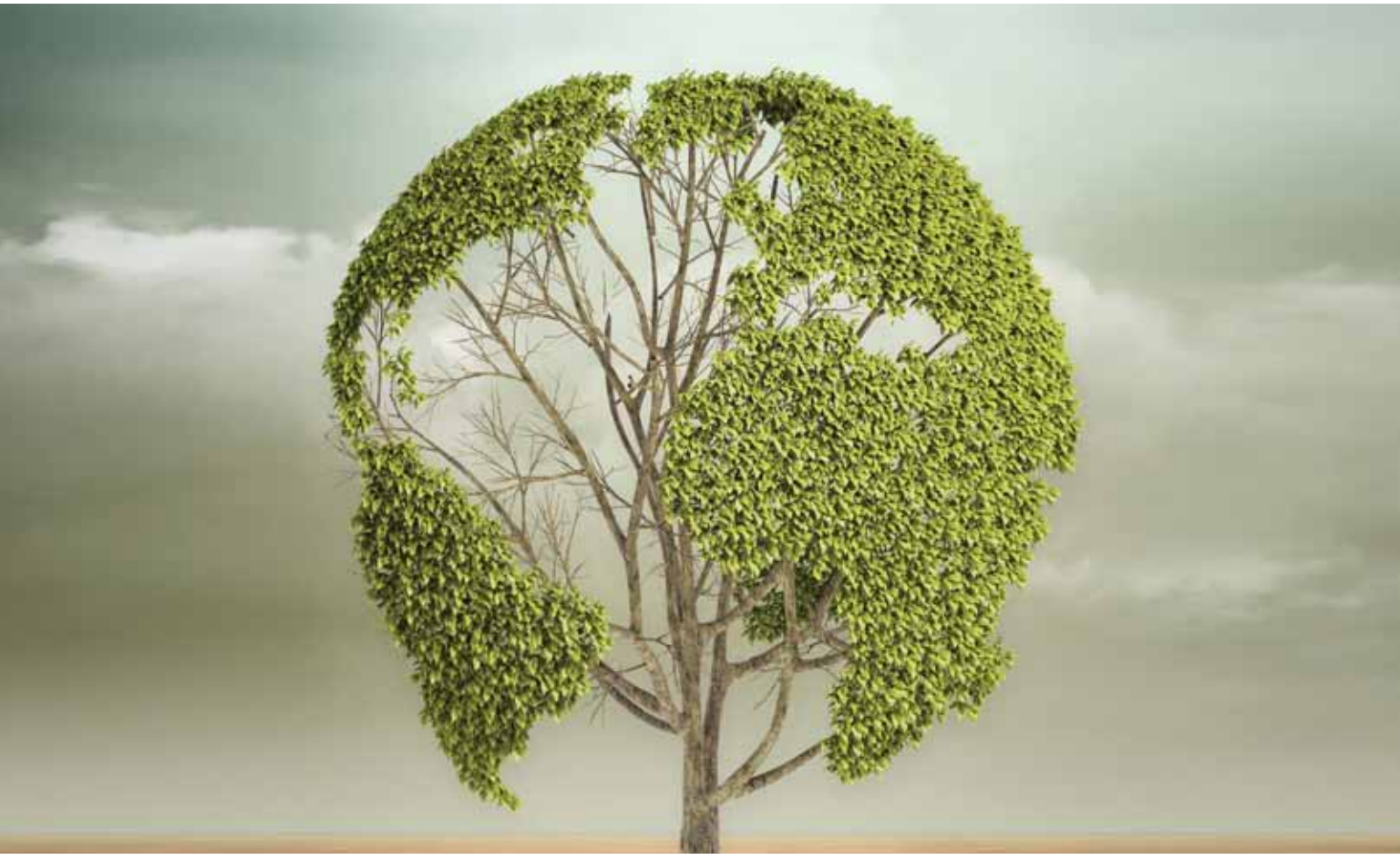

Chapter 18

Pursuing Sustainable Planetary Prosperity

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Executive Summary

China and the U.S. are the two largest consuming nations, their combined gross domestic products (GDPs) comprising one-third of global GDP. The two nations consume one-quarter of world natural gas and one-third of world oil production, and produce nearly two-thirds of world coal. The two nations are also the planet's largest CO_2 emitters, jointly releasing nearly half of the world total.

Business-as-usual scenarios are insufficient to address the acute sustainability challenges that both nations – as well as the community of nations – are facing. However, collaboration in pursuing solutions through unprecedented statesmanship, leadership and technological advances will simultaneously provide national and global sustainability solutions.

Joint initiatives are in both of our nations' enlightened self interest – from immediate and sustained economic and environmental gains to long-term well being and prosperity of our peoples – and will make a major, essential contribution to finding global solutions to the devastating risks facing humanity and the biosphere.

Pursuing Sustainable Planetary Prosperity

The Challenge

The family of nations faces two inextricably interwoven biophysical threats of unprecedented historical and global magnitude: catastrophic dangers from climate destabilization and deterioration and destruction of the planet's biosphere productivity, resilience and stability, which are the sources of and services for sustaining humanity's health, well being and inter-generational prosperity.

These destructive threats and outcomes are being accelerated by three primary drivers:

Combustion: Producing goods and services through the combustion of fossil and biological resources annually, emitting more than 40 billion tons of CO_2.

Consumption: Consuming a gigantic and expanding amount of the world's renewable and non-renewable natural resources, with the massive waste streams contaminating and degrading the planet's natural capital assets.

Population: An enormous, expanding population that has grown 500% between1950 and 2050. It is important to note that population growth is a central sustainability concern, but not relevant to the actions that must be taken within the next 10 years to rapidly slow down climate destabilization.

Combustion

Humanity's unceasing ingenuity is generating vast economic gain for billions of people, with goods

unavailable even to the wealthy throughout most of history. Fossil fuels have admirably served humanity in this capacity, fueling the engine of economic activity, especially through access to cheap oil over the past century. Indeed, virtually every facet of the US$70tr global economy is dependent upon these historically cheap and abundant fossil resources.

However, in deriving and consuming these fossil energy resources, they have unwittingly – but now knowingly with a vast accumulation of empirical evidence and scientific findings – become a primary driver of most of the global risks and threats confronting humanity[i]. Worldwide, governmental programs pay a staggering US$700bn to US$1tr per year in subsidies to produce and consume fossil fuels. In addition to these market-distorting subsidies, recent assessments by environmental consultants TruCost indicate fossil fuel externalities cause human health and environmental impacts globally exceeding US$4tr per year.

For example, according to a comprehensive analysis by Harvard Medical School, the externality costs just from coal production and combustion in the U.S. amounts to upwards of US$500bn per year – more than 10 times the total revenues of the U.S. coal industry.

Unfortunately, failure to include these externalities in the price of each kiloWatt hour (kWh) means citizens are forced to incur the costs through sickness, chronic illness and premature mortality, and serious declines in the health of terrestrial ecosystems, watersheds and marine life. If these externality costs were factored into the delivered price of electricity, consumers would be paying US$0.37 per kWh. That is 12 to 40 times more expensive than end-use efficiency improvements, six times more costly than wind power, and two to three times the price of solar photovoltaic (PV) delivered electricity.

The costs and consequences are now undeniably immense and clearly indicate business-as-usual is driving the economy, society, humanity and the biosphere towards accelerating (premature) morbidity and mortality. We are exceeding planetary boundaries and collapsing the safe operating space for humanity.

An assessment commissioned by 20 governments in 2012, the "Climate Vulnerability Monitor", calculated that five million deaths occur each year from air pollution, hunger and disease as a result of climate change and carbon-intensive economies. That toll would likely rise to six million a year by 2030 if current patterns of fossil fuel use continue.

The report noted that the effects of climate change have lowered global output by 1.6% of world GDP, or by about US$1.2tr a year, and losses could double to 3.2% of global GDP by 2030 if global temperatures are allowed to rise.

Humanity's health and well-being hang in the balance. To keep the global temperature from rising more than 2 degrees Celsius and sparking dangerous consequences, leading scientists calculate that less than 900 gigatons (Gt) of cumulative CO_2 emissions can be released into the atmosphere in the first half of this century.

