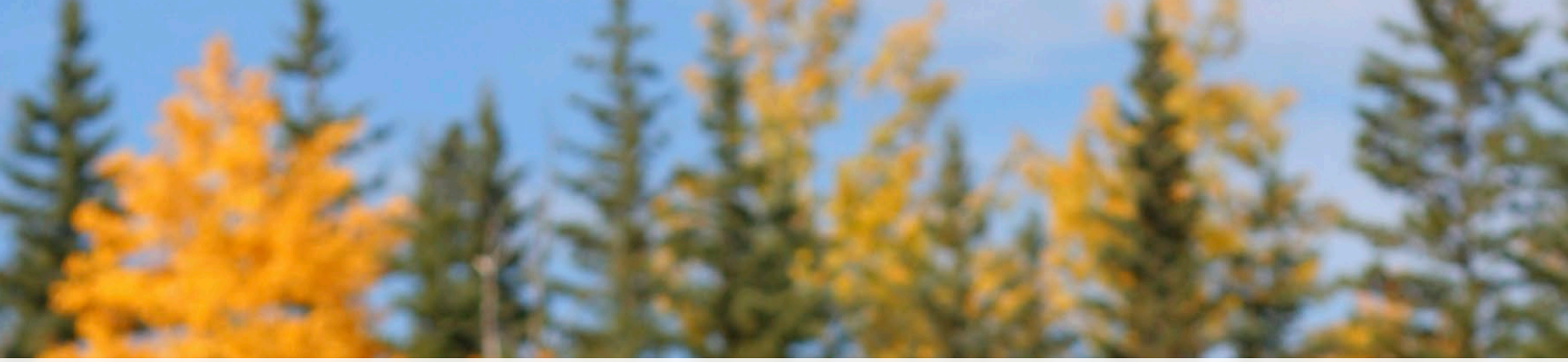

BLOWING HOT AIR ON THE WRONG TARGET?
A Critique of the Fossil Fuel Divestment Movement in Higher Education

BY PIERRE DESROCHERS & HIROKO SHIMIZU | JULY 2016

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Media Inquiries and Information:
Deb Solberg
Tel: (403) 919-9335

Development Inquiries:
Samantha Leclerc
Tel: (403) 400-6862

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PIERRE DESROCHERS

Pierre Desrochers is Associate Professor of Geography at the University of Toronto. His main research interests are economic development, technological innovation, environmental, energy and food policy. He has published widely on these and other topics in academic, policy and popular outlets. He is the co-author of *The Locavore's Dilemma: In Praise of the 10,000-Mile Diet* (PublicAffairs, 2012). His website can be found at http://geog.utm.utoronto.ca/desrochers/.

HIROKO SHIMIZU

Hiroko Shimizu is a policy analyst who writes extensively on energy, food, and environmental issues with a special emphasis on globalization. She holds a Master's of International Public Policy from Osaka University. She has studied at and worked for several academic institutions and private companies in Canada, Japan, China, and the United States. She is an Associate Researcher of the Molinari Economic Institute in Brussels, Belgium (www.institutmolinari.org) and was, among others appointments, an International Fellow at the Johns Hopkins University's Institute for Policy Studies. Her academic, policy and popular writings have been published in Japanese, English and French. She co-authored the book *The Locavore's Dilemma: In Praise of the 10,000-Mile Diet* (PublicAffairs, 2012).

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EXECUTIVE SUMMARY

By 2015, students and faculty at more than 1,000 college and university campuses across the world (including nearly 30 in Canada) had pressured academic trustees and administrators to divest their institutions' endowment holdings in publicly held fossil fuel companies (i.e., to sell or part way with stocks and other funds invested in corporations engaged in the extraction of coal, crude oil, bitumen (oil sands) and natural gas). Invoking computer-generated catastrophic climate change scenarios, they insist that most economically recoverable carbon fuel reserves be left in the ground. The divestment activists' rhetoric and policy prescriptions, however, are morally questionable because they imply no sacrifices on the part of consumers and will hurt primarily poor people, futile because achieving their goals will have no impact on the value of corporate stocks and the production of carbon fuels, and misguided because drastically curtailing their use in the absence of better alternatives will harm both human society and the environment.

First, divestment activists claim the moral high ground by equating fossil fuel divestment with past campaigns against tobacco, arms, apartheid-era South Africa and even slavery. Unlike their predecessors, however, anti-carbon-fuel activists are in no apparent hurry to divest themselves of the countless products derived from the object of their scorn and typically do not even suggest that affluent Westerners cut back on their consumption so that poor people in less advanced economies could boost (if only a little) their energy use on a per capita basis. The activist's sole focus on corporations also conveniently omit the fact that most of the CO_2 emissions associated with carbon fuels come from the combustion rather than the production stage. For instance, in the case of most liquid fuels, tailpipe exhaust accounts for between 70 per cent to 80 per cent of all greenhouse gas emissions, with the remaining portion traced back to upstream production, refining and distribution. Furthermore, assuming that divestment activists succeed in making carbon fuel energy more expensive and/or scarce, the main victims will be people of lesser means throughout the globe.

Second, university endowments are minor financial players with insignificant resources invested in energy stocks. As long as financial returns remain attractive, politically motivated divestment actions amount to making a tiny fraction of a drop in an oil barrel available at discounted prices to other buyers. Even assuming that divestment campaigners could somehow lower stock prices, this would have no impact on a corporation's bottom line or its ability to raise capital for promising projects. Furthermore, if divestment campaigners were able to revoke the social licence of publicly traded carbon energy producers in a context where the demand for their products remained high, the main beneficiaries would be nationalized producers in countries such as Venezuela, Saudi Arabia, Iran and Russia whose environmental and social records are much more problematic.

Third, divestment manifestos are silent on the economic, social and environmental benefits of carbon fuels and petrochemical products for which there are currently no better substitutes. For instance, carbon fuels made possible large-scale, reliable and affordable long-distance transportation which paved the way to improved overall nutrition (by concentrating food production in the most-suitable locations thus making food more plentiful, diverse and affordable), the eradication of famines (by moving the surplus of regions with good harvests to those that had experienced mediocre ones), wealth creation (by facilitating the migration of large number of people away from the countryside and into cities), and advances in modern medicine (by allowing more people to devote themselves to medical research and the development of a wide range of new and better medical products). As a direct result of greater use of carbon fuels, in the last two centuries every indicator of human well-being, from overall number, life expectancy, income per capita, hunger and infant mortality to child labour and education, has improved, very often dramatically. Increased usage of carbon fuels and feedstock was also directly responsible for environmental and public health benefits ranging from improved air and water quality and sanitation to reforestation. For instance, kerosene, propane and heavy oil displaced poor quality biomass fuels such as firewood and dung that filled houses with soot, particles, carbon monoxide and toxic chemicals (and still kill millions of people today who cannot afford carbon fuels or electricity). Humanity's increased reliance on resources extracted from below the Earth's surface helped preserve and promote life forms on the surface. A case in point is the relatively recent large-scale reforestation of all advanced economies and of some developing economies (e.g., China, India, Bangladesh and Vietnam) that can be traced back to carbon fuels-driven advances such as drastically increased agricultural yields that made much marginal agricultural uneconomical and available for spontaneous reforestation (in most cases) and tree plantations (in a few selected locations), the replacement of work animals such as horses and mules by tractors and other machinery, and the substitution of agricultural products such as plants grown to produce fibres, dyes and rubber to animals raised primarily for their wool and fur by synthetic products.

As it currently stands, the fossil fuel divestment campaign is an exercise in futility that even if successful would have no impact on greenhouse gas emissions, climate change or the financial standing of carbon energy producers. What its overall demonization of conventional energy would achieve if it was echoed by policy-makers, however, is a hefty price for the middle class in terms of both lost jobs and more-expensive energy bills, a less reliable electric grid, and additional significant environmental problems in advanced economies. It would mean energy poverty among people of lesser means, as well as lost development opportunities and much greater levels of disease, death and environmental degradation in poor countries.

INTRODUCTION

Activists on more than 1,000 college and university campuses across the world (including nearly 30 in Canada)[1] have pressured academic trustees and administrators to divest their institutions' endowment holdings in fossil fuel companies (i.e., to sell or part way with stocks, bonds and other funds invested in corporations engaged in the extraction of coal, crude oil, bitumen [oil sands] and natural gas). Building their case on a strong version of the precautionary principle in which the absence of absolute certainty of outcome gives a licence to ban a product that might nonetheless prove beneficial, they insist that most economically recoverable carbon fuel[2] reserves be left in the ground in order to prevent the risk of climate harm forecast by computer-generated scenarios.

As one analyst observed, the divestment campaign has become this generation of idealistic students' "defining cause" while being simultaneously endorsed – and sometimes actively promoted – by thousands of professors.[3] The divestment activists' rhetoric and policy prescriptions, however, are both futile, because achieving their goals will have no impact on the value of corporate stocks and the production of carbon fuels, and misguided, because drastically curtailing their use in the absence of better alternatives will harm human society and the environment.

We make our case by first reviewing the history, rhetoric and impact of the fossil fuel divestment movement. Next, we discuss the neglected social and environmental benefits of carbon fuels. After reviewing the main arguments made by divestment opponents, we illustrate how market processes have long promoted both reduced waste and efficiency and the development of less problematic technologies than those that existed before. By ignoring this reality and promoting once-discarded ways of doing things, sustainability and divestment activists ensure that their "green" cure will prove worse than the "carbon fuel" disease they are fighting. We then put concerns about global climate change into a broader historical and policy perspective and suggest that current scenarios do not warrant going off fossil fuels until better alternatives prove financially sustainable. We finally list a few other environmental problems that well-meaning activists could tackle instead.

THE FOSSIL FUEL DIVESTMENT MOVEMENT[4]

1.1 History

The roots of the fossil fuel divestment movement extend back to a 2010 Swarthmore College (Pennsylvania) campaign against mountaintop-removal coal mining in West Virginia whose organizers were inspired by similar campaigns against tobacco manufacturers and apartheid-era South Africa. Fossil fuel divestment as a movement, however, only became prominent once reframed by environmental writer and activist Bill McKibben and his organization 350.org as a broader fight against global climate change.

> 350.org was founded less than a decade ago at Middlebury College, an institution with which Bill McKibben has long been affiliated.[5] It first favoured political lobbying but later took a more direct aim at the fossil fuel industry by utilizing actions such as its campaign against the Keystone XL pipeline, which would deliver Alberta bitumen to some U.S. petroleum refineries. The organization's name is derived from its goal to reduce the atmospheric concentration of carbon dioxide (CO_2) from a current level of approximately 400 parts per million (ppm) down to at most 350 ppm – in other words, lowering atmospheric CO_2 from 0.04 per cent to 0.035 per cent.[6]

McKibben's call to arms was an August 2012 *Rolling Stone* magazine article titled "Global Warming's Terrifying New Math" in which he claimed that if a "college's endowment portfolio has fossil-fuel stock," then the education it provides is "being subsidized by investments that guarantee [students] won't have much of a planet on which to make use of their degree."[7] Quoting Bob Massie, former anti-apartheid activist and co-founder of the Investor Network on Climate Risk, McKibben urged society to "sever the ties with those who profit from climate change – now." Indicting carbon fuel producers as "a rogue industry, reckless like no other force on Earth" and "Public Enemy Number One to the survival of our planetary civilization,"[8] he borrowed from the Carbon Tracker Initiative (CTI, a self-described "independent financial think tank") a list of 200 publicly traded corporations – 100 coal and 100 petroleum and natural gas producers – singled out on the basis of the potential carbon dioxide (henceforth CO_2) emissions of their reported reserves.[9] CTI's 2011 carbon budget analysis[10] was premised on the notion that a rise in global mean temperature must be "no more than 2°C above the pre-industrial level"[11] under penalty of unmanageable environmental problems. Relying on modelling approaches that assumed high sensitivity of the climate to CO_2, CTI analysts argued that perhaps as much as 80 per cent of then-economically recoverable carbon fuels (i.e., with current technologies and prices) should be left in the ground. Furthermore, assuming governmental regulations (e.g., carbon taxes, cap-and-trade policies, higher taxes and royalties on extraction, strict emission limits, etc.) and social disapproval prevented their development, these reserves would turn into "stranded assets," i.e., "fossil fuel energy and generation resources which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return (i.e. meet the company's internal rate of return),"[12] and the economic valuation of carbon fuel producers is revised downward accordingly.

> According to the computer-simulated models and assumptions used by CTI analysts, no more than 565 gigatons of CO_2 can be added to our atmosphere between now and 2050 if we want to avoid catastrophic climate change. Because burning all current carbon fuels reserves would generate approximately 2,795 gigatons of CO_2, most of our coal and much of our crude oil and natural gas reserves should therefore never be exploited.[13]

1.2 Rhetoric

Although one can observe minor variations between student-sponsored divestment manifestos, most show remarkable consistency in terms of divestment strategies, demonization of fossil fuel producers, alarmist climate rhetoric and complete failure to acknowledge the social, economic and environmental benefits provided by coal, oil and natural gas. As one critic observes,[14] even the evolving rationale for divestment is now widely shared among activists:

> *Early on, its proponents cast divestment as a way to defund fossil fuel companies. Then divestment metamorphosed into a tool of moral shame. Recently advocates of divestment have recast their cause once more as a financial weapon – this time as a way to protect portfolios from foreseen price collapses in fossil fuels, rather than as a means to attack the industry's bottom line.*[15]

To summarize some of the key grievances and demands found on the Web sites of organizations such as 350.org and Go Fossil Free Canada:[16]

1. Our carbon fuel addiction not only creates local environmental and social injustices, but also will soon trigger "tipping points and irreversible impacts that could send climate change spinning truly beyond our control."[17] In this context, policy debates about energy options and trade-offs are diversions promoted by intellectual mercenaries in the pay of Big Oil and create needless delays in a matter of civilizational life and death;

2. Because it suffers from unsustainable greed, the fossil fuel industry ignores the present and future social and environmental costs of its operations and should lose its social licence to operate;

3. Carbon energy producers should stop exploring for new hydrocarbons, stop lobbying politicians for fiscal privileges and pledge to leave 80 per cent of their current reserves underground;

4. More capital should be made available for alternative power sources (e.g., wind and solar power, biomass), energy-efficiency measures (e.g., green buildings) and more-compact community development models (e.g., planning policy that favours public transit, walkable urban cores and bicycle lanes while discouraging car-oriented suburbanization);

5. Academic endowment managers should "immediately freeze any new investment in fossil fuel companies, and divest from direct ownership and any commingled funds that include fossil fuel public equities and corporate bonds within 5 years."[18]

6. Institutions of higher education should devote more class time to teaching the tenets of environmentalist thought, promote reduced emissions and use their endowment funds as tools of political engagement through campaigns calling not only for "cut[ing] investment in the industry," but also "stigmatiz[ing] its practice, and mak[ing] it unfashionable to associate with or accept donations from fossil fuel corporations";[19]

7. Divestment – as opposed to boycotting carbon fuel products individually or as a social movement – is the most important direct contribution students can make in the fight against dangerous climate change.

