# AFF

# -no leaks

**CCS is safe – no leaks**

**--their evidence is alarmist environmentalism**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

It is often claimed that carbon capture and storage is 'not proven'. For example, the US's oldest environmental organisation, the Sierra Club, has said, "We don't have any idea whether or when this [carbon storage] will be possible...it's pie in the sky.'11\*' Andrew McKillop dismisses the idea as 'exotic technological fantasies',117 while Greenpeace com¬mented that the Swedish utility Vattenfall was attempting to deceive ecologists with its CCS plans.118 Yet, as we will see, the individual elements of CCS are **all** technolo-gically **proven**. Four industrial-size carbon storage projects are operat¬ing, in various parts of the world, and numerous pilots are investigating all the aspects of carbon capture, transportation and storage. Long-distance carbon dioxide transport and storage for enhanced oil recovery is commercially proven, and operating on a large scale. Experience from these projects suggests that they arc **safe** and that leakage will be **minimal**.

**No leaks from earthquakes**

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A large earthquake at the Nagaoka test site in Japan did not cause any leakage,151 although obviously it would be preferable to use stor­age sites away from seismic and volcanic activity. In the USA, with the exception of western California and local areas along the west coast, the New Madrid fault zone in Missouri and coastal New Carolina, there is negligible to low seismic risk.132 The same minimal level of seismic danger applies globally, to most of Canada east of the Rock­ies, most of South America east of the Andes, northern Europe and Russia, most of sub-Saharan Africa away from the Great Rift Valley, the Middle East (excluding the Zagros and Oman Mountains), most of India south of the Himalayas (excepting a belt running east-west across the country at the latitude of Mumbai), most of peninsular South East Asia (excluding Myanmar) and Borneo, South Korea, and eastern Australia.133 China and Japan are the two clear CCS candidates where seismic activity might be problematic: in Japan's case, across most of the coun­try; for China, in the west (which has sparse population and industry), and around Beijing, in the south-west, and in some coastal areas south of Shanghai. In these areas, major faults will have to be carefully mapped and the risk of disruption to storage sites assessed. Injection of fluids (including oilfield water, natural gas, carbon diox­ide and other waste-water) into the sub-surface has been associated with micro-seismic events, detectable only by instruments, and might have induced moderate local seismicity in Denver and Ohio. The larger events were not due to CO^-EOR, and in general, despite the James Bond film A View to a Kill, significant earthquakes linked to fluid injection are extremely rare.

**No leaks and monitoring checks**

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Long experience of transport, injection and production of carbon dioxide and natural gas shows a very good safety record. Leakage from pipelines and facilities is likely to be minimal, and it is improbable that carbon dioxide in air would reach dangerous levels. These installations, anyway, are carefully monitored. Leaks are quickly detected from direct measurements or from drops in pressure, and automatic shutdown occurs. Any escaping carbon dioxide will diffuse harmlessly into the atmosphere within minutes, as long as the area is well-ventilated.'

**Monitoring solves leaks**

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In order to avoid leakage, remedy it if it does occur, and accurately account for stored carbon dioxide, storage sites will be monitored in any variety of ways. These methods are well developed from the oil industry and other uses, and some modest adjustments make them suitable for monitoring carbon dioxide. Numerous monitoring techniques are available, including acquiring seismic data, as mentioned (using sound waves to detect changes in underground fluids), tracking reservoir pressures, measuring the elec­trical resistivity of groundwater and soils, and detecting elevated levels of carbon dioxide in the air. An advancing carbon dioxide front is sig­nalled by geochemistry, including changes in alkalinity, electrical resis­tivity and carbon isotopes, before it even arrives at wells.146 Carbon dioxide that has leaked to shallow levels and returned to gaseous form (from a supercritical fluid) stands out very strongly on seismic data. Satellite imaging can detect bubbles of carbon dioxide rising through sea water, and areas where vegetation is affected by leaks. Recent advances in electromagnetic surveys can highlight sub-surface oil and gas, and may be effective for carbon dioxide too, although they can currently only be used offshore. Gravity data can detect shallow car­bon dioxide accumulations, while tilt-meters and satellite altimeter surveys pinpoint how the surface is rising14 (by a matter of millime­tres) in response to increases in underground pressures.148 Geo-mechanical techniques for estimating the strength of cap-rocks have been long-used in the oil business, and are already employed in the various pilot projects to ensure that pressures in the storage reser­voir do not approach dangerous levels where they might fracture the seal. Micro-earthquakes can also be tracked, for any evidence that the seal is cracking. The combination of a variety of these techniques, most of them well-tested in the petroleum business over many years, can give a clear picture of where injected carbon dioxide is in the sub-sur­face, and where any leaks may be occurring.

**Even worst case leaks are not offense – still solves 30%**

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Modelling of natural fractures suggests that leakage would be low. For instance, studies examining the effect of a fracture 8 kilometres from an injection well suggest that it would start to leak after 250 years, and total leakage might be 10-20% over the next 2,000 years,1'6 i.e. less than 0.01% per year. This is acceptable, particularly when considering that most sites, if well-planned, would not be near such fractures. Since some 30% of carbon dioxide dissolves within decades, and the heavier C02-saturated water will tend to sink, it seems implau­sible that, even in a site with no seals, total leakage could ever exceed 70%. To give three examples: For the Forties oilfield in the North Sea, even over 1,000 years, fluid dynamic simulations suggest that only 0.2% of injected carbon diox­ide would enter overlying layers, and even in the worst case, it would reach only halfway to the seabed. Similarly, at Sleipner, it is calculated that there will be no leakage into the North Sea for 100,000 years, and even after a million years, annual escape would be only 0.001%. At Weyburn, calculations show 95% confidence that leakage over 5,000 years will be no more than 0.00026% annually, with an aver­age total release over this period of 0.2% of injected volumes.

**Air capture solves leaks**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

If it becomes apparent that leakage is occurring after some decades of CCS, then air capture forms a useful 'last line of defence'. Air cap­ture machines could be deployed in enough quantity to offset the leak­age. Alternatively, biomass CCS plants or biological sequestration could be used. So the occurrence of small amounts of leakage is not fatal to the success of underground storage. It would, though, be extremely useful to demonstrate at least one of these forms of air cap­ture on a large scale and set an upper limit on its cost. That would greatly help in determining the maximum permissible leakage from geological storage.

**Even poor sites won’t leak much – sufficient to solve warming**

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

The more insidious long-term threat to CCS is that slow leakage can dent the mitigation effect. Perfect storage is emphatically **not required**, nor can it be assured. Our knowledge of the underground is never complete—mere uncertainty is not an excuse to rule out carbon stor­age. The oil business has developed sophisticated approaches over many years for dealing with sub-surface uncertainty, and in other fields—climate modelling, economic forecasting, predicting technologi­cal change—we have to deal with imperfect knowledge of even greater magnitude. Very slow leakage will **not affect** the climate significantly, because there will be time for the excess carbon to be mopped up by the natu­ral cycle—converted into plant matter and minerals. Even in badly chosen sites, the **majority** of injected carbon dioxide will be retained for geological time, millions of years, in pore spaces and dissolved in formation water. Anyway, we cannot make any sensible predictions about the energy system, economy, society or climate 10,000 years from now. The sun's output may have risen or dipped, humanity may be so technologically advanced that carbon is a forgotten problem only recalled by archaeologists, or we may have become extinct or gone back to living in caves.

# -at storage

**Sufficient storage**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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These estimates indicate that total storage capacity is in the range of the required amount. Considering some realistic estimates for the likely scope of CCS, the IEA's estimate of 80 Gt to be stored up to 2050 is only 6% of the lowest quoted figure for capacity; most of the estimates are sufficient to hold the IPCC's maximum requirement of 2,200 Gt over the century. Only in the case of low storage capacity, high baseline emissions and a large role for CCS in mitigation might we run short of space. By no means all business-as-usual emissions will be captured, since many other low-carbon options will be used, and we have not considered some of the more exotic storage options, so worldwide technically-available capacity should be ample. A useful illustration of the size of the storage capacity required is given by the Netherlands. This small country, with a high density of energy use, storing all its emissions for the rest of this century would require a sub-surface space of about 160 x 160 km, a little over a quarter the country's area.91 It also seems clear that storage in oil- and gasfields and coal beds, although an important and potentially low-cost starting point, is a small part of the total capacity. A major storage effort will have to rely mostly on saline aquifers. This is also implied by geography, since most industrial sites are within a few hundred kilometres of aquifers, but suitable petroleum reservoirs are much rarer. On a regional basis, the story is more complicated. One set of estimates is shown in Figure 3.9.92 Here, the storage capacity in each region (in gigatonnes, Gt) is compared to the likely volumes available for capture up to the year 2100. Other capacity estimates, such as those quoted by the IEA, may vary significantly, either higher or lower. If major emissions locales have insufficient nearby storage, the requirement for shipping or long-distance pipelines will drive up cost and complexity. North America appears to have plenty of storage space, enough for more than 500 years of emissions at today's rate.93 American annual demand for EOR alone could be some 10% of its emissions. The USA has some 900-3,400 Gt of space in saline aquifers, about 170 Gt in unminable coal, and some 85 Gt in oil- and gasfields. Canada's capacity is particularly large compared to its emissions, suggesting that it could store American carbon dioxide, if there is no political opposition to being a 'dumping ground' for its larger neighbour. Canadian capacity estimates vary significantly, with some much higher figures than those shown in the figure, including larger potential in oil- and gasfields (around 850 Gt), coal beds (up to 200 Gt) and aquifers (1,000-10,000 Gt).94

# -at not feasible

**It’s feasible and can solve quickly**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

It is sometimes argued that CCS cannot be built fast enough to make a difference in the short term, or, alternatively, that it can never make up a large part of emissions reductions, or that the scale of a complete CCS system would be unfeasibly large.

Firstly, Greenpeace and others often repeat the claim that carbon capture cannot be ready before 2030, while large emissions reductions are needed immediately. But it takes about six years to build a new coal plant in Europe or the USA; allowing for some additional time for permits suggests a total of between six and ten years. Installation in industry and in many developing countries could be faster. So it is emi­nently feasible to have a substantial demonstration programme in place by 2020.

Several reports indicate that CCS could already be a major source of carbon abatement by 2030, up to 15% of current emissions.3 To get the same amount of carbon savings with wind power would require more than 1 million large wind turbines. Figure 5.1 shows McKinsey's view, where red bars indicate emissions, and green show potential cuts. This chart indicates that carbon capture could be the second-largest contributor to emissions reductions in the power sector by 2030. CCS's contribution here is somewhat less than that of energy efficiency, but way ahead of renewable power. On the second point, several comprehensive studies show that CCS has the potential to be a large contributor to emissions reductions, at least on the scale of other approaches such as wind power. Climate change is such a big issue that any meaningful approach to tackle it has to be on a huge scale. All the leading contenders are, in magnitude, similarly plausible or implausible, depending on your point of view. Large sources provide most emissions. For instance, four-fifths of Chinese emissions from major stationary sources come from just 600 or so facilities.5 Globally, 8,100 large fixed sources produce some two-thirds of emissions. This makes the task of fitting CCS seem more manageable—certainly, several thousand carbon capture projects do not seem more daunting than the several million wind turbines that would be required for comparable carbon reductions Total current technically capturable emissions from large stationary sources amount to some 19 Gt of C02 annually (Figure 5.2). Of this, somewhat more than half comes from coal-fired power stations, by far the largest opportunity; about a quarter from industrial sources, and the remainder from power stations burning gas, oil, petroleum coke, biomass and waste. Of the industrial sources, about a third is repre­sented by iron and steel, and another third by cement, for both of which it is rather challenging to implement capture. The remaining third is a mix of smaller opportunities, including some (such as ammo­nia, hydrogen, contaminated gas and DRI) which are ideal for capture, and others (carbonation of alumina, fly ash, waste concrete and steel slag) which use by-products to implement low-cost, albeit rather small-scale, capture via mineralisation. There are, of course, numerous scenarios for emissions growth in a 'business-as-usual' case, for the possible levels of reductions, and how they could be achieved. It is useful to see these figures in terms of Socolow wedges, each wedge achieving around 3.7 Mt per year of reductions by the year 2050. The IPCC suggests that, in a low fossil fuel world, CCS might represent a significant contribution, 4.7 Gt, about one-and-a-half wedges. In a high fossil fuel world, CCS is the majority of the solution, as many as ten wedges (37.5 Gt). Other stud­ies suggest a reasonable maximum around 11—16 Gt,6 between three and four-and-a-half wedges. To meet, for example, the IPCCs lower target, CCS would have to be fitted to fewer than 1,000 typical coal-fired power stations. This figure sounds substantial, but the equivalent of about 200 such stations are now being built each year. If this were to continue to the year 2050, equipping a little more than 10% of new plants with CCS would be enough to reach the target. To reach the IPCC's high case for emissions, then all these new coal plants would have to include CCS. This is obviously challenging, but again conceivable, certainly if combined with retro-fits of existing plants, and with CCS implementation on gas power stations and industrial sites as well. For instance, the IEA's sce­nario for strong climate change mitigation would fit CCS to half of iron, steel, cement, pulp and paper and ammonia plants by 2050. Figure 53 shows a scenario for CCS implementation to 2030, cul­minating in almost 800 active projects. This compares to about 100 currently in existence or under development, which, even conceding that many current projects are small-scale pilots, still gives reasonable encouragement that the task is manageable. Approximately one-third of the projects are industrial rather than power plants.

**Even if CCS doesn’t work, we still solve**

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The problem, though, of moving fast is that learning from the first generation of plants will be reduced,28 and there is a risk of repeating the same mistakes. The first group of demonstration facilities should therefore each test out different aspects of CCS so that there is more learning, and less risk that a single common factor derails all the projects.29 This also reduces the risk of 'lock-in' to a single technology, which may not turn out to be the best. Even if CCS itself does not take off in a large way, much of the fundamental research can still give eco­nomic and environmental benefits, particularly in driving significant advances in power station efficiency.30

**Capture leads to investment into IGCC**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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Figure 5.7 shows the cost of electricity produced by coal and gas power plants, with and without carbon capture. Plants without capture are shown in blue and those with capture in green. We can see that, for non-capture plants, natural gas provides the cheapest electricity, although this is very dependent on circumstances. The high gas prices of 2005-8 led to something of a resurgence of coal in the USA, and some countries, especially India and China, have access to low-cost domestic coal but are short of affordable gas. Pulverised coal plants are generally cheaper than IGCCs, explaining their dominance. With carbon capture, the picture is different. Gas is still generally the cheapest option, but coal IGCCs gain considerably in competitive­ness. IGCCs become clearly preferable to pulverised coal plants on the grounds of carbon mitigation cost, cost of electricity and energy effi­ciency. IGCCs have the advantage that at zero or low carbon costs they are not much more expensive than pulverised coal, and at higher car­bon costs they are clearly cheaper. So if an electricity generator has any expectation that the cost of emitting carbon is likely to rise, then IGCCs are preferable, particularly given the relatively lower cost of capture-readiness (as discussed below). This suggests that, with more familiarity and some improvements in reliability, IGCCs could become the dominant choice for new coal power plants. However, this partly depends on fuel type. IGCCs may be preferable for high-grade (bituminous) coals, while for cheaper, low-grade brown coals (lignite), post-combustion capture may be superior.31

**CCS saves 1.2 trillion a year**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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A CCS contribution on such a major scale greatly brings down the cost of meeting climate targets, by removing the need for very costly, marginal mitigation measures. For instance, if we consider the Interna­tional Energy Agency's scenario for strong action on climate change,129 carbon mitigation in general costs about $1.8 trillion per year by 2050, about 0.6-1.9% of the predicted global GDP.130 But if we rule out CCS (or assume it does not work, for some reason), annual costs balloon by 70%—an extra $1,280 billion. Consider that the cost of reaching the Millennium Development Goals (eradicating extreme poverty, improv­ing education and health, etc.) by 2015 is 'only' about $50 billion per year,131 and we can understand the vast increase in human and envi­ronmental welfare that is possible if CCS works.

**No tech barriers**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

We have seen that, technically, it is hard to envision why CCS would not work. Transport and large-scale storage of carbon dioxide is already demonstrated. The basic science and engineering issues of cap­ture are well understood. Both pre- and post-combustion capture tech­niques are already in use in various places. Oxyfuel is also conceptually straightforward and now working at demonstration scale in two loca­tions. All these systems would require scaling up for large power plants, which always creates an element of risk, but fundamentally there is no obvious barrier. Various breakthrough technologies, such as carbon fuel cells, still require large amounts of research and develop­ment, but they are not essential for carbon capture to work in the medium term.

**Ocean fertilization fails**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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Nevertheless, experiments on ocean fertilisation so far have not been very promising. Fertilisation efforts at some sites were limited by the lack of other nutrients, particularly silica, and the blooms created were quickly devoured by fish and so had no carbon sequestration effect.74 Fertilising in short pulses may allow the algal material to sink before the slow-growing animal life can multiply enough to eat it. It appears, though, that only a small fraction of algal particles actually sink out of surface waters.75 Phosphorus may also be a limiting nutrient, but if mixed together phosphorus makes the iron inactive, so they have to be added separately in low concentrations. Phosphate would be needed in large quantities, and is relatively costly. A major algal bloom may deplete the oxygen in deeper waters, affecting marine life, and consume other nutrients which would normally be carried by currents to different parts of the ocean. Hence, we may enhance fertility in one place, at the cost of diminishing it in another. Algal blooms may feed creatures such as jellyfish and disrupt marine food chains, including whales, while the decomposing organic matter can cause 'dead zones' in the deep sea, depleted of oxygen.

**Algae fails**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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Biological processes include the use of large ponds of algae, which use carbon dioxide to grow, and possibly waste heat to warm them in the winter.M The algae can be used for biofuels, and perhaps the non-fuel residue could be burned in the power station. Algae do not need potable water; indeed, many strains thrive in salt water. They grow fast and have a very high productivity compared to other biofuels. The approach is being mailed at the Redhawk power plant in Arizona.34 However, this approach suffers from the rather slow take-up of carbon dioxide by the algae, which would require enormous ponds to process all the gas from a large power station. A 500 MW coal plant would need ponds as large as Manhattan or Vancouver, comparable to the area required by a solar thermal plant of the same capacity.\*5 Costs of algal biofuels are still high, and projects have encountered various problems, including the growth of invasive weeds. The biofuel will, of course, be burned and its carbon dioxide released in a rather short period, so the greenhouse gas benefit is largely limited to displacing petroleum-based fuels. This would reduce, but not eliminate, the carbon footprint of coal-fired power, unless the storage of waste from processing the algae is enough to make the whole process carbon-neutral.