By 2012, collective emissions reached 360 Gt CO_2, or 40% of the 50-year budget. Unchecked, the rising level of CO_2 emissions will result in the global average temperature increasing by 2°C in the next two decades, 3.5°C by 2040 and 4°C by 2050[ii].

Consequences are already being seen in the agriculture heartlands of both the U.S. and China, gripped by multi-year droughts. An article published in *Science*[1] summed up China's agriculture predicament from climate destabilization in its title, "Losing Arable Land, China Faces Stark Choice: Adapt or Go Hungry". China has one-fifth of the world's population, but just 7% of arable land, that is shrinking further from urbanization converting nearly nine million hectares of farmland per decade[iii].

China's agriculture and livestock growth trends are at high risk of reversal due to rising tempera-

1 *Science* 8 February 2013:
Vol. 339 no. 6120 pp. 644-645
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tures (0.8°C over the past half century) and declining rainfall, causing shorter growing seasons in China's farm belt. The Chinese Academy of Sciences reported in 2009 that warming caused a 4.5% decline in growth of wheat yields across China from 1979 to 2000, resulting in the annual loss of hundreds of thousands of tons of grain.

Resource patterns collapsing biosphere resilience, stability and ecosystem services

Biologists and ecologists have been sounding alarms over the last quarter century of an unfolding extinction spasm of planetary dimensions, due to humanity's liquidation of intact ecosystems and assemblages of flora and fauna. The loss of these natural capital assets and services are occurring in the wake of converting nation-size landscapes for food, feed, fiber, forestry, fuel and other commodities[iv].

As detailed in the multi-volume "Millennium Ecosystem Assessment" and the more recent studies "The Economics of Ecosystems and Biodiversity" (TEEB) and "Principles for Responsible Investment", the wholesale destruction of worldwide ecosystem services – the planet's natural capital – is destroying some US$6tr per year of assets and economic value[2].

Ecosystem services' irreversible losses

With the world's population expanding by the population size of the U.K. every year, the projected figure of 10 billion by 2050 will require a 70% increase in food production. Along with the increased energy and materials feeding humanity's rising economic 'metabolism', the continued loss of ecosystem services and natural capital is estimated to cost nearly 20% of annual gross world product by 2050. This is a conservative estimate because it is not based on the 4°C global temperature rise that will occur by then from business-as-usual emissions.

Global fisheries are being exploited into extinction. One-third of all fish stocks globally have collapsed, and at current fishing rates, they will have collapsed completely by the middle of the century. A full three-quarters of the world's fisheries are now either collapsed, over-exploited or significantly depleted.

Species extinction rates have accelerated due to habitat destruction. Humans are implicated directly or indirectly in the 100 to 10,000-fold increase in the 'natural' or 'background' extinction rate that normally occurs as a consequence of gradual environmental change. Harvard Biology Professor Edward O. Wilson estimates some 40,000 species go extinct each year. The continuation of current habitat destruction trends will drive more than half the planet's species to extinction by the middle of the century.

Ironically, ecosystem destruction is fueling business-as-usual CO_2 emissions. In recent decades the yearly burning and clearing of 14 million hectares of tropical forests has released several billion tons of CO_2 emissions – an amount greater than the emissions released by the global transport sector (including all vehicles, trucks, trains, planes and ships). It is roughly the same level as the CO_2 emissions released by the U.S. or China every year.

TEEB estimates the cost of forest ecosystems currently lost in just one year amounts to US$2tr to US$4.4tr, far exceeding the profits made from the deforested land. In the wake of the 14 million hectares of tropical forests burned down each year, it is estimated that some 16 million species populations go extinct[v].

Ocean acidification threat to the collapse of fisheries

The oceans face multiple extreme risks. Recent marine evidence has found that over the past half-century, phytoplankton – the base of the ocean

2 Millennium Ecosystem Assessment. Millennium Ecosystem Assessment Synthesis Reports, 3 Volumes, Island Press. Washington, DC, 2006, http://maweb.org/en/Synthesis.aspx; TEEB - The Economics of Ecosystems and Biodiversity, 4 volumes, Routledge Press, Boston, MA, 2012; Trucost, *Universal Ownership* Why externalities matter to institutional investors, 2011, UNEP Finance Initiative and Principles for Responsible Investment, London, UK.

food web – has declined by 40%, corresponding to a 0.5°C global temperature increase over the past century. In addition, humanity's annual 35+ gigaton pulse of CO_2 emissions is accelerating the rate of ocean acidification faster than at any time during the last 300 million years.

Marine scientists warn that the failure to peak global CO_2 emissions by 2015 and then steadily reduce these emissions by at least 5% per annum could, by the end of the century, cause acidification levels that essentially unravel the ocean ecosystem and collapse major fisheries and marine species. Only 1% of marine fishery catch revenues are not influenced by changes in ocean pH levels. Marine acidification and global warming risks are compounding humanity's already massive overfishing, depletion and collapse of major fisheries[vi].

One-third of all coral species are already at risk of extinction as a result of bleaching and disease caused by ocean warming in recent years. Catastrophic risk increases greatly when acidification interacts with the temperature stress on coral reefs: with 1.7°C warming, all coral reefs will be bleached, and by 2.5°C – within several decades – they will be extinct. Recent research has shown that agri-chemical and industrial run-off into coral rich coastal areas accelerates coral die-off at even smaller temperature increases.

Energy-driven materials and resource consumption

The past century's access to low-cost fossil fuels, combined with faster technological progress and preferential government policies and subsidies, played instrumental roles in the dramatic growth in resource consumption. During the 20th century, the price of key resources fell by almost half in real terms, despite global population quadrupling, economic output increasing 20-fold, and a jump in demand for different resources by six to 20-fold.

Resources are increasingly linked. Many nations liquidate and sell their natural capital resources to secure financing to pay for imported fuels and to build power plants. Over the past decade the price and volatility of diverse resources have become tightly linked. Price changes and shortages in one resource can suddenly impact other resources[vii].

The throwaway habits of historic consumption further aggravates price and volatility issues. A multi-nation study led by the World Resources Institute, "The Weight of Nations", discovered the astounding fact that half to three-quarters of the materials and resources consumed by society became waste within 12 to 24 months[3].

This linear pattern of expanding extraction-consumption-waste will pose a formidable, if not impenetrable barrier to achieving the 2% to 3% average annual global economic growth rates assumed by most economists; such growth rates imply a nearly 10 to 20-fold expansion of the world economy within this century.

Going Forward

A growing number of statesmen, corporate and civic leaders, and scientific experts have been exclaiming loud and clear, humanity has the next 10 years, starting immediately, to take and make transformational changes that will put the economy on a path consistent in keeping the global temperature rise below 2°C[viii].

Give the scale of the catastrophes looming on the horizon, which could be amplified by a dozen identified 'negative tipping points' – for example, the gargantuan release of methane emissions from melting permafrost, massive emissions from the dieback of the Amazon rainforest – it is incumbent upon leaders and citizens to support the rapid pursuit of bold, ambitious, transformational changes to our global economic development practices.

This section highlights several key transfor-

3 Emily Matthews et al., Weight of Nations: Material Outflows From Industrial Economies, 2000, World Resources Institute, Washington, DC.

mational opportunities available for ensuring economic and environmental sustainability for current and future generations of people and nature. The past half century has been witness to an explosion of knowledge generation, scientific breakthrough, technical advances, engineering progress and accumulated evidence from applied innovations in markets and governance that offer promising prospects for addressing the seemingly intractable perils confronting humanity and the planet.

Empirical evidence accumulated over the past four decades clearly and unequivocally point to improving the efficiency in the way utilities (electricity, natural gas, water), mobility and industrial services are delivered to the point of use as the largest pool of least-cost-and-risk (LCR) opportunities for achieving immediate, ongoing, deep reductions in global CO_2 emissions.

This amounts to a paradigm shift from the industrial smokestack era of economic growth which achieved economies of scale by constructing larger factories powered by bigger centralized power plants. The scientific revolution in solid-state electronics and space-age materials have led to new economies of scale through the delivery of distributed services at the point of use.