To examine but one particular instance in more depth, in March 2014, the student-led group Toronto350.org submitted a petition that requested the authorities of the University of Toronto to "fully divest from fossil fuel companies within the next five years and to immediately stop investing new money in the industry."[20] In April 2015,

Commingled funds consist of assets from several accounts – including, but not limited to, university endowments – stewarded by an outside manager. Their rationale is the creation of economies of scale in their management, e.g., lower trading costs per dollar of investment, diversification and professional money management.;

the activist organization submitted an update in which the petitioners decried our "dependence" on fossil fuels as having delivered nothing but unmitigated harm because of the potential risk of catastrophic anthropogenic climate change. As the authors saw it, "Climate change is a defining example of social injury" because firms "that produce fossil fuels do not bear any economic burden as a result of the many forms of harm they are imposing on other people, including agricultural impacts, sea level rise, damage to human health, and more severe extreme weather." As well, "[T]hose who use fossil fuels enjoy the benefits while imposing these costs on others."[21]

Their solution was to leave "80 percent of the planet's fossil fuel reserves unburned."[22] This stance not only "requires a massive redirection of investment from funding fossil fuel energy sources to deploying different energy sources that do not alter the climate," but it also implies that the "stock market value of fossil fuel companies is based on the outdated assumption that fossil fuel extraction and use can continue without limit." Much of the value of these companies is therefore "illusory, based on the outdated assumption that we can forever use the atmosphere as a free dumping ground for CO_2."[23] By selling its shares in fossil fuel companies, the university would contribute to the transition beyond fossil fuels, "make a powerful statement about the kind of future the university wishes to help bring about" and help "strip the fossil fuel industry of its social license to operate."[24]

1.3 Impact

According to Fossil Free, as of March 2016, about 500 institutions representing approximately $3.4-trillion in assets had made some form of divestment commitment.[25] Colleges, universities and schools make up about 12 per cent of these, with the remainder being faith-based organizations (27 per cent), foundations (25 per cent), governmental organizations and pension funds (13 per cent), non-governmental organizations (6 per cent), for-profit corporations (3 per cent) and health foundations and institutions (1 per cent).[26] Non-academic institutions include the Rockefeller Brothers Fund (RBF, legatees of John D. Rockefeller's Standard Oil Company) and the Norwegian Sovereign Wealth Fund (NSWF, the world's biggest state-owned investment vehicle, with more than $7-trillion in assets mostly funded from oil export). (It is worth noting, however, that RBF managers financially supported the divestment movement for years before finally deciding to walk their talk while NSWF administrators only shed their coal-related investments.[27]) Activists have also launched initiatives such as Divest Vatican and Divest Gates Foundation & Wellcome Trust.[28]

Premier universities such as Oxford (U.K.), Stanford (U.S.A.), and Georgetown (U.S.A.) have announced a partial divestment of carbon fuel-producing corporations.[29] As of March 2016, 37 universities and 17 colleges worldwide had officially divested or were committed to divest from fossil fuel producers[30] (approximately 0.24 per cent of the colleges and universities in the world, with the fossil fuel investments affected by these decisions comprising roughly 1.16 per cent of total endowment value[31]). Among them, 29 schools (54 per cent) are in the United States, followed by 17 schools (31 per cent) in the United Kingdom.[32] In a few cases, academic administrators joined the divestment movement without any significant student pressure.[33] In Canada, no academic institution has yet divested from carbon fuel producers, although faculty and students at the University of British Columbia (UBC) and the University of Victoria voted in favour of such a measure, while a University of Toronto report written at the request of the institution's president recommended partial divestment.[34] In Montreal, the Concordia University Foundation announced in 2014 the creation of a new $5-million sustainable fund (out of a total $130-million endowment) that will screen out fossil fuels and tobacco.[35] In 2016, UBC proposed to create an alternative low-carbon endowment fund, the Sustainable Future Fund.[36]

These numbers, however, should be looked at critically. For one thing, prominent institutions such as Oxford University

that pledged to divest from coal and oil sands had no direct investments in these sectors.[37] Stanford administrators announced an end to direct investments in coal mining companies[38] yet kept their petroleum and natural gas stocks and took no action in terms of carbon fuel holdings in mutual and commingled funds.[39] This latter issue seems widespread among institutions whose trustees and administrators have pledged to divest themselves from direct ownership in carbon fuel producers. Furthermore, a number of institutions whose administrators promised some time ago to divest from such stocks have yet to live up to their official statements.[40]

On the other hand, at least 35 colleges and universities have formally rejected fossil fuel divestment including institutions such as Swarthmore College, Philadelphia, and Middlebury, where activists had been especially active.[41] In Canada, as of March 2016, the trustees and administrators of Queen's, Dalhousie, McGill, Trent, Toronto and the University of Calgary had decided against divestment, although news reports suggest that "[t]he boards of governors at McGill and Dalhousie University are [still] under strong pressure to divest."[42]

2.0 THE INCONVENIENT TRUTH ABOUT THE BENEFITS OF FOSSIL FUELS

A striking characteristic of all divestment manifestos is their complete silence on the economic, social and environmental benefits of carbon fuels and petrochemical products and their emphasis on preserving a planetary climate very "similar to that on which civilization developed and to which life on Earth is adapted."[43] Furthermore, divestment activists never entertain the idea that the adverse impact of carbon fuel use is far outweighed by its very tangible benefits.

To summarize a few inconvenient facts for the activists' case, increased energy use has always been indispensable in generating wealth, and carbon fuels have long accounted for at least 85 per cent of the commercial energy used worldwide.[44] Despite significant subsidies over the last two decades, the share of global primary energy consumption represented by non-hydroelectric renewable energy sources (i.e., wind, geothermal, solar, biomass and waste) still amounted to less than 2.5 per cent in 2014 (Figure 2).[45] Furthermore, after humans began using coal, crude oil and natural gas on a significant scale, world population increased from less than 1 billion before the 19th century to over 7 billion today. Global life expectancy went up from approximately 30 years in 1900 to almost 70 today, and the share of the global population living in extreme poverty fell from approximately 84 per cent in 1820 to well below 10 per cent today.[46]

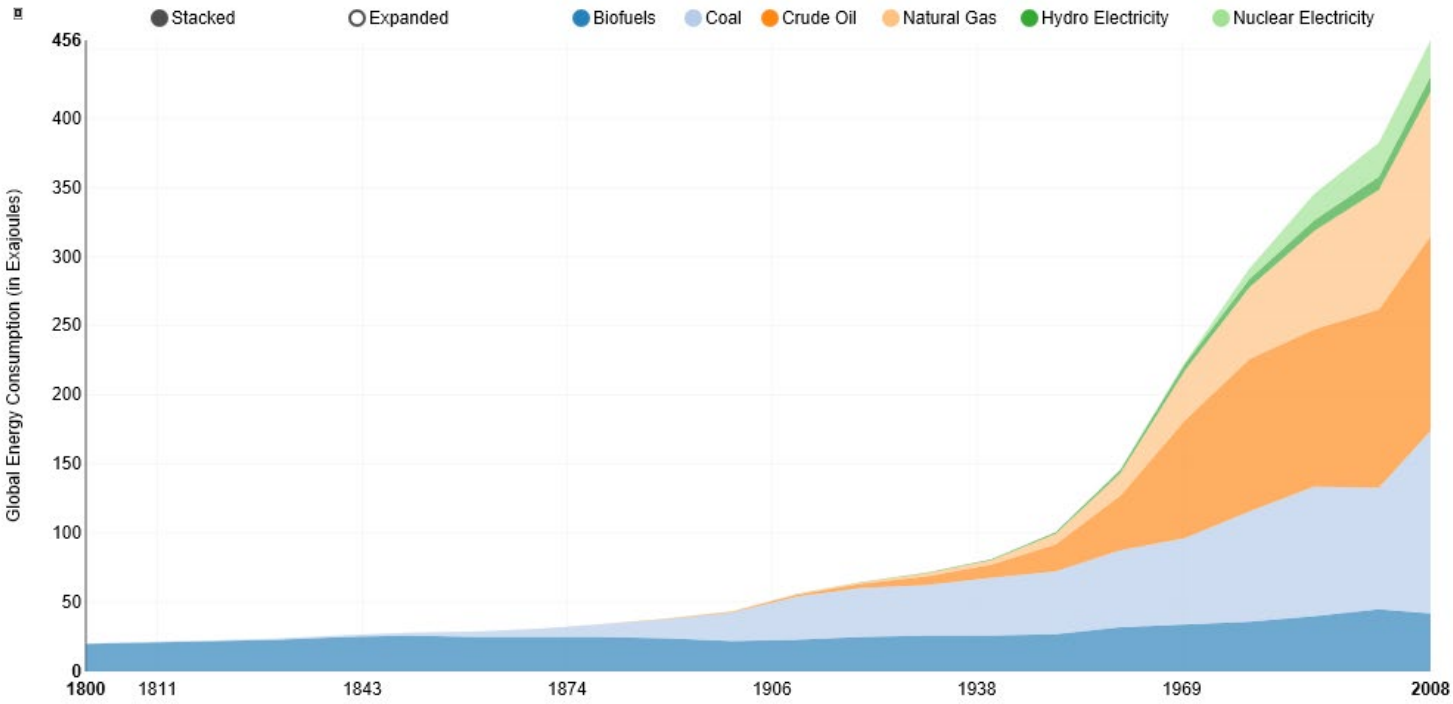

Figure 1: World Energy Consumption by Source, 1800-2000[47]

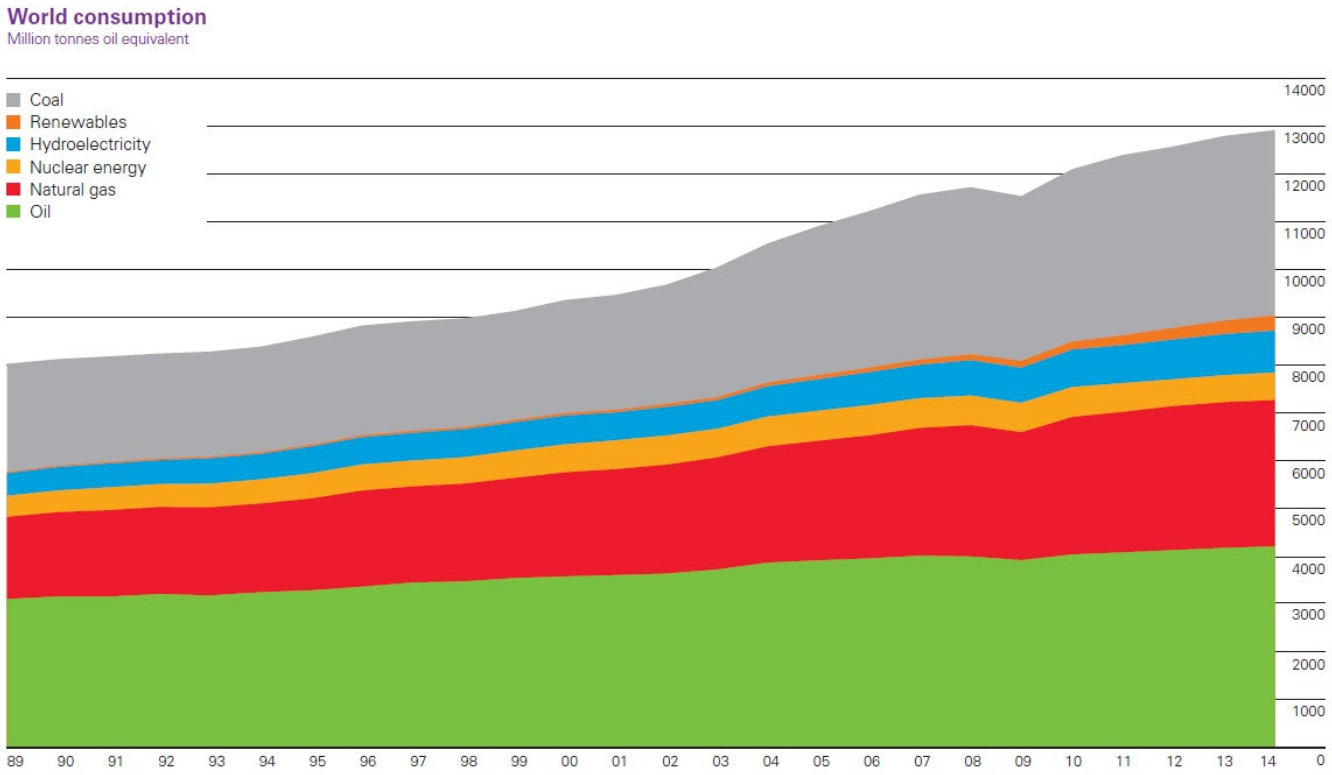

Figure 2: World Primary Energy Consumption by Fuels (Million tonnes equivalent), 1989-2014[48]

As the physicist Robert Zubrin eloquently put it:

> *Since 1950, humanity has utilized a great deal of carbon. Simultaneously, three major changes have occurred worldwide:*
>
> *1) The standard of living, as measured by average global Gross Domestic Product per capita, has increased by 400 per cent;*
>
> *2) The rate of plant growth on Earth has increased by 15 per cent;*
>
> *3) The average global temperature has increased by 0.2 per cent.*[49]

Zubrin rightly labels as "carbon-benefit deniers" the people who ignore tangible positive outcomes and focus instead on hypothetical – and often worst-case scenario – climate change risks.