# -at steel shortages

**Will import from China**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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China, with its massive coal use, has an abundance of CCS potential, yet the country has been somewhat cool on CCS. The country is work­ing on GreenGen, a CCS demonstration of 300-400 MW IGCC, but Su Wei, director-general of the National Development and Reform Commission's climate change unit, has said, 'Carbon capture and stor­age, particularly for China, is not one of the priorities—the cost is an issue. If we spent the same money for CCS on energy efficiency and the development of renewables, it would generate larger climate-change benefits.'124 It is probably true that China has cheaper carbon abate­ment options initially, and therefore the OECD countries will have to be prepared to shoulder much of the cost for the first generation of Chinese carbon capture projects. Yet the partnership on CCS is not all one way: low-cost Chinese manufacturing could be crucial in bringing down the expense of carbon capture, and churning out the vast amounts of steel pipelines, power plant turbines, amine units and so on that will be required.

# -at energy efficiency

**Efficiency fails**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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It is often claimed that energy efficiency improvements 'save money', even without considering carbon cuts.195 The question then arises as to why intelligent consumers and profit-oriented businesses have not already made these free savings. The reasons,19h still a matter of academic study, include: • Lack of capital {can we afford a Toyota Prius, even though we calculate it would save money in the long term? Or possibly we are a government department or school that has a fixed investment budget regardless of profitability). • Competing investment opportunities (an energy efficiency project that has a ten-year payback might appear to 'save' money, but not if investors can put their money into buying distressed real estate that pays back within five years). • Imperfect awareness (do we know where we use most energy, and what technology there is to reduce energy use?). • The 'hassle factor' (energy efficiency opportunities are often small-scale and it takes a lot of effort and expertise to detect and implement all of them). • Subsidies for energy use (particularly prevalent in the developing world, and in oil exporting states). • Misaligned incentives (the owner of a building docs not fit insulation when the tenant will gain the savings on the gas bill). • The risk of new technologies (unforeseen problems with our new hybrid car may mean more breakdowns and maintenance bills). • New products being imperfect substitutes for older ones (will that LED give as good quality light as the old incandescent bulb?).

**Efficiency potential is never realized**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Many of these obstacles can be tackled by improved technology (e.g. smart meters), policies (regulation, information, removing energy subsidies) and 'energy service companies', who improve the efficiency of others in return for a share of the benefits. Yet because of these barriers, the full potential for efficiency is unlikely to be realised. More fundamentally, attempts to make radical increases in energy efficiency are likely to fall foul of two phenomena: the 'rebound' effect and the Khazzoom-Brookcs Postulate (or Jevons Paradox). The rebound effect occurs because, at the level of an individual consumer, making energy use more efficient encourages us to use more.14 If we are driving a super-efficient hybrid, we may make that crosscountry trip to see Grandma that we would not have done in our fuel-hungry Hummer. Levels of rebound vary depending on the context, and are hard to estimate accurately, but for transport are probably in the range 10-30%: i.e. improving car efficiency by 50% would cause us to drive 5-15% more (or use heavier vehicles, cars with more accessories, etc.). The Khazzoom-Brookes Postulate operates at the level of an entire economy. It states that improvements in energy efficiency spur eco-nomic growth, and so lead ultimately to higher energy consumption. When washing machines become more efficient, people buy dishwash-ers; when heating becomes cheaper, they build bigger houses.1yK For example, as Len Brookes comments, 'It is inconceivable that we should have had the high levels of economic output triggered by the industrial revolution if energy conversion had stayed where it was at the beginning of the nineteenth century',1'" i.e. if we were still reliant on Thomas Newcomen's 1712 steam engine, with its efficiency of 1%. From 1750 to 2000, the efficiency of lighting increased by 860 times; the efficiency of transport has increased by a factor of 2,000 since 1800.2UO Yet the global middle class of today use much more, not less, energy for light and mobility than King George II or President Jefferson.

# -gov investment key

**No first movers absent government action**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Short Term: Need to Start Soon The implementation of carbon capture is urgent. The IPCC report, published in 2005, covered all of the key issues and received great attention. A flood of research emerged on all the key issues: capture technologies, transport and storage, economics, law and policy. Around the same time, BP announced the Peterhead-Miller project, and Shell/ Statoil the Haltenbanken carbon capture plan. Yet since then both projects have been cancelled, and disappointingly little concrete progress has been made. During this time, although perhaps obscured by a period of cooler weather, the scientific evidence on climate change is, if anything, grow­ing more worrying. Coal use and carbon emissions have continued to climb (until temporarily derailed by the 2008-9 recession). Lord Stern says, 'If coal is going to be used, the only response—because it is the dirtiest of all fuels—is that we have to learn how to do carbon capture and storage and we have to learn how to do it quickly on a commer­cial scale...If we can't then it's plan B and plan B will be more expen­sive probably.'25 Between 2005 and 2018, 750 new coal plants are planned (fifty in Europe, fifty in the USA, almost 300 in China and 200 in India). These will mostly be large, modern, efficient designs, which will operate for decades and be expensive and difficult to retro-fit with CCS. On the storage side, there is a window of opportunity for making use of low-cost EOR options, especially in Europe. Most of the big North Sea fields are coming up to decommissioning. It is already too late for two of the largest fields, Brent (UK) and Statfjord (Norway), as well as Miller. On the side of business opportunities, it may be advisable for facilities with a low capture cost to press ahead. They can possibly lock up value-added opportunities in enhanced hydrocarbon recovery now, before the much larger volumes from power plants come into play.26 Government support is essential in this early phase. The first mov­ers will bear all the risks: technical, commercial, political, reputa-tional. But they will not be able to reap all the benefits. Once one electricity generator demonstrates that CCS is feasible, others will be able to proceed with confidence, and will have a clearer idea of what works and what does not. The first-of-a-kind plant will, as discussed in Chapter 5, probably cost much more than its successors. There are therefore strong incentives to wait; but if everyone waits, then nothing happens. Only a large-scale, government-supported programme can catalyse action.

# -ferc solves

**FERC solves**

**Zarraby 12 -** chemical engineer for the Federal Energy Regulatory Commission, JD expected from GWU in 2012

Cyrus, “Note: Regulating Carbon Capture and Sequestration: A Federal Regulatory Regime to Promote the Construction of a National Carbon Dioxide Pipeline Network,” 80 Geo. Wash. L. Rev. 950, Lexis

FERC is the **ideal agency** to administer these regulations because it has extensive expertise and experience in regulating pipelines associated with the energy industry. Currently, FERC is responsible for both the siting and economic regulation of all interstate natural gas transportation projects and the economic regulation of interstate oil pipelines. This experience would be **invaluable** as the administrative agency works through issues regarding the siting of new CO<2> pipelines. For example, FERC environmental staff routinely deals with landowner complaints and works with both the pipeline and landowner to resolve specific issues. 263 Additionally, FERC's experience regulating the rates and terms of service of both oil and natural gas pipelines would be invaluable when setting up a comprehensive set of administrative regulations to ensure that CO<2> pipeline customers were adequately protected. Finally, FERC's enforcement division investigates complaints from pipelines and customers. Therefore, rather than creating a new agency, Congress should rely on FERC's expertise and allow it to lead in the area of CO<2> pipelines.

**FERC or STB work**

**Mack and Endemann 10 -** \* partner in the Houston office and global Chair of the Environmental Transactional Support Practice, provides over 25 years of experience advising on the transactional, environmental and regulatory issues associated with all sectors of the oil and gas industry, power (including both fossil and renewable energy), mining and chemical industries in the United States and abroad, in addition to the development, financing and entitlements for telecommunications and other industrial and public infrastructure facilities in the United States and offshore, \*\*JD, Faculty @ USD Law, provides comprehensive environmental counseling on energy and infrastructure projects, and represents clients in related litigation

Joel and Buck, “Making carbon dioxide sequestration feasible: Toward federal regulation of CO2 sequestration pipelines,” Energy Policy, http://lw.com/upload/pubContent/\_pdf/pub3385\_1.pdf

As discussed above, there are very substantial challenges presented by the current regulatory structures for CO2 sequestration pipelines that will greatly complicate our ability to scale up such a pipeline system should the United States choose to make a substantial investment in CO2 removal from its ﬂeet of coal-ﬁred power plants. A regulatory structure like that in effect for natural gas pipelines would solve the majority of these concerns while creating few additional problems for the industry. Such a program would consist of the following elements: (1) vesting exclusive siting jurisdiction in an appropriate federal agency (similar to the FERC’s siting for natural gas pipelines), (2) continuing Ofﬁce of Pipeline Safety management over safety and technical issues, (3) providing for condemnation authority for such pipelines (whether they have single or multiple customers), consistent with the existing scope of condemnation authority granted to natural gas pipelines, (4) rate regulation with appropriate access and tariff protections, (5) clarifying the treatment of CO2 as a waste gas or commodity gas, including clarifying the scope of other statutes such as the Clean Air Act and Safe Drinking Water Act with respect to such facilities, and (6) and co-location authorization for CO2 pipelines within the rights-of-way of existing or future federally regulated natural gas pipelines or transmission facilities, in order to reduce cost and mitigate environmental impacts. Such a program could be assigned either to the STB (which has similar authority respecting railways) or to the FERC (with its expertise in natural gas pipeline regulation). Either agency would have the capability and expertise for such a program.

# -air capture solves emissions

**CCS creates the *ultimate backstop* against runaway warming – allows for indirect air removal**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Indirect capture is therefore the ultimate backstop for climate policy. Storage capacity permitting, we can, at a cost in money and energy, remove any quantity of carbon dioxide from the atmosphere. This may be crucial if we discover that we are on the path to sudden, cata-strophic climate change. Even if we were to halt all emissions immediately, it would take millennia for the elevated concentration of atmospheric carbon dioxide to be fully absorbed. By contrast, air cap-ture might be able to take us back to pre-industrial levels within some decades. As a 'geo-engineering' solution, it addresses the problem directly, rather than reducing global warming indirectly.141 Undesirable sjde-effects are, as tar as we can tell now, minimal compared with other gco-cngincering techniques, and it also addresses the other key issue of ocean acidification. Some major studies have dismissed air capture without serious consideration,14- mainly on cost grounds. It is, indeed, likely to be one of the more expensive carbon mitigation options, but it does not have to compete with CCS on large centralised sources, nor with major low-carbon power solutions such as wind or nuclear. It is intended to address otherwise intractable polluters such as flying, and to provide a way of returning rapidly to a pre-industrial atmosphere. In contrast to other 'carbon offset' schemes such as forestry (see Chapter 4), which have been heavily criticised,141 it offers completely verifiable, and unde-niably 'additional', reductions. I will return to this issue in Chapter 6.

**Its proven to work**

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Professor Klaus Lackner of Columbia University has been the pio-neer of air capture. His company, Global Research Technologies, has produced a number of 'artificial trees'. These are the size of a shipping container (6 x 2.4 metres, 15 m1) and use a polymer-based resin which responds to changes in humidity, absorbing carbon dioxide when dry and releasing it when wet. A gentle breeze moves air past the device fast enough for it to be effective, and sea water can be used for "wash-ing' to release the trapped carbon dioxidc.,3J Some low-grade heat is required for regeneration, and electrical power for compressing cap-tured carbon dioxide. The low-grade heat could be supplied by a solar thermal plant, or by waste heat from a power station. Carbon dioxide is well-mixed in the atmosphere, and therefore this system would not produce areas of depleted C02 air, harmful for plants. Lackner's is not the only machine available. Professor David Keith from the University of Calgary has devised a system which sprays a solvent into the air inside a tower, several metres tall. The solvent dissolves carbon dioxide and drains to the bottom of the tower, where electricity or chemicals arc used to reconstitute it. The device is simple and uses commonly available sodium hydroxide, capturing about half of the carbon dioxide chat passes through it. According to Keith, it is intended to demonstrate that air capture is technically feasible and to set an upper limit for the possible cost. One disadvantage is the rather high water loss from evaporation, though this can be reduced in cold, humid climates," or possibly made less consequential by using sea water.

**It is comparatively better than “conventional” CCS**

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Air capture is, particularly at the moment, considerably more expen-sive than capture from large-point sources such as power stations. But it has several advantages over 'conventional' CCS.11' The devices: • Can be placed next to a suitable storage site, so avoiding transport costs. • Can be located in a remote region, to avoid community objections. • Do not have to be in any special location (unlike, say, wind turbines), other than being close to a suitable storage site, and supplied with a {fairly modest) quantity of energy. • Arc much less visually intrusive than power plants or wind turbines; indeed, they could probably be made completely unnoticeablc. • Are several thousand times more effective at removing carbon diox-ide than natural trees. • Could be run from a suitable cheap energy source, such as solar power in a desert, flared gas in a remote oilfield, or hydropowcr, lacking nearby consumers. Another possibility would be to take their power from intermittent sources (such as wind}, during off-peak times, when output would otherwise be wasted, or would have to be stored. • Can address one of the main objections to carbon capture, the risk of leakage. As I discuss in Chapter 3, I believe that leakage from good storage sites is likely to be negligible. But if we did discover that there was significant leakage, we could simply add additional air capture machines to compensate.

# -ccs solves emissions

**Avoiding a 3 degree increase solves – otherwise positive feedbacks lock in runaway warming**

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Even if carbon dioxide emissions were to stop today, the built-in inertia in the climate system would lead to temperatures increasing further. In addition to the 0.75CC rise since the nineteenth century, we are already committed to a further warming of 0.6°C. If emissions, and hence temperatures, continue to rise, warming may be as much as 4°C by 2050—and locally much more, 15°C hotter in the Arctic and 10°C in western and southern Africa. At this level, climate impacts will become more and more serious. Extinctions are likely to increase sharply, while extreme heat-waves, forest die-offs, flooding of major river deltas, persistent severe droughts, mass migrations,33 wars and famines are all possible. We may soon pass, or already have passed, the point at which, over the next few centuries, parts of the West Ant¬arctic and Greenland ice sheets melt irreversibly, with potential sea level rises of 1.5 and 2-3 metres respectively.34 Due to feedback mechanisms and poorly understood components of global climate, there is even the possibility of a sudden, rapid catastrophic change. For example, open ocean absorbs more heat from the sun than ice. Melting permafrost''' and warming ocean bottom waters3\* release carbon dioxide and the powerful greenhouse gas methane, driving further warming. Carbon sinks will become increasingly ineffective37 as forests die off, soils dry out and warmer oceans dissolve less carbon dioxide, so that ecosystems may become net contributors of carbon dioxide to the atmosphere, rather than net absorbers as today. The shade of clouds may diminish over warming oceans,38 while melting ice shelves may lead to sudden collapse of grounded ice, and hence rapid rises in sea level.w The picture is complicated further by some offsetting effects, due for instance to increased plant growth in a warmer, more C02-rich world. Changes in cloudiness, snowfall and albedo (reflectiveness) of vegetation may have warming or cooling effects. Such positive feedbacks may **greatly accelerate** warming. Unpre-dictable, non-linear effects can lead to prolonged droughts in the Mediterranean, California41 or West Africa,42 or to weakening of ocean circulation43 with knock-on effects including a rise in North Atlantic sea levels of up to 1 metre, a collapse of fisheries, disruption of the South Asian monsoon,44 and possibly (albeit unlikely) sharp cooling in Europe.45 Similar rapid changes are documented from Earth history, as at the end of the Ice Ages. At one time, at the end of the so-called Younger Dryas event around 12,000 years ago, Europe warmed by some 5°C within two decades.4" It seems increasingly clear, from geo¬logical studies, that the climate system is unstable and prone to abrupt transitions from one state to another, so further warming might trigger entirely unforeseen consequences.47 We should not give in to alarmism, and such disastrous shifts are thought to be unlikely—but their consequences are serious enough to be worth guarding against. This is about as far as the weight of consensus has reached,4\*1 Yet many individuals and corporations continue to deny the reality of anthropogenic climate change. The US petroleum and coal businesses, in particular certain commentators,49 and many of the general public across the world,''" continue to maintain that the climate is not warming, that elevated carbon dioxide does not cause warming, that rising carbon dioxide and temperatures are not caused by humans, that the consequences of climate change will be benign, or some combination of these positions. Beyond this understanding, there remains great uncertainty and debate on how much warming will occur for given changes in atmospheric carbon dioxide, how serious the impacts of this warming will be, how the climate will change at regional and local levels, how much it is worth spending to reduce climate change,1' exactly what types of action we should take, and how we should go about encouraging global action. Despite extensive and continuing research, these major uncertainties will persist for the foreseeable future. Some of the debate is a normative one, about the values of our civilisation, and therefore is not even capable of being solved by scientific inquiry. Such uncer-tainty and controversy, though, is not a reason for inaction. After all, we ban certain drugs suspected to be carcinogenic, without waiting for absolute proof, and we will only know the truth about some of these climate change disasters when they actually strike. I will take as my starting point here, in this fast-evolving area of research, the view that we should attempt to keep total warming below 2-3°C.52 The original goal of the EU, recommended by the Interna¬tional Climate Change Task Force, was for a maximum temperature rise of 2°C,j3 but given the delay in taking major action, and the latest science, this already seems to be very tough to achieve. Anything above 2°C is already dangerous but, with luck, avoiding rises over 3CC will prevent the **most damaging** effects of climate change. Otherwise, we will venture into uncharted territory, where the risk of abrupt climatic changes is high: 'Once the world has warmed by 4°C, conditions will be so different from anything we can observe today (and still more dif¬ferent from the last ice age) that it is inherently hard to say where the warming will stop.'55

**CCS percolates – solves emissions from *all other* industries**

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Carbon capture is often attacked on the grounds that it perpetuates a reliance on fossil fuelled electricity. Yet many industrial processes, other than power generation, emit carbon dioxide: hydrogen production (from coal or natural gas), cement, fertilisers, ammonia, chemicals, iron and steel. To some extent, we might be able to create substitutes, or reduce the demand for these products, or the carbon intensity of their production. But in general, such vital industries would be expensive, difficult or technically unfeasible to run on renewable sources. For cement in particular, which accounts for some 5% of global carbon dioxide emissions125 (more than aviation), the produc¬tion of carbon dioxide is a fundamental part of the process. And even wind turbines and nuclear plants require large amounts of concrete for construction. Anti-CCS activists have the duty to explain how they would decarbonise these basic industrial processes at acceptable cost. There are some limited alternatives, but they are mostly expensive and/ or at considerably earlier stages of development than carbon capture. Some industrial processes, in particular ammonia and hydrogen manufacturing, produce concentrated streams of carbon dioxide which are ideal for capture. Carbon capture is also an **enabling** or **enhancing technology** for several future energy sources. Hydrogen, in particular, is often touted as a key part of a zero-carbon economy, as a fuel for home heating and possibly vehicles. But making hydrogen from gas is far cheaper than the cumbersome and inefficient route of generating renewable electricity and using that to electrolyse water. Centralised co-generation of hydrogen and power, with capture of the produced carbon dioxide, is an attractive option. By keeping hydrogen and electricity cheap, we greatly improve the prospects for achieving **zero-carbon transport** and **residential sectors**.I2h Carbon capture can also be applied to combined heat and power (CHP) facilities, power plants running on biomass, landfill gas or waste; biofuel refineries; and possibly geothermal projects with high carbon dioxide emissions, to boost further their climate credentials. Therefore, carbon capture remains important **even if** we are shifting away from coal- and gas-fired power. And it is not an enemy of renew-able energy—it is a potentially **valuable addition** to the arsenal of future energy techniques.

