

Olivine - time for action!

The "olivine option" is admirably set out by Olaf Schuiling, who has devoted much of his professional life to this excellent cause. To summarise, it is the weathering of olivine which mainly is responsible, in nature, for the long term withdrawal of carbon dioxide from the atmosphere. The aqueous reaction of carbon dioxide and olivine chemically sequesters carbon dioxide as bicarbonate. Over the long term the carbon dioxide is fated to settle at the bottom of the oceans as carbonate rock.

So, by artificially accelerating the rock-weathering process, carbon dioxide can be safely and for our purposes permanently removed from atmosphere. This can be done at low cost, of the order of \$10 per tonne, by the simple expedient of mining and grinding olivine-bearing rock, and spreading it to land and coast, where a combination of chemical weathering, physical abrasion and biological activity can weather away grains of around 0.1mm in size within a ten year period.

We also know that the process is intrinsically safe: nature is doing this all the time anyway with no ill effects. Indeed its acceleration is likely to prove beneficial quite aside from the CO₂ sequestration: combatting acidification on land and in sea and providing valuable nutrients. The chemical products of olivine weathering are the benign, acid buffering ions of magnesium and bicarbonate; iron (in varying quantities), an frequently limiting nutrient for marine phytoplankton; and the very weak acid, silicic acid, an essential nutrient for diatoms: widespread phytoplankton in both freshwater and marine environments. Any additional silicic acid has the effect of prolonging diatom blooms, providing additional fish food and increasing the drawdown of carbon to the ocean depths.

But there is a mystery: why has this tremendous opportunity to safely and cheaply sequester carbon dioxide received virtually no attention? Papers have been published in scientific journals and in the popular press, including detailed plans and costings. The cost is roughly a tenth that of the far better-known and assiduously promoted "carbon capture and storage" approach, which is to chemically extract CO₂ from power station flue gases and inject it into underground reservoirs. CCS would be expensive in fuel, adding 25-40% to the fuel burn for a given power output. It would also be costly - the World Coal Association reckons that costs begin around \$80-120 per tonne of CO₂, and will decline to half that level with increased

investment [<http://www.worldcoal.org/coal-the-environment/carbon-capture-storage/financing-ccs/>].

As for nuclear power, it is astonishingly difficult to discover its true cost. The best estimate we have comes from the negotiations now in progress between the UK Government and the French parastatal corporation EDF over the construction of a twin-reactor station at Hinckley Point, Somerset. The fact that EDF is demanding a guaranteed electricity price approaching £100/MWh for 40 years is now widely known, and this is our best indicator of nuclear power's real cost. CO₂ emissions from modern gas burning power stations run at about 330-360kg/MWh (say 345), and the electricity sells wholesale for about £50/MWh. This compares to life cycle emissions for nuclear power of 90-140kg/MWh (say 115 [<http://timeforchange.org/co2-emission-nuclear-power-stations-electricity>]), so a difference of 230kg/MWh.

Using nuclear power to save that 230kg per MWh relative to CCGT gas-fired plant therefore costs £50, implying a carbon price of £217 per tonne. Note that this is to disregard other public subsidies to nuclear power like construction cost guarantees, insurance limitation, decommissioning cost guarantees and waste management cost guarantees. The direct price subsidy alone makes nuclear power a very expensive a way to cut CO₂ emissions - around twice as costly as CCS.

So here is the mystery. Why are governments (around 25 worldwide in all are currently intent on building new nuclear power stations) so keen to put serious money into very expensive ways of sequestering CO₂, or avoiding its emission? While they completely ignore this effective, low cost, low risk alternative? The main reason is surely the very large vested interests that have been created over the years by government largesse with public funds. And here's how it works: the greater the public funds that an industry has captured, the harder it fights to retain the flow of funds - and the more money it has to fight with. Hence the nuclear industry is top dog in this game.

The CCS lobby is also powerfully supported. Its not just chemical engineers who like it, but the entire fossil fuel industry, and the coal industry in particular. They see in CCS just the right "magic bullet" - it won't just allow them to carry on producing coal and gas for the power sector, but will actually increase the amount of fuel CCS power stations burn by around a third. Never mind that as yet the only industrial scale CCS is not about

reducing emissions, but squeezing more gas and oil from depleting wells - the point is to establish the principle that coal can be climate friendly. And to allow coal power stations to carry the "CCS-ready" moniker - a feint at environmental responsibility that carries no obligation ever to follow through.

Now you might think the same would apply to the olivine option. Though not my intention, the large-scale sequestration of CO₂ using olivine spread land and coast would surely allow the fossil fuel industry (and fossil fuel users) to stay in business while sequestering their CO₂ emissions at modest cost - tilting the market only slightly in favour of low-carbon energy producers. It would also create an enormous opportunity for mining companies, as the olivine mining industry leapt from nowhere to become the world's single biggest mining activity.

Shippers, truckers, farmers, machinery manufacturers, the steel industry and many other industries besides would all stand to profit.

The scale of the enterprise is readily calculated. The world currently emits some 32Gt of CO₂ per year. So to sequester the whole lot at \$10 per tonne implies an expenditure of of \$320 billion per annum. This is a colossal sum, but nonetheless an affordable one, representing 0.4% of estimated gross world product of around \$75 trillion for 2013. The pie is certainly big enough for the industries that would benefit to get very excited about - and to be well worth their while to campaign for.

Yet there is no organised, effective, well-funded lobby arguing for the olivine option. And sadly that means, from the point of view of governments and politicians, that it might as well not exist.

So why might that be? In my view it is because the olivine option has its origins in academia and civil society. It has never received industry support, and no commercial lobby "owns" it. Many industries stand to benefit, both directly and indirectly. But there again, that is the problem - no single industry has a paramount interest in promoting it. There is no equivalent of the coal industry for CCS, or the nuclear industry for more atomic power stations.

But there must be a way forward. The answer surely lies in building an effective global organisation for the promotion of the olivine option. It needs to include environmental and other campaigning bodies to represent social and environmental interests. It must include scientists: geologists, climatologists, biologists, agronomists and foresters. But most important, it must attract industrial supporters who will see the

investment of some millions of dollars as a very good long term investment, which could see the establishment of a new global industry worth hundreds of billions - and one in which they would take a major share.

The basis of such an organisation already exists: the Netherlands-based Olivine Foundation, which operates the website www.smartstones.nl. It's doing a fine job given its resources. But in the absence of serious commercial or industrial support it will inevitably struggle to influence national and global climate policy. Now is the time for progressive companies to step up to the line, and help to establish a transformational new industry - one that could just save the world.

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