Services are delivered while dramatically reducing the amount of upstream natural resources and downstream waste and pollution, as well as lifecycle costs, as detailed extensively with respect to utility services in "Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size"[xi].

For example, the U.S., according to Amory Lovins in "Reinventing Fire: Bold Business Solutions for the New Energy Era", could reduce consumption by 25 million barrels of oil per day through efficiency, at an average cost below US$20 per barrel. By comparison, the average price of world crude oil since 2006 has ranged between US$60 and US$120 per barrel.

China has even larger savings opportunities at significantly lower cost, given all of the new construction, manufacturing expansion and consumer purchasing[x].

Least-cost-and-risk delivered utility services

Both the U.S. and China have tapped into this immense, and still expanding, pool of efficiency gains in the way the services of energy, water and resources are delivered to the point of use[xi].

Among a dozen states leading the U.S. in efficiency gains, California has been the exemplary model. Since the 1980s, California has been a world leader in developing a utility regulatory process that aligns the financial interests of the utility with those of their customers to capture end-use efficiency opportunities. This holds true for private-owned and public-operated utilities. California achieved this alignment by decoupling utility earnings from revenues to eliminate the perverse incentive of expanding supplies that are five times more costly than end-use efficiency gains.

This is combined with a comprehensive Integrated Resource Planning (IRP) methodology that calculates the levelized lifecycle cost-and-risk of delivering utility services from all supply and all end-use efficiency options. All options are priority ranked in order of LCR. End-use efficiency options have consistently and persistently ranked as the LCR. Ongoing assessments by McKinsey Global indicate LCR end-use options could provide half to three-quarters of all new utility services worldwide, based on utilities' 10% to 12% fixed earnings on capital[xii].

One among many 30% + solutions:
High-performance electric motor drive systems

A clear example of how important comprehensive IRP utility regulatory reform is needed to capture end-use efficiency services, involves the persistence and ubiquity of obsolete and inefficient electric motor drive systems around the world. Half of the world's electricity is consumed by industrial electric

drive systems – electric motors, pumps, compressors and fans (60% in China).

New motor systems could achieve 50% in savings if users implement high-efficiency electric motor industrial drive system components. However, the conventional practice is to procure technologies that require the lowest capital cost, while ignoring how inefficiently they perform in terms of energy consumption, lifecycle costs and emissions. In some instances, these inefficient devices will consume up to 20 times more in electricity costs when compared to the motor's purchase price.

IRP-based utility efficiency incentive programs have been instrumental for decades in overcoming this distortion; utility financed efficiency upgrades to existing systems can achieve 30% in savings at five to 10 times less cost per kWh when compared to building new generation facilities to power the inefficient devices that dominate the current market[xiii].

China end-use efficiency initiatives

China has been a world leader in pursuing ambitious energy efficiency targets. From 1980 to 2002, China experienced a 5% average annual reduction in energy consumption per unit GDP.

There was a dramatic reversal of this historic relationship between 2002 and 2005, when efficiency options were largely ignored and energy intensity increased by 5% per year. However, China's 11th Five-Year Plan (FYP) set a target of reducing energy intensity by 20% by 2010, followed by the 12th FYP target for a 16% reduction in energy intensity between 2011 and 2015[xiv].

Feed-In Tariffs – fit policy for driving zero emission options

Feed-In Tariff (FIT) performance payments are proving essential for spurring zero and near-zero emission power options – such as solar, wind, geothermal, biowaste and small-scale hydro. Depending on how effectively a FIT is designed and implemented, this can make a significant difference to the amount of clean power generated. Given the urgency in reducing CO_2 emissions, the adoption of advanced FITs has become an imperative for aligning good governance and flourishing markets. As of 2011, FIT policies have been enacted in China, seven U.S. states and more than 50 other countries[4].

Utility investments in regulated states typically receive a guaranteed 10% to 12% return on investment. FITs are often set to provide an 8% to 10% internal rate of return (IRR). A FIT guarantees a long-term performance payment for electricity to help investors recover their investment. Solar, wind and end-use efficiency projects have no fuel, water or waste storage and disposal costs, so their entire investment is up front. Long-term payment contracts – which generally cover 20 years – ensure that energy providers recover their costs and help them secure financing[xv].

Zeroing in on zero-emission supply options

• Wind power

In less than a decade, China has rapidly become the world's biggest manufacturer of wind turbines and solar PV panels. The country established a FIT for wind in 2009 and for solar PV in 2011[xvi].

In recent years, China's ambitious renewable power targets and support for wind energy manufacturers have fueled rapid growth. In 2006, China had only 3,000 megawatts (MW) of installed capacity, and was a small global player. By late 2012, China surpassed 70,000 MW, reaching nearly one-third of installed global capacity – a 25-fold increase in six years, while the rest of the world only expanded by a factor of 2.6.

A 2009 joint assessment by Harvard's School of Engineering and Applied Science and Tsinghua University's Department of Environmental Science and Engineering concluded that China's favorable

4 Tariff Watch, http://www.pv-tech.org/tariff_watch/list

onshore wind resources could provide nearly 25 trillion kWh of electricity annually, more than five times its national consumption in 2012. The team also made a key point: that assuming a 10-year FIT payment per kWh comparable to what is currently being offered, "wind could accommodate all the demand for electricity projected for 2030, about twice current consumption."

The Harvard team estimates wind power can supply 40 times world consumption of electricity, and more than five times total global use of all energy[xvii]. Available wind resources on the U.S. Great Plains were estimated to be as much as 16 times total current U.S. power consumption[xviii].

Wind power is an established LCR power supply. Both the U.S. and China could steadily displace all their current and proposed coal power plants and most natural gas power with their wind resources[xix].

• Solar power

Solar power systems have experienced dramatic declines in production costs, achieving grid parity (cost-competitive) in a wide range of locations worldwide. More than 100,000 MW were installed worldwide as of 2012, with annual growth rates of 25% (i.e. doubling every three years).

Solar power is now less expensive than nuclear power. U.S. Secretary of Energy Stephen Chu said in early 2013 that large-scale solar would also soon eclipse coal and natural gas in cost. In 2012 for example, First Solar signed a power purchase agreement to deliver energy from a 50 MW solar PV plant in New Mexico to the local utility for US$0.06 per kWh – half the cost of a new coal plant[xx].

According to assessments by the U.S. National Renewable Energy Laboratory (NREL), it would require roughly 15% of existing urban land area sited with solar PV panels to deliver all of U.S. current power and energy consumption. This could be done on roofs, parking lots, along the sides of highways, bridges and railways, and on the sides of buildings. Over three-quarters of America's current electricity could be supplied with PV systems built on the 'brownfields'– the estimated more than 2 million hectares of abandoned industrial sites that exist in cities across the U.S.[xxi].

In 20 years, China's cities will have over 350 million inhabitants, more than the entire population of the U.S. today. By 2025, China will have 221 cities with one million–plus inhabitants – compared with 35 cities of this size in Europe today. Designing and constructing new cities, and expanding and retrofitting existing cities, should take maximum advantage of the proven ways to deliver lower cost utility and mobility services with zero and ultra-low emissions, and reduced waste materials.

China declared an eight-fold increase in its solar power target for 2015 to 40,000 MW[xxii]. This will put China far ahead of any other nation. For comparison, the U.S. had 6,400 MW installed at the end of 2012, with solar tax incentives set to expire in 2015[xxiii].

Mobility access power with zero emissions

A key opportunity for displacing oil-fueled vehicles is the shift to ultra-lightweight battery-electric vehicles (BEV), while also largely avoiding biomass-fueled vehicles[xxiv].

Converting crops to fuels is very inefficient, while requiring enormous land area, chemical inputs, and water consumption. For example, just shifting from diesel to biodiesel to fuel the world's maritime fleet would require a 40-fold expansion of current global production of oil palm plantations. Oil palm plantations have been one of the primary causes of widespread deforestation – and CO_2 emissions – of biodiversity-rich rainforest in recent decades.