**Removes from atmosphere**

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Capture Can Tackle Carbon Dioxide Already in the Atmosphere We will quite possibly discover, in the next ten, twenty or thirty years, that our emissions abatements have been insufficient, and that the climate is much more sensitive than we had imagined. In any case, the allowable annual carbon emissions by 2050 are going to be very small, around 2 tonnes per person, less than a third of current levels—and that in the context of a much richer world. A single aeroplane journey can eat up most of this budget. In this case, **only carbon capture** can help us. We will have to reduce the carbon dioxide concentration in the atmosphere rapidly—not merely reducing our net emissions, but actually taking them below zero. This can also help reduce ocean acidification, a non-greenhouse but serious impact of the build-up of carbon dioxide. In order to be ready for this eventuality, we need to develop carbon capture techniques today on the easier opportunities—coal-fired power stations and so on—and have a **network of carbon dioxide pipelines** and storage sites **ready**. I, for one, don't wish to discover in 2050 that disaster is upon us, and regret that it's too late by then for a realistic 'Plan B'. There are several possible techniques for 'sequestration plus' or going 'carbon negative'. One is to add biomass to the feedstock of ordinary fossil fuelled plants with carbon capture. Another is the whole suite of biological techniques: reforestation, land-use changes, biochar and so on, A third is to **process air directly**, to remove its carbon dioxide, a method that, perhaps surprisingly, does not appear unfeasibly expensive.

**CCS solves runaway warming – allows for indirect air removal**

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Many carbon dioxide sources are not suitable for capture, typically because they are small and dispersed, such as residential gas- or oil-tin-d boilers. Emissions from mobile transport are, as discussed below, probably impossible to capture economically. Furthermore, if climate change proceeds rapidly, we may realise that, even with complete dccarbonisation of the economy, it is not sufficient to wait for slow natural processes to reduce the carbon dioxide concentration of the air to acceptable levels. To tackle this issue, interest is growing in indirect capture of carbon dioxide from the air. A number of methods have been proposed. Air, as wc have discussed, is now about 390 ppm (0.039%) CO,. Various chemicals can remove some of this carbon dioxide, which can then be compressed, transported to a storage site, and stored by any of the methods discussed in Chapter 3. The energy required to capture this carbon dioxide is more than for a concentrated source, but not hugely so. To produce high-purity carbon dioxide from air requires about 30% more energy than to do so from a coal-plant's flue gas.1" Air capture of other gases for industrial uses is routine, oxygen, nitrogen and argon all being extracted in this way. And, unlike for a power station, it is not necessary to capture all, or even much, of the carbon dioxide in the air moving through the unit. After all, there is plenty of air. The proportion of carbon dioxide captured is just an engineering trade-off; capturing a lower proportion of the air's carbon dioxide saves energy in the capture stage, but requires more energy to move larger volumes of air through the machine.

**Solves negative impact to growth**

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Carbon capture offers one way to slide down the 'environmental Kuznets curve'.175 This curve states that environmental damage initially increases with income. But at some point a level of wealth is reached at which the society feels able to afford environmental protection.176 This level is different for different pollutants and ecological problems. Clean water is one of the first priorities. At an annual per capita GDP of about $4,600, net deforestation ceases.177 Air pollution comes next: carbon monoxide, sulphur dioxide and so on. Some research suggests that carbon dioxide emissions per person may peak at an annual income of around $30,000.17s If so, about twenty countries worldwide would have reached this happy level.179 As wealthy countries also tend to have low or negative population growth, their absolute carbon dioxide output should also be declining.

# -ccs k/ economy

**CCS is key to the economy**

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Countries that implement CCS successfully should see lower energy prices, a boon for the entire economy. They will also find it easier to hit whatever global climate targets are then in force, so burnishing their reputation. If a global trading scheme is established, they will earn credits that can be sold to other, more C02-intensive countries, or at least reduce the amount of credits they need to buy. This will have a positive impact on their current account balance and general competi­tiveness. Nations with good geology for storage can be paid for receiv­ing carbon dioxide from other countries, possibly generating additional income from enhanced oil and gas recovery. A caveat is that public opinion may revolt against becoming a 'dumping ground\* for other people's waste.

# -ccs better than nuclear

**Comparatively better than nuclear**

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Carbon capture also has advantages over the other major option for low-carbon baseload generation: nuclear fission. 1 personally consider that nuclear energy probably has a role to play in fighting climate change,1\*" but many environmentalists and members of the public are determinedly opposed to it. In the developed world, at least, the approval of new nuclear plants is likely to be a long and difficult process, substantially raising its costs." If concerns about the links of civilian atomic energy to nuclear proliferation and terrorism are perhaps overstated, there is still the issue of long-lived radioactive by-products. Many experts maintain that the technical issues have largely been solved, and that new plants produce much less waste than previous generations, but waste storage has, as yet, no politically agreed solu¬tions. And CCS installations, though taking longer to build than a wind turbine, are likely to come onstream faster than new nuclear capacity.

# -coal inevitable

**Coal is locked in – legacy electricity and inefficient alternatives ensure long-term coal use**

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Power generation systems (of all types) tend to have very long life-times, typically forty years for a coal-fired plant. Even if we cease build-ing new fossil fuel capacity today, the existing units will continue to emit **for decades**. This legacy electricity is extremely cheap, since a coal plant's fuel is only a small part of its costs. If a power station is decommissioned, it will be relatively cheap to build a new one on the same site, since many facilities, power lines and so on will already be in place, and the site is **unlikely to be attractive** for many alternative uses. This is not some 'unfair advantage’ of fossil fuels, as some commentators have rather naively suggested;"" the situation is exactly the same for a hydroelectric dam. It is merely an indication that it is not efficient to abandon capital goods before the end of their useful life.102 Similarly, the traditional energy industry has tremendous resources of skilled people, institutional knowledge, political relationships, physical assets and financial strength. To some extent, that can be turned to developing renewable energy. But, just as coal-miners from northern England mostly did not find new employment as North Sea rough¬necks, a rapid abandonment of fossil fuels would waste many of these strengths. Continuing use of carbon energy, combined with carbon capture, though, can continue to use this intangible capital. Environmental organisations might reflect that the fossil fuel industry is unlikely to cooperate in its own destruction. However, it can be a very powerful ally in realising a new energy future, as long as the will for cooperation is there, from all parties.

# -coal k/ china energy security

**Key to Chinese energy security**

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Nations rich in coal but relatively lacking in gas can use carbon cap­ture as a vital plank of energy security. This applies particularly to China, India and South Africa, where coal is important too because of its role in domestic employment. Similarly, the USA has large coal reserves, but there is political pressure to ban imports of high-carbon unconventional oil. Carbon capture, by making coal- and gas-to-liquids, oil shales and oil sands more environmentally acceptable, can anchor North American energy security in the face of any threats to Middle Eastern oil. Underground coal gasification, combined with CCS, can unlock large coal reserves with minimal environmental problems.

# Updates

# -renewables fail

**Renewables can’t meet demand and lead to increase consumer costs**

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

• Fourthly, renewable electricity sources are mostly intermittent. It is a big challenge to maintain a stable electricity grid, and provide power at peak times, even with the current system, a fantastically complicated entity which has grown up, in developed countries, over more than a century. This balancing task becomes increasingly difficult with large quantities of wind, which is rather unpredictable, and solar, which does not necessarily match peak load, especially in winter in northern climates. A given wind turbine, for instance, produces no power at all between a sixth and a third of the time. In cloud, solar panels generate only 10% of the electricity they do in direct sunlight,113 particularly problematic for northern Europe and parts of the tropics during the rainy season. To some extent, this can be managed by intelligent management of demand, redundant generation capacity, including a geographically dispersed range of sites and plugging in other renewable sources such as geothermal and ocean power, employing 'dispatchable' renewable power such as biomass-fired plants, electricity storage (including 'pumped storage" behind dams and perhaps the batteries of a future fleet of electric vehicles), and long-distance imports. But these solutions become increasingly expensive as the proportion of renewables in the energy mix increases. Views on required back-up capacity vary, but might be as high as 60-95% for wind power. In fact, wind power may end up mainly displacing (low-carbon) gas-fired generation, and lowering electricity prices during windy spells, rather than replacing high-carbon coal.114 It has yet to be demonstrated, beyond theoretical calculations, that a national-scale, mainly renewables-powered grid can achieve reliability at acceptable costs."5 The rapid growth in alternative energy could easily be dented by a couple of high-profile black-outs and consequent loss of public faith. The **most economic solution** is therefore likely to involve a mix of generation options, including coal-fired baseload fitted with CCS, and gas-fired capacity, some of which is held in 'spinning reserve', operating at low levels, ready for demand surges.

**Only trades off with useless renewables**

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There is an idea that investing in carbon capture will take money away from renewable energy projects. But, except at the margin, this appears unlikely. $100 billion was invested in renewable energy R&D and manufacturing during 2007,2nv which hardly suggests a shortage of finance. The economic crisis is being tackled with heavy government-led spending focussed on 'green energy'. Adding more realistic options for tackling climate change will, if anything, increase the finance flowing to the sector; for one thing, it would open up the participation of cash-rich petroleum and utility companies. Only the more marginal and costly renewable energy projects are likely to be displaced by CCS.

**Renewables fail**

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Renewable energy is also exposed to the risks that all new technolo¬gies face. In the 1950s, we were assured that nuclear electricity would be 'too cheap to meter'. But high-profile accidents and rising costs have led to disillusionment and a very poor public image for nuclear power. Something similar may happen if major renewable energy projects, for instance offshore wind farms, run into problems of budget, schedule or reliability. At Horns Rev in Denmark, the first large-scale offshore wind project, there were 75,000 maintenance trips by helicopter in the first year and a half of operation, working out at two per turbine per day.147 In that period, the eighty turbines only operated together for half an hour. All had to be removed to shore and replaced. Manufac¬turing faults and the rough marine environment were blamed.14\*

There is also often significant local opposition to wind turbines: the UK has 2 gigawatts of wind capacity, but 9 CiW of potential is mired in planning permission.14\* Technological progress in solar photovolta-ics, batteries and hydrogen fuel cells may stagnate. Rnergy crops seem particularly vulnerable to protests by competing land-users.

**Renewables fail**

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Nor are renewable energy sources flawless environmental performers,

• The recent rush to biofuels has highlighted their environmental limi¬tations. It quickly became apparent that some biofuels were contribut¬ing to deforestation (destroying habitats and, ironically, accelerating global warming), driving up food prices, and reducing carbon emis¬sions only marginally, if at all. The prospect of increasing biomass use by a factor often, as proposed by Greenpeace, would probably lead to the establishment of vast monoculture plantations, with low biodiversity, vulnerable to disease, and probably with negative social impacts. Fast-growing energy crops also tend to be thirsty for water and fertilisers—and nitrous oxide from agriculture is a serious green-house gas in its own right. Widespread drought, increasingly likely as climate change advances, could cause not only famine, but also an energy crisis. Really effective biofuels seem likely to require genetic modification, a prospect which, no doubt, many environmental groups would oppose.

• The burning of biomass (plant material and organic wastes) can be dirtier than coal, in its emissions of air pollutants, especially particu¬lates1™ responsible for lung disease. Biomass combustion also releases the greenhouse gas methane. Burning the biofuel ethanol in car engines creates smog.lsl

• Hydroelectric dams and tidal barrages are damaging to the local environment; imagine the public opposition if a plan with impacts similar to that for the Severn Tidal Barrage152 in the UK were proposed by the oil business! Dams produce surprising amounts of methane from rotting vegetation: Indian dams yield a fifth of that country's greenhouse gas emissions.,53 They are not necessarily safe either: a major explosion at a Siberian hydroelectric power station in August 2009 killed seventy-six people and also polluted the Yenisei River.154

• Wind farms built on peat—as are more than half of those in windy Scotland—also generate large amounts of carbon dioxide, while damaging unique ecosystems.1^

• Geothermal energy can release carbon dioxide from underground waters, and has been blamed for triggering earthquakes.156 These were minor but did trigger local concern.

• Proponents of covering the Sahara Desert with solar panels should recall that the desert is a unique and diverse ecosystem in its own right, something I am vividly aware of through trips into the fringes of the famous Rub' Al Khali (Empty Quarter) in the UAE. The Sierra (.Hub and other environmentalists held up construction of a solar plant in California's Mojave Desert, as it threatened the habitat of a rare tortoise.157

• As another example, both cadmium and tellurium, used in some solar panels, are toxic, cadmium highly so. Solar panel manufactur¬ing yields 4 tonnes of poisonous silicon tetrachloride for every tonne of silicon, and there are instances of this being dumped by Chinese manufacturers. Environmentally responsible manufacturing might increase costs by 50-300%.15B Mining rare earth metals has been blamed for pollution and damaging landscapes in south-eastern China.159

• The energy payback period for solar panels is about four years, and some manufacturing processes release the powerful greenhouse gas nitrogen trifluoride, only just recognised as an environmental prob¬lem and so not even included in the Kyoto process. Marine and wind power also require substantial amounts of carbon-intensive concrete and steel. The life-cycle carbon emissions from renewable energy arc certainly low, but not zero—averaging typically 10% of those for gas-fired power generation. Solar electricity is responsible for about two-thirds the amount of greenhouse gases of a capture-equipped coal power plant.

• Solar thermal power plants require large amounts of water.lMi Water availability is increasingly a concern for new solar power in Califor¬nia, and water-efficient facilities arc considerably more costly.161

Furthermore, a number of renewable energy technologies, notably biomass and to some extent hydropowcr, are threatened by the very climate change they are trying to prevent, if crop yields fall due to drought and higher temperatures, and river and wind flows decrease or become less predictable.1"2 The destruction by floods of the Namche Bazaar hydropower facility in Nepal is one example;ib3 slowing winds over the USA and globally, reducing wind turbine output, perhaps another.164

# -at warming advantage CPs

**Perm do both – double-solvency has a *tangible* effect on warming**

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Writers and researchers on the climate change issue often fall into what I call the 'panacea fallacy'. This is the idea that a single technology or approach is the way to solve climate change—whether the panacea is nuclear power,127 renewable energy, reforestation, carbon capture, energy efficiency, geo-engineering or some other concept. The converse is to pick on a particular technology, show that it cannot solve the climate change problem on its own, and therefore dismiss it as useless. In fact, given the scale of the problem, even a 5% solution is highly worthwhile.

**Doing both is best – makes consumption increases carbon-neutral, and warming is a linear impact**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

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Part of this fallacy is to say that carbon capture (or nuclear, or some other energy option) is not required because the author's favourite plan is already 'enough'. This assumes, firstly, that energy demand is a fixed quantum. In reality, of course, if we had abundant, cheap, green energy, we would find ways to use more—and that is not a bad thing, since it would enhance human welfare. Secondly, such talk gives the impression that 2°C of global tempera-ture rise (or 3°C, or 450 ppm atmospheric (X)2, whatever our climate target is), is a magic number: below it, nothing bad happens; above it, hell is unleashed. In fact, if keeping the temperature rise below 2°C is a good thing, limiting it (at reasonable cost) to less than 1.8°C, or 1.6°C, would be **even better** (it is only at very low levels of warming that we might argue there is a net global benefit). And there is only a hazy knowledge of how much carbon dioxide will cause 2°C warming (and, indeed, how much carbon dioxide a given plan will really emit over the next half-century)—so **every tonne** of carbon dioxide saved **reduces the risk** of rapid, catastrophic climate change. In short, any plan that rules out ab initio some valid options is bound to be sub-optimal.

# -at reforestation

**Reforestation fails**

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It is sometimes suggested that reforestation is superior to industrial carbon capture schemes: It is a typical modern human response by the [UK] Government to excess carbon—implement a complicated, technological industrial system that is expensive, requiring carbon to be transported over great distances and much energy use, thereby creating as much of a problem as a solution....Nature, of course, has a much more elegant carbon capture system: plant life. So, Ed Miliband, if you want to capture carbon, plant more trees.1 ' However, reforestation raises several problematic issues, including competing land use, the vulnerability of forests to natural or human-caused destruction, the social challenges of establishing and maintain¬ing them, and the long periods they require to reach maximum carbon absorption. I explore some of the other issues in Chapter 4.

**Reforestation doesn’t solve**

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Young trees take some time to reach their maximum rate of carbon uptake: twenty years for loblolly pine in the southern USA, but seventy-five years for Ponderosa pine in the Rocky Mountains.36 The rate of absorption for US examples is 800-4,000 tonnes of C02 per square kilometre per year. Trees also do not absorb carbon forever; new forests continue gaining carbon for typically twenty to fifty years after plant­ing,3 but they contain much less carbon per hectare than old forests. M

As the forest matures, carbon storage in soils, roots, litter (forest floor detritus) and undergrowth may continue to increase, although at a slower pace. At some point, older trees cease to grow, those that die are replaced by younger trees, and the forest reaches steady-state. The

capacity of forest sequestration is therefore limited by the amount of land that can realistically be covered with trees. For these reasons, although reforestation measures can be implemented immediately, they take a long time to give their full benefits. This complicates comparing them to other carbon mitigation methods (CCS, shifting away from fossil fuels, and avoiding deforestation) that take effect immediately.

**CCS is comparatively more effective than reforestation**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Forests can also be destroyed by natural processes (fires, floods, pests) or re-grow on abandoned lands; this has an effect on the atmos­pheric carbon balance, but should a country be able to count this towards its international climate targets? In some cases, it may be very hard to disentangle natural and human-caused changes. Of course, if a country or company has received carbon credits for establishing a forest, then it should also be liable for the subsequent destruction of that forest, whether naturally or artificially. Large year-by-year varia­tions in forest cover, with vegetation being destroyed by fire or drought one year and re-growing the next, would lead to volatile carbon pay­ments to and from the country, probably hard for a poor nation to manage.

Rising carbon prices will inevitably encourage forestation, reducing the land available for agriculture and hence increasing food prices. Forestry products and food are traded worldwide, so simple mandates to convert certain lands to forests will be mostly or entirely offset by deforestation to arable land elsewhere, unless measures are imple­mented on a near-global scale. The success in stopping deforestation in China and Vietnam has been matched by a corresponding increase in logging, often illegal, in the neighbouring countries of Laos, Cambodia and Indonesia.49

Balancing the need for food, fuel, water and carbon sequestration is likely to be a major twenty-first-century challenge.i0 Those commenta­tors and members of the public who, when confronted with climate change and carbon capture, blithely reply, 'Plant more trees', are clearly unaware of the complex issues of forestation in the real world.