As a casual glance at any human-made surroundings quickly reminds us, we are born, live and die surrounded by coal and hydrocarbon-derived products of all kinds.

Far from having harmed us as any addictive substances or policies without redeeming qualities would, carbon fuels have been more akin, in humanity's ever-greater reliance on them, to our dependence on beneficial nutrition. As the writer James K. Glassman put it, "America is no more addicted to oil than it is addicted to bread, to milk, to paper, to water, to computers or, in the immortal words of the late Robert Palmer, to love."[51] As will now be discussed, producers and consumers once selected coal, crude oil and natural gas over other alternatives (and sometimes over each other) because they delivered significant benefits of all kinds.

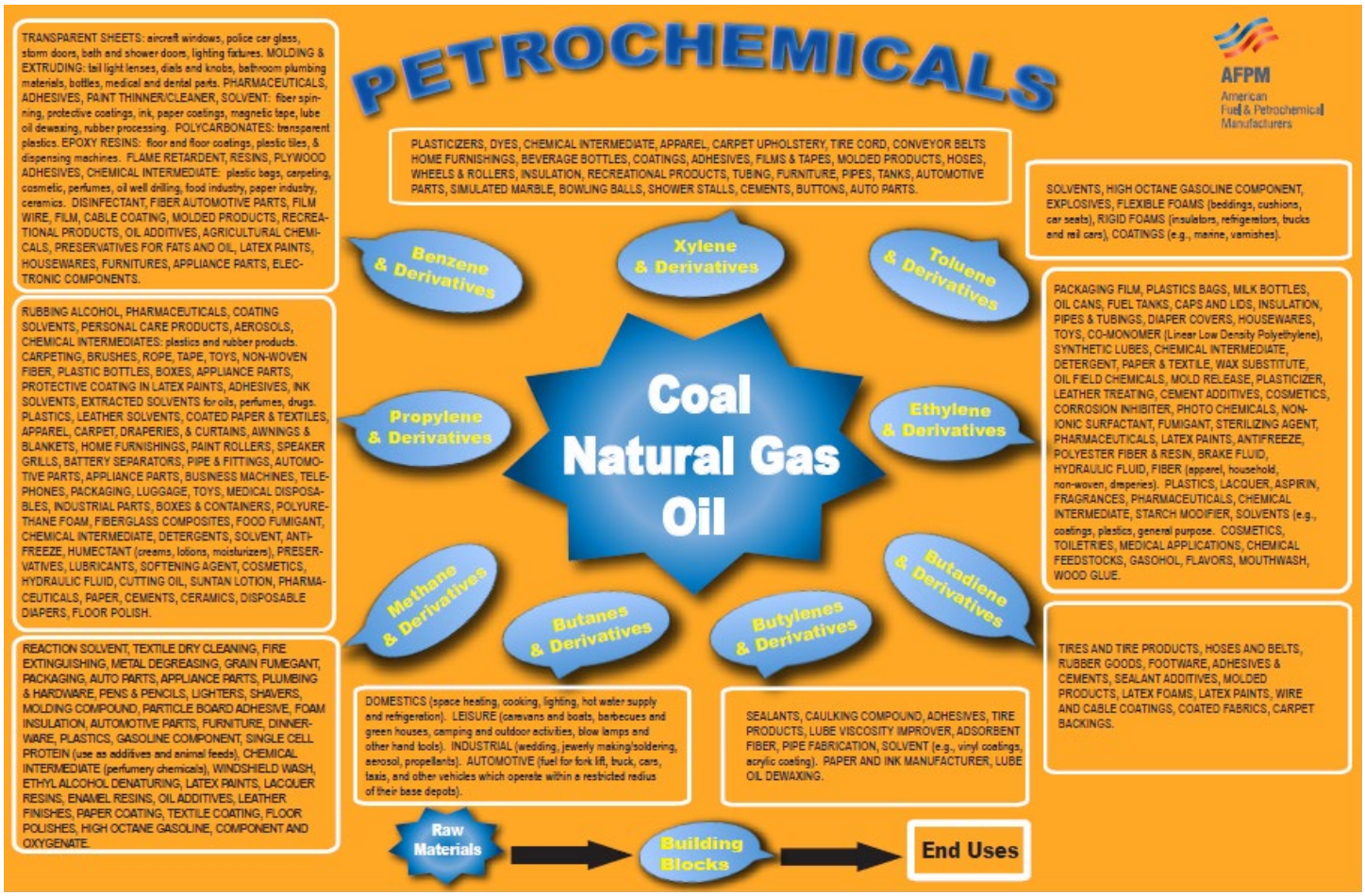

Figure 3: Chart of Products made from Petrochemical[50]

2.1 Economic Drivers of Energy Transitions

Up until the 1890s, renewable power sources (e.g., water, wind, solar and biomass – i.e., fuelwood, charcoal, animal dung and crop residues) dominated the world's energy supply. In earlier centuries, some quantities of coal, petroleum and bitumen had been used throughout the world, but their overall contribution was marginal. Among other problems, before the development of better combustion technologies, the burning of coal filled household and production sites with noxious smoke and gases, and people who could afford to do so relied on fuelwood and wood-derived charcoal instead. While some quantities of (sometimes distilled) crude oil and bitumen had been used as architectural adhesives, ship caulking, medicines (laxative), road-surfacing material, lamp oil and domestic fuel, unreliable supplies and lack of markets for most fractions of crude oil prevented their large-scale development and exploitation.[52]

Beginning with the development of better steam engines and coal stoves in the late 18th century, carbon fuels made possible new economic activities and the scaling up of earlier ones to unprecedented levels, because of their capacity to deliver much more plentiful and reliable heat, power and feedstock. For instance, coal at first not only displaced human and animal muscle power, biomass and wind (mill and sail) power in countless applications, but it also powered a range of activities that would have been impossible without it. As the economist William Stanley

Jevons observed in 1865, "[F]orests of an extent two and a half times exceeding the whole area of the United Kingdom would be required to furnish even a theoretical equivalent to [the country's] annual coal produce."[53] In later years, both humanity and the environment benefitted greatly from the substitution of coal by crude oil products (gasoline, diesel, kerosene and bunker fuel) in transportation and from the substitution of coal and fuel oil by natural gas in electricity production and home heating.[54] These substitutions occurred because crude oil and natural gas have a number of technical (and therefore economic) advantages over coal including (in petroleum's case) a higher energy density (i.e., the amount of energy stored in a unit of volume); cleaner combustion with less-polluting gases and particulate matter; greater ease of extraction (i.e., no underground work by humans); greater ease of handling, transport and storage; and more-desirable feedstock for the production of a wide range of synthetic items.[55] In each case, these transitions occurred without government support, because new developments were truly superior (or at least less problematic) than older ways of doing things.

What follows is a more detailed assessment of some of the direct and incidental economic, social and environmental benefits historically delivered by carbon fuels.

2.2 Economic, Social and Environmental Benefits of Carbon Fuels[56]

Before carbon fuel use took off, renewable technologies (such as human and animal power, windmills and watermills) could only support approximately 1 billion people whose standards of living were, in most cases, barely comparable to today's rural inhabitants of the least developed economies (e.g., a one in three probability of being malnourished, an average income of around $1/day, a life expectancy barely beyond 30 years of age).[57]

Some undeniable benefits of carbon fuels include the following:

Economic and Social Benefits

- Long-distance transportation: For the first time in human history, carbon fuels made possible large-scale, reliable and affordable long-distance transportation. In time this paved the way for
    - *improved overall nutrition* by concentrating food production in the most-suitable locations, thus making food more plentiful, diverse and affordable;
    - *the eradication of famines* by moving the surplus of regions with good harvests to those that have experienced mediocre ones;
    - *large-scale urbanization* and the wealth creation that can only occur when large number of people move away from the countryside and into cities;[58]
- Advances in modern medicine: Among other benefits, the development of a wide range of new and better medical products was made possible, from operating room equipment and replacement hearts, valves, limbs and joints to a range of vitamins and medications.
- As a direct result of humanity's greater capacity to work and the synthetic products made possible by coal, petroleum and natural gas, every indicator of human well-being, from overall number, life expectancy, income per capita, hunger and infant mortality to child labour and education, has improved, very often dramatically.[59]

To give but a few illustrations:

- In 1950, approximately 1 out of every 2.5 individuals in the world was malnourished. This proportion is now 1 in 7;[60]

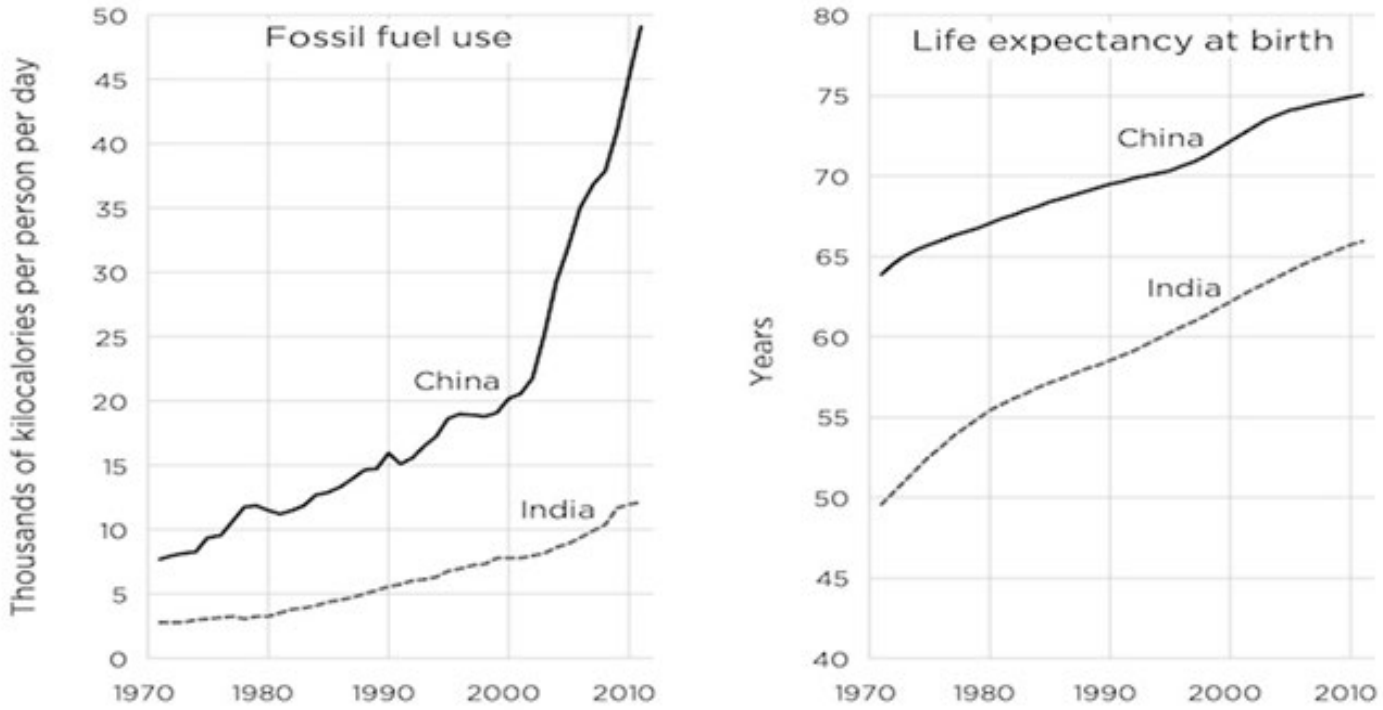

Figure 4: China and India Fossil Fuel Use and Life Expectancy at Birth, 1970-2010[64]

- Between 1990 and 2010, the percentage of people who lived in extreme poverty (defined as under $1.25/day) was halved.[61]

In terms of life expectancy, U.S. white males could expect to live on average roughly 38 years in 1850, 47 years in 1900 and 76 years in 2008.[62] The world's average life expectancy was 56 years in 1970 and is now 68 years.[63] As energy writer and activist Alex Epstein observes, in India and China over the last 40 years, coal and oil use increased by at least a factor of 5 and both life expectancy and prosperity skyrocketed.

Environmental benefits

Increased usage of carbon fuels and feedstock was directly responsible for environmental and public health benefits ranging from improved air and water quality and sanitation to reforestation.[65] To give a few illustrations:

- Air quality: *Kerosene and heavy oil displaced poor quality biomass fuels* such as firewood and dung that filled houses with soot, particles, carbon monoxide and toxic chemicals (and still kill millions of people today who cannot afford carbon fuels or electricity);

- Water quality: The correlation between increased fossil fuel use and access to improved water sources and sanitation also illustrates the benefits attributable to the countless advances made possible by carbon fuels in terms of sanitizing drinking water and removing and treating sewage.

