Bio-Energy with Carbon Storage (BECS): a Sequential Decision Approach to the threat of Abrupt Climate Change

(forthcoming **Energy**)

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Expert Workshop, Paris, 30Sept/1st Oct

Abrupt Climate Change and Greenhouse Gas Emissions: Positive Options and Robust Policy

Mission Statement

"to address the policy implications of potential abrupt climate change"

Acknowledge
Bob Watson
UNFoundation's Better World Fund
Edward Sumoto

Visit www.accstrategy.org

The conclusion of the workshop was that policymakers should be urged to stimulate the growth of a global bioenergy industry, with world trade (mainly 'North-South' trade) in liquid bio-fuels such as ethanol and synthetic (e.g. Fischer Tropsch) bio-diesel.

Why?

1

Energy related emissions are just over 5 per cent of CO_2 flows into and out of the atmosphere. This suggests that mitigation investment in the heavily capitalised energy sector is likely to be less cost-effective than investment designed to increase photosynthesis on under-capitalised land.

Why?

2

Defossilization is much easier than decarbonization

High alleged costs of bio-energy are based on dedicated crops grown in temperate climates

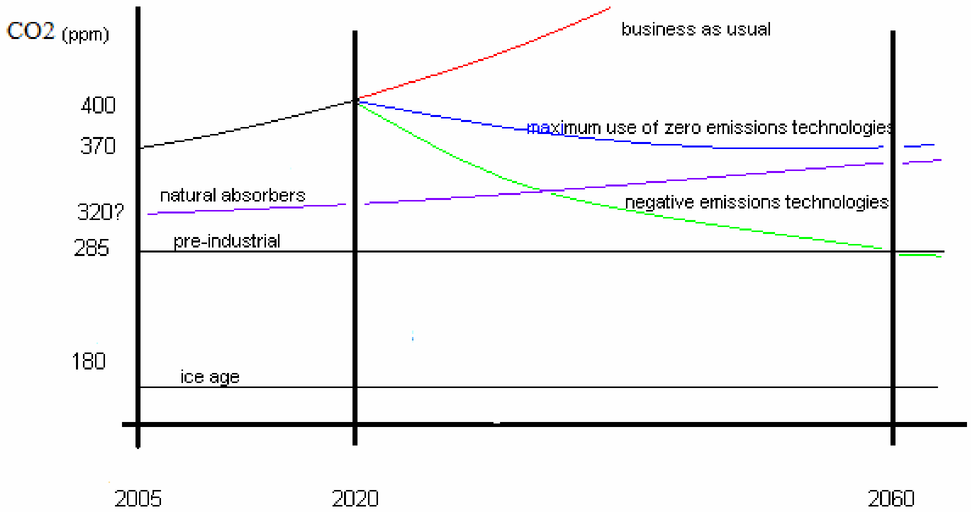
- Co-producing energy and food can, with plausible technology gains, maintain existing output on US crop-land whilst delivering about half current transport fuel requirements (eliminating imports) by 2025 at prices below central US DoE forecast for gasoline (Greene et al)
- Co-producing energy and timber yields zero cost CO_2 abatement, also using plausible assumptions on technological improvement (Read, earlier papers referenced in Read and Lermit)
- Ethanol is fuel of choice and widely used in dual fuel cars in Brazil while oil prices over $35/bbl (Moreira)

Why?