Reforestation is more expensive than the plan

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

But unlike carbon capture from power and industry, the costs of which fall or rise only slowly with increasing use, bio-sequestration becomes rapidly more expensive as its scale increases. The reason is that it competes increasingly with other land uses—for food, timber and fuel. The breakdown above shows that, for low land prices, most of the sequestration cost is for establishing the forest, but as land prices rise, they become the largest single component of costs. With land costs being generally lower in developing countries, this suggests that they will be the main host for forestation initiatives, but this may be at least partly offset by population pressures and higher transaction costs.

**Forestation is counter-productive**

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Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Naive payments for forestation run the risk of repeating boondog­gles of the past, rewarding planting the wrong kind of tree in the wrong type of soil. Partly because of the political power of farmers, agriculture is notorious for attracting expensive subsidies that prove impossible to repeal: as experience in the USA, EU, India6 and else­where demonstrates. The current absence of meaningful carbon prices for forestry, combined with mandates and subsidies for biofuels, leads to disastrously counter-productive activity. For instance, in Indonesia, oil palm cultivation earns about $11,400 per km1, yet clearing the land for these plantations releases as much as 50,000 tonnes of C02, worth $1 million or more at current carbon prices.68

**Corruption prevents global solvency**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

As we have seen (Figure 4.2), a small number of countries account for most deforestation. Brazil and Indonesia, the top two, are middle-income states with reasonable prospects for implementing bio-seques­tration projects. Indeed, Indonesian President Susilo Bambang Yudhoyono recently committed to curb deforestation and make his country's forests a net carbon sink by 2030,71 while President Luiz Inacio Lula da Silva offered to eliminate four-fifths of Brazilian defor­estation by 2020.71 However, corruption and a tenuous presence of government in remote areas of these vast nations are problematic. Continuing down the 'unlucky thirteen' who account for 90% of gross deforestation, the Democratic Republic of Congo, Nigeria and Myan-mar in particular, all look like tough places to make a success of such projects; the others are somewhat more promising.

**No global investment**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

In general, all these approaches require a major effort in capacity-building: establishing the required skills in law, management, forestry techniques, finance, marketing and value-added industry, for schemes to function effectively at a local level. Community forest management has been successful in Mexico, but experience elsewhere has been less positive.7 So far, most offsets have gone into China, which offers a secure environment, and indeed progress in reforestation has been dra­matic.78 However, Chinese timber imports have increased in conse­quence, so it is possible that the problem is just being displaced.79 In some major potential carbon sinks, such as the Democratic Republic of Congo, private investment is deterred by very high political and security risks, and a weak legal and banking system. But these lower-cost opportunities in Africa and Latin America will have to be taken up for bio-sequestration to deliver its full potential.

**Forestation is insufficient – warming tanks it before it can solve**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

Bio-sequestration faces five main risks: sequestration integrity; veri­fication; social challenges; land-use competition; and climate policy. Of these, sequestration integrity' is perhaps the most serious, at least for forestation. Forests are vulnerable to the very thing they are trying to prevent: climate change. A drought, forest fire, storm, flood or pest infestation can destroy the trees. Or, 'climate refugees' driven off their farmlands by climatic change may turn to clearing forests. As we have seen, geological storage, even in a badly chosen site, should not leak more than 0.1% annually, probably much less. A forest can easily leak **100% within hours**. And a carbon-rich soil, established by years of conservation tillage, can be degraded by a single season of conven­tional ploughing. Unlike underground carbon dioxide, a forest represents a valuable resource, a permanent temptation. The land it stands on also has potential other uses, unlike saline aquifers. The forest has to **endure for centuries** at least to make a meaningful contribution to fighting long-term climate change. Of course, destroyed forests can always be replanted, but this demands a very long-term commitment that we cannot guarantee, as well as extra costs to be incurred, and paid for by somebody, at some point in the near or distant future.

# -at fossil fuel lobby link

**AT Fossil fuel lobby bad**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

A renewable energy future would not necessarily usher in an era of "energy democracy' based around small-scale, sustainable local com-munities. It seems more likely to be dominated by massive solar tech-nology companies (such as Microsoft and Google); big-scale utilities (offshore wind farms, tidal barrages, etc.) able to manage large, com-plicated projects and to balance risk and demand across a large gener-ating portfolio; major mining companies extracting important rare minerals; and large manufacturers relentlessly trying to drive down costs, probably outsourcing work to developing countries.1Sh Intermit¬tent power generation will be hard to manage within a decentralised system; as conceded in some environmental studies,187 more long-dis¬tance power interconnections will be needed, rather than fewer.

CCS may be criticised as promoted by vested interests, but the renewable energy business is becoming a vested interest too. It docs not make sense to argue that CCS is an 'easy way out' for the fossil fuel business; does that mean we should prefer difficult, costly solu¬tions? It is also questionable whether most people really want respon¬sibility for their own electricity generation. Some local generation For district heating and grid support from micro-generation is certainly worthwhile, and householders might appreciate receiving a cheque in the mail for selling some local power to the utility company. But in general, life is complicated enough; people are content to receive power as a service, without having to worry about where it comes from, or actively balancing their own load and bills.

# -at backstopping

**CCS trades off with unconventional oil – better for OPEC**

**Mills 11** - \*MSc in Geological Sciences @ Cambridge

Robin, “Capturing Carbon: The New Weapon in the War Against Climate Change,” Google Book

A more subtle effect is that some major unconventional sources of liquid petroleum—oil sands, heavy and extra-heavy oil, coal-to-liquids and perhaps oil shales—are very carbon-intensive. There is growing recognition, for instance, of the risk this poses to the public acceptabil­ity and cost structure of the Canadian oil sands.97 CCS would amelio­rate this carbon footprint.98 Since the resource base of unconventional oil is enormous,99 it competes with OPEC oil when prices are high. OPEC would be very happy to see the oil sands torpedoed by carbon taxes. A flood of unconventional oil would force the major exporters to accept lower prices, volumes or both.100 In the longer term, CCS may make it environmentally acceptable to continue using fossil fuels. By eliminating large stationary emissions, it can open up a 'carbon space' for oil (and perhaps gas) to continue as a transport fuel, as noted by Shell director Malcolm Brinded.101 Ulti­mately, emissions from oil for transport can possibly be tackled by air capture. Carbon capture can therefore extend the viability of OPEC nations' oil far into the twenty-first century.

**AT Regulations CP**

**point-to-point da**

**-links**

**Without federal investment, the private sector will build point-to-point pipelines—drives up cost and delays deployment**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

**For carbon dioxide capture and geologic storage to be deployed commercially and in a widespread manner will require well**¶ **thought out approaches for transporting the CO2 in a pipeline system** from the capture facility to the injection site. **Establishing a**¶ **widespread CO2 transportation infrastructure will require strategic long-term planning, taking into account** the potential¶ magnitude of **future deployment scenarios for CCS, up to a scale of infrastructure** that could be **comparable to** the scale of **oil &**¶ **gas infrastructure**. This paper outlines the results of **a study**, commissioned **by the CO2 Capture Project** (CCP) **and** completed by¶ **Environmental Resources Management** (ERM) that **evaluated** the benefits and risks of two **approaches to developing CO2**¶ **pipeline systems. The two** basic **approaches are** described in the paper as:¶ 1. **On a point-to-point basis, which matches a specific source to a specific storage location; or**¶ 2. Via the development of pipeline networks, including **backbone pipeline systems,** which allow for common carriage of CO2¶ from multiple sources to multiple sinks.¶ **An integrated approach** to pipeline infrastructure approach **offers the lowest average cost on a per ton basis for operators over the**¶ **life of the projects** if sufficient capacity utilization is achieved relatively early in the life of the pipeline. **Integrated pipelines also**¶ **reduce the barriers to entry and** are more likely to **lead to faster development and deployment of CCS. Without incentives to**¶ **encourage the development of optimized networks project developers are likely to build point to point pipelines because they**¶ **offer lower costs for the first movers and do not have the same capacity utilization risk.**

**Financial support from the government is key to prevent point-to-point construction**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

¶ Future strategies for private business and policy-makers should take account of the following:¶ 􀁸 That **while point-to-point pipelines may be readily funded on a project-by-project basis by individual**¶ **developers, there may be a need for public policy that encourages the development of optimized**¶ **networks. Development on this basis can** help to **reduce costs, broaden participation and deepen**¶ **deployment of CCS;**¶ 􀁸 **The incremental cost of building optimized networks ahead of point-to-point pipelines may not pass**¶ **project-specific commercial evaluation criteria**;¶ 􀁸 Consequently, other **forms of financial support which overcome commercial barriers may be needed to**¶ **ensure optimized development of CO2 pipelines networks.**

**Absent government incentives, developers will build point-to-point**

**Bohm 10 –** Climate Change Engineering Specialist with Suncor Energy, a CO2 Capture Project member company (“The economics of transportation of CO2 in common carrier network pipeline systems” Carbon Capture Journal Feature Articles, March 4 2010, <http://www.carboncapturejournal.com/displaynews.php?NewsID=523)//MR>

It is clear that **without government incentives for the development of optimized networks, project developers are likely to build point-to-point pipelines.** Other forms of **financial support may be needed which overcome commercial barriers and ensure optimized development of CO2 pipeline networks**¶ So what is the way forward? Guaranteed capacity utilization is essential for integrated backbone pipeline networks to become economically viable. **Public policy is needed that provides** some **guarantees as to capacity utilization. Government incentives** or loan guarantees **are** also **needed to support a backbone infrastructure and encourage the development of optimized networks. Government support in the first years, when capacity is ramping up, will be essential for** eventual **commercial viability.**

**-backbone good**

**Backbone pipelines are comparatively the most cost effective**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

In this section **we compare the two options using** as metrics **the cost of service associated with their use and the**¶ **capital investment required for their development.**

[table omitted]

Key findings of the research can be summarized as:¶ 􀁸 **The cost of service for** Option 2 (i.e. **backbone pipeline**) **presents the cost effective scenario for the system**.¶ 􀁸 Cost of service for the system is higher for Option 1 than Option 2 **because additional smaller pipelines are**¶ **developed separately** for Tranches 2, 3 and 4.¶ 􀁸 From a first mover perspective the reduction to the cost of service for the operator of Tranche 1 (cost of¶ service in year 1) that follows Option 2 is small $0.4 ($8.1 vs. $7.7).¶ 􀁸 **There is a risk that if the first mover opts for Option 1 then additional tranches may not be able to carry out**¶ **CCS due to prohibitive costs, absent of a backbone pipeline** (i.e. Option 2).

**Backbone system sequesters more CO2, speeds up deployment, and connects smaller emitters to the cluster**

**National Grid 12** – international electricity and gas company and one of the largest investor-owned energy companies in the world (“The benefits of a clustered carbon capture and storage system over point-to-point” National Grid, 2012, <http://www.nationalgrid.com/uk/EnergyandServices/NonRegs/CCS/ClusteringBenefits/#header)//MR>

**A shared pipeline system can** very **effectively serve a cluster of emitters** situated **in a** single **geographic area. It also provides a more cost effective and reliable solution than individual emitters developing their own point-to-point CO2 pipelines.**¶ **Clustering reduces costs as a given storage site can serve multiple emitters and only one backbone pipeline is needed. A clustered transport system could** potentially **save well over 25 per cent of expenditure compared to a point-to-point system**, depending on the scale of the cluster.¶ **A cluster system allows extra capacity over point-to-point systems, reduces barriers to future investment and increases the speed of deployment. It** also **opens up the opportunity to connect small emitters for whom point-to-point solutions may be too expensive.**

**Backbone pipeline saves costs and has extra storage capacity—connects small business emitters**

**National Grid 12** – international electricity and gas company and one of the largest investor-owned energy companies in the world (“The benefits of a clustered carbon capture and storage system over point-to-point” National Grid, 2012, <http://www.nationalgrid.com/uk/EnergyandServices/NonRegs/CCS/ClusteringBenefits/#header)//MR>

The diagram below illustrates **a cluster of emitters being served by point to point** pipelines going to dedicated stores. In the long run, there will be four parallel pipelines and four storage sites. **Each chain will require transportation and storage to be developed and sanctioned, making for complicated and expensive projects.**¶ ¶ The next diagram illustrates **a 'shared infrastructure' model** which is similar to what we have on our electricity and gas networks. It **delivers a number of benefits:**¶ ¶ **It offers cost-saving as a given storage site can serve multiple emitters and only one backbone pipeline is needed.**¶ **The main transportation line allows extra capacity which will reduce barriers to future investment and speed deployment.**¶ **Reliability and availability increase as network develops.**¶ **It also opens up opportunities to connect small emitters for whom point-to-point solutions could be too expensive.**

**Most efficient in the long term and encourage fast transition—studies prove**

**Carbon Capture Journal 10** (“The economics of transportation of CO2 in common carrier network pipeline systems” Feature Articles, March 4 2010, <http://www.carboncapturejournal.com/displaynews.php?NewsID=523)//MR>

The CO2 Capture Project (a partnership of seven oil and gas majors to advance CCS) has been looking at the issues surrounding the economics of transportation of CO2 in common carrier network pipeline systems. **The CCP commissioned a study to examine different approaches to infrastructure development**. In the study **two approaches have been evaluated.**¶ **The first would see the development of a point-to-point system, the second the development of common carrier pipeline networks, including backbone pipeline systems.** This study has helped our understanding of the challenges involved; shedding light on what would be the best scenario and how in practical terms CO2 infrastructure might evolve. The results of this study were presented in a paper - Assessing issues of financing a CO2 transportation pipeline infrastructure commissioned by the CCP, and completed by Environmental Resources Management (ERM).¶ Results of the Study¶ **The study confirmed that an integrated backbone pipeline network is** likely to be **the most efficient long-term option. It offers the lowest average cost** on a per tonne basis for operators over the life of the projects if sufficient capacity utilization is achieved relatively early in the life of the pipeline.¶ Crucially, **integrated pipelines reduce the barriers to entry and** are more likely to **lead to the faster development and deployment of carbon capture and storage**. Particularly in situations where government money is being used to finance CO2 transportation it makes sense to pursue **an integrated approach that provides equitable, open access to other large final emitters**. This **will reduce the barriers to entry and will encourage faster adoption of CCS**. However, point-to-point pipelines offer lower costs for the first movers and do not have the same capacity utilization risk.

**Network transport systems streamline development and connect small emitters**

**Global CCS Institute 11** (“TRANSPORT OF CO2” November 24 2011, [http://cdn.globalccsinstitute.com/sites/default/files/publications/25906/fact-sheet-1b-transportv4-2.pdf)//MR](http://cdn.globalccsinstitute.com/sites/default/files/publications/25906/fact-sheet-1b-transportv4-2.pdf)/MR)

**A clustered transport system could** potentially **save over 25 per cent of expenditure compared to a point-to-point system**, depending on the scale of the cluster. **Developing such a network can** also **significantly reduce barriers to future investment.**¶ **Large-scale deployment of CCS should result in the linking of clusters of proximate CO2 sources**, through a hub, **to clusters of sinks by trunk pipelines**. Then shorter collection, feeder or distribution pipelines would link the individual sources and sinks into the network. **A simple network would consist of a ‘tree’ where each of the branches represented feeder pipelines from sources of CO2, the trunk of the tree would be the main CO2 pipeline and the roots would be the distribution pipelines** linking to the various sinks. The **participation of multiple stakeholders and industries has the potential to develop business and financing structures to underpin future commercial CCS markets. Networks** can also **encourage and increase the speed of deployment in the region**, for example, **by reducing the** total **number of permits that would need to be issued for pipelines.**¶ **Networks** also **provide the opportunity to connect small emitters for whom point-to-point solutions may be too expensive and to build up regional employment and expertise in the** necessary **technologies**.

**Trunkline approach solves environmental damage and greater storage**

**DECC 12** (“Building networks: transport and storage infrastructure” Department of Energy and Climate Change, April 2012,

[http://www.decc.gov.uk/assets/decc/11/cutting-emissions/carbon-capture-storage/4905-ccs-roadmap--transport-and-storage-infrastructure.pdf)//MR](http://www.decc.gov.uk/assets/decc/11/cutting-emissions/carbon-capture-storage/4905-ccs-roadmap--transport-and-storage-infrastructure.pdf)/MR)

2.5. **In addition to** these prospective **economic benefits, other** less tangible **benefits** are also likely to **emerge from a networked approach. It** obviously **makes sense in terms of reducing environmental damage and public inconvenience to avoid the construction of multiple pipelines along the same or similar routes** within a relatively short period. It is also likely to be the case that **businesses would be more likely to capture and permanently store CO2 if transport infrastructure were readily available than if they were required to develop and install an infrastructure from scratch. A readily available CO2 transport and storage network is** therefore **likely to provide an attractive mitigation option for high emitting industries** looking to reduce emissions. **This** in turn **is likely to have implications for the make-up of the economy in** those **areas of the country with** a high concentration of **carbon intensive industries.**

**federal investment key**

**Government support is key to ensure commercial-scale CCS**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

**Point-to-point pipelines will be funded on project-by-project basis by individual developers because of certainty**¶ **over capacity utilization**. The **study found that integrated backbone pipeline networks may be the most efficient**¶ **long-term option**. At the same time, **such integrated backbone pipeline networks will need "guaranteed" capacity**¶ **utilization** in order **to be economically viable**. Therefore, **public policy that encourages development of optimized**¶ **networks with** some **support of capacity utilization will be needed. Government support in the first years when**¶ **capacity is ramping up will be important to commercial viability. Government incentives** or loan guarantees **are** also¶ **needed to support a backbone infrastructure.**

**Government funding key to security and optimal construction**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

¶ **Government funding can enable the project to operate commercially at a comparative cost of service** (~8$t/CO2)¶ to Option 1 even when Tranches 2, 3 and 4 are not realised (i.e. see Figure 4.4 at 40% capacity utilisation). In this¶ sense, **governments through favorable financing** or other types of support **can provide security to first mover over**¶ **future capacity up-take and mitigate risks in order to promote optimised deployment options for** a **CCS** scenario¶ such as the one modelled.