- Reforestation: Another widespread and large-scale benefit of carbon fuels to which divestment activists are seemingly oblivious is how humanity's increased reliance on resources extracted from below the Earth's surface helped preserve and promote life forms on the surface. A case in point is the relatively recent

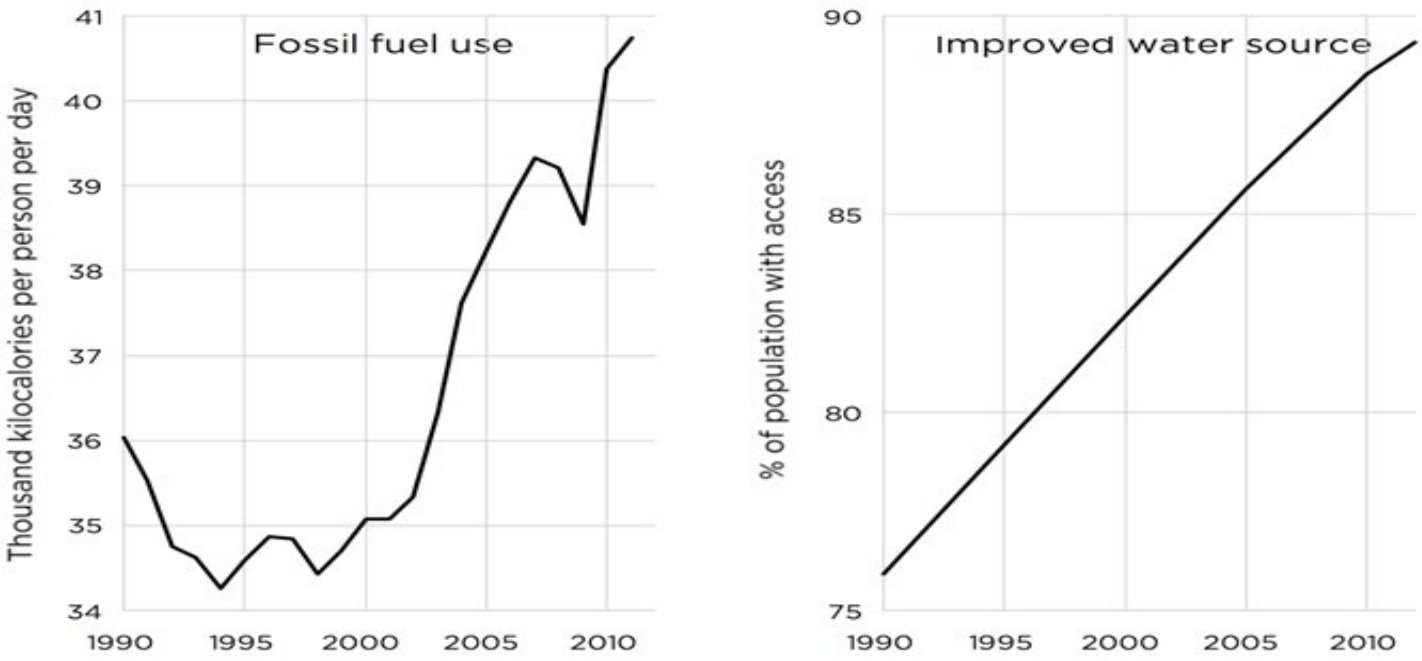

Figure 5: Fossil Fuel Use and Improved Water Source (World), 1990-2010[66]

large-scale reforestation of all advanced economies and of some developing economies (e.g., China, India, Bangladesh and Vietnam) because of carbon fuels-driven advances such as

- *Drastically increased agricultural yields*, i.e., the much larger amounts of food produced on the same piece of land that are attributable to inputs ranging from diesel and synthetic pesticides to plastic sheeting, electricity and veterinary medicine that have made marginal agricultural lands once cultivated through environmentally damaging methods (e.g., slash-and-burn) uneconomical and available for spontaneous reforestation (in most cases) and tree plantations (in a few selected locations);

- *The replacement of work animals* such as horses and mules by tractors and other machinery, which never got sick, did not require care when not being used and did not consume more than a fifth of the food they helped to grow;

- Coal and hydrocarbon-based *synthetic products* displaced many agricultural products from plants grown to produce fibres, dyes and rubber to animals raised primarily for their wool and fur;[67]

- *Large-scale rural migration to cities and the abandonment of marginal agricultural lands*;

- *Increased availability of atmospheric CO_2 for photosynthesis* and (to the extent it can be traced back) a lengthening of the growing season and increasing rainfall since the middle of the 19th century.[68]

While long problematic in terms of localized pollution (e.g., urban smog), coal burning historically relieved much pressure on forested ecosystems by providing a more desirable alternative to (at the time, increasingly scarce) fuelwood and charcoal. The development of synthetic dyes first manufactured out of coal tar, a thick, black, highly polluting residual liquid from the manufacture of gas out of coal (a process later supplanted by the delivery of more

energy-dense natural gas), eventually eliminated the need to extract dyeing matters from plants, roots, berries, leaves, bark and animals (mostly insects and shellfish).[69] Refined petroleum products reduced harvesting pressure on wild resources such as whales (whale oil, perfume base), trees (lumber and firewood), birds (feathers), agricultural products (fats derived from animals and plants, leather from livestock) and other wildlife (ivory, furs, skin).[70] Ironically, increasing the use of (completely natural and organic) fossil fuels turns out to be a crucial component of any successful ecosystem preservation strategy.

- Sanitation: *Cars and trucks removed the need for urban horses*. Apart from their stench and other problems (from their propensity to kill people through kicking and trampling to the concentration of vermin and flies in urban horse stables), horse excrement and carcasses were a source of deadly diseases such as typhoid fever, yellow fever, cholera and diphtheria. In the late 19th century, New York City horses produced well over **four million pounds of manure each day, sometimes piling up to a height of between 40 feet and 60 feet in vacant lots.[71]**

While correlation need not imply causation, none of these advances would have been possible without carbon fuels' superior energy density and other benefits over other real-world alternatives. They liberated human labour and brains from subsistence agriculture and made it possible for creative and hard-working individuals to pursue an ever-wider range of occupations with ever-more diverse, useful and powerful means.

Finally, a common yet profoundly mistaken assumption among environmental and divestment activists is that some power sources and commodities are inherently sustainable because of their renewable character. Unfortunately, human history provides many examples of such resources being exploited unsustainably (e.g., eroded agricultural landscapes, deforestation and the overharvesting of

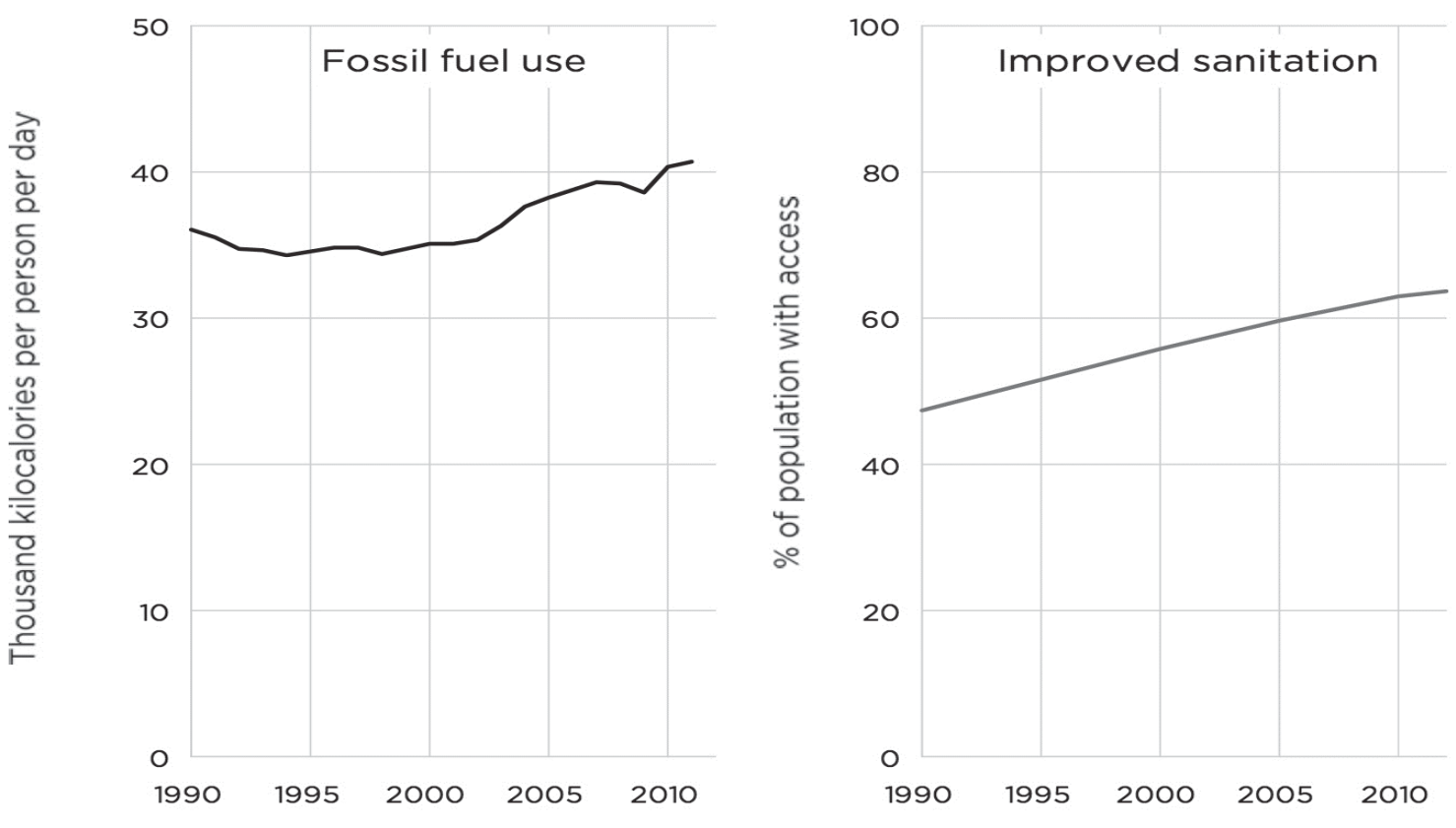

Figure 6: Fossil Fuel Use and Improved Sanitation (World), 1990-2010[72]

wildlife) while not only has the world never run out of non-renewable resources for which there is a significant demand (e.g., minerals and hydrocarbons), but when they are in high demand their supply keeps increasing.[73]

Activists ignoring the undeniable benefits of carbon fuels and focusing almost exclusively on worst-case, hypothetical climate change scenarios are reasons enough to challenge the divestment rhetoric, but there are others as will now be discussed.

3.0 CONVENTIONAL CASE AGAINST FOSSIL FUEL DIVESTMENT INITIATIVES

Several university trustees and administrators in the United States, Canada and elsewhere have made public statements against fossil fuel divestment.[74] In the most comprehensive review of the issue, Rachelle Peterson, the National Association of Scholars' Director of Research Projects,[75] distinguishes three broad categories of reasons to reject divestment demands wholly or partially: 1) *principled* (too political, anti-intellectual, slippery slope); 2) *financial* (cost, donor intent, fiduciary duty); and 3) *practical* (ineffective, does not discriminate among fossil fuel companies, fossil fuels are a necessity, very few peer institutions participating). To summarize and supplement somewhat Peterson's nomenclature, we will now distinguish between principled/moral, economic/financial and other considerations.

3.1 Principled/Moral Arguments

Divestment activists claim the moral high ground by equating fossil fuels with tobacco, arms, apartheid-era South Africa and even slavery.[76] One cannot fail to notice, however, that smoking and slave ownership were never deemed acceptable among anti-tobacco campaigners and abolitionists. Anti-carbon-fuel activists, on the other hand, are in no apparent hurry to divest themselves of smart phones, synthetic rubber bicycle tires, cars, jet fuel, synthetic fabrics and plastics, medicine and countless other products derived from the object of their scorn, a behaviour they rationalize by saying that individuals on their own can't effect much social change. Indeed, far from even suggesting that affluent Westerners cut back on their consumption so that poor people in less advanced economies can boost (if only a little) their energy use on a per capita basis, divestment activists are apparently only required to find time in their (one would like to believe) busy academic schedules to either engage in respectful debate and demonstrations or more-radical actions (e.g., occupying academic administrative offices, shutting down meetings and shouting down speakers with opposite viewpoints).[77]

Yet, if something as significant as planetary survival is at stake, and if one really believes in the existence of competitive, cleaner and renewable alternatives, then why should one not call for an outright boycott of specific fuels and feedstock? Or else, at least commit oneself to a few personal sacrifices, be they forbidding work- and protest-related travel (including daily commuting, attending conferences or rallies and participating in study abroad programs) by car or airplane; lowering campus building temperatures in winter to the minimum required to prevent structural damage; replacing dryers in university residences and facilities by clotheslines; and limiting the use of electricity-powered computers, smartphones, iPads and other devices to perhaps one hour a day? After all, worldwide, approximately 1.2 billion people have no access to electricity; one billion more have access only to unreliable electricity networks and nearly 3 billion people rely on traditional biomass (such as wood and charcoal) for cooking and heating.[78] Besides, asking wealthy activists to experience the low-energy, pastoral and renewable lifestyle involuntarily "enjoyed" by a large number of people strikes us as a valuable educational experience.