3

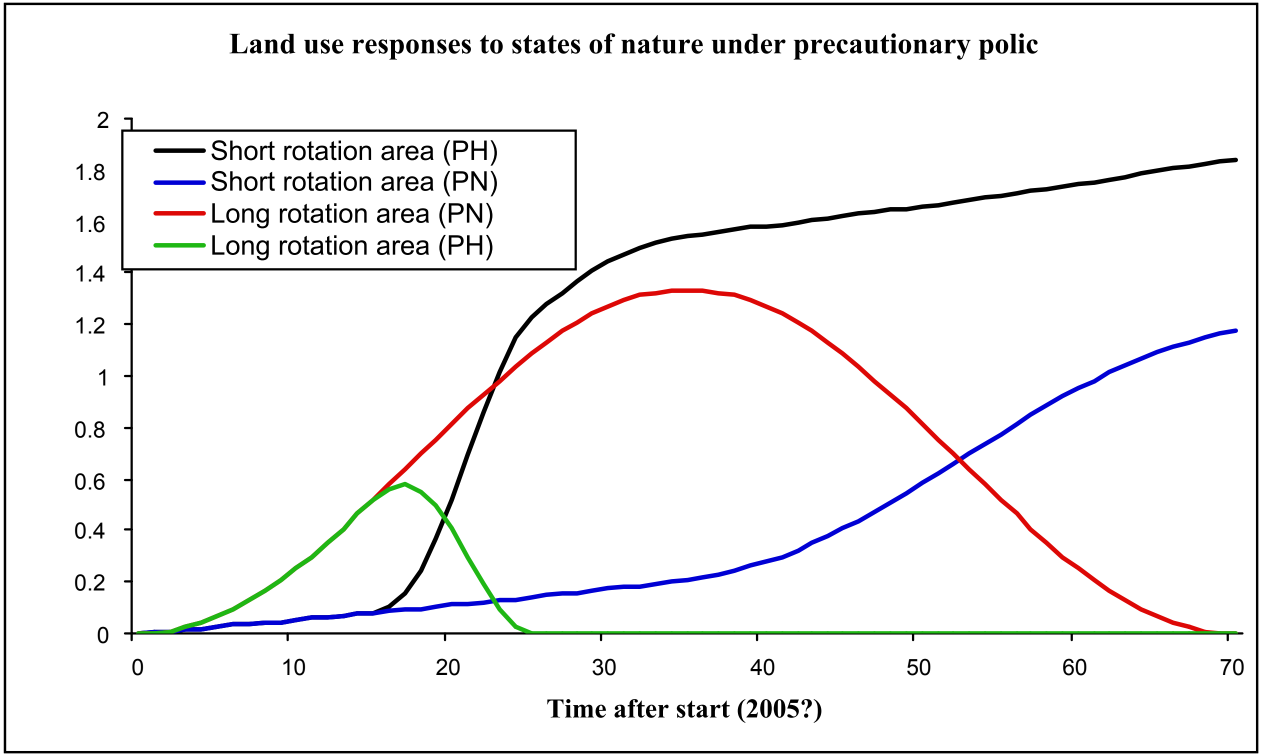
Negative emissions energy systems (e.g. bio-energy combined with CCS) yield effective control of Carbon in atmosphere in the event of imminent abrupt climate change

But large scale land use change involves many thousands of rural communities, will take a long time ***and should start soon***



