To constrain climate change, such unconventional oil use needs to be stopped, according to scientists

January 23, 2013 | By David Biello

James Hansen has been publicly speaking about climate change since 1988. The NASA climatologist testified to Congress that year and he's been testifying ever since to crowds large and small, most recently to a small gathering of religious leaders outside the White House last week. The grandfatherly scientist has the long face of a man used to seeing bad news in the numbers and speaks with the thick, even cadence of the northern Midwest, where he grew up, a trait that also helps ensure that his sometimes convoluted science gets across.

© *David Biello*

This cautious man has also been arrested multiple times.

His acts of civil disobedience started in 2009, and he was first arrested in 2011 for protesting the development of Canada's tar sands and, especially, the Keystone XL pipeline proposal that would serve to open the spigot for such oil even wider. "To avoid passing tipping points, such as initiation of the collapse of the West Antarctic Ice Sheet,

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we need to limit the climate forcing severely. It's still possible to do that, if we phase down carbon emissions rapidly, but that means moving expeditiously to clean energies of the future," he explains. "Moving to tar sands, one of the dirtiest, most carbon-intensive fuels on the planet, is a step in exactly the opposite direction, indicating either that governments don't understand the situation or that they just don't give a damn."


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He adds: "People who care should draw the line."

Hansen is not alone in caring. In addition to a groundswell of opposition to the 2,700-kilometer-long Keystone pipeline, 17 of his fellow climate scientists joined him in signing a letter urging Pres. Barack Obama to reject the project last week. Simply put, building the pipeline—and enabling more tar sands production—runs "counter to both national and planetary interests," the researchers wrote. "The year of review that you asked for on the project made it clear exactly how pressing the climate issue really is." Obama seemed to agree in his second inaugural address this week, noting "we will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations."

At the same time, the U.S. imports nearly nine million barrels of oil per day and burns nearly a billion metric tons of coal annually. China's coal burning is even larger and continues to grow by leaps and bounds. Partially as a result, global emissions of greenhouse gases continue to grow by leaps and bounds too—and China is one alternative customer eager for the oil from Canada's tar sands. Neither developed nor developing nations will break the fossil-fuel addiction overnight, and there are still more than a billion people who would benefit from more fossil-fuel burning to help lift them out of energy poverty. The question lurking behind the fight in North America over Keystone, the tar sands and climate change generally is: How much of the planet's remaining fossil fuels can we burn?

The trillion-tonne question

To begin to estimate how much fossil fuels can be burned, one has to begin with a guess about how sensitive the global climate really is to additional carbon dioxide. If you think the climate is vulnerable to even small changes in concentrations of greenhouse gases—as Hansen and others do—then we have already gone too far. Global concentrations of greenhouse gases in the atmosphere have reached 394 parts per million, up from 280 ppm before the Industrial Revolution and the highest levels seen in at least 800,000 years. Hansen's math suggests 350 ppm would be a safer level, given that with less than a degree Celsius of warming from present greenhouse gas concentrations, the world is already losing ice at an alarming rate, among other faster-than-expected climate changes.

International governments have determined that 450 ppm is a number more to their liking, which, it is argued, will keep the globe's average temperatures from warming

more than 2 degrees C. Regardless, the world is presently on track to achieve concentrations well above that number. Scientists since chemist Svante Arrhenius of Sweden in 1896 have noted that reaching concentrations of roughly 560 ppm would likely result in a world with average temperatures roughly 3 degrees C warmer—and subsequent estimates continue to bear his laborious, hand-written calculations out. Of course, rolling back greenhouse gas concentrations to Hansen's preferred 350 ppm—or any other number for that matter—is a profoundly unnatural idea. Stasis is not often found in the natural world.

Concentrations of greenhouse gases in the atmosphere may not be the best metric for combating climate change anyway. "What matters is our total emission rate," notes climate modeler Ken Caldeira of the Carnegie Institution for Science Department of Global Ecology at Stanford University, another signee of the anti-Keystone letter. "From the perspective of the climate system, a CO_2 molecule is a CO_2 molecule and it doesn't matter if it came from coal versus natural gas."

