the fortunate position of expecting to recoup that investment in approximately 9 years. Through approximate time-matching of loads such as oven and washing machine to available sunlight, I currently receive small credits instead of the previous $800 pa bills. I recognise that others are not so fortunate, with rental or Body Corporate restrictions, shaded or inappropriately oriented roofs or inadequately insulated houses.

To gain experience of further renewable energy developments, I maintain a watching brief on battery storage systems and the implications of their distributed use. Although inclined to wait a couple of years for price, connectivity and performance to settle, I am keen to buy a battery system and eventually an electric car. I am confident that lithium batteries or their technological successors are sufficiently viable, with photovoltaic power, to fundamentally change road vehicle usage and utilisation of electricity grids.

The Climate Change Authority should strive to ensure that Federal and State regulations optimise the emission reduction potential for the electricity grid by replacing fossil fuelled baseload generators with despatchable renewables. Smart metering and tarriff structures should be regulated to ensure that the benefits of renewable electricity and battery storage extend to those without photovoltaic-suitable roofs who wish to install batteries to import and export energy for time-shifting local and grid demand according to price Subscribers must thus be encouraged to stay connected to the grid, exporting power as required for industrial and other household users.

Diverse sources including wind farms, large-scale PV installations and solar thermal generators with storage can thus be integrated with distributed household batteries to enhance capacity and reliability of 100% renewable electricity.

Legacy of Australia's Mineral Boom.

For years our Governments have delayed local action on GHG emission reductions because of perceived risk of economic uncompetitiveness if other countries failed to do likewise. Now due to economic slowdown emissions are tapering off even in the USA and China, while our economy, like oil producers in the Middle East, is still floundering in glutted minerals markets.

The minerals boom which delivered budget surpluses and unsustainable tax cuts also sucked the life out of other sectors of the economy, particularly manufacturing. The policies that encouraged “go for broke” minerals development have now done so. It is hard to escape the conclusion that much of the industry and political approach of the noughties was not as naively short sighted as it appears. Influenced by the prospect of future greenhouse emission constraints, it was probably aimed to deliberately preempt, block and delay such constraints through a grab for profit while China's clearly unsustainable demand growth persisted.

An effective emission reduction program must take a long term view with the legislative provision and power to avoid boom-bust fluctuations in the now essential wind-back of over-capacity mineral extraction. Several activist organisations have proposed the compromise of “no new coal” for example, providing for continuation of existing mines for decades in many cases to allow orderly restructure of employment opportunities and communities. A similar compromise should be extended to all but a few other mining projects, refusing applications for indefinite extension of those operations.

Defining a timescale for termination will clarify, while a mine is still operating, the planning and adequacy of financial provision for safe minesite rehabilitation. Indefinite deferrment of rehabilitation appears to motivate some current applications for extension of marginal or uneconomic operations, particularly in coal.

At-Source Accounting for Emission pricing Schemes.

In any greenhouse gas emissions policy it is important to reecognise that ALL minerals, including metal ores and limestone for cement, impose a climate burden, not just fossil fuels. The smelting or calcining and processing of all such minerals to useful products requires provision of complementary quantities of fossil fuel from somewhere. While avoiding double-counting, all minerals exported to overseas juristictions therefore should be included in the scope of emission constraints in the country of origin unless securely covered by explicit agreements on responsibility.

The current practice of attempting to account for emissions at the widely dispersed end of the production chain, often across borders under different regulatory arrangements with variable commitment to emission constraints, imposes measurement difficulties, costly overheads and multiple avenues of evasion. For an effective global price incentive scheme the simplest and cheapest place to impose price signals is at the mine or well-head, where tonnage is easily measured and emission accounted for using standard chemical formulae for processing operations. That implies that the tax or permit responsibility for emissiongenerating minerals must lie with the juristiction covering the mining project, even where raw or partially processed material is exported.

Material Consumption and The Economic Growth Presumption.