The difference between zero and negative emissions

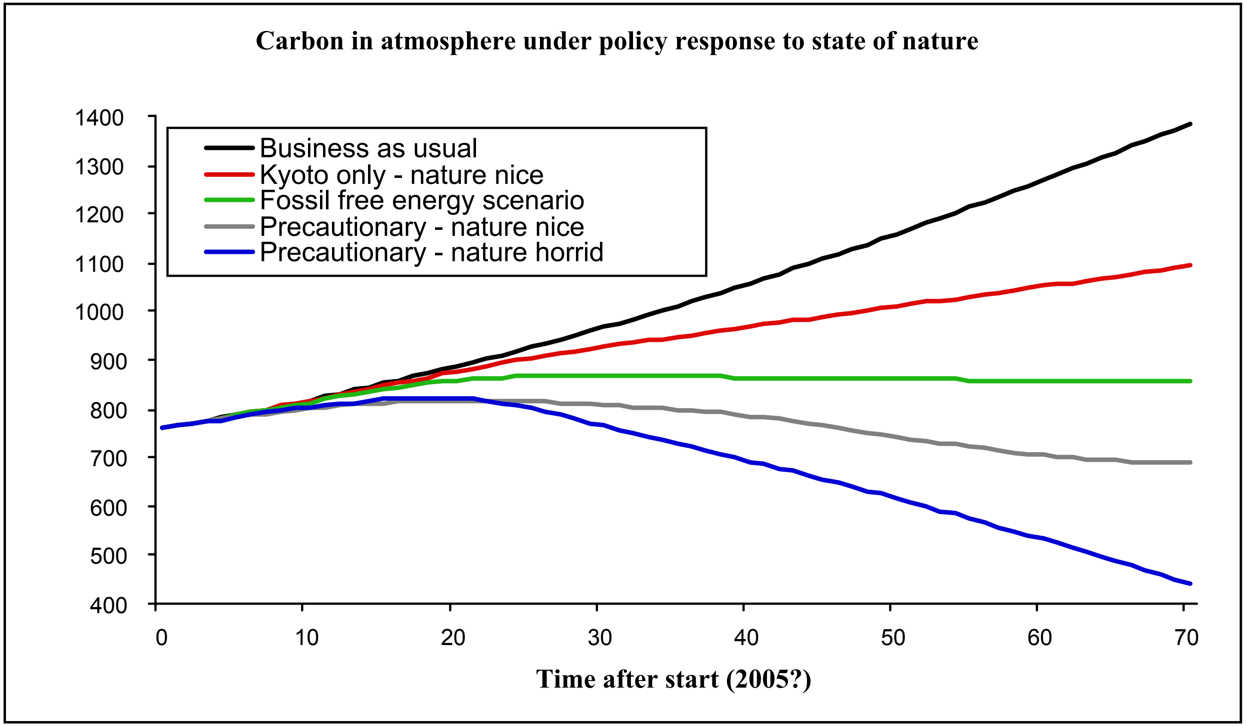
Policy driven global land allocations under a 'be prepared strategy'.
With (H=nature horrid) and without (N=nature nice) precursor signals of Abrupt Climate Change 15 years hence.



“Manhattan Project” style actions taken over the following decade in response to scientific news of Abrupt Climate Change precursors in 2020 (Nature Horrid)

The effect of these measures is that emissions per ton of fossil fuel fall from .025tC/GJ to .015tC/GJ and per ton of biofuel from zero to – 0.01tC/GJ,with biofuel supply eventually dominating the market.

Gigatons C in atmosphere (= ~2 x ppm C_{at}) for three reference scenarios and with 'be prepared' policy related to 'Kyoto' case with and without response to ACC precursors after 2020.



Caveats

1. land use is assumed ‘Maximal’
2. need for capacity building
3. resistance to rational land use may turn out to be very great
4. technological progress with biomass production and conversion may prove disappointing
5. population trends may put greater pressure on land than is currently projected

So do not put all eggs in the bio-energy basket: Low C_{at} levels require, in addition, high energy efficiency and increased use of non-fuel renewables

Soil improvement (better than CCS)

Bio-char (“charcoal”)

•retains water and nutrients
•reduces polluting nutrient run-off,
•acts as a substrate for microbe and fungal activity essential for the functioning of root systems
•raised fertility yields quick returns to land users while storing carbon long-term (~5Kyr half life)

Back of envelope calculation

1.36e9 ha arable land * e4sqm/Ha * .2m deep*10% biochar
* 0.4 sp gravity
~11e10 tons C ~110Gt C or ~25 years emissions

And there is 3.48bHa of pasture land (and/or 20 % biochar)

the Terra Preta or black earth story. Also ancient Japanese practice of ‘charcoal’ soil amendment

www.eprida.com for a high-tech version where bio-char is used to scrub flue gasses of CO_2 , Sox and Nox to yield soil conditioner loaded with nutrients

Can bio-energy do the job?