Physicist Myles Allen of the University of Oxford in England and colleagues estimated that the world could afford to put one trillion metric tons of carbon into the atmosphere by 2050 to have any chance of restraining global warming below 2 degrees C. To date, fossil fuel burning, deforestation and other actions have put nearly 570 billion metric tons of carbon in the atmosphere—and Allen estimates the trillionth metric ton of carbon will be emitted around the summer of 2041 at present rates. "Tons of carbon is fundamental," adds Hansen, who has argued that burning all available fossil fuels would result in global warming of more than 10 degrees C. "It does not matter much how fast you burn it."

Alberta's oil sands represent a significant tonnage of carbon. With today's technology there are roughly 170 billion barrels of oil to be recovered in the tar sands, and an additional 1.63 trillion barrels worth underground if every last bit of bitumen could be separated from sand. "The amount of CO_2 locked up in Alberta tar sands is enormous," notes mechanical engineer John Abraham of the University of Saint Thomas in Minnesota, another signer of the Keystone protest letter from scientists. "If we burn all the tar sand oil, the temperature rise, just from burning that tar sand, will be half of what we've already seen"—an estimated additional nearly 0.4 degree C from Alberta alone.

As it stands, the oil sands industry has greenhouse gas emissions greater than New Zealand and Kenya—combined. If all the bitumen in those sands could be burned, another 240 billion metric tons of carbon would be added to the atmosphere and, even if just the oil sands recoverable with today's technology get burned, 22 billion metric tons of carbon would reach the sky. And reserves usually expand over time as technology develops, otherwise the world would have run out of recoverable oil long ago.

The greenhouse gas emissions of mining and upgrading tar sands is roughly 79 kilograms per barrel of oil presently, whereas melting out the bitumen in place requires burning a lot of natural gas—boosting emissions to more than 116 kilograms

per barrel, according to oil industry consultants IHS Cambridge Energy Research Associates. All told, producing and processing tar sands oil results in roughly 14 percent more greenhouse gas emissions than the average oil used in the U.S. And greenhouse gas emissions per barrel have stopped improving and started increasing slightly, thanks to increasing development of greenhouse gas–intensive melting-in-place projects. "Emissions have doubled since 1990 and will double again by 2020," says Jennifer Grant, director of oil sands research at environmental group Pembina Institute in Canada.

Just one mine expansion, Shell's Jackpine mine, currently under consideration for the Albian mega-mine site, would increase greenhouse gas emissions by 1.18 million metric tons per year. "If Keystone is approved then we're locking in a several more decades of dependence on fossil fuels," says climate modeler Daniel Harvey of the University of Toronto. "That means higher CO_2 emissions, higher concentrations [in the atmosphere] and greater warming that our children and grandchildren have to deal with."

And then there's all the carbon that has to come out of the bitumen to turn it into a usable crude oil.

Hidden carbon

In the U.S. State Department's review of the potential environmental impacts of the Keystone project, consultants EnSys Energy suggested that building the pipeline would not have "any significant impact" on greenhouse gas emissions, largely because Canada's tar sands would likely be developed anyway. But the Keystone pipeline represents the ability to carry away an additional 830,000 barrels per day—and the Albertan tar sands are already bumping up against constraints in the ability to move their product. That has led some to begin shipping the oil by train, truck and barge—further increasing the greenhouse gas emissions—and there is a proposal to build a new rail line, capable of carrying five million barrels of oil per year from Fort McMurray to Alaska's Valdez oil terminal.

Then there's the carbon hidden in the bitumen itself. Either near oil sands mines in the mini-refineries known as upgraders or farther south after the bitumen has reached Midwestern or Gulf Coast refineries, its long, tarry hydrocarbon chains are cracked into the shorter, lighter hydrocarbons used as gasoline, diesel and jet fuel. The residue of this process is a nearly pure black carbon known as petroleum (pet) coke that, if it builds up, has to be blasted loose, as if mining for coal in industrial equipment. The coke is, in fact, a kind of coal and is often burned in the dirtiest fossil fuel's stead. Canadian tar sands upgraders produce roughly 10 million metric tons of the stuff annually, whereas U.S. refineries pump out more than 61 million metric tons per year.