Both Chinese and U.S. officials have raised security concerns that more than 50% of their oil use is dependent on vulnerable foreign oil imports, and China's oil imports are projected to double by 2020. The U.S. spent roughly US$430bn on foreign oil in 2012 – a direct wealth transfer out of the country. Billions more are spent to keep oil shipping lanes

open and oil geo-politics add considerable additional burdens[xxv].

In his 2011 State of the Union speech, President Barack Obama announced a goal of having one million BEVs and plug-in hybrid electric vehicles (PHEVs) on the road by 2015 – compared to 500,000 on the road in 2012. This coincided with China's 12th FYP targets for ownership of five million BEVs and PHEVs by 2020[xxvi].

The combination of solar and wind powering ultra-lightweight BEVs accrue multiple economic and environmental benefits: dramatic improvements in urban and rural air quality and tremendous health gains for those experiencing record-breaking air contamination; the elimination of vulnerable and volatile-priced foreign oil imports; savings from replacing the cost of gasoline with solar or wind power; the elimination of vehicle combustion and emissions; and significant reductions in CO_2 emissions.

Consumption

The definitions of 'consumption' and 'consumer' refer to two elements: buying a good, and using, exhausting and wasting a resource. Humans perform both, however, the latter poses a threat to the long-term economic and ecological status.

The world is sitting on a consumption time bomb – more consumers lead to higher consumption and more material intensity. The Organisation for Economic Co-operation and Development projects the global middle class will increase by 250% to five billion people by 2030, with almost 90% of the growth coming from the Asia-Pacific region. Consumption in emerging markets is expected to rise from US$12tr in 2010 to US$30tr by 2025. These new consumers will move from bulk, unbranded products to highly processed and packaged goods.

According to the 2012 report "Towards the Circular Economy"[5] some 65 billion tons of raw materials entered the economic system in 2010, and this figure is expected to grow to about 82 billion tons in 2020. In the conventional linear economy of extract-consume-waste, society currently recovers only 20% of this material – well short of the 50% that could be recovered in the near term.

Supply chain practices – shifting from a linear to circular economy[xxvii]

Unilever CEO Paul Polman summed up the critical importance for business to move to a circular economy:

> "It is evident that an economy that extracts resources at increasing rates without consideration for the environment in which it operates, without consideration for our natural planetary boundaries, cannot continue indefinitely. In a world of soon to be nine billion consumers who are actively buying manufactured goods, this approach will hamper companies and undermine economies. We need a new way of doing business. The concept of a circular economy promises a way out. Here products do not quickly become waste, but are reused to extract their maximum value before safely and productively returning to the biosphere."[xxvii]

China and the U.S. have enormous global standing in the span of their supply chain networks, and are highly dependent upon natural resources from many other nations for food, feed, fiber, forests, fish, fuel, minerals, etc. Together they have an opportunity – as well as a global responsibility – to promote and encourage radical innovation in sustainable resource development from supplying nations.

Great progress could be made if both nations collaborated on encouraging and supporting other nations to manage their resources sustainably, including comprehensive energy, water and resource efficiency improvements and minimizing their land and water-use footprint. A step forward would be to

5 Towards the Circular Economy, 2012, The Ellen MacArthur Foundation, Isle of Wright, UK, www.circulareconomy100.org/

align U.S. and Chinese resource extraction policies when working in developing nations to meet global best-practice standards – and strengthen them over time.

China-U.S. statesmanship in governance and leadership in markets

China and the U.S. are categorized as 'megadiversity' nations, which means that their ecological assets are enormous – literally worth tens of trillions of dollars in social and economic value. Most people are unaware of these free services delivered through the rich diversity of ecosystem structures and functions. Many of the natural capital assets would be ridiculously expensive to replace, and some are irreplaceable once destroyed and irreversibly lost[xxix].

The fundamental sustainability challenge for both nations is to sustain growth while maintaining, not diminishing or depleting, natural capital productivity and resilience. The science is clear on major steps to ensure this happens: transitioning to reliance on zero-emission renewable energy resources; radically increasing energy and resource efficiency throughout the lifecycle of economic activity; and rigorously maintaining safe global limits – so-called planetary boundaries – in climate, resource stocks and flows, freshwater systems, etc.

The U.S. and China, although at different stages in their respective economic and environmental challenges, are each increasingly vulnerable to resource scarcity (from minerals, water, food and biodiversity) and climate destabilization (through drought, floods, wildfires and extreme weather). Both nations also have extensive supply chains operating in, and drawing significant resources from, other megadiversity countries. These nations face similar threats of natural resource exhaustion and collapse, but also can tap into the large pool of best practices in markets and governance to sustain their irreplaceable natural capital assets.

There are many areas where the U.S. and China could work together to help achieve large-scale sustainability gains for themselves and for their trading partners. Two primary areas include:

• Tech-knowledge

The U.S. and China jointly account for 50% to 60% of global research and development (R&D), and tremendous mutual gains in radical innovation are achievable through such valuable mechanisms as collaborative innovation networks. 'Tech-knowledge' is a broad term encompassing advances in science, technology, engineering, economics, finance and myriad ancillary fields involving capacity building, skills development, continuous learning, communication, etc.

• Policy

Tech-knowledge flourishes when good governance sets policies and incentives in alignment with market opportunities capturing highly desirable social and public goods. The next decade is critical to establish effective policies that help drive markets to capture the zero-emission LCR utility and mobility services highlighted in this chapter.

Being the two largest economies in the world, the U.S. and China should take the lead in fostering global agreements, such as on climate change and on governance policies that promote radical innovation solutions for sustainable global development. This requires adopting proven best-in-play options that supersede outdated and suboptimal subsidies/incentives, non-LCR utility regulations, lax environmental standards and enforcement mechanisms, and weak or modest efficiency standards for building, motors, appliances, vehicles, etc.

Regarding natural capital conservation, both China and the U.S. should strive to attain the Convention on Biodiversity (CBD) targets for both terrestrial and marine conservation[xxx].

UN Global Compact and International Union on the Conservation of Nature framework for corporate action on biodiversity and ecosystem services

The failure to manage impacts and dependencies on biodiversity and ecosystem services (BES) raise the likelihood of a myriad of risks that can directly impact on a company's competitiveness and profitability. It poses the increased potential of liabilities, placing the firm's long-term viability at risk. These risks encompass all facets of business engagement: operational, regulatory, legal, market, financial and reputational.

When biodiversity and ecosystem services are degraded or lost a company's operations may face reductions in productivity, disruption to business activities and interrupted or limited access to resources, all of which affect the bottom line operating costs. Corporations can find it difficult to secure a legal, regulatory or social license to operate for their failure to use ecosystem management[xxxi].

Businesses need to frame biodiversity and ecosystem targets in ways that are 'specific, measurable, achievable, relevant and time-bound' (SMART). They should begin by identifying what to avoid; for extractive industries this starts with 'no go' areas for exploration or clearing and includes identifying prohibited technologies. Expressed more positively, BES targets can promote 'reduce, reuse, recycle and restore', and adopt net balance approaches.

Integrating the mitigation hierarchy into corporate practices is the best practice approach to managing biodiversity risk. The efforts should result in preventing or avoiding biodiversity and the impact on the ecosystem. Consequently, successive efforts focus on restoring adverse effects, then addressing any residual negative effects. This is done with a 'biodiversity offset' in order to achieve 'no net loss' of biodiversity, or 'net positive impact' on biodiversity.

Offsets are "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented," as defined in the Business Biodiversity Offsets Program (BBOP) Standard on Biodiversity Offsets hierarchy of "Criteria and Indicators and Principles", established in 2009. The standard enables project developers to manage biodiversity related risks by providing an audit-able approach to no net loss, as well as enabling auditors and assessors to determine whether an offset has been designed and subsequently implemented in accordance with the BBOP principles.

Net positive impact

Many companies are exploring how to manage the adverse impacts of their activities on BES[xxxii]. A few companies have made public commitments to 'no net loss', 'ecological neutrality' or even 'net positive impact' (NPI) on biodiversity, or on specific ecosystem services such as water resources. Managing biodiversity risk involves looking beyond sites and products to the wider land and seascapes. Several examples of these efforts include:

The Consumer Goods Forum – an independent global network of retail and manufacturing companies, showcasing its ability to develop standard approaches with members through its intention to mobilize its collective resources to help achieve zero net deforestation by 2020.