Acknowledge Jose Roberto Moreira and Andre Faaij

CENBIO
CENTRO NACIONAL DE REFERÊNCIA EM BIOMASSA

	Gross potential arable land (rainfed cultivation) (1,000 ha)	Protected Land		Settlement (% of total area)	Net potential arable land (rainfed cultivation) (1,000 ha)	Actual arable land (1994) (1,000 ha)	% of potential arable land (rainfed cultivation) actually in use (1994)	Equivalent potential arable land (1,000ha)
		% of total area	% of potential arable					
Sub-Saharan Africa	1,119,492	8.6	4.3	1.9	1,050,083	157,608	15	752,344
North Africa and Near East	50,017	8.1	4.0	6.4	44,815	71,580	160	29,009
North Asia, East of Urals	286,800	3.0	1.5	(2.3)	275,802	175,540	64	226,774
Asia and the Pacific	812,561	9.4	4.7	3.9	742,672	477,706	64	561,890
South and Central America	1,046,071	10.6	5.3	1.2	979,946	143,352	15	743,243
North America	463,966	9.9	4.9	(2.1)	431,465	233,276	54	345,169
Europe	363,120	10.1	5.0	(5.8)	323,803	204,322	63	286,887
World	4,144,017	8.9	4.4	2.8	3,818,809	1,463,384	38	2,945,316

Amount of energy produced from sugar/alcohol mills distributed over world agricultural land area at a density of 1 every 6,200km^2 – BIG, Combined Cycle, and 40% more yield – Total number of renewable energy producing units is 4,000

FINAL ENERGY CATEGORY	PRIMARY ENERGY (EJ/yr)	FINAL ENERGY (EJ/yr)	TOTAL LAND AREA USED FOR CROPS
ELECTRICITY	94.1	37.9	
LIQUID FUEL	69.9	51.5	
TOTAL	163.9	89.5	1.43 X 10^6 km^2 (143 MHA)

About 7 per cent of arable land is needed – the shortage is not a shortage of land but a shortage of investment in land

International Framework for Bioenergy Action

Scenarios	A1	B1	A2	B2
Tech	Hi	Hi	Lo	Lo
Pop	Lo	Lo	Hi	v. Hi
Globalise	Yes	Yes	No	No
Values	Econ	Enviro	Econ	Enviro
Bioenergy Potential In 2050				
North Am	111	137	4	34
Latin Am	253	315	46	178
Africa	363	449	42	151
S Asia	21	24	14	21
W Eu	32	40	0	14
E Eu &CIS	125	153	3	76
E Asia	178	221	10	21
Ocaeania	100	125	15	60
Total	1183	1464	134	555

Do CO_2 storage sites exist ?

(acknowledge Stuart Haszeltine)

Figure 4

CO_2 disposal into depleted oil or gas fields is possible, but currently is only economic in the onshore USA and Canada – where CO_2 is used to enhance oil recovery. Natural CO_2 is transported through pipelines which are hundreds km long, and 44M m^3/day is typically moved. Similar networks could be engineered for CO_2 storage onshore offshore