Sarcasm aside, as one critic observes, until some personal sacrifices materialize, "[w]hy should [endowment and investment] funds listen to a protest that is not taken seriously by the activists themselves?"[79] To put it in activists' language, how can divestment campaigns revoke a social licence when protesters continue to benefit from the object of their outrage in every aspect of their daily lives? As Harvard University President Catharine Drew Gilpin Faust put it, "Given our pervasive dependence on these companies for the energy to heat and light our buildings, to fuel our transportation, and run our computers and appliances, it is hard for me to reconcile that reliance with a refusal to countenance any relationship with these companies through our investments."[80]

More realistically, could not one expect activists to ask for an end to ALL energy subsidies? After all, in past energy transitions, truly superior alternative technologies did not need a massive dose of direct subsidies, feed-in tariffs and renewable mandates to be delivered to houses and many shovel-ready projects. Besides, the recent massive infrastructure build-up required to usher in a new wireless information and communication age was financed privately. Or could not activists who cannot give up on the idea of subsidizing the development of better alternatives at least acknowledge that in the meantime the only proven ways to reduce CO_2 emissions while delivering scalable and reliable electric power are limited to uranium (nuclear), water (hydroelectric) and (fracked) natural gas power?[81]

Another fundamental problem with the divestment campaign is that activists have singled out publicly traded corporations and ignored their private and state-owned competitors, along with the industry's suppliers and product users (be they corporate or individual consumers). Yet in 2014, nationalized firms in countries such as Venezuela, Saudi Arabia, Iran and Russia held 97.57 per cent of worldwide proven reserves among the 20 largest oil companies,[82] to say nothing of the fact that they displayed more-problematic environmental and social records. Another issue is that most of the CO_2 emissions associated with carbon fuel come from the combustion stage rather than the production stage. For instance, in the case of most liquid fuel, tailpipe exhaust accounts for 70 per cent to 80 per cent of all greenhouse gas emissions, with the remaining portion traced back to upstream production, refining and distribution.[83]

In the end, as many critics and academic trustees have observed, an academic institution exists to serve its educational and research missions. Its endowment funds are typically raised for this purpose and the divestment of assets for reasons unrelated to the endowment's financial performance will hinder an institution's ability to fulfil its fundamental roles. For example, assuming that university administrators remove fossil fuel stocks from their endowments' portfolios for moral – as opposed to economical – reasons, then some of the main victims of lower financial returns will be future students when fewer resources are available for financial aid, and teaching and research support. Divestment campaigners further disregard the intent of the donors whose goal was to support education and research rather than radical political actions. They also disregard the chilling effect upon free speech and the open debate of an official stance on a controversial issue as well as how such a campaign unavoidably opens the doors to the politicization of any number of legitimate debates. Politicizing controversial issues might also in time result in some form of societal and political backlash against the fiscal privileges and financial support of institutions of higher learning that are expected to be politically neutral. Last but not least, assuming that divestment activists succeed in making carbon fuel energy more expensive and/or scarce, the main victims will be people of lesser means who in all advanced societies include a fair portion of students.

3.2 Economic/Financial Arguments

Although many activists originally marketed their campaign as a way to hurt the bottom line of fossil fuel producers by reducing share prices, impeding access to capital and curbing overall fossil fuels use, most now acknowledge that their actions cannot generate these outcomes.[84] First, viewed in the context of global financial markets, university endowments are insignificant players with minimal resources directly invested in energy stocks while most traditional investors do not believe the stranded asset rhetoric.[85] As long as financial returns in the carbon-based energy sector remain attractive, politically motivated academic divestment actions amount to making a tiny fraction of a drop in an oil barrel available at discounted prices to other buyers and perhaps even to targeted corporations that might want to buy back some stocks through retained earnings. Furthermore, even if divestment campaigns could somehow lower stock prices, this result would have no

impact on either a profitable corporation's bottom line or its ability to raise capital for promising projects. On top of this, assuming that divestment campaigners were able to revoke the social licence of publicly traded carbon energy producers in a context where the demand for their products remained high, the main beneficiaries would be competing government and privately owned producers untouched by activists' actions.[86]

From an academic endowment manager's perspective, a fossil fuel divestment strategy presents at least four types of financial problems: 1) higher risk (through reduced diversification); 2) lower returns; 3) higher management/ transaction fees; 4) potential loss of access to the best managers.[87] In short,

> (#1) Wishful thinking aside, carbon fuels will remain indispensable for decades to come. Conventional fuel stocks should therefore remain part of the diversification strategy of any large academic endowment;
>
> (#2) While coal, petroleum and natural gas stocks have not performed well in the last few financial quarters, past reliable returns and the cyclical nature of the industry suggest that institutions that divest from them might suffer a financial penalty in both the medium term and the long term.[88] Of course, financial managers may wish to divest – in most cases temporarily – from such stocks depending on their analysis of specific companies and previsions of future commodity prices. Such cases, however, should not be listed as victories by activists whose rationale is moral rather than economic;
>
> (#3) Most conventional energy stocks owned by university endowments are managed through commingled investment funds in which different kinds of stocks owned by different institutions are mixed together. Managers of such funds are unlikely to screen out fossil fuels on the basis that other investors might object to this stance or that it might open the door to the screening of many other investments most people save a few activists view as legitimate (e.g., agribusiness or pharmaceutical stocks). University endowment managers who would nonetheless like to exit these funds would need to pay substantial management/ transaction fees to transfer their funds to specialized (typically more expensive and less performing) index funds that screen out specific investments;
>
> (#4) Because the best fund managers may be unwilling to see their freedom of action constrained by activists, they might be unwilling to oversee university endowment funds.

3.3 Other Considerations

Other arguments raised by critics of the divestment campaign include the following:

- Past divestment campaigns had nowhere near the impact claimed by activists. For instance, there is little to no evidence that they played a significant role in bringing down apartheid. The authors of a comprehensive study on the topic even suggest, "[L]egislative/shareholder pressure or voluntary corporate divestment from South Africa had little discernible effect on the valuation of banks and corporations with South African operations or on the South African financial markets."[89] Similar, albeit to our knowledge less documented, claims have been made about the tobacco divestment movement of the 1990s with some financial professionals suggesting that temporarily discounted share prices provided an opportunity for targeted corporations to buy back their shares. Other investors who purchased discounted tobacco stocks were also reportedly able to beat the market over the next decade;[90]

- In the eyes of prominent environmentalists (including a number of reputable academics), the fact that the divestment campaign does nothing to curb fossil fuel

use means it is nothing more than a distraction or diversion from more-effective regulatory and fiscal approaches to reducing greenhouse gas emissions;[91]

- The divestment campaign will do nothing to alter conventional energy producer behaviour, as they will have no incentive to heed the suggestions and wishes of ex-investors. Academic investors, it is argued, could achieve better results by engaging with these corporations rather than by divesting from them;[92]

- One of the core missions of academic research institutions is to help create new knowledge. This is where they can play a useful role, sometimes by relying on the financial returns earned by their endowments.

4.0 ON SUSTAINABILITY INITIATIVES THAT IGNORE MARKET PROCESSES

An alternative strategy pursued by most university trustees and administrators who have declined to divest from fossil fuels has been to further promote studies and initiatives related to sustainable development,[93] often by increasing the resources allocated to courses, task forces and dedicated offices devoted to the topic. Apart from the hiring of additional human resources, academic commitments to this goal typically include the production and/or purchase of alternative energy sources (typically wind- and solar power-generated electricity and the building of geothermal infrastructure) or carbon offsets and the adoption of (allegedly) green construction techniques and recycling programs on campus.[94]

Unfortunately, while much of today's sustainability rhetoric revolves around meeting the needs of the present without compromising the ability of future generations to meet their own needs, it is typically rooted in a perceived trade-off between profit-driven, business as usual practices and environmental protection. Indeed, the core problem in the eyes of most sustainable development theorists and activists is that the profit motive imposes a short-sighted perspective and rewards business people for reducing costs by increasing polluting emissions. Cut-throat competition also reinforces monopolistic and ultimately unsustainable (because of non-renewable and CO_2 emitting) large-scale industrial processes over local, artisanal, renewable and "natural" alternatives.

As will now be argued, however, proponents of sustainable development typically misunderstand the scope of the incidental environmental benefits spontaneously delivered by market processes.

4.1 Fundamental Problems of Sustainability Initiatives[95]

The Canadian engineer and communist activist H. Dyson Carter observed nearly eight decades ago that commercially successful inventions must display at least one of the following characteristics: save time, lower costs, last longer, do more, work better and sell more easily.[96] While not all of these characteristics have environmentally beneficial implications, most do. In other words, a generally sustainable feature of successful innovations is that they must create smaller or less important problems than those that existed previously did.[97] Furthermore, far from rewarding wasteful and polluting behaviour such as reducing production costs by releasing polluting emissions, the profit motive has long rewarded corporations that turned these emissions into valuable by-products, thus creating both economic wealth and environmental improvements.[98] Apart from synthetic dyes (originally manufactured from coal tar) already discussed in section 2, one could also mention the large accumulation of cottonseeds, which were once an unmitigated nuisance that fouled the air and water and attracted vermin, which in time became cattle feed, fertilizer, table food and a feedstock for a wide range of products (including mattresses, explosives, cosmetics, battery boxes, baseball filler and cellophane)[99] before many of these were replaced by alternatives manufactured from what had once been petroleum refining residuals.

Indeed, the phenomenon was so widespread that in the third volume of his *Capital*, first published in 1894, Karl Marx observed that the "capitalist mode of production extends the utilisation of the excretions of production and consumption" and that the "so-called waste plays an important role in almost every industry." Like analysts before and after him, he observed that this reworked waste "reduces the cost of the raw material to the extent to which it is again saleable, for this cost always includes the normal waste, namely the quantity ordinarily lost in processing," which ultimately "increases *pro tanto* the rate of profit." Marx even viewed industrial waste recovery as "the second big source of economy in the conditions of production," after production efficiencies arising from economies of scale.[100]

One can get a glimpse of the wide range of useful substances created from industrial residuals in the 19th and early 20th century in a 1919 figure drawn by the prominent U.S. animal ecologist Victor E. Shelford.

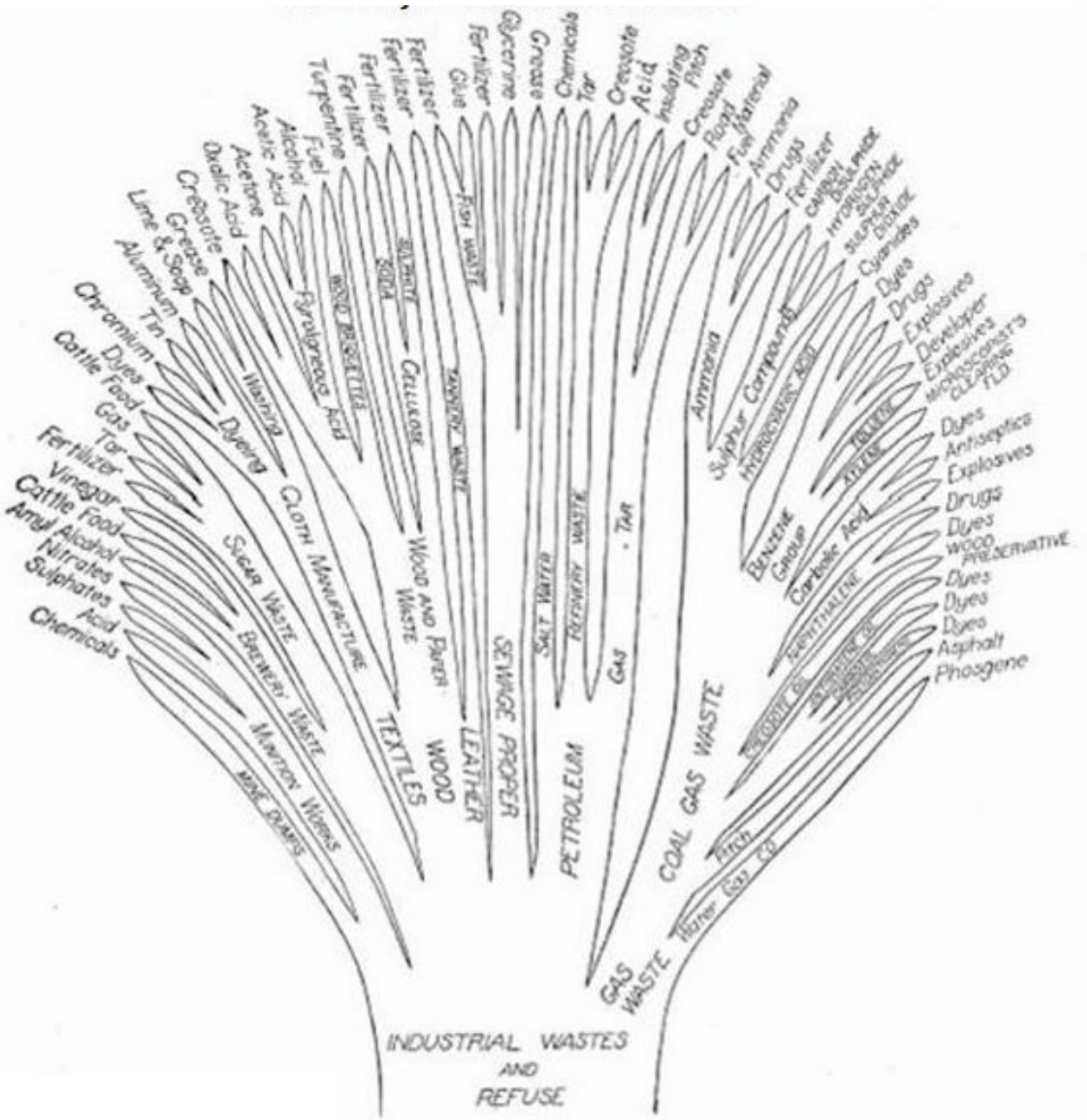

Figure 7. In the form of a tree, the various wastes and the useful substance into which they may be manufactured or which may be obtained from them.[101]

One can also look at more-recent advances in much-maligned coal-burning technologies to illustrate the environmental benefits of economically profitable innovations. Suffice to say that fluidized bed combustion and pelletized coal burned at high temperatures is now so efficient that the only unwanted heat loss takes the form of conduction through furnace walls. Far less soot is emitted than in the past, and it can be scrubbed before it leaves the power station. The ashes can be turned into bricks.[102]

In short, much evidence suggests that the most successful corporations have always been the most efficient and innovative ones. In the words of businessman Charles G. Koch:

> *It is easy to fall into the trap of a single-minded emphasis on cost reduction. Cost is only one component (although a critically important one) of value creation. If your goal is to lose weight, you could accomplish this by cutting off your leg, but that is hardly beneficial. Cost-cutting for its own sake can be just as shortsighted and can seriously damage future profitability. It is more appropriate to focus on eliminating waste.*[103]

Scientist Jesse Ausubel synthesizes much data on the topic as follows: "Pollution and waste usually indicate inefficiency. In an economy of competing companies, inefficiency is for losers. So, over the long run, successful companies are going to be green and clean."[104] Mikhael Bernstam, economist and demographer, suggested in his comparative work on the diverging environmental performance of market (e.g., the United States) and centrally planned economies (e.g., the Soviet Union) that over time the former became wealthier and cleaner while the latter stagnated or even regressed while becoming increasingly polluted because the elimination of waste, rather than increased production or consumption, ultimately determines the impact of economic growth on the environment.[105] In other words, when the growth in output exceeds the growth in resource input required, increased material wealth will be created while pollution levels decline. By contrast, a poorer economy that uses a smaller amount of resources less efficiently will experience greater environmental damage. As such, there has never been a direct relationship between greater population number and material affluence, on the one hand, and greater environmental degradation on the other.