**Public funding key to catalyze the private sector**

**Posner 10** – Global Director of Energy, The Climate Group (Rupert, “Carbon Capture

and Storage: Mobilising Private Sector Finance” The Climate Group, Ecofin, and the Global CCS Institute, September 20 2010 http://www.theclimategroup.org/\_assets/files/CCS-report.pdf)//MR

**In the current stage, where CCS plants are yet to be**¶ **demonstrated at scale, projects will** most likely **have to be**¶ **funded** almost **exclusively by public sources. Public funding**¶ **will** likely **need to cover both the upfront capital costs**¶ **and also the long-term fuel inefficiencies** created by CCS.¶ **As the amount of private sector capital that is available**¶ **to follow that public funding is limited, public funding**¶ **should be focused on a few projects** instead of the current¶ trend of being spread across a suite of technologies and¶ locations. **Once the first plants are up and running, there**¶ **should be little difficulty in attracting large scale private**¶ **sector funding for other CCS plants.**

**-carbon price**

**Federal carbon pricing key**

**Chrysostomidis et al. 9** – Ioannis Chrysostomidis and Paul Zakkour, Environemtal Resources Management; Mark Bohm and Eric Beynon, Suncor Energy; Renato de Filippo, Eni SpA; Arthur Lee, Chevron Corporation (“Assessing issues of financing a CO2 transportation pipeline infrastructure” Energy Procedia Volume 1, Issue 1, Pages 1625–1632, February 2009, http://www.sciencedirect.com.proxy.lib.umich.edu/science/article/pii/S1876610209002148)//MR

¶ **In interviews with staff from** banks and **financial institutions2, the** key **conclusion is that CO2 pipeline projects, if**¶ **they can be reduced in terms of carbon price risks, will become the same in terms of risks similar to any other oil &**¶ **gas pipeline project**. At the same time, **these same banks and financial institutions view such projects as having**¶ **significant regulatory and market risks associated with the carbon price, in addition to** the **typical geopolitical and**¶ **commercial risks** associated with other oil and gas projects.

**-private won’t invest now**

**Private investors are hesitant to invest in pipeline infrastructure absent federal support**

**Insight Economics 11** (“Development of Carbon Capture and Storage Infrastructure” 4.4 Role for Government, Global CCS Institute, March 21 2011, http://www.globalccsinstitute.com/publications/development-carbon-capture-and-storage-infrastructure/online/39031)//MR

**Understanding these risks and uncertainties is** particularly **important in** terms of **setting the policy environment for** building **the future pipeline network** that will be required **for the large scale deployment of CCS.** Financial analysis suggests that **the private sector would be** understandably **unwilling to invest in the currently oversized pipelines that would provide more efficient transport in the longer term.** A reasonable question then is why should taxpayers take on this risk if private investors will not? One answer is that **there may** well **be public benefits in reducing the costs of CCS transportation, in terms** perhaps **of electricity prices and** the **carbon price being lower** than otherwise, **together with** any social **benefits** that accrue **from** having **a wider portfolio of emissions reduction technologies** than may otherwise be the case.¶ The conclusion from this analysis is that**, at this stage** at least, **governments will** probably **need to play an important role in facilitating investment in CCS infrastructure** via the mixed funding model. This may involve subsidising the construction of efficiently sized CO2 pipelines. Another option is for governments to construct CCS infrastructure itself and then sell it to the private sector when the risks are better understood and the uncertainties have been substantially reduced.

(I’m hesitant—I think this takes out the aff as well)

**Ongoing risks deter the private sector from investing**

**Insight Economics 11** (“Development of Carbon Capture and Storage Infrastructure” 4.4 Role for Government, Global CCS Institute, March 21 2011, http://www.globalccsinstitute.com/publications/development-carbon-capture-and-storage-infrastructure/online/39031)//MR

On the other hand, while it is never easy to look into a crystal ball, **there may** well **be ongoing risks and uncertainties for potential investors in CCS infrastructure**. Indeed, **while many of these risks and uncertainties will have been reduced by** the end of the **demonstration** phase**, it is unlikely that all of them will have been**. In the case of CCS for power generation, for example, **there will still be uncertainty over the future competitiveness of CCS relative to other base load technologies**, including nuclear power. **Uncertainties over future carbon prices** (including the possibility of purchasing cheaper abatement options on an emerging global market) **may be compounded by technical progress in industries** such as steel and cement **whereby** their emissions intensity is reduced to a level where **it becomes cheaper to emit the remaining GHGs rather than capture and store them.** **Risks around liability and community resistance to CCS deployment** also **may not go away in the medium term.**

# eminent domain links to politics

**Supreme Court eminent domain ruling sparked massive backlash**

**Kanner 6** – Professor of Law Emeritus, Loyola Law School, Los Angeles (Gideon, “Kelo v. New London: Bad Law, Bad Policy, and Bad Judgment” The Urban Lawyer Vol. 38, No. 2, 2006, http://www.americanbar.org/content/dam/aba/events/real\_property\_trust\_estate/joint\_fall/2007/kelo\_v\_new\_london\_bad\_law.authcheckdam.pdf)//MR

Last term’s five-to four, Kelo1 decision has precipitated a great¶ deal of controversy. Large numbers of Americans were dismayed and¶ angered to find that anyone’s unoffending home may be seized and¶ razed to convey the site to a municipally favored redeveloper, on the¶ theory that redevelopment will increase revenues and wages, thus tending¶ to revitalize the community. Public opinion polls indicate that¶ Kelo’s broad reading of the Public Use Clause has left the great majority¶ of Americans gasping with disbelief.2 Kelo has precipitated a¶ flood of proposed (and in some cases enacted) legislation to curb this¶ breathtaking expansion of unreviewable and unaccountable government¶ power.3 A strong public reaction to a Supreme Court ruling is¶ hardly a new phenomenon, but in this case its intensity and its ability¶ to stir legislatures into immediate corrective action are, at least in my¶ experience, unprecedented.¶

**Widespread opposition to eminent domain**

**Scribner 9** (Marc, “Fighting Eminent Domain Abuse” Competitive Enterprise Institute, October 13 2009, http://www.openmarket.org/2009/10/13/fighting-eminent-domain-abuse/)//MR

Popular outrage over eminent domain abuse may have waned a bit since the Supreme Court’s poorly-reasoned Kelo ruling in 2005, but economic development takings remain incredibly unpopular throughout the country. Public opinion polls indicate that more than 80 percent of Americans oppose eminent domain for economic development, which is surprising when one considers the relative inaction on the part of state legislatures to meaningfully protect their citizens’ property rights.

**Multiple polls prove—eminent domain is a political lightning rod**

**Castle Coalition 9** (“The Polls Are In” The Castle Coalition, 2009 (last date mentioned), http://castlecoalition.org/index.php?option=com\_content&task=view&id=43)//MR

Ask pretty much anyone else, though, and there’s clear consensus. Americans across the nation from all walks of life-regardless of their religious or ethnic background, political affiliation or geographic location-say the use of eminent domain for private gain is wrong. There is near universal agreement that taking private property should not be taken just so someone else can make more money-regardless.¶ The following polls all reflect this sentiment. Since the Kelo v. City of New London decision, polls all across the country have reflected the fact that Americans find the landmark-and now infamous-Supreme Court decision just plain wrong:¶ Constitutional Attitudes Survey¶ In 2009, Knowledge Networks conducted a survey on behalf of Harvard University and Columbia University to assess people's attitudes on constitutional issues. Question 215 in the survey asked: “Governments sometimes use the power of eminent domain to acquire a person’s property at a fair market price for other uses. Recently, a local government transferred someone’s property to private developers whose commercial projects could benefit the local economy. Do you think the local government should be able to use eminent domain for this purpose or not?” An overwhelming 83.5% of respondents said "no," the government should not be allowed to use eminent domain for economic development.¶ Results ¶ New Jersey Association of Realtors Smart Growth Survey¶ In December 2008, the New Jersey Association of Realtors conducted a telephone survey of 814 registered voters in the state, questioning them about various political issues. The voters surveyed were asked one of two questions about whether they favored or opposed the use of eminent domain to force homeowners to sell their homes to the government to build businesses for economic development. One of the questions mentioned compensation for "fair market value" while the other did not. Nearly 83% of respondents opposed the use of eminent domain for economic development and nearly 77% opposed eminent domain for economic development even with the inclusion of "fair market value" compensation in the question. ¶ Results ¶ Associated Press-National Constitution Center Poll¶ In an August 2008 poll with questions about various constitutional issues, 87% of respondents said government shouldn't have the power of eminent domain for redevelopment and 60% said they were opposed to the use of eminent domain for redevelopment even with fair market price for the property seized. 75% of those surveyed opposed government taking private property and handing it over to a developer, and 88% of respondents said property rights are just as important as freedom of speech and religion.¶ Results

# AT Private CP

# -federal liability

**Federal ownership limits private liability**

**EPA 10**

“Report of the Interagency Task Force on Carbon Capture and Storage,” http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf

The legal analysis could be different under existing environmental statutes. To the extent that the government owns land on which sequestration occurs, this arguably could give rise to governmental liability by operation of law. Similarly, governmental ownership of CO2 ; ownership of pipelines or other equipment; and even governmental oversight, financing, and encouragement of CCS activities could be claimed to give rise to governmental liability. (The government might contest the claim depending on the particular facts at issue.) There is no discretionary function or government contractor defense available under these statutes, and government contractors that are involved in geologic sequestration operations in any of a range of ways would not necessarily be immune from such liability. Advantages: Structuring a program so that the government is directly liable for CCS activities, and no private party has remaining liability, could reduce the complexity of assigning long-term liability.

**Private liability limits investment**

**EPA 10**

“Report of the Interagency Task Force on Carbon Capture and Storage,” http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf

As discussed in Section IV.C, many stakeholders have identified long-term liabilities associated with CO2 sequestration as a potential barrier to CCS deployment. These potential long-term liabilities could be addressed using seven different general approaches: (1) reliance on existing legal and regulatory framework; (2) substantive or procedural limitations on claims; (3) Federal legislation facilitating private insurance coverage; (4) establishment of a liability fund; (5) **government ownership** or direct government liability; (6) governmental indemnification: and (7) transfer of long-term risk to the Federal government after site closure. These approaches, discussed in more detail below, are not mutually exclusive and can be combined in various hybrid formats.

**Plan solves tort liability – key to private investment in CCS**

**Horne 10** – JD @ U of Utah

Jennifer, “Getting from Here to There: Devising an Optimal Regulatory Model for CO<2> Transport in a New Carbon Capture and Sequestration Industry,” 30 J. Land Resources & Envtl. L. 357, Lexis

Regulation is a better way to deal with the issue - specifically preemptive regulation that removes the risk of "climate change liability" for entities engaged in climate change mitigation activities. CCS is an expensive endeavor, untested at the commercial scale. 91 The limits of tort liability at each phase are unknown. This is a significant concern for private entities, and could **deter them** from investing in CCS altogether. 92 A comprehensive regulatory regime for transport should address that problem, and should do so consistently across the entire CCS spectrum. At a minimum, regulation should provide substantial penalties and other disincentives for CO<2> leakage during transport, and provide clear rules about who is liable for damages resulting from such leakage, including potential liability for contribution to global warming.

# -gov first key

**The government must facilitate transportation – private industry is skeptical without large-scale demonstrations of success**

**Forbes et al 8** - senior associate at the World Resources Institute, former member of the National Energy Technology Laboratory

Sarah, CCS Guidelines: Guidelines for Carbon Dioxide Capture, Transport, and Storage, World Resources Institute, http://pdf.wri.org/ccs\_guidelines.pdf

In technology development there is a period referred to as the “valley of death,” where a technology has been proven in the laboratory and on a small scale, but has yet to become commercially viable. CCS technology has progressed quickly from being a concept to a key part in proposed climate change mitigation plans. This progression is partly the result of early successes in pilot capture demonstrations and field validation tests, where small volumes of CO2 have been injected for research purposes. It is also due in large part to the experience that has been gained injecting CO2 for enhanced oil recovery over the past three and a half decades. There are skeptics who believe that CCS remains infeasible, with continued interest driven by the lack of any other viable solution that would allow the continued use of coal. To achieve the potential benefits of CCS and prove that safe and permanent storage can be realized, it is important to continue large-scale demonstration and deployment of this technology.

**Private sector won’t invest absent a demonstration of feasibility**

**EPA 10**

“Report of the Interagency Task Force on Carbon Capture and Storage,” http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf

Large-scale demonstrations of CO2 capture technologies are very important for encouraging the successful commercial deployment of CCS (Kuuskraa, 2007; MIT, 2007; National Research Council, 2007; GAO, 2008). While industrial CO2 separation processes have been commercially available for some time, they have not been deployed at the scale required for large power plant applications. The CO2 capture capacities for current industrial processes are typically an order of magnitude smaller than the capacity required for a typical power plant. A concern regarding CO2 capture technologies is whether they will safely and reliably work when applied to coal-based power generation. Based on previous experience of CO2 capture technologies in industrial applications, it would appear that these systems should be effective at larger scale in power generation applications. However, until these systems are constructed and successfully demonstrated at full scale, uncertainty over the technology’s performance and cost yield a **substantial risk premium** for early projects.

# -monopoly da

**Privatization leads to a monopoly – takes out solvency**

**Monast 8** - \*PhD, Director of the Climate and Energy Program at Duke University’s Nicholas Institute for Environmental Policy Solutions

Jonas, “From Carbon Capture to Storage: Designing an Effective Regulatory Structure for CO2 Pipelines,” http://www.nicholas.duke.edu/ccpp/ccpp\_pdfs/co2\_pipeline.pdf

Some form of rate regulation for C02 transport will likely be necessary. As with any capital-intensive project, there will be high barriers to entry into the C02 transport market. Because of these high costs, there will likely be monopoly power associated with pipeline ownership, creating the possibility of rate manipulation and overcharging users. Rather than rely on an ad hoc state-by-state system to deter these issues, a federally-regulated rate structure may be desirable, similar to that used for interstate electricity transmission lines or natural gas pipelines.

# AT States CP

# -coordination key

**Piecemeal production fails – must be centralized**

**Parfomak and Folger 7** - \*Specialist in Energy and Infrastructure Resources, Science, and Industry Division, \*\*Specialist in Energy Policy Resources, Science, and Industry Division

Paul and Peter, CRS Report for Congress, “Carbon Dioxide (CO2) Pipelines for Carbon Sequestration: Emerging Policy Issues,” Scholar

Cost Implications for Network Development. In light of the overall costs associated with CO2 pipelines, including the uncertainty about future materials costs and cost recovery, some analysts anticipate that a CO2 network for CCS will begin with shorter pipelines from CO2 sources located close to sequestration sites. Larger CO2 trunk lines are expected to emerge to capture substantial scale economies in long-distance pipeline transportation. According to the 2007 MIT report, “it is anticipated that the first CCS projects will involve plants that are very close to a sequestration site or an existing CO2 pipeline. As the number of projects grow, regional pipeline networks will likely evolve.”48 It is debatable, however, whether piecemeal growth of a CO2 pipeline network in this way, presumably by individual facility operators seeking to minimize their own costs, would ultimately yield an economically efficient and publically acceptable CO2 pipeline network for CCS. Weaknesses and failures in the North American electric power transmission grid, which was developed in this manner, may be one example of how piecemeal, **uncoordinated** network development may **fail to satisfy** key economic and operating objectives.

# -federal lands

**Use of federal lands necessitates federal investment**

**Stephenson 8** - Director, Natural Resources and Environment @ GAO

“Federal Actions Will Greatly Affect the Viability of Carbon Capture and Storage As a Key Mitigation Option,” GAO, http://www.gao.gov/new.items/d081080.pdf

In addition to the technical and legal issues affecting CCS’s prospects, key studies, federal advisory committees, and the stakeholders we interviewed also identified an array of other issues that would need to be resolved if the technology is to be deployed within a time frame scientists believe is needed to address climate change. Moreover, whereas many of the technical and regulatory issues discussed earlier fall within the domain of two agencies (DOE and EPA), these other issues cross the jurisdictions of the Departments of the Interior and Transportation, the Federal Energy Regulatory Commission, and other agencies in a manner that would require collaboration between agencies and, in many cases, coordination with state governments and other entities. Under a national CCS program, CO2 could be sequestered on both federal and nonfederal lands and would raise complex property rights issues needing resolution in both instances. In the case of federal lands, BLM, which manages the federal government’s mineral resources, is **required** by the Energy Independence and Security Act of 2007 45 to report by December 2008 on a framework to manage geological carbon sequestration activities on public lands. According to BLM officials, the report will include a discussion of the unresolved property ownership and liability issues related to long-term CO2 storage. They note that the report will also discuss the statutory authority BLM currently has and what it lacks, such as the authority to establish a funding mechanism for monitoring and mitigation efforts associated with sequestration sites. They cautioned, however, that the report will not recommend solutions to current uncertainties and explained that since injected CO2 can move onto adjacent private or state lands, resolving them will require collaboration with private landowners and state agencies. Nationwide CO2 sequestration would also pose major challenges on nonfederal lands. EPA notes that states with primacy for the UIC program have typically addressed such challenges when they have arisen under that program. The agency acknowledged the additional complications that would arise as stored CO2 crossed state boundaries, but noted that such cross-jurisdictional issues typically occur under the UIC program and that states have worked together to address them. Nonetheless, the significantly larger scale of a future CCS program could magnify the problems posed by these jurisdictional issues. EPA officials noted that they are hoping that the proposed rule’s comment process will surface ideas to address these problems. However, EPA officials also note that the agency lacks authority to issue regulations resolving these issues. Furthermore, while EPA’s proposed rule reaffirms liability related to underground sources of drinking water, ambiguity remains regarding who—the injector or the property owner— is ultimately responsible for unanticipated releases of the injected CO2 that have other effects. As discussed earlier, the released CO2 could interfere with the adjacent mineral owners’ abilities to extract those resources, and the injection well’s operator could be held liable for nuisance, trespass, or another tort. Pipelines are the preferred method of transporting large amounts of CO2 . The Department of Transportation’s Pipeline and Hazardous Materials Safety Administration (PHMSA) administers safety regulations for CO2 pipelines that affect interstate commerce and certifies states that have adopted regulations compatible with the minimum federal safety standards to regulate their intrastate pipelines. No federal agency has claimed jurisdiction over siting, rates, or terms of service for interstate CO2 pipelines. 46 However, early assessments indicate that a nationwide CCS program could require a network of interstate CO2 pipelines that would raise **cross-jurisdictional issues** and involve multiple regulatory authorities—all in the unprecedented context of a nationwide program to transport massive volumes of CO2

# -pre-emption solves over-regulation

**Federal investment is key – otherwise states will over-regulate**

**Klass and Wilson 8** - \*Professor of Law @ Minnesota, \*\*Professor of Public Policy @ Minnesota

Alexandra and Elizabeth, “CLIMATE CHANGE AND CARBON SEQUESTRATION: ASSESSING A LIABILITY REGIME FOR LONG-TERM STORAGE OF CARBON DIOXIDE,” http://www.law.emory.edu/fileadmin/journals/elj/58/58.1/Klass\_Wilson.pdf

Existing federal environmental statutes that govern air, water, and hazardous waste can act as examples of the federal government setting a floor for environmental standards and allowing states to innovate using their regulatory authority and common law. 217 Legislators could use these statutes for guidance in enacting CCS legislation. On the other hand, when a commercial project is **not accompanied** by **federal** research dollars, the siting difficulties that plague much infrastructure development, characterized by “not in my backyard” attitudes, could emerge for CCS as well. 218 If states choose to use high liability barriers to keep CCS projects out of their territories, eventual CCS project siting—and potential benefits of greenhouse gas reduction—could become **impossible**

# AT NEPA CP

**Environmental impact statement is already being prepared**

**EPA 10**

“Report of the Interagency Task Force on Carbon Capture and Storage,” http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf

Energy Corridors/Federal Lands: In an effort to expedite the permitting of energy infrastructure crossing Federal land, section 368(a) of the Energy Policy Act of 2005 (EPAct) requires agencies to designate energy corridors across Federal lands in eleven Western States for “oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities.” In November 2008, a final programmatic environmental impact statement **was issued** that evaluates issues associated with the designation of energy corridors on Federal lands in eleven Western States. Energy corridors on Federal lands provide pathways for future pipelines as well as long-distance electrical transmission lines that are expected to help relieve congestion, improve reliability, and enhance the national electric grid. Future use of the corridors should reduce the proliferation of ROWs across the landscape and minimize the environmental footprint from development. Section 368 corridors are sited to avoid, to the maximum extent possible, significant known resource and environmental conflicts. The Act does not specifically identify CO2 pipelines, but it also does not specifically exclude them. It seems that a CO2 pipeline could reasonably fit the definition of “gas pipelines” in EPAct. Section 368(b) requires agencies to designate energy corridors across Federal lands in the remaining 39 States; a programmatic environmental analysis is **currently** **being prepared**.