Pet coke is possibly the dirtiest fossil fuel available, emitting at least 30 percent more CO_2 per ton than an equivalent amount of the lowest quality mined coals. According to multiple reports from independent analysts, the production (and eventual burning) of such petroleum coke is not included in industry estimates of tar sands greenhouse gas emissions because it is a co-product. Even without it, the Congressional Research

Service estimates that tar sands oil results in at least 14 percent more greenhouse gas emissions than do more conventional crude oils.

Although tar sands may be among the least climate-friendly oil produced at present—edging out alternatives such as fracking for oil trapped in shale deposits in North Dakota and flaring the gas—the industry has made attempts to reduce greenhouse gas pollution, unlike other oil-producing regions. For example, there are alternatives to cracking bitumen and making pet coke, albeit more expensive ones, such as adding hydrogen to the cracked bitumen, a process that leaves little carbon behind, employed by Shell, among others.

More recently, Shell has begun adding carbon-capture-and-storage (CCS) technology to capture the emissions from a few of its own upgraders, a project known as Quest. The program, when completed in 2015, will aim to capture and store one million metric tons of CO_2 per year, or a little more than a third of the CO_2 emissions of Shell's operation at that site. And tar sands producers do face a price on carbon—$15 per metric ton by Alberta provincial regulation—for any emissions above a goal of reducing by 12 percent the total amount of greenhouse gas emitted per total number of barrels produced.

The funds collected—some $312 million to date—are then used to invest in clean technology, but more than 75 percent of the projects are focused on reducing emissions from oil sands, unconventional oils and other fossil fuels. And to drive more companies to implement CCS in the oil sands would require a carbon price of $100 per metric ton or more. "We don't have a price on carbon in the province that is compelling companies to pursue CCS," Pembina's Grant argues.

In fact, Alberta's carbon price may be little more than political cover. "It gives us some ammunition when people attack us for our carbon footprint, if nothing else," former Alberta Energy Minister Ron Liepert told *Scientific American* in September 2011. Adds Beverly Yee, assistant deputy minister at Alberta's Environment and Sustainable Resource Development agency, more recently, "Greenhouse gases? We don't see that as a regional issue." From the individual driver in the U.S. to oil sands workers and on up to the highest echelons of government in North America, everyone dodges responsibility.

Price of carbon

A true price on carbon, one that incorporates all the damages that could be inflicted by catastrophic climate change, is exactly what Hansen believes is needed to ensure that more fossil fuels, like the tar sands, stay buried. In his preferred scheme, a price on carbon that slowly ratcheted up would be collected either where the fossil fuel comes out of the ground or enters a given country, such as at a port. But instead of that tax filling government coffers, the collected revenue should be rebated in full to all legal residents in equal amounts—an approach he calls fee and dividend. "Not one penny to reducing the national debt or off-setting some other tax," the government scientist argues. "Those are euphemisms for giving the money to government, allowing them to spend more."

Such a carbon tax would make fossil fuels more expensive than alternatives, whether renewable resources such as wind and sun or low-carbon nuclear power. As a result, these latter technologies might begin to displace things like coal-burning power plants or halt major investments in oil infrastructure like the Keystone XL pipeline.

As it stands, producing 1.8 million barrels per day of tar sands oil resulted in the emissions of some 47.1 million metric tons of CO_2-equivalent in 2011, up nearly 2 percent from the year before and still growing, according to the Canadian Association of Petroleum Producers. In the same year coal-fired power plants in the U.S. emitted more than two billion metric tons of CO_2-equivalent. "If you think that using other petroleum sources is much better [than tar sands], then you're delusional," says chemical engineer Murray Gray, scientific director of the Center for Oil Sands Innovation at the University of Alberta.

In other words, tar sands are just a part of the fossil-fuel addiction—but still an important part. Projects either approved or under construction would expand tar sands production to over five million barrels per day by 2030. "Any expansion of an energy system that relies on the atmosphere to be its waste dump is bad news, whereas expansion of safe, affordable and environmentally acceptable energy technologies is good news," Carnegie's Caldeira says.

There's a lot of bad news these days then, from fracking shale for gas and oil in the U.S. to new coal mines in China. Oxford's Allen calculates that the world needs to begin reducing emissions by roughly 2.5 percent per year, starting now, in order to hit the trillion metric ton target by 2050. Instead emissions hit a new record this past year, increasing 3 percent to 34.7 billion metric tons of CO_2 and other greenhouse gases.