Apart from having long rewarded increased efficiency of material use and the development of valuable by-products out of industrial waste and pollution, the profit motive has also encouraged the development of less problematic inputs with incidental environmental benefits, such as whale oil being supplanted by coal gas and kerosene, which were themselves displaced by the incandescent light bulb. Similarly, biomass (fuelwood and charcoal) and wind power were displaced by coal (steam engine), itself later superseded by electric power obtained by burning coal (a more efficient use of the resource), heavy oil or natural gas or else through hydroelectric- or nuclear-power generation.

During the ascendency of carbon fuels, the sun shone, the wind blew, the tides rolled, and there was plenty of molten rock under humanity's feet (geothermal energy). Many kinds of biomass were harvested, and many people experimented with alternative ways of generating heat and torque. To give a few illustrations:

- Henry Ford originally wanted to run his Model T on ethanol;
- Wind-powered water pump manufacturers marketed their wares by pointing out that farmers who used them did not need to spend money on fuel;
- Electric cars dominated the automotive market at the turn of the 20th century.

Yet, alternative power sources were soundly defeated in the marketplace by carbon fuels, because of trade-offs that are still relevant today. Writing in 1838, U.S. economist Francis Wayland observed that water power – all of which would now be classified as small scale – could be capable

of "exerting great mechanical force" when "cheap [and] tolerably constant." Unfortunately, it could only be used "in situations where it has been created by nature," which were often "at a considerable distance from the seaports whence the manufacturer derives his supplies, and whence he exports his products," thus often adding significant transportation costs to the price of manufactured goods. Furthermore, water could not always "be commanded in sufficient quantity" and "[v]ery few mill-seats [were] secure from the liability to suffer from the want of water" such as in "seasons of drought" when "a large number of the laborers must be unemployed, and a large portion of the expenses of the establishment must be incurred, without yielding any remuneration to the proprietor." Water power was also liable to "dangers from inundation."[106] Of course, severe freezing conditions would also have been problematic.

The British economist Richard Jones commented at about the same time that while water power was "cheap," it was also "uncertain" which is why "more certain and continuous" – and in most cases more powerful – coal-powered steam engines proved more desirable.[107] Wayland went further and observed that while steam engines were more costly (mostly because of the price of the engine, fuel and maintenance), the advantages of coal-powered steam engines over water wheels were overwhelming. Steam power, he remarked,

- could be used "to create any required degree of mechanical force;"
- was "perfectly under human control;"
- could "be created in any place where fuel can be obtained;"
- could "be used at will, either as a stationary, or a locomotive power;"
- could "be made to act with perfect regularity."[108]

In later decades, technical advances of all kinds led to a significant expansion of large-scale water power in many parts of the world. For instance, the development of better turbines made it possible to harness much more powerful rivers. As one contemporary observer put it, the development of Niagara Falls had occurred to many people long before the end of the 19th century, "but with the [water] wheels then available it was like trying to bind a giant with a thread."[109] Needless to say, the use of concrete for the building of dams and the development of electricity (as opposed to the ropes, wires and transmission belts used in older mills) were also instrumental in harnessing the power of rivers and lakes once too remote and inaccessible, yet extremely reliable and powerful in terms of water supply, over ever-longer distances. While governments subsidized some of these projects, hydroelectric output proved an economically viable proposition from the turn of the 20th century onward and now accounts for approximately 6.8 per cent of global primary energy consumption.[110] Increased demand for electricity and a limited number of suitable sites, however, meant that in most jurisdictions during that time period, most of the electricity supply was derived from coal and natural gas and, for a time, heavy oil. (Of course, nuclear power also proved significant in a few locations.)

Nothing of the sort happened with wind power, once used to power mills and pump water. In 1865, the economist William Stanley Jevons elaborated on the advantages of coal-generated steam over this older way of doing things.

> *The first great requisite of motive power is, that* it shall be wholly at our command, to be exerted when and where and in what degree we desire. *The wind, for instance, as a direct motive power, is wholly inapplicable to a system of machine labour, for during a calm season the whole business of the country would be thrown out of gear. Before the era of steam-engines; [sic] windmills were tried for draining mines; [sic] "but though they were powerful machines, they*

> *were very irregular, so that in a long tract of calm weather the mines were drowned, and all the workmen thrown idle. From this cause, the contingent expenses of these machines were very great; besides, they were only applicable in open and elevated situations."*[111]

Jevons further added, "No possible concentration of windmills" could ever "supply the force required in large factories or iron works."[112] With coal, on the other hand, "almost any feat is possible or easy" and going without it would mean his contemporaries would have been "thrown back in the laborious poverty of earlier times."

None of the key problems of wind power highlighted over a century and a half ago by Jevons has been solved. True, in the name of sustainable development, governments the world over have promoted the use of wind turbines, but as the worldwide failure of green energy schemes illustrates, modern economies cannot be built on a foundation of countless, little, distant, costly, intermittent, unreliable and low-density power sources. Indeed, even the pitiful percentages of the commercial energy picture now accounted for by wind (3 per cent of total world electricity generation) and solar (0.8 per cent) power generation[113] are entirely attributable to massive government support in the form of artificially inflated feed-in tariffs, the building of increased transmission capacity (to deliver electricity produced in distant locations where wind conditions are somewhat less problematic) and back-up power generation (ideally natural gas or hydroelectric power that can be quickly turned on and off). If this were not bad enough, their environmental impact in terms of land use per unit of power produced and bird and bat mortality is significant.[114]

The key problems of wind (intermittency and low-power density, to say nothing of costs) have also plagued solar power generation and made it an even less attractive option. True, some news reports claimed that in 2014 Germany produced half of its electricity – although many commentators confused this figure with total energy use, which would include hydrocarbon-powered transportation – with solar power. Citing analysis by the Fraunhofer ISE research institute, however, analyst Vaclav Smil observed that this peak usage "lasted for only 1 hour" and that this "record share (50.6 percent) was due not only to hot, sunny weather but that day being a public holiday with lower than normal demand – and, most fundamentally, to the fact that solar and wind have legal priority over fossil fuels and when available must be used to the maximum possible extent."[115]

The well-known shortcomings of trendy renewable power sources also defeated Google's Renewable Energy Cheaper than Coal (RE<C) initiative launched in 2007, an effort to drive down the cost of renewable and clean energy with a particular emphasis on geothermal and solar power technology.[116] In 2011, Google executives announced that they were retiring the initiative and sharing its key findings, and yet they vowed to continue supporting renewable energy in other ways.[117] One such initiative, the Ivanpah Solar Electric Generating System (ISEGS), was the world's largest solar thermal plant, which was launched in February 2014 in California's Mojave Desert.[118] Not surprisingly, the project soon proved problematic in many respects, not the least of which was that the contract price per unit of power was almost four times more expensive when compared with new photovoltaic plants.[119] According to one report, after 15 months of operation, the plant generated only 40 per cent of the expected electricity due to both technical difficulties and cloudy weather.[120] As with all wind- and solar power-generating technologies, the tower not only required much petrochemical feedstock for both its construction, maintenance and back-up power, but it also consumed huge amounts of natural gas in order to generate steam before sunrise. On top of this, according to a report the plant kills approximately 3,500 birds per year.[121] As of this writing, ISEGS was facing default on its contracts, as two of the three units could not meet the 70 per cent threshold required in the first two years.[122]

Another little-appreciated fact is that among non-hydroelectric renewable power sources, wood biomass (e.g., burning wood pellets or logging and wood-processing

wastes) is usually dominant when available because it does not display some of the key shortcomings of wind and solar technologies (most notably intermittency). For instance, in 2012, about 47 per cent of the electricity generated from renewable technologies in the European Union came from wood, with figures ranging from 80 per cent in Finland and 52 per cent in Sweden to approximately 36 per cent in Germany.[123] In some countries such as the United Kingdom, wood pellets need to be imported from North American and Russian forests in order to meet renewable quotas (and much evidence suggests that further biomass will likely be imported from Brazil in the near future).[124] Smil also calculates that, because of their inherent limitations (mainly the intrinsically low extraction power density of liquid fuel from biomass), substituting ethanol and biodiesel would require up to 10,000-fold more cultivation area than that currently occupied by oil-extracting and producing infrastructures.[125] He concludes, "Today's great hope for a quick and sweeping transition to renewable energy is fuelled mostly by wishful thinking and a misunderstanding of recent history."[126]

Unlike energy transitions achieved by spontaneous outcomes of market processes through many trials, errors and failures, subsidized (and otherwise uneconomic) jobs in the wind, solar and biomass sectors created through renewable energy mandates come at tremendous economic costs, including massive job destruction in other economic sectors where manufacturers must pay (often significantly) higher rates for a less reliable power supply. Besides, wind, solar, tidal and geothermal alternatives are neither substitutes for petroleum products in the transportation sector (including the production of road asphalt) nor feedstock for the creation of countless synthetic by-products. While biomass can be turned into ethanol, biodiesel or plastics, none of these products is either technologically preferable or scalable enough to meet more than a tiny fraction of the overall market demand currently supplied through petroleum and natural gas-derived feedstock.[127]

The bottom line is that sustainability proposals based on technological approaches once discarded by decentralized and incremental market processes are preordained failures. What activists and theorists misunderstand is that market outcomes are not determined by ruthless displays of corporate power but by a selection process in which alternative technologies are pitted against each other, with the best (or least bad) in terms of a wide range of trade-offs eventually being adopted and continually improved upon. Wishful thinking is unfortunately no corrective to the fact that reality is not optional.

A more detailed academic case study will further illustrate how promoting once-discarded approaches now deemed more desirable because of their local and renewable nature can never live up to the hype.

4.2 Academic (Un)Sustainable Mirages: A Middlebury Case Study

The American College & University Presidents Climate Commitment (ACUPCC) was established in 2006 as a "high-visibility effort" to address "global warming by garnering institutional commitments to neutralize greenhouse gas emissions, and accelerate the research and educational efforts of higher education to equip society to re-stabilize the earth's climate."[128] According to a 2014 annual report, 679 institutions representing 41.6 per cent of all U.S. students had signed the commitment, and 82 per cent argued that their Climate Action Plans had saved their institution money.[129]

Middlebury College, a leader among such institutions, made a commitment in 1999 to become carbon neutral.[130] Founded in central Vermont in 1800 and boasting an enrolment of approximately 2,500 undergraduate students,[131] the elite private liberal arts college announced in 2007 an ambitious Carbon Neutral by 2016 initiative, which vouched to either offset or eradicate 100 per cent of the campus carbon emissions.[132] This goal was to be

achieved through a combination of energy conservation and efficiency measures, renewable fuel sources, technological innovations and educational efforts.[133] The measure that encapsulated most of these actions was the building of a heating and cooling system powered by wood chips, a local, renewable and carbon-neutral fuel. Middlebury trustees approved the financing for the biomass system in October 2006 with the expectation it would be operational by the fall of 2008. This project, it was argued, would allow the college to cut in half its annual consumption of nearly two million gallons of #6 fuel oil, thus getting it much closer to its initial carbon emission reduction goal of 8 per cent below 1990 levels by 2012.[134]

Almost immediately, however, reality intruded with the cost-benefit analysis used to justify the construction of the biomass gasification plant. In short, the plant opened in February 2009 and required almost 20,000 tons of local biomass (i.e., local trees harvested within a 75-mile radius of the campus) per year.[135] The actual construction cost turned out to be $12-million, more than five times the original 2003 student report estimate,[136] and it ended up consuming the equivalent of about 4 per cent of the 2013-2014 college-operating budget of $292-million.[137] Proponents of the plant had also seriously underestimated its annual operating costs, which included six operators' annual compensation and benefits ($457,805), annual maintenance fees ($50,000) and wood pellets feedstock ($925,000), for a total of $1.43-million. Other costs such as repairs, additional fuel oil required during the maintenance period and removal of wood ashes also proved much more significant than originally budgeted for.[138]

Middlebury administrators also launched many other sustainability projects and environmental initiatives that required additional staff and faculties. According to a National Association of Scholars' report, the institution's annual sustainability costs amounted to $4.9-million, which, apart from operating the biomass plant and other material expenses, included $2.5-million in faculty and staff salary and benefits.[139] Perhaps because of the ideological nature of many of these endeavours, Middlebury administrators appear to have significantly underestimated their cost and overestimated their benefits. While such initiatives might attract millions of dollars of outside grants from private foundations and donations,[140] achieving true carbon neutrality while propping up uneconomical capital projects must always come at the expense of other worthwhile enterprises.[141]

According to the 2014 annual report of Second Nature, more than 400 universities and colleges (about 60 per cent of institutions signed the ACUPCC) reduced on average their gross greenhouse gas emissions by 21 per cent while annually producing more than 500 million kWh of renewable energy.[142] This being said, one needs to wonder whether these results actually passed a basic cost-benefit test and whether society really benefitted from (in all likelihood) purchasing renewable electricity at inflated prices. What if this money had instead been spent on supporting students of lesser means, research activities, academic support services or community programs with real benefits? What if the student courses and homework time, and staff attention and faculty research that was devoted to carbon neutrality had been redirected toward more-timeless pursuits, from public health to literacy initiatives?[143]

Carbon neutrality sounds benign and simple enough, yet according to the authors of a critical National Association of Scholars' report, it is often "something of an economic black hole" as "[f]ull elimination of carbon emissions requires an expensive overhaul of campus life."[144] Furthermore, as will now be argued, our current carbon obsession is likely blown out of proportion.