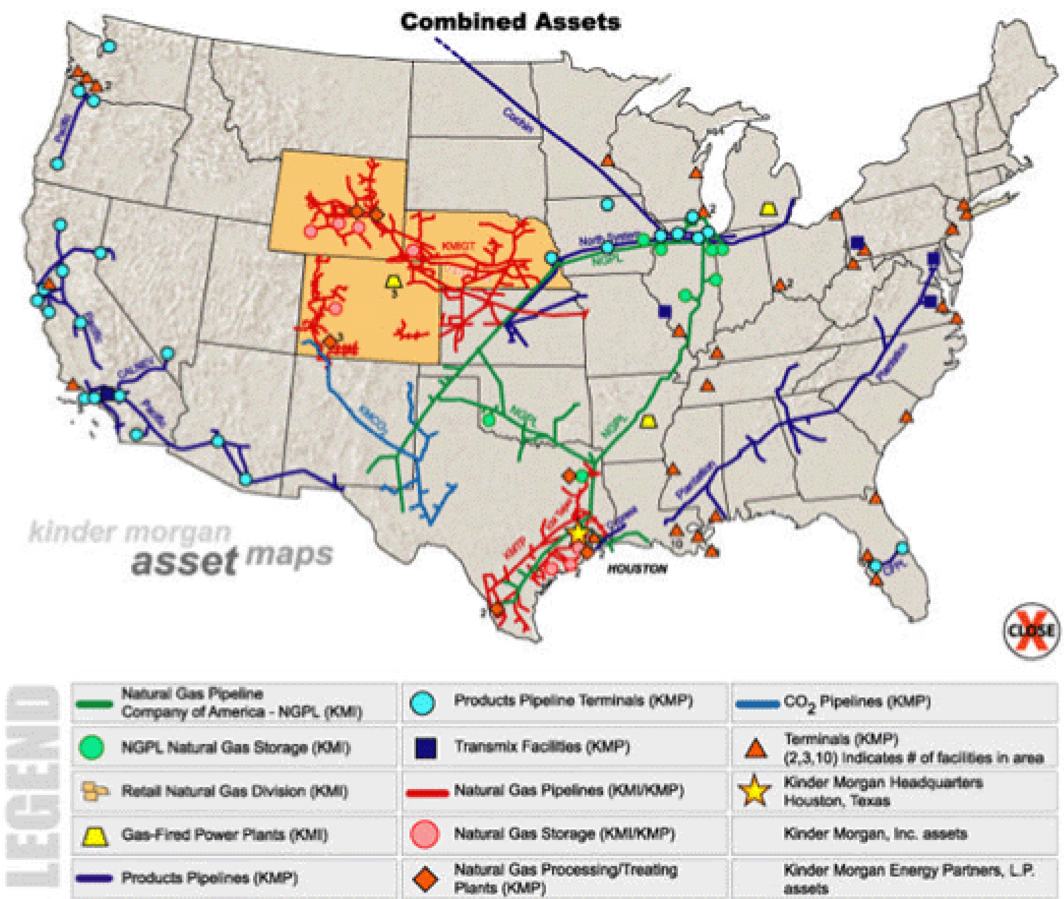
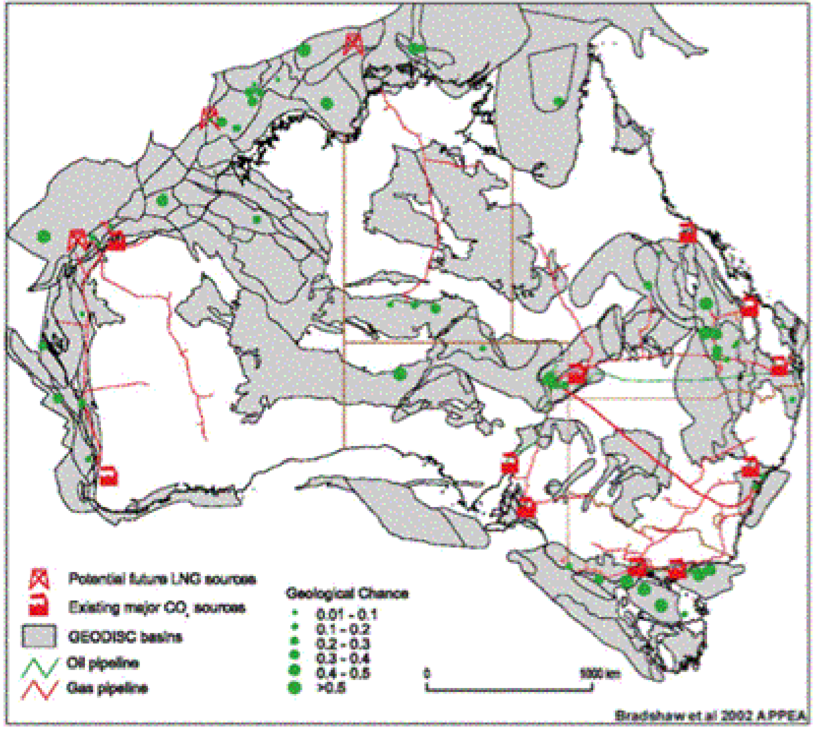