Implicit in Government and commercial assessment of effectiveness, as in Section 1.5.1 , is an assumption that for “budget sustainability” a policy or process must promote, or at least not impede, economic growth. This “business as usual” objective, although sometimes defied in policy, eg. in ending assistance to motor vehicle manufacturing in Australia, remains politically powerful in undermining policy change, eg. on mining tax, carbon tax or restricting the diesel fuel rebate for mining.

The Climate Change Authority must explain to slow-learner politicians that emission reduction is inconsistent with expanded extraction of coal, gas and oil. Oil and gas are currently used in mobile and multiple distributed applications for which CO2 capture is impossible. Alternatives must be found for those applications. It is unlikely too that CO2 capture and storage for fossil fuelled electricity generation will be cheaper than using renewable generators and simply leaving coal in its secure million-year sequestration underground. Australia cannot continue to plan for and depend on increasing coal and gas extraction whether for local combustion or export. Continued operation of existing mines affords a period of economic readjustment but no new coal mines should be permitted or new generations of workers recruited into this dead-end industry.

The truism “ perpetual growth is impossible on a finite planet” remains ignored and unrecognised in a blindspot of economics. Growth advocates either assume that Earth and its natural systems will dwarf any human influence for the forseeable future, or that economic growth can persist despite material and energy constraints eg. in services.

I challenge the Climate Change Authority to find any credibility in either proposition.

Greenhouse gas induced climate change itself refutes the first assertion, with irrefutable evidence that human influence is already dangerously distruptive to the most fundamental of Earth's natural features. The second assertion demands at least one example of “post material” economic growth.

The most likely candidates would be in abstract activities such as education, health, scientific knowledge, literature or the visual and performing arts. As demonstrated by the clamour over annual budget constraints, none of these pursuits can proceed without consuming materials for buildings, electronic devices, travel for experience and performance, clothes, even paper and paint. Teachers and performers have families and houses, and depend on affluent audiences. Like any other citizens they consume greenhouse gas-generating materials. Some place blind faith in future technologies to rescue the prospect of eternal growth.

Knowledge embodies energy. The human brain generates a significant fraction of body heat. Libraries require buildings, tons of paper and humidity stabilising air conditioning. Laboratories demand rare materials and energy, sometimes on an unjustifiably gross scale as for the Large Hadron Collider and space telescopes. The servers for electronic knowledge banks such as Google consume ever increasing electric power. I know of no example where miniaturisation of any device has resulted in a global reduction of material throughput. Individual cars become more frugal on fuel but in overwhelming numbers. Even given Moore's Law for electronics, amortisation of the investment required for each successive advance enables and demands an increase in production scale that consumes ever more materials and energy.

Material recycling is a grand aspiration and current efforts represent a useful, if inadequate start. So many waste streams however defy efficient recycling, eg. the ultra-pure crystalline silicon wafers which form the basis of electronic devices and most solar photovoltaics can at best be crushed and used for less demanding purposes or dumped in landfill. Mine dumps and unfilled pits throughout the country contain and sometimes destructively release chemically intransigent waste materials. The problems of nuclear waste disposal remain unresolved.

Renewable energy is a significant but by no means complete solution to the material sustainability problem. It is not only greenhouse emissions that must plateau, then reduce but the throughput of every mining and material refining process that contributes to those emissions. That can only happen with a stable population and development of a stable, low-throughput economy. Stability does not imply stagnation or stasis. As with an aircraft, stability is a state in which movement can be controlled smoothly and deliberately, anticipating side-effects and feedbacks.

Policy development for the Climate Change Authority must recognise and pursue consistency with that eventually stable outcome. The Earth and its people are approaching a crucial period in which natural disaster, global war or chaotic dysfunction of the economy, like the GFC, would imperil civilisation and human survival.

Underground extraction of Coalseam Gas.

Whether from petroleum wells or coalseams, natural gas represents a vast resouce of energy. Its exploitation is politically difficult to constrain for greenhouse gas emission reduction. Nevertheless, it should not be burned now to expand the use of fossil fuels, albeit one ostensibly slightly less polluting than coal. Having been securely sequestered for eons, this gas could in centuries to come be part of the solution to providing not only non-polluting hydrogen fuel but also structural materials without having to oxidise coking coal.