**NEPA would be used on sequestration**

**Grant 9** - Physical Scientist Office of Systems, Analyses, and Planning @ DoE

Tim, “Storage of Captured Carbon Dioxide Beneath Federal Lands,” Dept of Energy, http://www.netl.doe.gov/energy-analyses/pubs/Fed%20Land\_403.01.02\_050809.pdf

Laws such as the National Environmental Policy Act (NEPA), 30 the National Historic Preservation Act (NHPA), 31 and the Endangered Species Act (ESA) 32 apply to Federal actions that authorize private activities on public lands, such as the issuance of leases and pipeline ROWs. Some require reclamation. **Sequestration** projects on Federal lands will likely be subject to these types of stipulations. They will also be subject to a yet-to-be-established application process and its associated impacts to project costs and schedule.

# Natural Gas Advantage

# -1ac switch link

**US switch goes global**

**Kemp 12** (John, March 28, “COLUMN-EPA emission regulations shut door on coal: John Kemp”, http://www.reuters.com/article/2012/03/28/column-epa-coal-fired-power-idUSL6E8ES90R20120328)

The main effect of the proposed rules is therefore to entrench the current financial advantage of natural gas. It confers a substantial benefit on gas producers and ensures the coal industry will remain shut out of the power generation system even if gas prices eventually rise. NOT QUITE ALL THE ABOVE President Barack Obama has been touting his administration's "all of the above" strategy of blending fossil fuels and clean technology to meet future energy needs in an affordable manner. But while **the president** has sounded enthusiastic about clean tech, happy about gas and even cautiously supportive of oil, he **has been silent about coal**, which generates by far the highest carbon emissions. Now it is apparent why. **The decision to tilt the market against coal is quite deliberate.** As EPA chief Lisa Jackson hinted, **it is part of a broader strategy to remake the energy industry by limiting the use of coal in the power stack and substituting cleaner burning gas or zero emission wind and solar.** Because gas prices are currently so low and no new coal-fired plants are expected to be built, **EPA thinks the "proposed rule will not have direct impact on U.S. emissions** of greenhouse gases". **But "it provides assurance that emission rates from new fossil fuel-fired generation will not exceed the level of the standard and will send a strong signal** both domestically and **internationally**. "**Domestically, this** proposed **rule can** further **stimulate investment in CCS and other clean coal technologies** by making it clear that such technologies do provide a clear path forward for new coal-fired generating capacity. **Internationally, this rule may encourage others to consider less GHG-intensive forms of power generation.**"

**Nat gas switch link**

**Folger and Parformak 7** (Paul W. Parfomak, Specialist in Energy and Infrastructure, Resources, Science, and Industry Divison, Peter Folger, Specialist in Energy Policy, Resources, Science, and Industry Divison, CRS Report for Congress, "Carbon Dioxide (CO2) Pipelines for CarbonSequestration: Emerging Policy Issues", April 19, 2007)

Congress is examining potential approaches to reducing manmade contributions to global warming from U.S. sources. One approach is carbon capture and sequestration (CCS) — capturing CO2 at its source (e.g., a power plant) and storing it indefinitely (e.g., underground) to avoid its release to the atmosphere. A common requirement among the various techniques for CCS is a dedicated pipeline network for transporting CO2 from capture sites to storage sites. In the 110 th Congress, a number of bills include aspects of CCS, but **do not discuss** in any detail proposals for pipeline infrastructure to transport captured CO2 from sources to storage sites. Many bills that mention some form of CCS focus on incentives for enhancing CO2 capture and/or on characterizing geologic reservoirs. Some bills, such as S. 962 and H.R. 931, include sections on promoting the development of technologies needed to separate and capture CO2 at its source, often as part of research and development provisions. Other bills, such as H.R. 1267 and S. 731, call for enhancing or expanding the national capability to assess potential U.S. capacity for safe and long-term CO2 storage in geologic reservoirs. That CCS and related legislation generally focuses on the capture and storage of CO2 , and not on its transportation, reflects the current perception that transporting CO2 via pipelines does not present a significant barrier to implementing large-scale CCS. Notwithstanding this perception, and even though regional CO2 pipeline networks already operate in the United States for enhanced oil recovery (EOR), developing a more expansive national CO2 pipeline network for CCS could pose numerous new regulatory and economic challenges. There are important unanswered questions about pipeline network requirements, economic regulation, utility cost recovery, regulatory classification of CO2 itself, and pipeline safety. Furthermore, because CO2 pipelines for EOR are already in use today, policy decisions affecting CO2 pipelines take on an **urgency** that is, perhaps, **unrecognized** **by many**. Federal classification of CO2 as both a commodity (by the Bureau of Land Management) and as a pollutant (by the Environmental Protection Agency) could potentially create an immediate conflict which may need to be addressed not only for the sake of future CCS implementation, but also to ensure consistency of future CCS with CO2 pipeline operations today. In addition to these issues, Congress may examine how CO2 pipelines fit into the nation’s overall strategies for energy supply and environmental protection. If policy makers encourage continued consumption of fossil fuels under CCS, then the need to foster the other energy options may be diminished — and vice versa. Thus decisions about CO2 **pipeline infrastructure** could have consequences for a broader array of energy and environmental policies.

# -nat gas high

**Natural gas high**

**Silverstein 5-23** – Energy Central Editor @ Forbes

Ken, “Natural Gas Smothering 'Clean Coal' and Carbon Capture,” Forbes, http://www.forbes.com/sites/kensilverstein/2012/05/23/natural-gas-smothering-clean-coal-and-carbon-capture/

Natural gas is **dominating** the headlines. But five years ago it rested firmly on the back pages. The budding issue back then had been how new technologies would keep coal at the top of the energy hierarchy and how its associated emissions could be minimized and its carbon releases buried. What happened? The energy business is supposed to move at a snail’s pace. And while no one had heard of shale gas 10 years ago, it is now the hot topic. At the same time, the price of such unconventional natural gas has declined precipitously, making it an economic bargain compared to coal. Meantime, the coal sector has been given a number of **one-two punches** by environmental **regulators** with the most recent coming in March that nullified any future plants that can’t sequester carbon. “Regulation is certainly a key,” says Nick Akins, chief executive of American Electric Power, during an EnergyBiz appearance. “It must be consistent and coherent. But decisions are being made and the regulations could change overnight.”

# -regs lead to natural gas

**Regulations will force a transition to natural gas – locks in price increases and volatility**

**Johnson 6-11**

Steve, “Co-op Rep: EPA Off Base on Carbon,” http://www.ect.coop/public-policy-watch/energy-environment/electric-cooperative-epa-carbo-reduction-rule/45194

That means the rule will push utilities from coal to natural gas, which has a **volatile** price history, he noted. “Electricity affordability from natural gas generation is significantly driven by the fuel’s price. EPA’s proposed standard will effectively **eliminate** ODEC’s choice for affordable baseload electric power,” Hudgins said. He urged the subcommittee to take steps to persuade EPA to withdraw the rule.

# -ccs k/ coal

**Key to coal**

**Horne 10** – JD @ U of Utah

Jennifer, “Getting from Here to There: Devising an Optimal Regulatory Model for CO<2> Transport in a New Carbon Capture and Sequestration Industry,” 30 J. Land Resources & Envtl. L. 357, Lexis

Concern over climate change has fueled a flurry of scientific studies, Congressional hearings, public debate, and, not insignificantly, corporate research. Climate change mitigation has implications for the business of energy production. Carbon regulation may well mean the emergence of entirely new industries. Carbon capture and sequestration (CCS) is one such industry. CCS is a potential means of assuring the **position of coal** 1 as a **major energy source** while reducing its climate change effects. 2

**CCS is key to the coal industry**

**Katzer 7** – PhD in Chemical Engineering, member of the National Academy of Engineering, Professor @ MIT

James, “The Future of Coal,” http://web.mit.edu/coal/The\_Future\_of\_Coal.pdf

A central conclusion to be drawn from our examination of alternative futures for coal is that if carbon capture and sequestration is successfully adopted, utilization of coal likely will **expand** even with stabilization of CO2 emissions. Though not shown here, extension of these emissions control scenarios further into the future shows continuing **growth in coal use** provided CCS is available. Also to be emphasized is that market adoption of CCS requires the incentive of a significant and widely applied charge for CO2 emissions.

# -coal k/ china

**Keeping China on coal is key to avert energy wars**

**Katzer 7** – PhD in Chemical Engineering, member of the National Academy of Engineering, Professor @ MIT

James, “The Future of Coal,” http://web.mit.edu/coal/The\_Future\_of\_Coal.pdf

The inevitable dominance of fossil fuels in China is not good news for the global climate. But the severity of the problem will depend on the proportions of oil, gas, and coal in China’s future energy mix, and that is much less certain. In one scenario, China, like almost every country that has preceded it up the economic development ladder, will rapidly shit from reliance on solid fuels towards oil and gas, with gas playing an increasingly important role in electric power generation, in industrial and residential heating, and potentially also in transportation. In an alternative scenario, China will remain heavily dependent on coal for electric power, for industrial heat, as a chemical feedstock, and increasingly, for transportation fuels, even as demand continues to grow rapidly in each of these sectors. The prospect of continued high oil and gas prices make the coal-intensive scenario more plausible today than it was during the era of cheap oil. These two scenarios pose very different risks and benefits for China and for the rest of the world. For the Chinese, the heavy coal use scenario would have the merit of greater energy autonomy, given China’s very extensive coal resources. It would also mean less Chinese pressure on world oil and gas markets. But the impact on the environment would be substantially greater, both locally and internationally. In the worst case, the heavy environmental toll inflicted by today’s vast coal mining, shipping, and burning operations, already by far the world’s largest, would grow much worse as China’s use of coal doubled or even tripled over the next 25 years. More optimistically, China would become the world’s largest market for advanced clean coal technologies, including gasification and liquefaction, and eventually also including carbon dioxide capture and storage. But these technologies will add considerably to the cost of coal use, and, in the case of carbon capture and sequestration, are unlikely to be deployable on a large scale for decades. The high oil and gas use scenario would not prevent these problems, but it would make them more manageable. A modern gas-i red electric power plant is not only cleaner than its coal-i red counterpart, but also emits 70% less carbon dioxide per unit of electrical output. A petroleum-based transportation system emits only about half as much carbon dioxide per barrel as it would if the liquid fuels were produced from coal. But the high oil and gas scenario would also force China, with few resources of its own, to compete ever more **aggressively** for access to them around the world. In that case, the recent tensions with Japan over drilling in the East China Sea and the flurry of deal making in Iran, Africa, Central Asia, South America, and elsewhere may in retrospect come to seem like a period of **calm before the storm**.

# -china impact

**Econ collapse**

**Heinberg, 10** – fellow at the Post Carbon Institute, fellow at the Committee on International Trade and advisor to the European Parliament, National Petroleum Council, and the U.S. Secretary of Energy, (Richard, “China's Coal Bubble...and how it will deflate U.S. efforts to develop "clean coal”, Post Carbon Institute, May 4, 2010, http://www.postcarbon.org/article/96251-china-s-coal-bubble-and-how-it-will)//JK

China: Leading the Global Economy…Into the Ditch   Some commentators are concerned about China's economy for reasons that have nothing to do with coal. The prime example: it would appear that Beijing has a problem with over-reliance on property development as an engine of domestic economic growth. One of those sounding the alarm on this score is hedge fund manager James Chanos, founder of Kynikos Associates Ltd.; he says China is "on a treadmill to hell," and that the nation is "Dubai times a thousand." He has also been quoted as saying, "They can't afford to get off this heroin of property development. It is the only thing keeping the economic . . . numbers growing."   A bursting of China's property bubble could collapse the nation's economy quickly and soon. But it is essentially a problem of money, and money is a creation of the human mind. Currencies can be reformed; banking systems can be reorganized. Such things are painful and take time, but they are certainly possible—and historic examples are numerous.   Energy is different. **Without energy, nothing happens**. Transport systems stall; building construction and manufacturing cease. The lights go out. You can't make energy out of nothing and you can't call it into existence with computer keystrokes, as bankers can do with money. Generating electrical power requires physical resources, infrastructure, and labor. And so there are natural limits to how much energy we can summon for our human purposes at any given time.   China has become a great manufacturing powerhouse largely because it was able to grow its energy supply quickly and cheaply. And so China's contribution to the world economy is to this extent a function of China's contribution to world energy. One significant gauge of this link is the fact that Chinese coal production represents more than double the amount of energy contributed to the world economy as compared to Saudi Arabia's oil production (1,100 million tons of oil equivalent vs. 540 Mtoe.)   **If China faces hard energy limits, that means its economy is living on borrowed time**. That also means the world as a whole confronts energy and economic constraints that are harsher, and closer, than we are being told.

# -no china transition

**No Chinese transition from coal**

**Katzer 7** – PhD in Chemical Engineering, member of the National Academy of Engineering, Professor @ MIT

James, “The Future of Coal,” http://web.mit.edu/coal/The\_Future\_of\_Coal.pdf

**Coal is** today **China’s most important and abundant fuel, accounting for** about **two thirds of the country’s primary energy supply. Coal output in China rose** from 1. 30 billion tonnes in 2000 **to 2. 23 billion tonnes in 2005, 2 making China by far the world’s largest coal producer** (the next largest, the United States, produced 1.13 billion tonnes last year). All but a few percent of this coal is consumed domestically, and China’s coal use amounts to nearly a third of all coal consumed worldwide (see Figure 1). Electricity generation accounts for just over half of all coal utilization in China, having risen from 22% of total consumption in 1988 to over 53% in 2002. 3 **Coal** currently accou**nts for about 80% of China’s electricity generation, more than 50% of industrial fuel utilization, and about 60% of chemical feedstocks**. Forty-i ve percent of China’s national railway capacity is devoted to the transport of coal. 4 h e central government has announced its intention to reduce the country’s reliance on coal, but **for the foreseeable future it will remain China’s dominant fuel, and will** very likely **still account for more than half of the country’s primary energy supplies in the year 2030. The largest contributor to future growth in China’s demand for coal will be the electric power sector.**

# -natural gas v. coal

**Energy prices impact**

**Miller 10 -** PhD, Associate Director, Energy Institute Senior Research Associate Energy Fuels

Bruce, Clean Coal Engineering Technology, p. Google Book

**Energy prices have a significant impact on the U.S. economy**, as evidenced by the oil embargoes and the recent rising energy—natural gas and oil—prices. Prior to the oil embargo of 1973–1974, total energy expenditures comprised 8 percent of the U.S. GDP, the share of petroleum expenditures was slightly less than 5 percent, and natural gas expenditures accounted for 1 percent [6]. The price shocks of the 1970s and early 1980s resulted in these rising dramatically to 14, 8, and 2 percent, respectively, by 1981. For the next two decades, the shares have decreased consistently to approximately preembargo levels. However, in the late 1990s, these shares began to increase again due to higher natural gas and petroleum prices. High energy prices result in increased inflation. Viewed from a long-term perspective, **inflation**, measured by the rate of change in the consumer price index (CPI), **tracks movements in the world oil price** [6]. Oil and other energy prices constitute a portion of the actual CPI but also impact other (downstream) commodity prices that will have a lagged effect on the CPI inflation. **Since the 1970s,** observable and **dramatic changes in GDP growth have occurred as the world oil price has undergone dramatic changes as well** [6]. The price shocks of 1973–1974, the late 1970s to early 1980s, and the early 1990s were all followed by recessions. **More recently** (2003 and 2008/2009), **higher energy prices contributed to a downturn in the U.S. economy. The strength and security of the U.S. economy is closely linked to the availability, reliability, and cost of electric power.** Since 1970, **real GDP in the U**nited **S**tates **and electricity generation have been clearly linked**, as illustrated in Figure 12.2 [7]. **Since economic growth is linked to reliable and affordable electric power, continued use of domestic coal resources will play a significant role in satisfying the energy needs of the U**nited **S**tates. This is likely to continue through the middle of the twenty-first century and beyond [7]. **The lowest-cost electrical generation plants are coal fired.** Figure 12.3 shows that **most states with low-cost electricity receive a large amount of their generation from coal**, with the noted exception of the three Pacific Northwest states—Washington, Oregon, and Idaho—which have ample hydroelectric resources [8]. Conversely, **the highest-cost electricity states are those that generate less than 30 percent of their electricity from coal**. Kentucky, West Virginia, and Wyoming), which have the lowest electricity costs—below 6¢/kWh—all generate more than 94 percent of their electricity from coal. The exception is Idaho, which generates all of its electricity from hydroelectric resources. **The abundance of coal helps keep prices low and stable**, both in long-term contracts and the spot market. **States that rely on coal** for most of their generation **are insulated from** wholesale **power price spikes** that have followed the volatility of the natural gas market. This is illustrated in Figure 12.4, which shows average fossil fuel receipts at electric generating plants for coal (averages of all coal prices), natural gas, and fuel oil for the period from 1990 to 2008 [9], and Figure 12.5, which shows oil, coal (PRB and Appalachian Basin), and natural gas daily spot prices for 2007 through 2009 [10]. These figures illustrate the price stability of coal and, even during periods where coal prices increased (e.g., February 2008 through May 2009), the increases were small compared to oil and gas price increases.