Walmart – by recognizing that 90% of its CO_2 emissions originate in its supply chain, it has a joint initiative with Earthster to create an open database for product designers, manufacturers, suppliers and sustainability experts looking for current information on materials, energy, water, social and climate impacts throughout the product lifecycle. Since 2005, Walmart has developed and used a Sustainable Product Index to assess the environmental impact of its products and relays this information to customers using a labeling system. The Sustainable Product Index measures such facets of production as energy usage, material efficiency and human conditions.

Rio Tinto – is committed to achieving an NPI on biodiversity, a strategy launched at the 2004 International Union on the Conservation of Nature World Conservation Congress. Biodiversity losses and gains were measured and forecast for the period 2004-65, in order to determine whether the current and proposed mitigation activities of Rio Tinto QMM [QIT Madagascar Minerals] (QMM) operations are sufficient to achieve NPI by closure[xxxiii].

E.U. – in the policy arena, the E.U. has established an E.U. No Net Loss initiative to begin in 2015, as part of the E.U. Biodiversity Strategy to 2020.

TEEB – The "TEEB Business Report" documents sustainability-related global business opportunities in natural resources (e.g. energy, forestry, food and agriculture, water and metals) that may be worth up to US$6tr by 2050 (at 2008 prices). Biodiversity or ecosystem services would be the basis for these new businesses.

However, the TEEB assessment emphasizes that "effective responses to biodiversity loss and the decline in ecosystem services require changes in economic incentives and markets." The global carbon market, which expanded from nearly zero in 2004 to over US$140bn in 2009, was largely due to new climate-related regulations. The carbon market potential is immense, with the possibility of generating sufficient funds to prevent most global deforestation and ecosystem destruction[xxxiv].

There are also business initiatives to address poverty and biodiversity together. Coffee retailer Starbucks supports the investment portfolio of Verde Ventures, an initiative of Conservation International. Verde Ventures provides loans to local non-governmental organizations and coffee farmers to help implement projects that maintain forest ecosystems and services. One example is a loan to a coffee-growing cooperative near the Sierra Madre, which helped finance the coffee harvest while also allowing farmers to undertake reforestation activities adjacent to their lands. The funding also supported training programs focused on environmentally friendly coffee cultivation practices, with an emphasis on female education[xxxv].

Using option value to protect natural capital assets

Conventional development models pose significant threats to the economic and environmental sustainability framework highlighted in this article. It is in the enlightened self interest of the U.S. and China to collaborate on promoting and supporting these positive climate and biodiversity solutions in other nations. This entails pursuing zero-emission technology, innovative financing methods for LCR and FIT energy services, zero waste and closed-loop manufacturing processes, and conservation of ecosystems. A risk and cost-minimizing strategy for corporations and governments confronting the increasingly uncertain future filled with unwanted, disruptive surprises, is to implement a robust portfolio of market practices and aligned governance policies that foster a sustained path towards resource efficiency, zero emissions and waste, and sourcing emission offsets[xxxvi].

An exemplary opportunity regarding the third component is sourcing land-based CO_2 emission offsets. Why? The combination of energy efficiency improvements and ramping up zero-emission solar and wind power systems is a long-term process. Plus there are non-energy greenhouse gas (GHG) emissions from agriculture and chemicals that cannot be reduced to zero and will continue for the unforeseeable future. Sourcing offsets provide an immediately available, highly cost-effective way to help sustain the deep annual emission reductions needed now and for decades to come[xxxvii].

Sourcing standards-based, multiple-benefit conservation carbon offsets

It is an astonishingly under-reported fact that 15% to 20% of total global CO_2 emissions over much of the past two decades were due to the burning of 14

million hectares of tropical forests each year. This is an amount greater than the emissions released by the global transport sector, and roughly the same level as the annual CO_2 emissions of the U.S. or China.

Nearly a decade ago, the Climate, Community & Biodiversity (CCB) standards were launched as a multiple-benefits approach to sourcing land-based emission offsets; technically referred to as REDD+, reducing emissions from deforestation, degradation plus protection, or commonly called ecological carbon storage (ECS). The voluntary standards help design and identify land management activities that simultaneously minimize climate change, support local sustainable development and conserve biodiversity[xxxviii].

CCB has become the most used land-based standard worldwide, and is widely recognized as a high-quality, triple benefits standard used for addressing three pressing social and environmental problems. In a world still without global agreement on capping and major reductions in GHG emissions, such voluntary leadership actions remain essential for sustaining momentum toward phasing out GHG emissions, while demonstrating that it can be achieved simultaneously with development and sustaining healthy ecosystem services.

Sourcing standards-based ECS/REDD+ offsets provides an important option value for the recipient countries. Tropical forests in developing countries are richly endowed with biologically diverse plants and animals, most of which are indigenous and unique to that area. Avoiding burning or clearing these carbon-rich forests offer immediate climate mitigation value.

In addition, the indigenous species and ecosystem services offer multiple values beyond their carbon storage value. Many of these still remain to be estimated. Most are not reflected in market transactions, even when estimated. A proportion may become increasingly valuable over time as science, technology and engineering advances create new product and service opportunities for the medical, pharmaceutical and agribusiness (food, feed, fiber, fuel and forestry) sectors. As Nobel economist Kenneth Arrow described decades ago, faced with such uncertainty of future value, it becomes economically advantageous to exercise the option value, postponing an irreversible investment decision until new information occurs.

Oceans Health Index

Humanity depends on oceans – the world's largest bank account – which are estimated to be worth US$30tr to US$50tr (at 2012 values) per year in ecosystem services to people. Earth's healthy oceans provide us with ecosystem services such as seafood, carbon storage, biodiversity, natural products, clean water, shoreline protection, artisanal fishing, sense of place, tourism and recreation, and livelihoods.

With unsustainable fishing, climate change, habitat destruction, pollution and invasive species already degrading ocean ecosystems, nothing less than our future and our children's futures are at stake. Already 87% of the world's fisheries are fully exploited or depleted. Wildcatch fisheries peaked in 2000 and have been on a decline since then.

A major step to sustain and restore the earth's healthy oceans is to incorporate the Ocean Health Index (OHI) as a metric tool for international and national policy decisions, sustainable business practices prioritization and multi-lateral program assessments. OHI – launched in 2012 – is a composite index developed by a global team of scientists. It measures how well the oceans provide benefits to people now and in the future[xxxix].

The OHI helps nations recognize ocean values, by adopting methodologies of valuing and accounting coastal and marine ecosystem services in decision-making processes. Integral to the valuation process is recognizing the value of marine flagship species, and in creating new marine protected areas through a flagship species approach.

Research, for example, decisively shows that "a live shark is worth more than a dead shark".

In the 518,000 square km area of the Bahamas that bans shark hunting, it is estimated that for its tourism industry, every shark is worth US$245,000, and annually worth US$80m to Bahamas' shark diving tourism. Meanwhile, the fine for shark fishing in the Bahamas is US$5,000, up from US$3,000.

The OHI is also important for creating understanding about the value-creation and restoration benefits of a seascapes approach. Through the Convention on Biological Diversity, countries have agreed to include 10% of the ocean in marine-protected areas to conserve biodiversity and ecosystem services. Although marine-protected areas are expanding, global efforts are still falling far short of the goal with less than 1.5% of the ocean currently covered by marine-protected areas[xl].

The OHI is instrumental in addressing the economic and environmental sustainability of Coastal Fisheries Management, including rights-based fisheries management and sustainable aquaculture development. This involves developing and sharing new methods and recommendations for determining ecological, social and economic outcomes of aquaculture in island and coastal nations.

Done properly, farmed seafood converts more feed to nutritional protein than farmed land animals. Of global seafood consumed, 20% to 50% is from aquaculture and is increasing each year[xli]. The weight of grain needed to produce 1 kg of protein range from a low of 13 kg fed to fish, compared to 38 kg fed to pigs and 61 kg fed to cows.