Stopping even more bad news is why Hansen expects to be arrested again, whether at a protest against mountaintop removal mining for coal in West Virginia or a sit-in outside the White House to convince the Obama administration to say no to Keystone XL and any expansion of the tar sands industry. The Obama administration has already approved the southern half of the pipeline proposal—and if the northern link is approved, a decision expected after March of this year, environmental group Oil Change International estimates that tar sands refined on the Gulf Coast would produce 16.6 million metric tons of CO_2 annually just from the petroleum coke, which would be enough to fuel five coal-fired power plants for a year. All told, the increased tar sands production as a result of opening Keystone would be equal to opening six new coal-fired power plants, according to Pembina Institute calculations.

Even as increased oil production in the U.S. diminishes the demand for tar sands-derived fuel domestically, if Keystone reaches the Gulf Coast, that oil will still be refined and exported. At the same time, Obama pledged to respond to climate change and argued for U.S. leadership in the transition to "sustainable energy sources" during his second inaugural address; approving Keystone might lead in the opposite direction.

For the tar sands "the climate forcing per unit energy is higher than most fossil fuels," argues Hansen, who believes he is fighting for the global climate his five grandchildren will endure—or enjoy. After all, none of his grandchildren have lived through a month with colder than average daily temperatures. There has not been one in the U.S. since February 1985, before even Hansen started testifying on global warming. As he says: "Going after tar sands—incredibly dirty, destroying the local environment for a very carbon-intensive fuel—is the sign of a terribly crazed addict."

Comments

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dwbd January 23, 2013, 9:46 PM

It won't add any more to GHG emission than other sources of Oil, or indeed actually less, IF AND ONLY IF they use Nuclear Electricity, Nuclear Steam & Process Heat and Nuclear Hydrogen to extract & refine the bitumen.

Canada has already stupidly thrown over $2B down the sewer on Carbon Capture(with $billions more to follow), $billions of 100% subsidies to Oil for a futile propaganda show that won't do ZIP to reduce Tar Sands emissions. For much less they could develop David Leblanc's (University of Carleton) Denatured Molten Salt Small Modular Reactor. Perfect for Mining Camps, Mining Camps, Bitumen Process Heat, Steam, Electricity & Hydrogen and Community Electricity & Building Heat.

The DMSR uses 1/6th the Uranium of an American type LWR or 1/4 that of the CANDU. And is a prelude to the LFTR which uses 1 tonne of thorium to generate a GW of electricity for a year. 1.4 gms of thorium/yr to supply the avg households electricity.

Inherently safe, meltdown proof (the fuel is already molten), they can't overheat, they are self-regulating, no control rods, and if they ever did over-temp a frozen plug would melt and the core would be dumped into a holding tank, they did that every weekend at ONRL - dumped the core. They run at atmospheric pressure - you don't need a giant containment building. You likely will bury them underground. High temp, very efficient, air cooling is practical. They are small & compact.

Denatured Molten Salt Reactors (DMSR)- An Idea Whose Time Has Finally Come? by D. LeBlanc:

energyfromthorium.com/forum/download/file.php?id=728&sid=5a94910cc159198f9adc52d69955e817

David Leblanc explains how effective the DMSR would be for Tar Sands steam, electricity & process heat:

youtube.com/watch?v=_-BXg18fAIk&feature=relmfu

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dwbd January 24, 2013, 12:39 PM

Man is natural, disease is natural, rape is natural, and murder is natural. So is agricultural pests &

disease. It don't matter ZIP whether it is natural or not.

A rational person, looks at a problem, and does some sort of cost-benefit analysis to find an optimal mitigation scheme for the problem. That will likely never be perfect since perfect is rarely optimal. The Greenie Moron, says: "...damn the costs, it is just too important a problem...". It is equally stupid to say: "...who cares, change is natural, don't worry about it..."

The simple fact is we are running out of economic Fossil Fuel resources, and the EROEI for those resources is dropping precipitiously. Worst off is Oil. We are already paying ~10X the cost per unit energy for Oil as we are NG & Coal, and >100X that of Uranium or Thorium. Ridiculously expensive. At the same time, the booming populations of the Developing World are not listening to the Greenie Dogma of "maintaining or reducing current consumption". They rightfully deserve the benefits of a high energy lifestyle, same as we have. Energy demand in the developing World is rising explosively. A time of reckoning is coming.