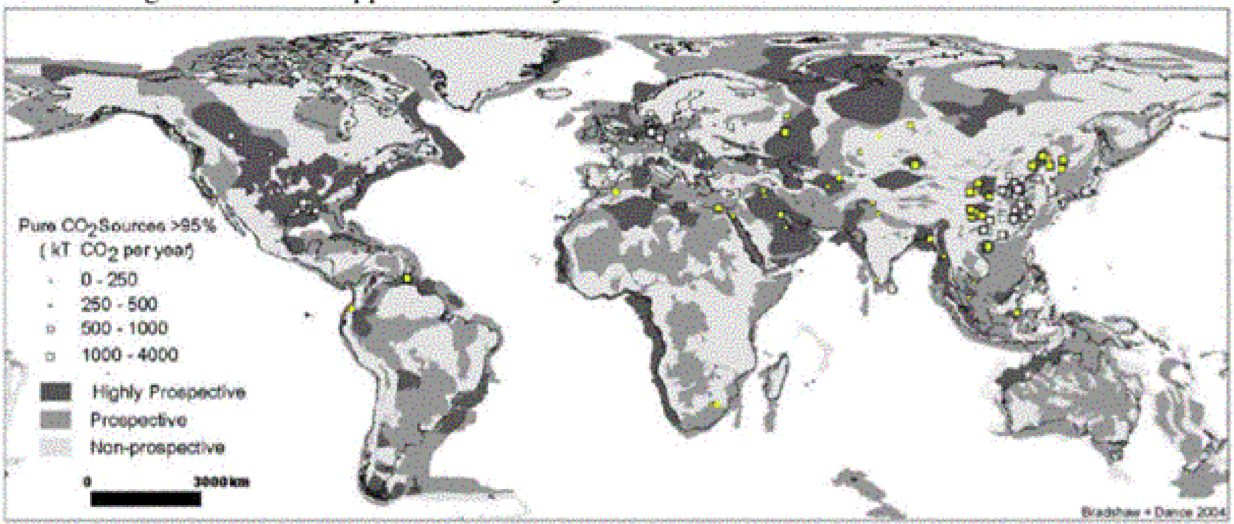
Figure 6

Australia is the first continent to have been assessed for sites of CO2 storage. All basins were evaluated, and simple five geological criteria were used to numerically score each basin's suitability. This is a similar procedure to that used in oil exploration

A Basins (shaded) with locations of CO2 sources (factory) and quality of candidate storage site represented by diameter of small circle.



B Comparison of basins, simply ranked for CO_2 storage, with sites of pure CO_2 emissions, which are less volumetric than those shown above, but may be easier to engineer into deep storage. Individual opportunities may exist in several "southern" countries.



Clearly the outcome in 2050 depends upon choices soon

NEGOTIATING A HEDGE AGAINST A.C.C.
PROVIDES A CHANCE TO AVOID THE ERRORS
OF KYOTO AND FOR THE RIO TREATY TO DELIVER:

- ENERGY SECURITY – a USA concern
  (NEEDS TRADE BUT WITH “OBEC” not OPEC)
- JOBS FOR SURPLUS AGRICULTURALWORKERS – an EU concern
  (AND BASIS FOR RURAL INDUSTRY)
- SUSTAINABLE RURAL DEVELOPMENT – a G77 concern
  (AND END OF ‘ENERGY POVERTY’)

Concluding comments

- *It could be that climate change policy has been misled by a plausible fallacy – that the energy sector's problem is best cured in the energy sector.*
- *This possibility is revealed by the emergence of two technologies for long-term disposal of carbon fixed by increased photosynthesis (CCS and bio-char soil amendment).*
- *It appears that (along with the industrial practicability and here-and-now availability of bio-energy systems) the GHG mitigating potential of photosynthesis has been overlooked.*
- *The policy-making community has been misled by economic theory that has focused on capping energy sector emissions.*
- *A technology-based approach to managing net carbon flows to and from the atmosphere is far less costly and offers many prospective benefits .*