**Coal solves oil dependence**

**Miller 10** - PhD, Associate Director, Energy Institute Senior Research Associate Energy Fuels

Bruce, Clean Coal Engineering Technology, p. Google Book

**The solution to** achieving **energy security in the U**nited **States does not involve isolationism or switching to importing crude oil only from non–Persian Gulf countries**, even if either of these options could be realized. Taylor [20] points out that **being energy independent with respect to oil** consumption **does not insulate oneself from a global crisis**. The oil price spike of 1979 affected Great Britain, where all of the oil Great Britain consumed came from the North Sea, as much as it affected Japan, a country that imports all of its oil. The reason for this is **the market for crude oil is global, not regional. The U**nited **S**tates is increasingly dependent on foreign crude oil and **is very vulnerable to an oil supply disruption**. Presently, five major producers provide almost 40 percent of the petroleum the United States uses: Canada (2.5 million barrels per day), Saudi Arabia (1.5 million barrels per day), Mexico (1.3 million barrels per day), Venezuela (1.2 million barrels per day), and Nigeria (1.0 million barrels per day). These countries account for 68 percent of the petroleum that is imported into the United States. Therefore, **reducing the quantity of imported crude oil consumed in the U**nited **S**tates is of utmost importance **and is a crucial step to attaining energy and economic security.** While the price of crude oil may be influenced by global events, reducing the total amount of imported crude oil needs to be pursued. Approximately 71 percent of the petroleum consumed in the United States is in the transportation sector, with another 23 percent consumed in the industrial sector. **Reducing the transportation sector’s reliance on oil is** clearly a **key to improving energy security. Options** to lessen the dependency on imported crude oil **include** improving vehicle fuel efficiency and diversifying the feedstocks to produce transportation fuels, transportation fuel additives, and **liquid fuels/feedstocks to the industrial sector. Feedstock diversification can be achieved by using** biomass and **coal**. Utilizing biomass for producing biofuels and additives is important and needs to be pursued; however, **coal can provide the greatest and quickest impact in reducing dependence on imported crude oil due to the vast** coal **resources and proven technological capability to produce liquid fuels from coal. Technologies are available to convert coal to liquid products** (as discussed in previous chapters), with activities underway to further improve these processes. Gasification followed by Fischer-Tropsch synthesis is the leading processing candidate for producing the liquid fuels. The importance of coal to produce a variety of products, including transportation fuels, is evidenced by the direction of DOE’s research and development programs addressing future plants that produce power, fuels, and chemicals.

**No coal terrorism**

**Miller 10** - PhD, Associate Director, Energy Institute Senior Research Associate Energy Fuels

Bruce, Clean Coal Engineering Technology, p. Google Book

Coal’s strategic value as a fuel source is due to its role in increasing economic growth and development and in providing energy security at local, national, and international levels [46]. The use of **coal provides jobs, supports infrastructure through taxes, supports economic growth and electrification, encourages productivity through electric technologies, provides a reliable energy source, is resistant to energy shocks, and stabilizes power prices. Coal-fired power plants provide system security through infrastructure reliability, which prevents sudden disruptions because there are many diverse sources of coal, which are less vulnerable to** supply **disruption; coal-fired plants have better storage capability** near the power generation site because they are less vulnerable to transportation disruption; **coal has a more certain availability during peak demand; coal-fired power plants are less vulnerable to outages**, since they are a mature, reliable technology; **and coal-fired power plants are less vulnerable to terrorism compared to nuclear power plants, natural gas pipelines, or liquefied natural gas facilities** [46].

**Coal is key to overall energy security**

**Miller 10** - PhD, Associate Director, Energy Institute Senior Research Associate Energy Fuels

Bruce, Clean Coal Engineering Technology, p. Google Book

**Energy security in the U**nited **S**tates **cannot be overemphasized**, and its importance is clearly evident in DOE’s Coal Power Program. One of the DOE’s strategic goals is to protect national and economic security by promoting a diverse supply of reliable, affordable, and environmentally sound energy [47]. **This** goal **is accomplished by developing technologies that foster a diverse supply of affordable and environmentally sound energy, improving energy efficiency, providing for reliable delivery of energy, exploring advanced technologies** that make fundamental changes in energy options, **and guarding against** energy **emergencies. Benefits of the Coal Power Program include reducing dependence on imported oil,** which can be achieved **by coproduction of power and environmentally attractive fuels** such as FischerTropsch liquids and hydrogen. Additional benefits include **maintaining diversity of energy resource options** to avoid overreliance on natural gas for power generation, **encouraging economical use of natural gas in other sectors, and reducing energy price volatility** and supply uncertainty. **The Coal Power Program** also **retains domestic manufacturing capabilities and U.S. energy technology leadership to enhance economic growth** and security. The **U.S. energy security/sustainability depends on sufficient energy supplies to support U**nited **S**tates **and global economic growth, and coal is a major contributor to this security. Coal-fired electricity generation will** enable and **stimulate economic growth** and social welfare. Diversifying energy production, through the use coal in power generation and production of chemicals and hydrogen provides the United States with energy security. Economic growth and energy security will enable cost-effective environmental controls and continued energy affordability.

# -nat gas bad—price volatility

**Natural gas leads to price volatility**

**Miller 10** - PhD, Associate Director, Energy Institute Senior Research Associate Energy Fuels

Bruce, Clean Coal Engineering Technology, p. Google Book

Natural gas is a premium fossil fuel that is easily transported, can be used in many applications, is often the least expensive option from a capital investment viewpoint, and burns with low levels of emissions. Of the fossil fuels, natural gas releases the lowest quantity of carbon dioxide per million Btu of energy consumed. For these reasons, **natural gas has become a popular choice among the residential, commercial, industrial, and electricity generation sectors**, and it is also becoming increasingly popular in compressed natural gas vehicles. **With this popularity**, however, **have come serious supply and demand** issues. In 2008, 23.8 quadrillion Btu of natural gas was consumed in the United States [1]. Of this, approximately 34, 29, 34, and 3 percent were consumed by the industrial, electric power, residential and commercial, and transportation sectors, respectively (see Figure 12.1). **Natural gas consumption is projected to increase to almost 25 quadrillion Btu in 2035**, with electric power generation responsible for much of the increase [11]. **Electric power generation from natural gas is projected to increase** from about 900 billion kilowatthours (kWh) in 2008 **to about 1,100 billion kWh in 2035** after decreasing to about 750 billion kWh around 2012. Using natural gas instead of coal in new power plants is an attractive option since the plants have lower construction costs, shorter construction times, and reduced environmental impacts, specifically about half that of CO2 emissions (per kW produced) compared to coal (e.g., natural gas, bituminous coal, subbituminous coal, and lignite emit approximately 117, 205, 213, and 215 lb CO2 per million Btu burned, respectively). This is a concern, since **supply is** currently **not keeping pace with demand as natural gas imports are increasing, price volatility is being experienced, and shortages during periods of extreme weather are occurring.**

**Natural gas leads to price volatility**

**Peek 6-11** – Columnist @ Fiscal Times

Liz, “Obama’s riskiest jobs-killer,” http://www.nypost.com/p/news/opinion/opedcolumnists/obama\_riskiest\_jobs\_killer\_jcCc1GTNgDfeOPAx4oJlVN

The lost **capacity will be replaced** mainly **by** cheaper **natural-gas plants, but the shift will require costly improvements to transmission facilities**, expected to run more than a billion dollars in Ohio alone. **Projected electric-rate hikes alarmed** Ohio **small businesses**, which protested to the state’s Public Utility Commission.¶ Those concerns seem justified, based on the results of a recent auction conducted by regional-grid manager PJM, which annually contracts for excess capacity three years out. Thanks to the plant closings, the auction prices in northern Ohio soared to $357 per megawatt, versus $136 per megawatt in PJM’s total area.¶ These auction quotes don’t translate directly into retail prices, but they foretell the direction.¶ Nor was the November rule **the EPA**’s only assault on coal. The agency also **recently imposed carbon-dioxide emission standards that could** effectively **prohibit any new coal-plant construction. That** ruling **almost guarantees the nation will** continue to **shift** electricity production **from coal to natural ga**s.¶ **The current low price of gas is already tilting demand**. In the first quarter, only 36 percent of our electricity production came from coal, down from 45 percent last year, with gas taking up most of the slack.¶ **This determination to kill coal is short-sighted. There’s no guarantee that natural-gas prices will stay at today’s 10-year low. The shale boom has pushed them down, but soaring demand could eventually push prices higher. The appetite for natural gas** as a transportation fuel for large truck fleets or for export, for example, **is just getting rolling**.¶

# -at nat gas solves warming

**Doesn’t solve warming**

**Freudenthal 7** - \*Governor of Wyoming

House Committee on Energy Independence and Global Warming, http://globalwarming.markey.house.gov/tools/assets/files/0015.pdf

It is clear the public attitude is changing with respect to greenhouse gas management and as proof you need look no further than the ads surrounding the Sunday morning talk shows. Company advertising now talks about how green they are, not how efficient they are, or how much growth they enjoy. Other advertisements publicly shame films which make money off of projects or companies which do not meet the "green" test. And much of the public conversation is about increased consumption of natural gas in lieu of coal. But even **the current shirt to natural gas is not without carbon implications. Burning natural gas has** fewer 002 emissions per unit of electricity produced but still has **carbon emissions and if one considers the upstream footprint of exploration and production natural gas is** an answer, but **not a perfect answer.** For example, i**n my state, natural gas processing plants emitted 6.9 million metric tons of C02** equivalent in 2005. **representing** nearly **25% of our net carbon footprint**. One of the two largest plants operated by **ExxonMobil has a large well field and plant that produces natural gas**. helium and 002 for the enhanced oil recovery industry. However **much of the C02 is** currently **vented to the atmosphere.** In fact, **for every million cubic feet of natural gas produced**, nearly **two million cubic feet of C02 is produced and a majority of it is vented to the atmosphere.** My friends in California where much of the natural gas ends up don't always take this into account when they do their carbon footprint analysis.

# Railroads Advantage

# -coal k/ railroads

**Railroads will be hurt in the short term if coal use decreases – only slow transition preserves the industry**

**Great Speculations 12**

[Financial Investment Advisory site, “EPA’s New Regulations Hit King Coal Railroad Companies,” 4/20/12, http://www.forbes.com/sites/greatspeculations/2012/04/03/epas-new-regulations-hit-king-coal-railroad-companies]//SH

Last Tuesday, the U.S. Environmental Protection Agency announced its first carbon pollution standard for new power plants. [1] The EPA move will discourage new coal fired power plants from being built, which will substantially dampen domestic coal demand. This will eventually hurt railroad companies in near term as coal is predominantly shipped by rail. The news has sent ripples to stocks of coal companies as well as railroad companies, which carry about 70% of the U.S. coal. CSX Corporation, Norfolk Southern Corporation, and Union Pacific Corporation were down by 2-3% following the announcement. The railroad companies, however, are confident about their earnings outlook as coal’s importance to these companies is gradually declining. Governments around the globe are calling for stricter environmental regulations to fight against the greenhouse gas emissions responsible for global warming. The EPA has taken an initiative and announced a set of standards for new power plants to reduce greenhouse gas emissions. The EPA’s contention that the health benefits will outweigh the costs substantially echoes with many. However, the new regulation don’t affect already existing power plants. But, the EPA could be planning separate regulation for these plants. Cheap natural gas is also driving utilities away from coal as more coal fired plants shift to natural gas. We expect the drop in demand for coal to hurt railroads in the short term, which transport coal to these utilities. This, however, could prompt coal companies to boost coal exports to Asia, where demand is still growing at a healthy pace. Railroads companies can mitigate the shipment losses by riding increase in exports. But, necessary infrastructure such as a west coal terminal will need to be in place for the U.S. coal to be competitive with Australian coal. [2] For years coal has been the most transported commodity by railroads. Railroad companies have seen a decline in utility coal cargoes in recent quarters. Lower coal demand for electricity generation is the major reason. However, the trend is changing and coal is gradually becoming a smaller fraction of their overall business. In the long term, other commodities such as agricultural, industrial and consumer products will likely drive the volumes and profits of railroads in the future, especially if gas prices continue remain high.

**Coal is key to the Railroad industry but its use is decreasing**

**AAR 12**

[Association of American Railroads, “Railroads and Coal,” June 2012, http://www.aar.org/~/media/aar/Background-Papers/Railroads-and-Coal.ashx]//SH

No single commodity is more important to America’s railroads than coal. Coal accounted for 43.3 percent of rail tonnage and 24.7 percent of rail gross revenue in 2011. Most coal in the United States is consumed at coal-fueled power plants. Historically, coal has dominated U.S. electricity generation because it is such a cost-effective fuel choice, and freight rail is a big reason for that. More than 70 percent of the coal delivered to coal-fueled power plants is delivered by rail. Electricity is also generated using other fuels, including nuclear power, wind, solar power, hydroelectric power, and natural gas. Recently, the price of natural gas has fallen sharply, increasing the competitiveness of electricity generated from natural gas vis-à-vis electricity generated from coal. In addition, increasingly stringent environmental regulations have targeted coal-fueled generation. Consequently, electricity generated from coal — and associated rail coal volumes — have fallen. Whether this is a short- or a long-term phenomenon remains to be seen.

**Coal is critical to railroads**

**AAR 12**

[Association of American Railroads, “Railroads and Coal,” June 2012, http://www.aar.org/~/media/aar/Background-Papers/Railroads-and-Coal.ashx]//SH

Coal is the most important single commodity carried by U.S. freight railroads. In 2011, it accounted for 43.3 percent of tonnage, 23.5 percent of carloads, and 24.7 percent of gross revenue for U.S. Class I railroads. Coal is also an important commodity for many non-Class I railroads. Coal accounts for approximately one in five railroad jobs.

**Railroads depend on coal shipments - revenue**

**E&E Publishing 9**

[Environment & Energy Publishing (E&E) is the leading source for comprehensive, daily coverage of environmental and energy policy and markets, 9/16/9, “Big coal carriers navigate a risky climate track,” http://www.eenews.net/public/climatewire/2009/09/16/2]//SH

Freight haulers with a presence on Capitol Hill, including the powerful Association of American Railroads (AAR), are lobbying for and against major aspects of climate legislation that splits along regional and ideological lines. The nation’s dominant railroads, Norfolk Southern, Burlington Northern Santa Fe Railway (BNSF), CSX Corp. and Union Pacific, rely on coal for roughly 15 to 20 percent of their revenue. The industry has an interest in preserving coal's position as the dominant source of electricity, and sources said that means joining utilities and coal companies in their fight for free carbon emissions permits and for long lead times for emissions reductions.

**Coal key to U.S. railroads**

**AAR, 10** (“Railroads and Coal: Looking back and Looking Ahead”, Statement of the Association of American Railroads to the Congressional Caucus on Coal, Association of American Railroads, May, 25, 2010, Lexis)//JK

U.S. coal production is focused in a relatively small number of states, but coal is consumed in large amounts all over the country. This is possible because the United States has the world’s most comprehensive and efficient coal transportation system, led by railroads. According to the Energy Information Administration, 70 percent of U.S. coal shipments were delivered to their final domestic destinations by rail in 2008, followed by truck (16 percent); water (9 percent, mainly barges on inland waterways); and the aggregate of conveyor belts and tramways (5 percent) (see Chart 1). In fact, coal is the most important single commodity carried by U.S. freight railroads. In 2009, it accounted for 787 million tons (47 percent of total tonnage), 6.8 million carloads (26 percent of total carloads ) and $12.1 billion in gross revenue (25 percent of total revenue) for the seven Class I U.S. freight railroads. Coal is also a key commodity for many short line and regional railroads. The vast majority of the coal that railroads haul is delivered to coal-fired electricity generators. Railroads haul enough coal to these power plants to supply the electricity needs of every home in America. Most coal transported by rail moves in highly productive unit trains, which operate around the clock, use dedicated equipment, generally follow direct shipping routes, and have lower costs per unit shipped than non-unit trains. Most coal is shipped under contracts that are voluntarily negotiated between shippers and railroads. Huge productivity gains have increased railroads’ coal-carrying efficiency. For example, in 2009 the average coal car carried 115.0 tons, up 17 percent from the 98.2 tons in 1990. Due in part to the growing use of low-sulfur Western coal by utilities in other parts of the country, the average length of haul for rail coal movements has trended steadily upward, reaching 830 miles in 2008. Rail coal movements exceeding 1,500 miles are not uncommon. Coal usually dominates rail traffic in states that produce large amounts of coal. In Kentucky, West Virginia and Wyoming, for example, coal accounted for 88 percent, 94 percent, and 96 percent, respectively, of those states’ total originated rail tonnage in 2008. Reflecting its widespread use in electricity generation, coal also accounts for a major share of terminated rail tons for most states. For example, in 2008 coal accounted for 50 percent of rail tons terminated in Illinois, 53 percent in Kansas, and 52 percent in Arkansas (see Chart 2). Revenue per ton-mile (RPTM) is a useful surrogate for rail rates. In 2008, average rail RPTM for coal was 2.43 cents, by far the lowest such figure among major commodities carried by rail. By comparison, average RPTM in 2008 for all commodities other than coal was 5.38 cents. In inflation-adjusted terms, average coal RPTM was 50 percent lower in 2008 than in 1981. This means a typical coal shipper can ship twice as much coal for the same cost as it could nearly 30 years ago. The average decline in rail coal rates is much greater than the average price of electricity (see Chart 3 on the top of the next page). The general pattern of sharply lower coalFor the past 20 years, rail coal shipments have trended upwards. Railroads moved more coal in 2008 than ever before (see Chart 4), but coal traffic fell in 2009. For most firms and industries, the recent recession has been extremely challenging. It has meant crippled consumer demand, sharply higher unemployment, and tumbling industrial production. Few countries were immune as the recession battered economies worldwide. Not surprisingly, America’s railroads suffered along with everyone else. Overall carload traffic on U.S. freight railroads in 2009 was down 16.1 percent from 2008; intermodal traffic was down 14.1 percent. Every major commodity category of rail traffic was down in 2009, most of them sharply. The sharp decline in rail traffic should not be surprising because railroading is a classic “derived demand” industry: demand for rail service occurs as a result of demand elsewhere in the economy for the products that railroads haul. If people and businesses are not buying and building things, then railroads are not hauling them. Coal is a perfect example. Chart 5 shows average weekly carloads of coal on U.S. freight railroads for each month from January 2006 through April 2010. Rail coal traffic in 2009 was holding its own until April, when it fell sharply. It stayed lower for the rest of 2009 and into 2010. In fact, year-over-year coal carloads were down every month from January 2009 through March 2010 — only in April 2010 did yearover- year coal carloads finally grow (see Chart 6 on the next page). Why the decline in coal traffic in 2009 and into 2010? Mainly because coal-fired power plants simply stopped needing as much coal. Chart 7 shows monthly coal stockpiles at power plants from 2003 through February 2010 (the most recent data available at this writing). Note the huge run-up in stockpiles in 2009. Stockpiles exceeded 200 million tons in October and November 2009 — higher than ever before. What’s behind the increase in stockpiles? At least two major reasons. First, U.S. electricity generation actually fell in 2009 from 2008, something that happens very rarely. Reduced demand for electricity, in turn, is a function of the poor economy (a factory that’s shut down doesn’t use much electricity) and a cooler-than-usual summer in areas that rely heavily on coal-generated electricity. Improved fuel efficiency played a role as well. A second key factor behind the increase in coal stockpiles in 2009 is the price of natural gas. Chart 8 shows the annual average delivered price of coal, petroleum, and natural gas to the U.S. electric power industry in recent years. Note the sharp drop in 2009 in the price of natural gas. The relative competitiveness of electricity generated from natural gas has risen at coal’s expense. Chart 9 shows the share of U.S. electricity generation from coal by month over the past few years. Not only is the overall electricity “pie” smaller, the coal “slice” is smaller too. In 2009, the coal share of U.S. electricity generation was 45 percent, the lowest coal share for any year since the 1970s. Over the years, the affordability of coal-based electricity has been a major factor behind America’s economic growth and global competitiveness. Nevertheless, coal’s future is threatened by serious environmental challenges, especially coal’s carbon emissions. Railroads respectfully urge Congress to carefully consider the ramifications of legislation designed to address carbon emissions from coal and other sources. One way to overcome the challenges related to carbon emissions is through the development of advanced carbon capture and storage capabilities. With these technologies, America would continue to produce affordable electricity from its abundant domestic coal, energy independence would be promoted, and the environment would be protected. It thus represents a win-win-win situation for all parties involved. Some proposals that address carbon emissions would risk drastic cuts in coal use. Coal accounts for approximately one in five railroad jobs and one in four railroad revenue dollars. Without coal, the U.S. freight rail network would face a need for vast restructuring and downsizing, with greatly reduced capacity and capability to meet our nation’s transportation needs. Consequently, railroads urge the adoption of an “insurance policy” to guard against excessively negative effects to railroads brought about by legislative actions designed to address climate change. Specifically, contingent allowances should be made available to railroads whose revenues from coal decrease as a result of the enactment of climate change legislation. If coal markets remain robust, no contingent allowances would be needed. However, if coal use falls, it could result in billions of dollars in rail assets being left without any value or greatly reduced value. The loss of use of these assets and all or part of the revenue derived from coal transportation would significantly impede railroads’ ability to meet the transportation needs of intermodal and other non-coal shippers throughout the country. If railroads cannot afford to renew and expand their capacity, more traffic will move by less efficient, less environmentally friendly, and already overcrowded highways.