Current practice for extraction of coalseam gas, whether or not fracking is required, has also created adverse impacts and land-use conflicts with agriculture, water catchment and residential amenity. In coalfields employing underground longwall extraction however, subsidence cracking of streambeds, swamp platforms and infrastructure presents even greater problems.

Gas extraction by horizontal drilling within coal seams is currently used eg. in the Southern Coalfield of NSW as a safety measure to avoid blowouts and gas explosions. Similar drilling from perimeter drives of those existing mines could provide a much less damaging and intrusive source of natural gas. The entire operations could take place underground using existing mining techniques and employee skills, avoiding surface roads, well-heads or pipelnes and with minimal subsidence. Such underground CSG operations offer the additional potential of providing continued income and employment for mining communities to facilitate the orderly shut-down of longwall coal operations. The Climate Change Authority should consider supporting its development.

Solar thermal Pyrolysis of natural gas.

Amongst the emission reduction technolgies awaiting exploitation is the use of concentrated solar thermal energy at temperatures of ~1000^{o}C to pyrolyse methane or other hydrocarbons from natural gas to produce hydrogen and solid carbon. Before retirement from CSIRO I used this well-known process (but not with solar heat) to produce solid carbon coatings for experimental carbon hipjoints balls.

Pyrolysis is the breakup of compounds by heating, through which hydrocarbons split, through stages of polyaromatic ring formation into hydrogen and carbon. The pyrolysis reaction is easily demonstrated with the carbon produced in the form of soot eg. from the inner yellow part of a candle flame or on an industrial scale for making carbon black for motor tyres. In such cases a restricted proportion of air is admitted to produce the required heat by burning off the hydrogen and some of the carbon in an open flame. If air is excluded and the heat applied externally, graphiite layers are formed. This process is also referred to as Chemical Vapour Deposition (CVD).

Even more interesting forms of carbon such as nanotubes or their coarser cousins, whiskers, are formed if small quantities of various transition-metal catalysts are used, a favorite being Fe2O3 ie. iron ore. Potentially useful continuous-flow variants of the process might use a volatile organic-iron liquid such as ferrocene to make iron nanoparticle catalyst.

The intermediate products of pyrolysis, aromatic hydrocarbons, are well known carcinogenic poisons but the end product, solid carbon, is one of the most inert materials known, immune to corrosion, funghi, bacteria, acids or alkalis. Pyrolytic graphite is used to make artificial heart valves. Only when exposed to air at temperatures above about 500 deg C, eg in fire, is its surface vulnerable. Protected from air, eg by thickness or by an inert coating however its strength actually increases with temperature, unlike structural steel. At temperatures above 2000 deg C, carbon-fibre-reinforced-carbon is the strongest material known, used for aircraft brake disks and pads which, depite being exposed to air are used repeatedly, briefly glowing white hot during landing. Graphitic (black) carbon in its many forms is useful stuff.

Two warning flags hang over this scenario, one in the form of unknown potential health threats from carbon nanotubes released, like asbestos, through weathering or fracture of structures that contain them. Another is the familiar disruptive and hydrological problems of conventional coalseam gas production, as noted above. All such problems must be thoroughly researched and evaluated before the process can be commercialised.

This short bibliography is far from exhaustive. Its purpose iis to roughly outline the potential applications of solid carbon in the form of nanotubes, whiskers or graphite obtained as a co-product, along with hydrogen gas, from the catalytic pyrolysis of methane from natural gas. As noted particularly in the brochure for Eden Energy Ltd (2 below), the pyrolysis process delivers hydrogen from natural gas without emitting CO2, unless additional fuel is burned to provide the heat input required.

Although these papers do not canvass the use of solar thermal heat to drive the pyrolysis reaction, the temperature range required of ~1000 deg C is well within the capability of reflecting solar concentrators. A multi-megawatt "power-tower" heliostat concentrator supplied with natural gas feedstock would afford industrial-scale production of hydrogen fuel gas and C nanotubes with zero CO2 emission. This rather obvious combination of technologies has not yet been commercially explored. Practical problems such as soot deposition on reactor vessels will no doubt occur but do not appear insuperable.