So we need to replace Fossil fuels anyway, climate change or otherwise. Fortunately Nuclear Energy can replace Fossil Fuels at a lower cost than continuing their use. And happy coincidence it doesn't emit Greenhouse Gases. Not to say it will be easy or fast.

ONLY RATIONAL CONCLUSION: Quit piss-potting around and lets get at it right now, build those new Nuclear Power plants ASAP, expand R&D 100 fold on commercial Nuclear Power - both fission, fusion & exotic. Cancel nutty scams like Wind & Solar, which cannot be anything more than minor adjuncts to Fossil Fuels. The longer we delay the harder it will be.

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S_G_B January 24, 2013, 6:09 PM

@null

You're living in a dream world. Case in point, your assertion:

"Wind power is already the single largest killer of birds globally, and it only accounts for around 5% of power. Perhaps as little as 1% realistically."

Wind turbines are one of the most trivial causes of bird mortality. See here for instance:
http://en.wikipedia.org/wiki/Environmental_impact_of_wind_power#Birds

Even fossil fuel power plants are estimated to kill 32 times as many in the USA and windows around 200 to 2000 times as many.

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bungay lad January 24, 2013, 7:47 PM

The Chinese are more than willing to fund pipelines to carry tar sands oil to Vancouver then on to China. So, the Keystone project won't necessarily increase flow from Alberta as it would have flowed toward China and the rest of Asia anyways. Stopping the Keystone project for redesign around the Ogallala Aquifer made sense. Completing it makes sense. Better the tar sand oil be processed under more stricter environmental law than have it processed in China. Reducing the ultimate carbon footprint is a challenge it can be overcome. There have been failures there will be more. We need to get serious about negating the emission of carbon and like products. The tar sands process produces a mountain of sulphur it must be turned into a marketable substance. If Edison stopped after 40 or 50 tries to find a viable filament the light bulb would have been a long time coming. We can find marketable uses for carbon. Sequestration should not be an option. We can't "throw" it away. There is no away. Mother Nature has already sequestered a mind boggling amount of Methane in the form of Methane Hydrate that we will contend with if global warming continues. Yes the earth warms and cools on a periodic basis. However, this is the first cycle in which billions of organisms are magnifying the warming process with billions of tons of carbon emissions. We are having an adverse change on climate change. We have much work to do and hard decisions to be made. Denial or absolutism will not help. We cannot stop all combustion of fossil fuels; we can be smarter in how we do it. I do think the Keystone project should be

completed and the tar sands utilized.... wisely.

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S_G_B January 24, 2013, 8:32 PM

According to NOAA, "2012 was also [the] warmest 'La Niña year' on record" (http://www.ncdc.noaa.gov/sotc/)

One of the reasons the warming trend due to rising GHG concentrations isn't a "straight line" is that quite a few other things are pushing global temps up or down, but mostly on a comparatively very short-term basis (in modern times, the slight, early 20th century increase in net solar irradiance was an exception and probably the main cause of the warming before GHG emissions, largely scrubbed of cooling air pollutants, took off in the 1960s and 70s). The ENSO - El Nino, La Nina - cycle is an important example. In 1998, for instance, an extremely powerful El Nino exaggerated the apparent warming due to GHGs alone, resulting in the warmest year on record up to that point. Last year, the cooling effect of La Nina helped depress GHG-caused warming. For more about separating the persistent unidirectional GHG signal from the fluctuating background noise, see this: http://www.skepticalscience.com/16_more_years_of_global_warming.html

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CharlieinNeedham January 24, 2013, 9:31 PM

Canada will build a pipeline.

The only question is whether it will be a very expensive one to the US or an immensely expensive one to the Pacific coast.

Why not build the one to the US so the petroleum can be refined without risking a terrible tanker spill on the coast?

Why not build the one to the US so there is a sure supply of petroleum in the event of the already combustible Middle East being plunged into more terrorist raids or even war?

Isn't it a matter of national security to have a steady supply of crude oil to supply the military?

It was 5 degrees Fahrenheit this morning in much of the East and Midwest. Isn't it wise to have a petroleum supply to keep warm in winter?

