

From: [REDACTED] <[REDACTED]@thetablet.co.uk>
Sent: 09 December 2014 15:51
To: Paul Younger
Subject: Re: Your article for The Tablet

Thanks so much for getting back to me so promptly. My heart sank when I got your out of office reply, as I was afraid you might be out of mobile contact.

In response to your query, the headline is "Carbon: problem ... and solution". I hope that's all right.

I'll pass your comments by [REDACTED] [REDACTED] but I can't see that there will be any major problems. And thanks for spotting the double "is" - there will be a proofreading stage to clear out any infelicities.

Best regards

[REDACTED]

On 9 December 2014 at 15:43, Paul Younger <Paul.Younger@glasgow.ac.uk> wrote:

Dear [REDACTED]

Greetings from the East African Rift Valley, where I am on day four of a five-day visit promoting development of renewable energy.

Thank you very much for letting me see this – and even more so for accepting it for publication. I spotted only a few very minor things:

1. What is the title to be? As I submitted, or something else? I note the standfirst text, which is fine – but surely this comes below a title?
2. "... simply reverts to water vapour used in a fuel cell ...": as edited, this gives a technically incorrect impression – you need to restore the word "when" between "vapour" and "used", as the point is that when hydrogen is used in a fuel cell it simply reverts to water vapour. You can't have "water vapour used in a fuel cell" – water vapour is the exhaust gas from a fuel cell. So please change this phrase to read: "... simply reverts to water vapour when used in a fuel cell ..."
3. "... Is the Glasgow City Council ..." – I don't think the definite article is needed before 'Glasgow City Council'

4. “ ... His latest book is *Energy: All That Matters* is published by Hodder & Stoughton at £8.99. ...”; you need to delete either the first or second use of “is” – personally, I would replace the second occurrence with a comma, and I would also put the title of the book in italics.

Would it be possible for you to send me a pdf of the final printed pages for my private collection of my publications?

Thanks again and God bless

Best wishes

Paul Younger

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From: [REDACTED] [mailto:[REDACTED]@thetablet.co.uk]
Sent: 09 December 2014 15:28
To: Paul Younger
Subject: Your article for The Tablet

Dear Professor Younger

Here is the text of your article - if you have any changes, would you be so kind as to let me know what they are? At this stage we would rather the article not get longer - if you wish to add material, I would be grateful if you could indicate what you would like to cut.

I'm afraid our deadline is looming - could you let me know today please?

Thanks so much for your help.

Best regards

[REDACTED]

[STANDFIRST]Although the latest UN Climate Change Conference in Lima this week has been working towards an agreement to reduce greenhouse gas emissions, a church-supported campaign that urges industry to reject fossil fuels is unrealistic, according to a leading energy engineer / By PAUL YOUNGER

Few scientists dispute the case for doing so. Hence it is not surprising that the voices of secular campaigners are increasingly being joined by prominent faith leaders in calling for a fundamental reorientation of our society. No less a moral authority than Archbishop Desmond Tutu recently proposed a freeze on fossil-fuel exploration, rejection of income from fossil fuels and divestment from the industry.

Subsequently Chris Bain, the director of the Catholic aid agency, Cafod, outlined the organisation's "One Climate, One World" campaign, which is prompted by the very real prospect that runaway climate change will disproportionately harm the world's most vulnerable people, through increasingly extreme weather events and stark oscillations between drought and flood.

Now Pope Francis is reported to be preparing an encyclical on climate change for promulgation in 2015. Christianity has clearly recognised the potential gravity of unabated global warming, and is rightly making common cause with people of goodwill seeking to avert calamity.

Yet as near unanimous as the climate scientists might be on the need for change, the engineers who must deliver it are flummoxed by the nature and scale of the challenges that decarbonisation presents. The strident calls for an immediate withdrawal of all support from the fossil-fuel sector presuppose that alternatives for the many uses of coal, oil and gas are already available at sufficient scale. Sadly, and alarmingly, this simply is not so.

We do not currently have large-scale alternatives to fossil fuels in the key industries of the production of electricity and heat on demand (as opposed to just when the sun shines or the wind blows); of transport fuel production, especially for international shipping and aviation; of fertilisers on which the large-scale agricultural production to support the burgeoning human population of our planet utterly relies; of the production of steel, which (as an alloy of iron and carbon) inherently requires incorporation of carbon that be supplied from renewable sources (for reasons of elemental purity and of the high temperatures needed for the key chemical reactions); of the production of plastics and most similar synthetic substances, which are the mainstay of the most cherished modern consumer goods, as well as the carbon fibre that has the optimal blend of strength and lightness to make large wind turbines feasible.