5.0 CARBON FUELS, CLIMATE CHANGE AND THE PRECAUTIONARY PRINCIPLE

Divestment activists' rationale for their actions is that dramatic and irreversible man-made global warming is a scientifically established fact endorsed by a near consensus of climate scientists, which can only be dealt with through drastically curbing conventional energy production. This set of beliefs can be challenged in several ways,[145] but arguably, some of the most salient points in the context of this paper include the following:

- 350.org and divestment activists' threshold for the "safe" level of CO_2 rests on the work of one scientist and his collaborators.[146] This threshold was passed more than 25 years ago and is now exceeded by a significant margin, yet no climate calamity ensued.[147] Indeed, much of the data show no global average temperature rise in satellite data[148] or inconclusive changes (usually within the margin of error) in surface temperature data.[149] The notion of a threshold or a tipping point in the context of climate change is also questionable, at least inasmuch as the Earth has been both much warmer and much colder in the past than is presently the case, yet neither extreme proved irreversible;

- The only proven ways to reduce carbon dioxide emissions are either economic collapse (as occurred in Eastern Europe after the fall of the Berlin wall) or the large-scale substitution of coal by nuclear, hydroelectric and (fracked) natural gas technologies. Activists who oppose these substitutions and recommend instead unreliable technological or bureaucratic alternatives with no actual proven track record of reducing CO_2 emissions do not take their own climate alarmist rhetoric seriously;

- Individuals such as Canadian author and columnist Murray Dobbin who believe in "the slow motion apocalypse of global climate change" and who think that "the ever-increasing production and use of fossil fuels will, over time, kill billions of us and irreversibly change all life on the planet"[150] are blissfully unaware that there would not be billions of us and as many trees and as much wildlife to save now without the historical development and large-scale use of carbon fuels. While the fear of catastrophic climate change remains theoretical, humanity going off carbon fuels in the absence of less problematic alternatives guarantees, among other deplorable outcomes, a large death toll in less advanced economies, a growing number of economically vulnerable individuals being pushed into energy poverty[151] in advanced economies and significantly higher extractive pressures on all of our planet's ecosystems;

- Computer-simulated scenarios do not generate evidence, and they are the sole source of belief in "runaway global warming" (i.e., beyond the parameters of natural climate variability) and its attending rapid sea level rises, extreme weather events, desertification, species extinction and ocean acidification.[152] As climate scientist Judith Curry further reminds us, the "climate models making dire predictions of warming in the 21st century are the same models that predicted too much warming in the early 21st century, and can't explain the warming from 1910-1945 or the mid-century grand hiatus."[153] Taking drastic actions against carbon fuels on the basis of a remotely possible – and arguably highly unlikely – threat when there is absolute certainty as to the devastating economic, social and environmental impact of these actions is not a sensible course of action;

- As long as our planet's orbital mechanics, the sun, and many other factors still affect our climate, eliminating carbon fuels will not stop cooling or warming trends nor, more importantly, extreme weather events (e.g., torrential rains and their resulting floods, droughts, hurricanes, tornadoes and unseasonable warmth and cold). As in the past, though, some individuals

would still undoubtedly blame natural fluctuations and extreme weather on anthropogenic causes. After all, these were once attributed to insufficient offerings to the gods, witchcraft, deforestation, the invention of the lightning rod and wireless telegraphy, cannon shots in the First World War, atomic tests, supersonic flights, nuclear testing and air pollution.[154] While many of these causes now strike us as utterly implausible if not risible, geologist Ian Plimer reminds us, "[O]nly one molecule of every 85,000 in the atmosphere is CO_2 of human origin, and yet we are asked to believe that this one molecule drives hugely complex climate change systems. We are also asked to believe that the 32 molecules of CO_2 of natural origin in every 85,000 molecules play no part in driving climate change."[155]

It is also worth observing that, far from being a game changer in terms of "how we live" and "how our economies function" as Canadian celebrity journalist Naomi Klein suggests,[156] the theory of anthropogenic climate change is but the latest in a long line of environmental crisis scenarios in which humanity is indicted for increasing its numbers and wealth at the expense of the environment and for which some form of economic degrowth (including reduced population numbers) is the only acceptable solution. In the first decades of the 20th century, the dominant issue in this literary genre was soil erosion, which was (paradoxically) blamed on agricultural practices that many now deem more sustainable (i.e., no fossil fuels or genetically modified crops, more labour-intensive practices, etc.). As ornithologist William Vogt put it in 1948 in the biggest environmental best-selling book until the publication of Rachel Carson's *Silent Spring* in 1962:

> *Fire, the ax, the plow, and firearm have been the four fundamental tools of our modern culture, and in some of the most fertile and productive regions of the earth they have raised the environmental resistance to such a height that the carrying capacity has been brought nearly as low as that of the Gobi or the tundra of Siberia. Hundreds of millions of acres of once rich land are now as poor as – or worse than – the city gardener's sterile plot. Despoiled forests, erosion, wildlife extermination, overgrazing, and the dropping of water tables are unforeseen and unwanted by-blows of a vigorous and adolescent culture on the loose.*[157]

"We must accept change," Vogt wrote, and "adjust our lives to it, if we are to survive," for a failure to understand some basic relationships "of man with his environment" would "almost certainly smash our civilization."[158] His prescription was twofold: 1) revert as much as possible to the use of renewable resources that should be used on a sustained-yield basis; 2) implement population control programs in order to adjust so that limited natural supplies could provide an acceptable (if lower) standard of living.[159]

Four decades later, population biologist Paul Ehrlich – who had first been introduced to this perspective by Vogt – published his best-seller *The Population Bomb*, in which he warned that the "battle to feed all of humanity is over" and that in the "1970's the world will undergo famines – hundreds of millions of people are going to starve to death in spite of any crash programs embarked upon now."[160] He added, "Nothing could be more misleading to our children than our present affluent society" and that in order to save tomorrow "[w]e must use our political power to push other countries into programs which combine agricultural development and population control. And while this is being done we must take action to reverse the deterioration of our environment before population pressure permanently ruins our planet."[161]

In 1980, geographer William Dando wrote in his book *The Geography of Famine* that most climatologists and a declassified Central Intelligence Agency report agreed that because of human-caused air pollution, our planet was "entering a period of climatic change" that had already resulted in "North African droughts, the lack of penetration of monsoonal rains in India and seasonal delay in the onset of spring rains in the Soviet Virgin Lands wheat area." *Global cooling* (our italics), Dando told his readers, was

"the greatest single challenge humans will face in coming years" because it would soon trigger "mass migration and all-encompassing international famines."[162] Like most people at the time, he also favoured population control and reduced economic activities.

There can be little doubt that this old overpopulation, overproduction, overconsumption and degrowth paradigm is deeply ingrained in the minds of prominent climate change alarmists. For instance, a former chair of the Intergovernmental Panel on Climate Change (IPCC), Rajendra K Pachauri, is on the record as saying that humanity has "been so drunk with this desire to produce and consume more and more whatever the cost to the environment that we're on a totally unsustainable path" and that he was "not going to rest easy until [he has] articulated in every possible forum the need to bring about major structural changes in economic growth and development. That's the real issue. Climate change is just a part of it."[163] Executive Secretary of the United Nations Framework Convention on Climate Change, Christiana Figueres, once said, "We should make every effort to change the numbers," and "obviously less [sic] people would exert less pressure on the natural resources," and humanity is "already exceeding the planet's planetary carrying capacity, today."[164] She added that population control was not enough and that fundamental changes need to be made to our current economic system.[165] Professor Hans Joachim Schellnhuber, director of the influential Potsdam Institute for Climate Impact Research, once estimated the carrying capacity of the planet at "below 1 billion people."[166]

Fortunately, the evidence presented in section 2 shows that critics of this perspective – including some coming from the political left[167] – had been right all along. In the end, free individuals are not only mouths to feed, but also arms to work as well as brains to develop new and better ways of doing things. As the physicist Robert Zubrin asks, who between Louis Pasteur and Thomas Edison should not have been born in order to improve the lot of mankind?[168] And because new ideas are born out of the combination of existing ideas, processes and things, the supply of new beneficial technologies will not only never run out, but it will also expand exponentially.

Finally, while divestment activists and the "climate justice" movement more generally continually invoke the vulnerability of poor individuals to climate change-caused hunger, disease and poverty, they remain oblivious to the fact that economic development and access to abundant and affordable energy is the best way to address these problems by *adapting* to local conditions and trends. After all, wealthy people can live well in climates as different as those found in the cities of Edmonton and Singapore. In short, much historical evidence convincingly shows that humanity's best insurance policy against unavoidable bad weather events and other natural challenges (from earthquakes to agricultural pests) is the greater wealth generated by fossil fuels (e.g., better infrastructure, advanced warning systems, long-distance transportation) and adaptation to whatever its climate effects might be. Indeed, if our planet saw an end to the current "climate pause" and a resumption of global warming, the problems it would create would simply be exacerbations of challenges that have long-plagued humanity. Besides, despite some global warming in recent decades, "aggregate mortality attributed to all extreme weather events globally has declined by more than 90% since the 1920s, in spite of a four-fold rise in population and much more complete reporting of such events."[169] In philosopher Alex Epstein's words: "We do not take a safe climate and make it dangerous; we take a dangerous climate and make it safe."[170] Moreover, even assuming that agricultural producers have to adapt to changing local conditions and look for alternative crops and livestock to earn a living, the fact is that many of them have had to do this over the last two centuries for economic reasons alone.

In the end, the divestment activists' take on the precautionary principle is that in the absence of certainty that global warming is not happening or that greenhouse gas emissions do not exacerbate it substantially, humanity should stop emitting greenhouse gases through the burning of carbon

fuels. This strikes us as a bad gamble, at least inasmuch as outlawing carbon fuel-based economic development will arguably cause far more harm than any predicted climate change scenarios will. One could even suggest that had the divestment activists' stance been taken seriously by our ancestors, humans would still be dwelling in caves without (dangerous and likely to cause much damage) fire and living a more solitary, poorer, nastier, more brutish and shorter existence. Had resistance to change and unwillingness to bear some risks been more significant in the last two centuries, real income, life expectancy and food consumption would be much lower than they currently are, while infant mortality, food prices and hours worked, among other things, would be much higher.

CONCLUSION: SYMBOLISM OVER SUBSTANCE AND RELEVANCE

As it currently stands, the fossil fuel divestment campaign is an exercise in futility in which first-world students (many of whom will belong to the global 1 per cent if they do not already) are given the opportunity to voice their profound concern about saving the planet while avoiding any meaningful personal inconvenience. Indeed, as the leaders of the movement themselves acknowledge, even if successful, their campaign will have no impact on greenhouse gas emissions, climate change or the financial standing of carbon energy producers. What their demonization of conventional energy might achieve if echoed in the policy arena, however, is a hefty price for the middle class in terms of both lost jobs and more-expensive energy bills, a less reliable electric grid, additional significant environmental problems in advanced economies, energy poverty among people of lesser means, lost development opportunities and much greater levels of disease, death and environmental degradation in poor countries.

As we tried to illustrate in this paper, a preponderance of evidence points to the benefits of carbon fuels significantly outweighing any climate risks or side effects as concocted in climate change models. Wealthy activists ignorant of the basic energy realities that make our current standards of living possible may tell energy-starved masses to forgo increasing their carbon footprint in favour of little, distant, costly, intermittent, unreliable and low-density energy cupcakes, but one wishes they would actually experience the reality of the low-energy lifestyle they advocate. Perhaps then, they might come to realize that while small, local renewable inputs and products might seem beautiful, bigger and more-distant carbon fuel-based alternatives are actually preferable for both people and nature. Perhaps, they might also come to understand that, while certainly not perfect, market processes have long been a ruthless selection mechanism in terms of rewarding the development of more efficient and less problematic energy systems and that ignoring the lessons of business and technological history can only deliver a poorer and more environmentally stressed world.

More than anything though, we wish that student activists would rediscover the value of intellectual freedom, spirited yet courteous debate, take the time to educate themselves on all aspects of a particular issue, respect their intellectual opponents and acknowledge that a true education is not about providing a safe space to support and reinforce one's beliefs and feelings but rather to challenge them by, among other means, a more-rigorous education on energy and environmental issues. In addition, once they have accomplished this, perhaps they will consider devoting some of their time and their desire to make the world a better place to addressing more-pressing environmental issues such as alternative energy policies with no redeeming virtues or indoor air pollution and sanitation problems that actually kill many (real) people.

ENDNOTES

[1] For worldwide figures, see Rachelle Peterson, "Inside Divestment," National Association of Scholars, November 2015, https://www.nas.org/images/documents/NAS_insideDivestment_fullReport.pdf; and Fossil Free, http://gofossilfree.org/. As of January 2016, Fossil Free Canada (http://www.gofossilfree.ca/campaigns) listed 27 such campaigns in the country, while the Sustainability and Education Policy Network (SEPN) counted 34 as of February 2015. "The State of Fossil Fuel Divestment in Canadian Post-secondary Institutions," Sustainability and Education Policy Network, February 11, 2015, http://sepn.ca/research_results/research-brief-state-fossil-fuel-divestment-canadian-post-secondary-institutions/.