# -railroad impacts

**Railroads key to military readiness and deployment**

**Pike 12**

[John, one of the world's leading experts on defense, space and intelligence policy, directed the Space Policy, Cyberstrategy, Military Analysis, Nuclear Resource and Intelligence Resource projects, He is a member of the Council on Foreign Relations " Strategic Rail Corridor Network (STRACNET)," 10/1/12, http://www.globalsecurity.org/military/facility/stracnet.htm]

The military places heavy and direct reliance on railroads to integrate bases and connect installations to predominantly maritime ports of embarkation. Mainlines, connectors, and clearance lines must all combine to support movement of heavy and/or oversized equipment. To ensure that military needs are factored into railroad industry decisions that may impact on national defense, the Department of Defense relies on the Military Traffic Management Command (MTMC). In this capacity, **MTMC identifies facilities of the** railroad infrastructure important to national defense, informs the commercial and civil sectors of Defense needs, and encourages the retention and upkeep of railroad assets vital to support military movements. To ensure this continuity and coordination, MTMC has created the Strategic Rail Corridor Network (STRACNET). STRACNET has identified 32,500 miles of rail line critical for movement of essential military equipment to ports located around the country as well as another 5,000 miles of track essential to connect one facility to another. To ensure this continuity and coordination, MTMC has created the Strategic Rail Corridor Network (STRACNET). STRACNET has identified 32,500 miles of rail line critical for movement of essential military equipment to ports located around the country as well as another 5,000 miles of track essential to connect one facility to another. In addition to identifying key lines and facilities, MTMC also conducts analysis of potential railroad industry construction, mergers, bankruptcies, and abandonments to determine how any of these actions may affect DOD mobility capabilities. Since 1976, MTMC has reviewed more than 2,100 abandonments affecting 33,000 miles of track, as well as eight bankruptcies affecting more 1/3 of the nation's railroad network. MTMC analysis and reviews are the main source of DOD input to the railroad industry in attempts to preclude the loss of a critical section of track or facility that is essential to effective movement of heavy military lift requirements. The Railroads for National Defense Program (RND) ensures the readiness capability of the national railroad network to support defense deployment and peacetime needs. The Program works to integrate defense rail needs into civil sector planning affecting the Nation's railroad system. Rail transportation is extremely important to DOD since the predominance of our heavy and tracked vehicles will deploy by rail to seaports of embarkation. The RND Program in conjunction with the US Federal Railroad Administration (FRA), established the Strategic Rail Corridor Network (STRACNET) to ensure DOD's minimum rail needs are identified and coordinated with appropriate transportation authorities. STRACNET is an interconnected and continuous rail line network consisting of over 38,000 miles of track serving over 170 defense installations.

**Readiness solves conflict**

**CNAS 8**

[Center for a New American Security, “Strengthening the Readiness of the U.S. Military”, 2/14/8 Prepared Statement of Michèle A. Flournoy, http://www.cnas.org/files/documents/publications/CNASTestimony\_FlournoyHASCFeb1408.pdf]

At the same time, the United States must prepare for a broad range of future contingencies, from sustained, small-unit irregular warfare missions to military-to-military training and advising missions to high-end warfare against regional powers armed with weapons of mass destruction and other asymmetric means. Yet compressed training times between deployments mean that many of our enlisted personnel and officers have the time to train only for the missions immediately before them—in Iraq and Afghanistan—and not for the missions over the horizon. These just-in-time training conditions have created a degree of strategic risk, which the Chairman of the Joint Chiefs of Staff noted in his recent posture statement. As we at the Center for a New American Security wrote in our June, 2007 report on the ground forces, the United States is a global power with global interests, and we need our armed forces to be ready to respond whenever and wherever our strategic interests might be threatened. The absence of an adequate strategic reserve of ready ground forces must be addressed on an urgent basis. Readiness is the winning combination of personnel, equipment, and training in adequate quantity and quality for each unit. Each of these components of readiness has been under sustained and increasing stress over the past several years. For the ground forces, the readiness picture is largely—although not solely—centered on personnel while the Navy and the Air Force’s readiness challenges derive primarily from aging equipment. The Army continues to experience the greatest strain and the greatest recruitment challenges.

**Railroads key to economy**

**NA, 11** – United States National Atlas, (“Overview of U.S. Freight Railroads”, National Atlas of the United States, 1/26/2011, http://www.nationalatlas.gov/articles/transportation/a\_freightrr.html)//JK

Freight railroads are critical to the economic well-being and global competitiveness of the United States. They move 42 percent of our nation's freight (measured in ton-miles) - everything from lumber to vegetables, coal to orange juice, grain to automobiles, and chemicals to scrap iron - and connect businesses with each other across the country and with markets overseas. They also contribute billions of dollars each year to the economy through investments, wages, purchases, and taxes. There were 554 common carrier freight railroads operating in the United States in 2002, classified into five groups. Class I railroads are those with operating revenue of at least $272 million in 2002. Class I carriers comprise only 1 percent of the number of U.S. freight railroads, but they account for 70 percent of the industry's mileage operated, 89 percent of its employees, and 92 percent of its freight revenue. Class I carriers typically operate in many different states and concentrate largely (though not exclusively) on long-haul, high-density intercity traffic lanes. There are seven Class I railroads <note 1 see below> ranging in size from just over 3,000 to more than 33,000 miles operated and from 2,600 to more than 46,000 employees. Regional railroads are linehaul railroads with at least 350 route miles and/or revenue of between $40 million and the Class I threshold. There were 31 regional railroads in 2002. Regional railroads typically operate 400 to 650 miles of road serving a region located in two to four states. Most regional railroads employ between 75 and 500 workers, although four have more than 600 employees. Local linehaul carriers operate less than 350 miles and earn less than $40 million per year. In 2002, there were 309 local linehaul carriers. They generally perform point-to-point service over short distances. Most operate less than 50 miles of road (more than 20 percent operate 15 or fewer miles) and serve a single state. Switching and terminal (S&T) carriers are railroads, regardless of revenue, that primarily provide switching and/or terminal services. Rather than point-to-point transportation, they perform pick up and delivery services within a specified area for one or more connecting linehaul carriers, often in exchange for a flat per-car fee. In some cases, S&T carriers funnel traffic between linehaul railroads. In 2002, there were 205 S&T carriers. The largest S&T carriers handle hundreds of thousands of carloads per year and earn tens of millions of dollars in revenue. In addition, the two major Canadian freight railroads Canadian National Railway and Canadian Pacific Railway - each have extensive U.S. operations. U.S. freight railroads employ approximately 177,000 people, the vast majority of whom are unionized. With average total compensation in 2002 of more than $80,000, freight railroad employees are among the nation's most-highly compensated workers. By any measure of capital intensity, freight railroads are at or near the top among all major U.S. industries. From 1980 through 2003, Class I railroads spent more than $320 billion approximately 44 percent of their operating revenue - on capital expenditures and maintenance expenses related to infrastructure and equipment. Non-Class I carriers spent billions of dollars more. These massive expenditures help ensure that railroads have the capability to offer high quality, safe, and cost-effective service to meet the freight transportation needs of our nation. Measured in ton-miles (the movement of one ton of freight one mile), railroads move 42 percent of intercity freight, more than any other mode of transportation. The rail share of intercity ton-miles has been trending slightly upward over the past 10 to 15 years, after falling steadily for decades. In part because railroads' rates are so low compared to their competitors, their 42 percent of ton-mile traffic generates less than 10 percent of intercity freight revenues. Railroads' share of intercity freight revenue has been trending down for decades, a reflection of the intensity of the competition for intercity freight transportation in the United States and of the significant rate reductions railroads have passed through to their customers. Coal is the most important single commodity carried by rail. In 2002, it accounted for 44 percent of tonnage and 21 percent of revenue for Class I railroads. The vast majority of coal in the United States is used to generate electricity at coal-fired power plants. Coal accounts for half of all U.S. electricity generation, far more than any other fuel source, and railroads handle approximately two-thirds of all U.S. coal shipments. Other major commodities carried by rail include chemicals, including massive amounts of industrial chemicals, plastic resins, and fertilizers; grain and other agricultural products; non- metallic minerals such as phosphate rock, sand, and crushed stone and gravel; food and food products; steel and other primary metal products; forest products, including lumber, paper, and pulp; motor vehicles and motor vehicle parts; and waste and scrap materials, including scrap iron and scrap paper. Over the past ten years, intermodal traffic - the movement of truck trailers or containers by rail and at least one other mode of transportation, usually trucks has been the fastest growing rail traffic segment. Intermodal combines the door-to- door convenience of trucks with the long-haul economy of railroads. Rail intermodal traffic has more than tripled in just over 20 years, rising from 3.1 million trailers and containers in 1980 to nearly 10 million units in 2003. Intermodal today accounts for about 22 percent of rail revenue. In 2003, for the first time ever, intermodal surpassed coal in terms of revenue for U.S. Class I railroads. Rail intermodal transports a huge range of goods - everything from bicycles to automotive parts, lawn mowers to glassware, greeting cards to bottled water, and toys to computers. As manufacturing has become more global and as supply chains have become longer and more complex, intermodal has come to play a critical role in making supply chains far more efficient for retailers and others. The efficiency of intermodal - and of freight railroading in general - provides our nation with a huge competitive advantage in the global economy.

# Topicality

# -at intent to define

**Intent to define is a poor standard – each definition is subjective, arbitrary, and fluid – prefer contextual evidence**

**Scholte 5** – Professor of Politics and International Studies

Jan, “Mastering Globalization: New Sub-States' Governance and Strategies (Routledge Series in Federal Studies),” p. 15

Second, **every definition** is relative. Each understanding of a key concept reflects a historical moment, a cultural selling, a geographical location, a social status, an individual personality, and - as already noted - a political commitment. Indeed, if the details if not in the general framework, **every account** of an idea is unique. Each person develops a conception that corresponds to her/his experiences and aspirations, No universally endorsable definition is available. To ask everyone to conform to a single view would he to ask many people to abandon themselves. The object of definition is not to discover one understanding that secures universal acceptance, but to generate insight that can he effectively communicated to and debated with others Third, no definition is definitive. Definitions of core concepts arc necessary to lend clarity, focus, and internal consistency to arguments. However, knowledge is a **constant process** of invention and reinvention. Every definition is tentative and subject to reappraisal. Definition is in motion **rather** than fixed. The point of the exercise is nor to end in a full stop, but to stimulate discussion that prompts further redefinition as situations change and (one hopes) wisdom deepens.

# -vehicles unlimit

**Unfathomable number of vehicles**

**Industrial Vehicles 12** (“Transportation Vehicles” 2012, http://www.industrialvehicles.ca/Transport.asp)//MR

When it comes to transportation and industrial vehicles, those that ship human beings from one place to another are often the first to come to mind. There are so many different types of industrial transport vehicles used to get people around, it is **difficult to fathom**. Like other types of industrial transport, these vehicles ply the waters, run on the roads, and fly through the skies and can be found in just about every corner of the planet (and yes, that does include both poles; arctic and Antarctic transportation are heavily reliant on industrial vehicles!) These are the vehicles you will most easily have an opportunity to experience, whether as a passanger or maybe to move to a house for sale in Mississauga, Ontario.

**311 potential vehicles—their interpretation explodes the topic**

**Walton 2** (“Types of Vehicles” Rick Walton's Stuff for Teachers and Librarians, October 25 2002, http://www.rickwalton.com/curricul/lvehicle.htm)//MR

18 wheeler aircraft carrier airplane¶ airship all terrain vehicle ambulance¶ ark armored car asphalt spreader¶ ATV autogiro automobile¶ baby carriage balloon barge¶ bathysphere battleship beach buggy¶ bicycle big rig biplane¶ blimp boat bobsled¶ bomber boxcar brougham¶ buckboard buggy bulldozer¶ bullet train bus cab¶ cabin cruiser cable car caboose¶ camel camper canal boat¶ canoe car caravan¶ cargo ship carriage cart¶ catamaran caterpillar tractor cement mixer¶ cement truck chair lift chariot¶ chopper circus wagon coach and four¶ coal car on train cog railroad combine¶ compact Concord Conestoga wagon¶ convertible coupe covered wagon¶ crane crop duster cruise ship¶ cycle delivery truck destroyer¶ diesel locomotive dinghy dining car on train¶ dirigible dirt bike dive bomber¶ dog cart dogsled donkey cart¶ dragster dray dugout¶ dump truck dune buggy earth mover¶ eighteen-wheeler electric train elephant¶ elevated railroad elevator escalator¶ express train ferry fighter¶ fire engine fireboat fishing boat¶ flatbed truck flatboat flatcar¶ flying boat foot scooter forklift¶ four-door sedan freight car freight train¶ freighter frigate front-end loader¶ funicular railroad galleon garbage truck¶ glider go-cart golf cart¶ gondola gyrocopter hand truck¶ handcar handcart hang glider¶ hansom cab harvester hatchback¶ hay wagon hearse helibus¶ helicopter hook and ladder horse and carriage¶ horse van horse-drawn cart horseback¶ hot air balloon hot rod houseboat¶ hover car hovercraft howdah¶ hydrofoil hydroplane ice boat¶ ice skates iceboat icebreaker¶ inline skates jeep jet pack¶ jet-propelled individual "jumpers" jetliner jumbo jet¶ kart kayak kite¶ land rover landau lawnmower¶ Lear jet lemon life raft¶ lifeboat limo limousine¶ litter livestock van llama¶ locomotive longboat man-of-war¶ microbus midget racer minesweeper¶ minibus minivan mobile home¶ monoplane monorail moped¶ motor home motor scooter motorboat¶ motorcycle mountain bike moving platform¶ moving van mule-drawn carat multipurpose vehicle¶ ocean liner off-road vehicle oil tanker¶ omnibus outrigger oxcart¶ pack-horse paddle wheeler pallet truck¶ panel truck parachutes passenger train¶ patrol car patrol wagon pedicab¶ pedicar pickup truck plow¶ police car pony express powerboat¶ prairie schooner push cart race car¶ racing sloop raft railroad coach¶ railroad Pullman rapid transit recreational vehicle¶ riverboat roadster rocket sled¶ rockets rocketship roller skates¶ rowboat sailboat sailplane¶ schooner scooter sea sled¶ seaplane seaplanes sedan chair¶ semitrailer ship shopping cart¶ side-wheeler skateboard skates¶ skiff skis sled¶ sledge sleeping car on train sleigh¶ slide snowmobile snowplow¶ snowshoes space shuttle space vehicles¶ spaceship speedboat sports car¶ spy plane squad car stagecoach¶ station wagon steam locomotive steam shovel¶ steam train steamboat steamroller¶ steamship stock car streetcar¶ stretcher stroller submarine¶ submersible subway supertanker¶ surfboard surrey swamp buggy¶ tank tanker taxi¶ taxicab ten-speed thresher¶ toboggan tow plane tow truck¶ town car tractor trailer trail bike¶ trailer train tram¶ trawler tricycle trolley car¶ truck tugboat turboprop¶ two-door sedan U-boat ultralight¶ unicycle van velocipede¶ wagon train walking water skis¶ water-ski sails wheelbarrow wheelchair¶ windjammer wrecker yacht¶ zamboni zeppelin

# -pipelines don’t unlimit

**Only 5 commodities transported by pipeline under STB**

**GAO 98** (“SURFACE¶ TRANSPORTATION¶ Issues Associated With¶ Pipeline Regulation by the¶ Surface Transportation¶ Board” Testimony¶ Before the Subcommittee on Surface Transportation and¶ Merchant Marine, Committee on Commerce, Science, and¶ Transportation, U.S. Senate, March 31 1998, <http://www.gao.gov/archive/1998/rc00127t.pdf)//MR>

**STB has jurisdiction over pipelines that provide interstate transportation of¶ commodities** other than oil, gas, or water. **We identified** 21 pipelines¶ carrying **five commodities—anhydrous ammonia, carbon dioxide, coal¶ slurry, phosphate slurry, and hydrogen—that are subject to STB’s¶ regulation**. STB’s regulation of these pipelines includes ensuring that¶ pipelines fulfill their common carrier obligations, including determining if¶ the rates charged for these services are reasonable and nondiscriminatory.¶ The ICC Termination Act limited STB’s role in regulating pipeline rates by¶ specifying that STB can begin a pipeline rate investigation only in response¶ to a complaint by a shipper or other interested party. The act also¶ eliminated the sole reporting requirement for pipeline carriers—tariff¶ filing. According to STB, over the past 10 years only five cases involving¶ pipelines have come before STB or ICC; one is ongoing. Because of the¶ limited caseload, STB issued only six decisions on pipeline cases in fiscal¶ year 1997 and devoted the equivalent of about one full-time staff member¶ to pipeline issues.2