It would be wonderful if we could replace all of these uses of fossil carbon with sustainable biological alternatives. Yet it is already clear that insufficient sources of exploitable biomass exist to support this. It is possible to conceive of vastly expanding human exploitation of the oceans to produce further biomass by the farming of marine algae. Like all human grand schemes for re-purposing natural ecosystems, though, such proposals are beset with thorny environmental drawbacks: we cannot have something for nothing, as the second and third laws of thermodynamics make clear.

The same inexorable laws mean that "energy storage" – the only real alternative to fossil-fuel back-up for counteracting the intermittency of renewable power production – is in reality a net-consumer of energy. Such has always been the case, for instance, at the only large-scale grid-connected sources of storage yet available: pumped hydropower storage plants, such as Dinorwic in Wales and Cruachan in Scotland. It is also true of emerging storage alternatives, such as compressed or frozen air storage, and even more so of battery storage.

Indeed, batteries are a particularly extravagant option, not just for the amounts of energy they waste, but for the vast increase in exploitation of minerals that a massive expansion in their use would require. They are also extremely expensive in use, never coming close to making economic sense except where there is absolutely no chance of obtaining a power grid connection.

Capture and storage of carbon emissions is now a reality, following the recent commissioning of the Boundary Dam power plant in Saskatchewan, the world's first commercial-scale power station equipped with carbon capture and storage technology. This technology – delivered without subsidy by the very fossil-fuel sector we are now queuing up to condemn – offers the only realistic option to actively remove CO₂ from the atmosphere, if we couple it to biomass power production. It would be folly to abandon this promising technology just as it becomes available.

Another superficially attractive option is to use otherwise unwanted renewable power (for example when wind turbines operate in the middle of the night) to produce hydrogen from water by electrolysis. This is entirely feasible, and produces a truly green fuel that simply reverts to water vapour used in a fuel cell to produce electricity. It is thus a perfect, carbon-free transport fuel – if only we could find ways of storing the lowest-density substance in the universe in sufficient quantities to make trans-oceanic journeys feasible. So far, this challenge has defeated some of the best minds in the business.

It would be easy to multiply examples of the lack of large-scale alternatives to fossil fuels. This lack is the principal reason why a simple, strident opposition to all fossil-fuel use is unrealistic. The interface with poverty is also knotty. Try telling the 750 million Chinese people who escaped poverty in the last 15 years on the back of fossil-fuel use – probably the greatest poverty alleviation episode in history – that fossil-fuel use is an unmitigated evil.




Or, much closer to home, telling the same to Glasgow's poorest families, living in the city's high-rises, whose only realistic hope of escaping fuel poverty any time soon is the replacement of their extremely costly electrical heating (two-thirds of it low-carbon incidentally, thanks equally to Scotland's nuclear and renewable generation plant) with district heating supplied by natural gas (fossil, of course). Is the Glasgow City Council evil for using the lowest-carbon form of fossil fuel – hydrogen-rich natural gas – as a frontline defence against the poverty of its citizens?

When it comes to formulating a robust Christian response to climate change, it is surely crucial that we combine a tender heart with a hard head; or, as Jesus put it, to be “wise as serpents but innocent as doves” (Matt 10:16).

Goodwill alone will not deliver justice to the poor. Step number one to an ethical, sustainable future is to examine our own consciences, and commit now to reducing drastically our own wanton consumption of those commodities for which no viable alternative to fossil fuels yet exists. Step two is to use our power as consumers and citizens to press industry and government for a massive expansion of research into alternatives, so that we may soon arrive at the point so many well-meaning campaigners already imagine we have reached – that there exists a simple ethical investment choice as easy to make as that on apartheid or tobacco.

Paul Younger, FEng, holds the Rankine Chair at the University of Glasgow, where he is Professor of Energy Engineering. He is also a non-executive director of two companies in the energy sector: one developing renewables in East Africa, the other developing a novel subsea technology for carbon-neutral use of deep coal deposits. His latest book is *Energy: All That Matters* published by Hodder & Stoughton at £8.99.

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