China and the U.S. are both highly dependent upon the ecosystem services of healthy oceans. The two nations should lead a 'Global Partnership for Oceans', helping to accelerate and scale the use of the OHI and recommended sustainable practices.

Blue carbon natural capital

Ocean ecosystems play a vital role in controlling CO_2 levels[xlii]. Seagrasses, tidal marshes and mangroves sequester large quantities of blue carbon in both the plants and in the sediment below them. Total carbon stored per square kilometer in these coastal systems can be up to five times that stored in tropical forests. However, these ecosystems are being destroyed at a rapid pace, four times faster than tropical forests, resulting in significant emissions of CO_2 into the ocean and atmosphere and accelerating climate change. Of the world's mangrove forests, 35% have been destroyed in the last 30 years[xliii].

'Blue carbon' is defined as the carbon stored, sequestered or released from coastal ecosystems of tidal marshes, mangroves and seagrass meadows. Blue carbon activities refer to a suite of sustainable policy, management and planning activities in coastal ecosystems to reduce emissions from conversion and degradation and to conserve and sustainably manage coastal carbon sinks.

Conserving and restoring terrestrial forests, and more recently peatlands, has been recognized as an important component of climate change mitigation[xliv]. These approaches should now be further broadened to manage other natural systems that contain rich carbon reservoirs and to reduce the potentially significant emissions from the conversion and degradation of these systems[xlv].

Performing natural capital accounting

The accounting profession and financial reporting bodies should accelerate efforts to provide standards and metrics for disclosure and audit/assurance of biodiversity and ecosystem service impacts.

Most existing initiatives are weak, however, at quantifying biodiversity impacts (the so-called 'externalities' of business) in terms of human welfare. Methodologies for sector and business-level quantification of biodiversity and ecosystem services values are needed, accompanied by appropriate reporting requirements. Credible audit and assurance mechanisms are also needed to validate business performance and the quality of disclosure[xlvi].

Natural capital and the services it provides are fundamental to the well being of our businesses and society. Unfortunately, they are not yet fully

represented within society's economic accounting system, despite facing rapid depletion and posing an increasing threat. Like other forms of capital, natural capital requires investment, maintenance and good management if it is to contribute fully to increasing prosperity and well being.

Natural capital accounting is a tool that can help measure and manage the full extent of a country's natural assets and now there is an internationally agreed methodology for natural capital accounting at the national level – the System of Environmental-Economic Accounting (SEEA).

Implementing wealth accounting and the valuation of ecosystem services

At the Rio+20 United Nations Conference on Sustainable Development in 2012, the World Bank Group launched the '50:50' campaign, an initiative for the public and private sectors to join forces, demonstrating on a global stage the importance of taking collective action in support of natural capital in economic decisions or business operations. It combines the support of governments, private sector leaders and other stakeholders for working towards integrating natural capital into decision-making. So called the '50:50' to represent the 50 governments and 50 corporations that have made their commitment to working towards natural capital accounting[xlvii].

A cornerstone of the effort is the Wealth Accounting and the Valuation of Ecosystem Services (WAVES). This initiative aims to integrate natural capital values into national accounting systems, and thereby encourage better, more efficient decision-making and planning. WAVES is a Global Partnership currently being implemented in five partner pilot countries. Developing countries such as Botswana, Colombia, Costa Rica, Madagascar and the Philippines are working to establish environmental accounts in practice[xlviii].

Recommended Opportunities for China-U.S. Joint Actions and Activities

Being the two largest economies in the world, the U.S. and China should take the lead in fostering global agreements, notably, on climate change and on governance policies that promote market deployment of innovative solutions for ecologically sustainable global development.

Ecosystem conservation and restoration should be regarded as a viable investment option in support of climate change mitigation and adaptation. Within the climate agreement process, Reducing Emissions from Deforestation and Forest Degradation plus prevention of deforestation should be prioritized for accelerated implementation, beginning with pilot projects and efforts to strengthen capacity in developing countries to help establish credible systems of monitoring and verification that will allow for the full deployment of the instrument.

Zero net deforestation by 2020 is an achievable, economically attractive opportunity that both nations should exemplify through leadership in attaining this goal, given their enormous global standing in the span of their supply chain networks, and their high dependence upon natural resources from many forest-rich nations for food, feed, fiber, forest products, fish, fuel, minerals, etc. Together they have an opportunity as well as a global responsibility, to promote and encourage radical innovation in sustainable resource development from supplying nations.

The principles of 'no net loss' or 'net positive impact' should be considered as normal business practice, using robust biodiversity performance benchmarks and assurance processes to avoid and mitigate damage, together with pro-biodiversity investment to compensate for adverse impacts that cannot be avoided.

China and the U.S. are both highly dependent upon the ecosystem services of healthy oceans. The

two nations should lead a Global Partnership for Oceans, helping to accelerate and scale the use of the OHI and recommended sustainable practices.

Given the U.S. and China are both immensely rich in the three near-zero emission energy resource options – end-use efficiency gains, wind and solar power – all capable of delivering utility, mobility and industrial services at least lifecycle cost and risk compared to fossil fuels that include their associated externality costs, the two nations should recognize this enormous opportunity by adopting proven best-in-play options that supersede outdated subsidies/incentives, suboptimal utility regulations, lax environmental standards and enforcement mechanisms, and weak or modest efficiency standards for buildings, motors, appliances, vehicles, etc.

The principles of 'polluter pays' and 'full-cost-recovery' are powerful guidelines for the realignment of incentive structures and fiscal reform. In some contexts, the principle of 'beneficiary pays' can be invoked to support new positive incentives such as payments for ecosystem services, tax breaks and other fiscal transfers that aim to encourage private and public sector actors to provide ecosystem services.

Governments should aim for full disclosure of subsidies in the areas of energy, water and natural resources, measuring and reporting them annually so that their perverse economic and environmental consequences may be recognized, tracked and eventually phased out.

The annual reports and accounts of business and other organizations should disclose all major externalities, including environmental damage affecting society and changes in natural assets not currently disclosed in the statutory accounts.

Regarding natural capital conservation, both China and the U.S. should strive to attain the Convention on Biodiversity (CBD) targets for both terrestrial and marine conservation.

Great progress could be made if both nations collaborated on encouraging and supporting other nations to manage their resources sustainably, including comprehensive energy, water and resource efficiency improvements and minimizing the footprint from land and water-use practices. A step forward would be to align U.S. and China's resource extraction policies when working in developing nations to meet global best-practice standards that strengthen over time.

The U.S. and China can lead the innovation process by shifting from the conventional linear economy of extract-consume-waste, where only 20% of this material is recovered, to adopting a circular economy model where all waste becomes the nutrient inputs to more economic activity.

The present system of national accounts should be upgraded to include the value of changes in natural capital stocks and ecosystem service flows.

An urgent priority is to draw up consistent physical accounts for forest stocks and ecosystem services, both of which are required, for example, for the development of new forest carbon mechanisms and incentives.

The establishment of comprehensive, representative, effective and equitably managed systems of national and regional protected areas – especially in the high seas – in order to conserve biodiversity and maintain a wide range of ecosystem services. Ecosystem valuation can help to justify protected areas policy, identify funding and investment opportunities, and inform conservation priorities.

Human dependence on ecosystem services and particularly their role as a lifeline for many poor households needs to be more fully integrated into policy. This applies both to targeting development interventions as well as to evaluating the social impacts of policies that affect the environment.

Pursuing sustainable planetary prosperity

As this chapter has highlighted, the challenging news confronting humanity of damaging human practices shows they are in desperate and rapid

need of transformation, matched by the abundance of wealth-generating opportunities waiting to be realized going forward.

Adopting a 'climate positive, earnings positive' and natural capital-preserving strategic portfolio made sense before we knew about life-threatening climate threats; now, it is the only sensible hope we have of avoiding the misery that inaction will bring upon us. As scientist Jared Diamond vividly recounts in his book, *Collapse: How Societies Choose to Fail or Succeed*[6], many past civilizations collapsed simply because they could not choose to cooperate and break out of their 'prisoner's dilemma'.