Many of the following papers focus on the exacting conditions for exploiting high-tech electronic, sensor and chemical properties of the nanotubes produced. It might even be possible to produce hydrogen along with nanotubes specially tailored to compactly store it. There is moreover a much larger middle-to-low-tech market for bulk quantities of less refined nanotubes, whiskers and fibres as reinforcment for structural materials. These range from aerospace polymer composites to replacement for steel in structural concrete. Dealing with byproducts of energy from fossil fuels by sequestration of solid carbons in soil or in the structural fabric of civilisation would be much more beneficial and reliable than Capture and Storage of CO_2 gas. Appendix 1. lists a number of papers illustrating the possibilities for this process

Appendix 1. Summary and short listing of Web-accessible Papers on pyrolysis of hydrocarbons.

The following papers were found in Google searches, mostly under the heading "Pyrolysis of methane to carbon nanotubes". Not all are available free of charge, links are included for those showing only an abstract.

Carbon nanotubes for reinforcement ceramic - matrix nanocomposites: synthesis, modeling, optimization - Технические науки - International Journal Of Applied And Fundamental Research
www.science-sd.com

www.edenenergy.com.au
Eden Energy

http://image.sciencenet.cn/olddata/kexue.com.cn/upload/blog/file/2010/2/20102193247668823.pdf
image.sciencenet.cn

http://image.sciencenet.cn/olddata/kexue.com.cn/upload/blog/file/2010/2/20102193247668823.pdf
scholar.google.com.au

https://books.google.com.au/books?id=FYOGY-TEXjUC&pg=PT386&lpg=PT386&dq=pyrolysis+of+alkanes+to+carbon+nanotubes&source=bl&ots=s6F_xesvRM&sig=Gkb1sjPDqA-LaPJEOgsJhEXy1mI&hl=en&sa=X&ei=n9i9VO_RBY2n8AX6q4LgCw&ved=0CDsQ6AEwBQ#v=onepage&q=pyrolysis%20of%20alk
books.google.com.au

Synthesis of aligned carbon nanotube with straight-chained alkanes by nebulization method
www.linknovate.com

http://web.stanford.edu/group/dailab/Reprint/58.%20From%20Synthesis%20to%20Integration%20and%20Properties.pdf
web.stanford.edu

http://scholar.google.com.au/scholar_url?url=http://www.stanford.edu/group/dailab/Reprint/58.%2520From%2520Synthesis%2520to%2520Integration%2520and%2520Properties.pdf&hl=en&sa=X&scisig=AAGBfm0lBzgEtupDPPfCGKEa_tJ3UN5iKA&nossl=1&oi=scholarr&ei=n9i9VO_RBY2n
scholar.google.com.au

CO2 enhanced carbon nanotube synthesis from pyrolysis of hydrocarbons. - ResearchGate
www.researchgate.net

http://scholar.google.com.au/scholar_url?url=http://carbon.imr.ac.cn/file/journal/1998/98_APL_72_3282-ChengHM.pdf&hl=en&sa=X&scisig=AAGBfm1pM136cMjX6YwC8h4kYTqPTV1Srw&nossl=1&oi=scholarr&ei=Qsy9VM-4GJDj8AWxy4KACg&ved=0CB8QgAMoAjAA
scholar.google.com.au

http://scholar.google.com.au/scholar_url?url=https://patentimages.storage.googleapis.com/pdfs/US3579601.pdf&hl=en&sa=X&scisig=AAGBfm39MImIHj-P-h_KvDM9jD34bhF1wA&nossl=1&oi=scholarr&ei=Qsy9VM-4GJDj8AWxy4KACg&ved=0CB4QgAMoATAA
scholar.google.com.au

Several papers on ScienceDirect:

Bundles of aligned carbon nanotubes obtained by the pyrolysis of ferrocene–hydrocarbon mixtures: role of the metal nanoparticles produced in situ

An overview on methods for the production of carbon nanotubes

Temperature-dependent growth of carbon nanotubes by pyrolysis of ferrocene and acetylene in the range between 700 and 1000 °C

Carbon nanotubes by the metallocene route

http://www.sciencedirect.com/