[2] Throughout this text, "petroleum" and "crude oil" are used interchangeably, as are "fossil fuels" and "carbon fuels." We favour using the latter in light of the controversy over whether hydrocarbons are really of fossil origin, a debate over which we claim neither technical expertise nor strong opinion.

[3] Peterson, "Inside Divestment," 10.

[4] For different perspectives and more-detailed discussions of the history, rhetoric and status of the fossil fuel divestment movement in higher education, see: Peterson, "Inside Divestment"; 350.org, http://350.org/; and a list of Web sites and other resources compiled by the authors at http://geog.utm.utoronto.ca/desrochers/ssm2020a-resources.htm.

[5] Middlebury College, "Author and environmentalist Bill McKibben appointed Schumann Distinguished Scholar at Middlebury College," Middlebury College Communications Office, 2010. http://www.middlebury.edu/newsroom/node/269059.

[6] See Bill McKibben, "Global Warmings' Terrifying New Math," *Rolling Stone*, July 19, 2012, http://www.rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719 and 350.org. To clarify, the 350 ppm ratio refers to the number of carbon dioxide molecules relative to all of the other molecules in the atmosphere. The 350 ratio was suggested by climate scientist James Hansen and his collaborators. See J. Hansen, M. Sato, P. Kharecha, D. Beerling, R. Berner, V. Masson-Delmotte, M. Pagani, M. Raymo, D.L. Royer, and J.C. Zachos, "Target atmospheric CO2: Where should humanity aim?" *Open Atmospheric Science Journal* 2 (2008): 217-231. http://benthamopen.com/ABSTRACT/TOASCJ-2-217.

[7] McKibben, "Global Warmings' Terrifying New Math."

[8] Ibid.

[9] Fossil Free Indexes, "Carbon Underground 2015," 2015, http://fossilfreeindexes.com/research/the-carbon-underground/.

[10] The main goal of a carbon budget analysis (CBA) is to calculate, based on the resulting emissions of greenhouse gases, the amount of coal and hydrocarbons (petroleum and natural gas) that can be burned to stay within the limits deemed safe by some climate theorists. Apart from CTI, the IPCC and the International Energy Agency have made the main contributions in this respect. Carbon Tracker Initiative, "Things to Look out for When Using Carbon Budgets!" October, 2013, http://www.carbontracker.org/wp-content/uploads/2014/08/Carbon-budget-checklist-FINAL-1.pdf is a concise discussion of similarities and differences in approaches to CBA.

[11] See, among others, Malte Meinshausen et al., "Greenhouse-gas Emission Targets for Limiting Global Warming to 2°C," *Nature* 458 (2009): 1158-1162, http://www.nature.com/nature/journal/v458/n7242/full/nature08017.html; and Johan Rockström et al., "A Safe Operating Space for Humanity." *Nature* 461 (2009): 472-475, http://www.nature.com/nature/journal/v461/n7263/full/461472a.html for discussions and other references to the origins of this threshold value.

[12] Carbon Tracker Initiative, "Stranded Assets," http://www.carbontracker.org/resources/. For a critique of this perspective, see Peterson, "Inside Divestment," 179-184.

[13] See James Leaton, "Unburnable Carbon – Are the world's financial markets carrying a carbon bubble?" Carbon Tracker Initiative, 2011, http://www.carbontracker.org/wp-content/uploads/2014/09/Unburnable-Carbon-Full-rev2-1.pdf for more details.

[14] Peterson, "Inside Divestment," 170.

[15] Ibid.

[16] See their perspective at 350.org; and Fossil Free Canada, http://www.gofossilfree.ca/.

[17] 350.org, "The Science," http://350.org/about/science/.

[18] Fossil Free Canada.

[19] Peterson, "Inside Divestment"; and Peterson and Wood, "Sustainability: Higher Education's New Fundamentalism" National Association of Scholars, 2015, 22, https://www.nas.org/images/documents/NAS-Sustainability-Digital.pdf.

[20] Toronto350, "The Fossil Fuel Industry and the Case for Divestment: Update (April 10)," 2015, 1, https://d3n8a8pro7vhmx.cloudfront.net/to350/pages/50/attachments/original/1428958642/fossil-fuel-divest-new.pdf?1428958642.

[21] Ibid.

[22] Ibid., 2.

[23] Ibid.

[24] Ibid., 3.

[25] Fossil Free, "Divestment Commitments," http://gofossilfree.org/commitments/.

[26] Ibid.

[27] Fossil Free; and Tavia Grant, "Campaigns to Divest from Fossil-fuel Holdings Gain Steam." *The Globe and Mail*, June 14, 2015, http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/campaigns-to-divest-from-fossil-fuel-holdings-gain-steam/article24953589/.

[28] Fossil Free.

[29] Ibid.

[30] Ibid.

[31] Peterson, "Inside Divestment," 11.

[32] Fossil Free, "Divestment Commitments."

[33] Peterson, "Inside Divestment," 36.

[34] For a recent discussion and several links to primary documents, see Eunize Lao, "U of T Could Make Divestment History," *Alternatives Journal*, December 21, 2015, http://www.alternativesjournal.ca/community/blogs/current-events/u-t-could-make-divestment-history. In short, the UofT presidential Advisory Committee recommended divesting from companies whose activities were deemed questionable, but not from all carbon energy producers as a "blanket divestment strategy would be unprincipled and inappropriate in the Committee's view." See Bryan Karney, et al., Report of the President's *Advisory Committee on Divestment from Fossil Fuels*, University of Toronto, December 15, 2015, http://www.president.utoronto.ca/secure-content/uploads/2015/12/Report-of-the-Advisory-Committee-on-Divestment-from-Fossil-Fuels-December-2015.pdf. UofT's President Meric Gertler, however, ultimately refused to commit to divesting from some fossil fuel companies (Gertler 2016).

[35] Noelia Gravotta, Matthiew Chehade and Trevor Smith, "Divestment is the Way to Go." *The Link*, November 23, 2015, http://thelinknewspaper.ca/article/divestment-is-the-way-to-go.

[36] *CBC News*, "UBC Divestment Controversy Grows After Alternate Low Carbon Fund Announced," *CBC News British Columbia*, February 3, 2016, http://www.cbc.ca/news/canada/british-columbia/ubc-divestment-controversy-grows-after-alternate-low-carbon-fund-announced-1.3432162.

[37] University Of Oxford, "Oxford University and fossil fuel divestment," Oxford University News & Events, http://www.ox.ac.uk/news-and-events/fossil-fuel-divestment.

[38]Stanford University, "Stanford to Divest from Coal Companies." *Stanford News*, May 6, 2014, http://news.stanford.edu/news/2014/may/divest-coal-trustees-050714.html; Georgetown University, "Georgetown Divests from Direct Investments in Coal Companies," June 4, 2015, https://www.georgetown.edu/news/sustainability-policy-regarding-investments.html.

[39] Peterson, "Inside Divestment," 31.

[40] Ibid., 11.

[41] Peterson, "Inside Divestment."

[42] Anonymous, "Canada's Campuses Emerge as Latest Battleground in Fast-Growing Divestment Movement," *CAUT Bulletin* 62, no. 10 (2015): A5, https://www.cautbulletin.ca/en_article.asp?ArticleID=4120. For a recent overview of the current state of the debate in Canadian universities, see Lao, "U of T Could Make Divestment History."

[43] Quoted on 350.org, "The Science."

[44] BP, "Statistical Review of World Energy 2015," 2015, 41-42, http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf.

[45] Hydroelectric power amounted to approximately 6 per cent. For a more detailed discussion of the issue, see BP, "Statistical Review of World Energy 2015."

[46] See, among other sources, Human Progress, http://humanprogress.org/; Our World in Data, http://ourworldindata.org/data; and The World Economy, http://www.theworldeconomy.org/.

[47] Energy consumption unit : 1 exajoule= 1018 joules, see: http://www.convertunits.com/info/exajoule. Max Roser, "Energy Production & Changing Energy Sources," Our World in Data, 2015, http://ourworldindata.org/data/resources-energy/energy-production-and-changing-energy-sources/.

[48] BP, "Statistical Review of World Energy 2015," 42.

[49] Robert Zubrin, "The Carbon-benefit Deniers," *National Review Online*, September 26, 2014, http://www.nationalreview.com/energy-week/388902/carbon-benefit-deniers-robert-zubrin.

[50] American Fuel and Petrochemical Manufacturers, http://www.afpm.org/policy-positions-petrochemicals/.

[51] James K. Glassman, "Addicted to What?" *Tech Central Station*, February 2, 2006, https://www.aei.org/publication/addicted-to-what/.

[52] See, among others, Vaclav Smil, *Energy in World History* (Boulder, CO: Westview Press, 1994); and Jesse Ausubel, "Where is Energy Going?" *Industrial Physicist* 6, no. 1 (2000): 16-19, http://phe.rockefeller.edu/IndustrialPhysicistWhere/where.pdf.

[53] William Stanley Jevons, "Chapter VIII: Of Supposed Substitutes for Coal," in *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines*, 2nd edition (MacMillan and Co., 1866/1865), http://www.econlib.org/library/YPDBooks/Jevons/jvnCQ8.html#VIII.13.

[54] Of course, fuel oil still plays an important role in heating buildings in a number of regional markets such as, among others, Atlantic Canada.

[55] Pierre Desrochers and Hiroko Shimizu, "Innovation and the greening of Alberta's oil sands," Montreal Economic Institute, October 11, 2012, http://www.iedm.org/41023-innovation-and-the-greening-of-albertas-oil-sands.

[56] Based on Elizabeth Arias, "United States Life Tables, 2008," *National Vital Statistics Report* (Centers for Disease Control and Prevention) 61, no. 3 (September 24, 2012), http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_03.pdf; Patricia Cohen, "Technology Advances: Humans Supersize," *New York Times*, April 26, 2011, http://www.nytimes.com/2011/04/27/books/robert-w-fogel-investigates-human-evolution.html?_r=1; Desrochers and Shimizu, "Innovation and the greening of Alberta's oil sands"; Pierre Desrochers and Hiroko Shimizu, *The Locavore's Dilemma: In Praise of the 10,000-mile Diet* (Public Affairs, 2012); Indur Goklany, "Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Humanity," *Policy Analysis* No. 715 (December 20, 2012), http://www.cato.org/publications/policy-analysis/humanity-unbound-how-fossil-fuels-saved-humanity-nature-nature-humanity; and World Bank, "Data: Poverty," 2015, http://data.worldbank.org/topic/poverty. See these sources for additional data and references. See also Jesse H. Ausubel, "The Return of Nature: How Technology Liberates the Environment," *Breakthrough Journal* 6 (Spring 2015), http://thebreakthrough.org/index.php/journal/past-issues/issue-5/the-return-of-nature, for a recent review of current environmental progress.

[57] For a wide range of statistics on these issues, see the Web sites Human Progress and Our World in Data.

[58] These issues are discussed in more detail in Desrochers and Shimizu, *The Locavore's Dilemma*. In the words of Harvard economist Edward Glaeser (2011: 7), "There is a near-perfect correlation between urbanization and prosperity across nations," as the per capita income in countries with a majority of people living in cities is nearly four times higher than the per capita income in countries where a majority of people still live in rural areas.

[59] Human Progress and Our World in Data.

[60] David J. Spielman and Rajul Pandya-Lorch, *Millions Fed: Proven Successes in Agricultural Development*, International Food Policy Research Institute, 2009, 1-2, http://www.ifpri.org/publication/millions-fed.

[61] World Bank, "Data: Poverty."

[62] Arias, "United States Life Tables, 2008."

[63] World Bank, "Data: Poverty."

[64] Alex Epstein, "How Opposition to Fossil Fuels Hurts the Poor Most of All." *Forbes*, January 14, 2015, http://www.forbes.com/sites/alexepstein/2015/01/14/how-opposition-to-fossil-fuels-hurts-the-poor-most-of-all/#67b92ddd7760. Original data from BP, "BP Statistical Review of World Energy 2013," Historical data workbook, 2013; World Bank, "World Development Indicators (WDI) Online Data," April, 2014.

[65] See, among others, Alex Epstein, "9 Graphs That Prove Using Fossil Fuels Hasn't Harmed the Planet," *Daily Caller*, November 13, 2014, http://dailycaller.com/2014/11/13/9-graphs-that-prove-using-fossil-fuels-hasnt-harmed-the-planet/; Rick Noack, "Watch: How Europe is Greener now than 100 Years Ago," *The Washington Post*, December 4, 2014, http://www.washingtonpost.com/blogs/worldviews/wp/2014/12/04/watch-how-europe-is-greener-now-than-100-years-ago/.

[66] Alex Epstein, "How Fossil Fuels Cleaned Up our Environment," *Forbes*, January 28, 2015, http://www.forbes.com/sites/alexepstein/2015/01/28/how-fossil-fuels-cleaned-up-our-environment/#389cd81c156a. Original data sources: BP, "Statistical Review of World Energy 2013," and World Bank, "World Development Indicators."

[67] Coal was the first significant source of feedstock but was later displaced by petroleum and natural gas.

[68] Craig D. Idso, "The Positive Externalities of Carbon Dioxide: Estimating the Monetary Benefits of Rising Atmospheric CO2 Concentrations on Global Food Production," Centre for the Study of Carbon Dioxide and Global Change, October 21, 2013, http://web.uvic.ca/~kooten/Agriculture/CO2FoodBenefit%282013%29.pdf. Another line of evidence supporting this perspective can be found in NASA/Goddard Space Flight Center, "Carbon Dioxide Fertilization Greening Earth, Study Finds," *ScienceDaily*, April 26, 2016, www.sciencedaily.com/releases/2016/04/160426162610.htm.

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