Joint collaborations and cooperative partnerships between China and the U.S. – demonstrating leadership in markets and statesmanship in governance – offer our respective countries, the global community of nations and the planet's biosphere a very hopeful, positive way forward. Let's make the most of it, so that future generations can praise our determination to sustain the health of the only planet we know of in the universe.

6 Jared Diamond, Collapse: How Societies Choose to Fail or Succeed, Penguin Books, 2011.

Endnotes

i. Combustion of fossil fuels and biomass are the primary drivers of: climate destabilization; ocean acidification; acid rain, smog, particulates, and air pollution; freshwater, land and marine contamination; deforestation, ecosystem destruction and biodiversity loss (in the case of biomass combustion); international wars and conflicts, including ethnocidal and genocidal acts. They are also responsible for large releases of mercury, toxic metals and hazardous chemicals; major contributors to chronic illness, premature morbidity and mortality; and major extractors of freshwater throughout their lifecycle.

ii. Humanity's current emissions trajectory is driving the planet into 5 to 7°C increases this century - a radically sudden global temperature change never experienced in the history of world civilization. CO_2 levels in 2100 will hit levels last seen when the Earth was 16°C (29°F) hotter – an ice-free planet with sea levels increasing more than 200 feet higher than today, and at a rate of sea level rise that taxes comprehension.

Consequences include desertification of roughly a quarter of global agricultural lands (as much as half of Africa's crop lands), the death of virtually all coral reefs and poisoning of most marine life from ocean acidification, as well as triggering largely irreversible changes in global ecosystems for 1,000 years after emissions stop.

According to an assessment by the International Institute for Environment and Development and the Grantham Institute for Climate Change, cost estimates from climate change impacts this century are projected to exceed US$1,200 trillion.

iii. At the same time, China's middle class has been shifting to more land- and water-intensive meat, rising from 8 to 71 million tons over the past three decades. By 2012, one-third of China's total grain harvest was being converted to feed for livestock

and aquaculture, while 120 billion cubic meters of water have been pumped from Yellow River and northern aquifers than have been replaced by rainfall over the past four decades.

iv. Extinction of species inevitably occurs over geological time spans, with some 99.9% of all life having gone extinct since life first formed 3.85 billion years ago. What is different about the current human-triggered planetary mass extinction is the phenomenal rate, estimated to be three to four orders of magnitude higher than the average natural background rate.

v. There are about five billion hectares of land in agricultural production worldwide, and roughly 40% of the world's agricultural land is seriously degraded. Nearly one-third of the world's cropland has been abandoned in the past 40 years because erosion has made it unproductive, and each year 12 million hectares are lost due to drought and desertification, where 20 million tons of grain could have been grown.

vi. Worldwide, approximately 1 billion people are dependent on fish as the principal source of animal protein and half a billion people depend on fisheries and aquaculture for their livelihoods; the vast majority of them live in developing countries.

Coral reef-related fisheries constitute approximately one-tenth of the world's total fisheries, and in some parts of the Indo-Pacific region up to 25% of the total fish catch, while also representing the breeding, nursing, and feeding grounds for one-quarter of economically important marine fisheries.

vii. As McKinsey Global Institute emphasizes in their study, Resource Revolution: Meeting the world's energy, materials, food, and water needs, "The correlation between resource prices is now higher than at any point over the past century, and a number of factors are driving a further increase."

The energy-water nexus looms large. The energy intensity of water has been rising with declining groundwater tables, the expansion of desalination plants, and the development of mega-projects for the surface transfer of water (such as China's South-North Water Transfer project and interstate water transfers in the western U.S.).

viii. President Obama articulated in his 2013 inaugural address that our obligations "are not just to ourselves, but to all posterity," and he spoke of our duty to "preserve our planet, commanded to our care by God."

ix. Without faster, smarter, more efficient ways of delivering energy services, energy consumption in the U.S. would have risen 225 percent from 1973 to 2005. Instead, energy consumption in 2005 increased only 30 percent. The difference (75 exajoules, EJ) also avoided $700 billion per year in higher energy bills.

How much is 75 EJ? Envision a freight train annually hauling nearly 18,000,000 railcars of coal, which would wrap around the world seven times. As world energy expert Amory Lovins calculated, the nearly 40% drop in energy required per unit of GDP from 1975 to 2000 represented, by 2000, "an effective energy 'source' 1.7 times as big as U.S. oil consumption, [and] five times domestic oil output."

x. How large of economic and environmental opportunities are energy efficiency gains for the world? According to a recent Ecofys analysis, one among a series of recent assessments coming to similar conclusions, energy-saving gains could accrue all the following benefits through 2050 worldwide:

ELECTRICITY: delivering the equivalent of 12,800 TeraWatt-hours per year (12.8 trillion kWh), compared to 20,000 TWh consumed in 2009 worldwide; and,
HEAT: delivering the equivalent of 46 ExaJoules

(EJ) per year, compared to 160 EJ consumed in 2009 worldwide; and,

TRANSPORT: delivering the equivalent of 80 EJ of liquid fuels per year, compared to 80 EJ consumed in 2009.

To put such massive figures into understandable context, these delivered energy efficiency services would displace the need for ALL THE FOLLOWING SUPPLY (illustrative purposes only, not in these exact quantities):

COAL: 28 million rail cars per year carrying 2.8 billion tons of coal; for comparison, China shipped 2 billion tons in 20 million rail cars, and the U.S. shipped 810 million tons in 8.1 million U.S. rail cars in 2011, with the two nations consuming nearly two-thirds of global production; and

LNG: 355 million cubic meters of LNG delivered by 1,775 supertanker shipments (200,000 m^3 per shipment); for comparison, 355 million m^3 of LNG were delivered worldwide in 2011; and

PETROLEUM: 17 million barrels per day of offshore oil; for comparison, 30 million barrels per day produced from 150 offshore oil platforms worldwide in 2011; and

OIL PALM: 15 million hectares of oil palm plantations for diesel fuel; for comparison, 15 million hectares was the total global oil palm production in 2011; and

SUGAR CANE: 10.3 million hectares of sugar cane for ethanol; for comparison, 24 million hectares was the total global sugar cane production in 2010; and

CORN: 32.4 million hectares of corn for ethanol, for comparison, 162 million hectares was the total global corn production in 2011; and

NUCLEAR: 372,000 MW of nuclear power plants; for comparison, 372,000 MW was the total global installed nuclear capacity in 2012; and

HYDRO: 750,000 MW of hydrodams (equivalent to 41 mega-sized Three Gorges dams); for comparison, there were 1 million MW of global installed hydroelectric capacity in 2010.

Tremendous financial benefits also accrue from these efficiency gains. Given the several-fold lower cost of efficiency improvements compared to supply expansion, the direct cumulative monetary savings amount to tens of trillions of dollars. The indirect cumulative savings include preventing hundreds of billions of tons of CO_2 emissions at essentially zero cost.

xi. A stellar example is how to cool down urban heat islands. A staggering sum of between 25 and 150 billion tons of CO_2 emissions could be prevented through this urban retrofit process, while accruing multi-trillion dollar savings through avoided power plants and air condition equipment. It involves painting flat roofs white, and replacing low-albedo roof shingles with high-reflecting ones, so the sun's heat is not absorbed. It also involves resurfacing black asphalt pavements with white cementitious finishes which also reflect away the sun's heat. The rooftop efficiency measure is so cost-effective it has now been integrated into California's world-leading Title 24 building standards.

xii. California's highly innovative regulatory framework is so effective because it is based on allowing utility companies to recoup lost earnings from reduced sales in return for assisting customers to reduce their utility bills through capture of cost-effective end-use and locally distributed efficiency gains in buildings, factories, appliances and devices. The result is delivery of more services with less energy or water resources.

The powerful paradigm shift refocuses the utility's attention and motivation, because their earnings remain robust even when revenues decline, while customers enjoy lower utility bills through smarter use even though the underlying rate increases (to recoup the utility's lost earnings). Most importantly, the utility's capital investment, previously limited to large power plants operating over 30 to 50 year time horizons, is diversified by focusing on a larger pool of lower cost end-use efficiency services.