The US has a 7.8% unemployment rate with a very slowly recovering economy. Even a minor disruption of Middle East oil will cause prices to skyrocket, and send the US into recession. And Europe is in even worse shape than the US.

If tar sands are so bad, why not push fracking and burn the cleaner-for-the-environment natural gas?

Let's face it.

The US will continue to need petroleum.

It is a lucky break the tar sands can provide a secure source of petroleum for the immediate future while grand schemes for attacking global warming can continue to be worked on.

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idic5 January 25, 2013, 2:00 PM

"Science is predicting ONLY a rise of 2 to 3 feet by 2100 AD"

there is a whole lot of other consequences that the models predict besides a rise in sea levels. Some other adverse consequences are: droughts, fires , and of course , fires destroying forests yields less co2 consumers/02 emitters as well as more erosion, less arable land, less food, more major , 'spikey' weather incidents like Hurricane Sandy and more.

lot of bad stuff . and teh models are all based on assumptions that might even be worse. recently , we discovered that the destruction of the siberian permafrost cd get us into an intractable feedback loop sooner than previously anticipated.

http://www.youtube.com/watch?v=pznsPkJy2x8

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4karats January 25, 2013, 4:42 PM

The production of crude oil from tar sands produces not only CO2, but also CO which has to be burnt continuously together with side (unwanted) products such as SO2, coke dust, amine gas, CH4, H2S, etc. to make steam for venting. (You cannot vent dirty gases into the sky, but you can vent steam which is environmentally friednly. This is one disadvantage when you have more fuel than you can hold). These dirty and poisonous gases have to be burnt in the dirtiest boilers called CO Boilers, which, unfortunately, have to be sitting in the open space without enclosures. You need training and special protective equipment (such as Scott Airpaks, etc.) in order to visit these CO Boilers in the plant sites north of Fort McMurray. These CO Boilers, being the only unique kind of boilers in all industries in the world, are very difficult to control becasue of the complicated thermo-dynamics inside them and the off gases (named above) are unpredictable in quantities due to various possible plant upsets of unknown size at unpredictable times. The fire ball inside these CO Boilers can occasionally migrate suddenly to the precipitators downstream due to sudden increase in flow of CO gas mixtures admitted, i.e. more than the CO Boilers can normally handle, resulting in precipitator fires or explosions. No known flow instruments were found that could reliably measure the flow of the admitted gas mixtures after many years of searches in industry. The gas duct, some 11 feet in diamter, is very hot (more than 1000 degrees F.), lined with more than 4~5 inches of slag internally, while the gas is full of very fine coke dust. When control of each CO boiler becomes poor, or rather, lost, you will see black plumes shooting out from the chimney(s) continuously, sometimes for days, sometimes for hours. At night, you cannot see them, but you can smell them in town (Fort McMurray) depending on wind directions and wind speeds, some 40 to 50 kilometers from site(s). We hope that all CO gases will be converted into CO2, otherwise the immediate consequence could be a lot worse than causing the ambient temperature raised by 0.1 degrees in a long run.

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Eric Grimsrud January 26, 2013, 1:56 PM

Some of us Montanas are doing our best to get this message across in our fossil-fuel-rich state - as is indicated in my op ed piece of a couple days ago in the Missoulian. (see http://missoulian.com/news/opinion/columnists/global-warming-is-our-greatest-immediate-challenge/article_199255c2-6638-11e2-b352-0019bb2963f4.html)

The argument made in it might be of general interest to others, as well, who are trying to inject some basic scientific thoughts into the public domain.

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g. oliver January 28, 2013, 2:47 PM

Author says, “Pet coke is possibly the dirtiest fossil fuel available, emitting at least 30 percent more CO2 per ton than an equivalent amount of the lowest quality mined coals.”

True, but nonsense: Carbon is carbon and coke has more carbon and less unburnable inorganic material (1 - 2 percent ash) than mined coal (3.3 – 20 percent ash). So you get more CO2 per ton burned, but need to burn fewer tons of coke than coal to produce the same amount of energy.

I don’t know a lot about tar sands and the Keystone pipeline and appreciate the author’s summary.

Still, such an “elementary” error makes me wonder whether some other facts are similarly misleading.

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