When combined with California's world leadership in setting continuously stronger appliance and building efficiency standards, these efforts have allowed the state to save customers an average of $165 per capita per year on electric and water utility bills, and the utility sector has CO_2 emissions 50 percent below the national average. If all U.S. states had followed California's end-use efficiency model, the U.S. national energy bill would be several hundred billion dollars less per year. The country also would have surpassed the CO_2 reduction targets of the Kyoto Protocol at essentially zero cost to ratepayers and taxpayers.

xiii. Worldwide, an initiative for transforming the efficiency of electric motor systems would deliver the services equivalent of 2 trillion kWh per year, equal in services to one-fourth of all power plants planned for construction through 2030. A successful market transformation would reduce global energy bills by ~$1.6 trillion per decade.

The ancillary benefits for a world confronting droughts and water shortages would be significant, as the following illustrates. If motor efficiency gains were used to displace thermal power plants, the savings in water use would range between two and 200 billion m^3 per year – equivalent to the water use of one to 10 Colorado Rivers.

In China, the potential energy savings from efficiency gains from electric motor drive systems are worth several hundred billion dollars per decade, displacing the need for 63,000 MW of planned power plants. Jiangsu province is leading the effort, identifying 10,000 MW of motor efficiency gains that can be delivered at a cost of US$ 0.01 per kWh. By comparison, the Jiangsu electricity price delivered to the industrial sector in 2012 was US$0.14 per kWh (0.87 Yuan).

Hypothetically, applied comprehensively to all power-consuming uses throughout China's residential, commercial, institutional, industrial and agricultural sectors, end-use efficiency and decoupling methodologies could help in avoiding half of an estimated US$10 trillion in utility expenditures incurred from the power plants to be built by 2030.

xiv. According to a recent assessment by LBNL, selected policies and programs that China has instituted to fulfill the national goal have made substantial progress. Many of the energy-efficiency programs appear to be on track to meet – or in some cases exceed – their energy-saving targets. Most of the Ten Key Industry Energy Saving Program, the Top-1000 Enterprise Energy Efficiency Program (1000 largest companies, consuming about one-third of the China's energy), and the Small Plant Closure Program (a total of 80,000 MW of inefficient thermal plants and industries were shut down) met or surpassed the 11th FYP savings goals. In the 12th FYP China extended the Top-1000 program to the Top-10,000 program.

According to China's National Development and Reform Commission (NDRC), between 2006-2010 the government's three major efficiency programs displaced 600 million tons of coal equivalent (Mtce). The Top-1000 Program yielded energy savings of 150 Mtce; the Ten Key Industry Program yielded 340 Mtce; and the Phasing-out Obsolete Capacity Program 110 Mtce.

With the deployment of more efficient technologies, overall energy consumption per ton of steel dropped by 12.1% in 2006-2010. At the same time, the deployment rates of all major new technologies went up. The medium and large steel companies achieved better performance than their Japanese peers who were considered world leaders in terms of many indicators.

xv. The benefits of a well-designed and implemented FIT outweigh the costs of the premium paid to renewables even without taking into account the economic development impacts. The German ministry overseeing their FIT estimates that the total benefits of the legislation have exceeded the costs by a factor of three.

xvi. China is developing different FIT rates depending on local resource conditions. The National Development and Reform Commission (NDRC) set four categories of onshore wind projects. Areas with better wind resources get lower FITs, while those with lower outputs will be able to access higher tariffs. The wind power tariffs per kWh are set between US$0.082 (0.51 RMB) and US$0.098 (0.61 RMB). For comparison, the average rate paid to coal-fired electricity generators is US$0.055 per kWh (0.34 RMB).

China is projected to shatter the government's 2015 target of 100,000 MW by 50 percent. China has been consistently exceeding its wind growth targets, so it is quite feasible their ambitious targets for 2020 (200,000 MW), 2030 (400,000 MW) and 2050 (1 million MW) will all occur much sooner. China now leads the world both in production and use of wind power.

The U.S., with 60,000 MW of installed wind capacity and ranked second with 25% of global total, may not renew the tax incentive for wind power after 2013. A tragic mistake if Congress takes this step. The U.S., like China, has immense wind resources, far larger and more economical than even their massive reserves of coal and oil shale.

xvii. Writing in the Proceedings of the National Academy of Sciences, Professor Michael McElroy et al conclude, "that a network of land-based 2.5 MW turbines restricted to non-forested, ice-free, non-urban areas operating at as little as 20% of their rated capacity could supply more than 40 times current worldwide consumption of electricity, [and] more than 5 times total global use of energy in all forms."

xviii. The land footprint of wind farms is remarkably small. Analysis indicate the several million wind turbines that could produce as much power as the U.S. currently consumes would take up less than three percent of the Great Plains region. The wind royalties paid to site the wind farms would generate twice as much revenue for the region than farming and ranching currently generate occupying 75 percent of the Great Plains!

xix. China has current plans to construct 558,000 MW of coal plants (the U.S. 17,000 MW), and the U.S. projects building 141,000 MW of natural gas plants. When wind (and solar) are phased in with utility bill-reducing efficiency opportunities, the system costs and risks of delivering electricity should be comparable to or less than continuing dependence on coal or natural gas plants powering inefficient devices. This transformational action would also position the two wind-giant nations to seize a substantial share of the multi-trillion dollar wind export market opportunity worldwide.

xx. The cost and cost-effectiveness of solar PV systems vary enormously due to a number of technical, financial, geographical, and institutional factors. A thorough discussion of these factors was published in 2012 by UNIDO and a consortia of other institutions, "Re-considering the Economics of Photovoltaic Power."

xxi. Silicon is the second most abundant element in the Earth's crust. The amorphous silicon cells manufactured from one ton of sand can produce as much electricity as burning 500,000 tons of coal. Solar cells currently in production (with 25 or more years of generating electricity) "pay back" the energy consumed in producing them within 6 months to 3.5 years. From the perspective of generating jobs, each million dollars spent on PV panels creates three times more jobs than coal mining, and nine times more jobs than oil and gas exploration.

xxii. FITs have been key in spurring solar PV (and wind power) growth. Beginning in 2011, China established a national FIT for solar projects, setting the FIT at US$0.15 per kWh. At the end of 2012, China had 5,000 MW of installed solar PV capacity;

its 2015 goal set a new high bar for other nations in committing to solar power.

xxiii. As in the case of U.S. wind production tax credits (PTC) set to expire in 2014, this is entirely in the wrong direction to be moving. Why?

First, because it undermines any semblance of a level playing field. Fossil fuels, as well as nuclear power, have received 20 times more government subsidies over the past half century than have solar and wind. Moreover, the tax incentives for solar and wind power represent a minute fraction of the massive costs due to fossil fuel externalities.

Second, unlike fossil fuel power plants (and nuclear and large-hydro), which use 40 percent of U.S. extracted water, solar PV and wind power require 95 percent less water. In a water-constrained world that is only worsening, the water frugality of solar PV and wind power make them low-risk assets over a lifetime of price volatility. They are also inherently low-risk assets in providing protection against any future price volatility as a result of being power generators with zero fuel requirements and zero emissions, pollution and wastes.

Third, given the imperative to expedite a global economy powered with zero emissions, the export market growth potential of solar and wind technology is immense. This is illustrated in the recent global renewable energy scenario by Stanford Professor Mark Jacobson and University of California Professor Mark Delucchi, A Plan for a Sustainable Future by 2030.

Beginning with the implementation of the robust energy efficiency improvements noted above – a gargantuan export market potential, in itself, in every energy-consuming end-use appliance, device, and equipment category – the authors show that solar and wind power could provide 90 percent of global total power and energy demand phased in over several decades. Geothermal and hydro power provide most of the other 10 percent, while also providing an important storage function to complement the intermittent solar and wind power.

One can debate the achievable annual growth rates, which appear to average 25 percent per year for wind and 40 percent for solar PV. There is historical precedence for such high growth rates. Between 1956 and 1980, before nuclear power fell out of favor, global installed nuclear generating capacity grew at an average rate of 40% per year. Like nuclear in its heyday, wind and solar will need strong, sustained supporting public policies to maintain such high growth rates.

xxiv. As car manufacturers replace heavy steel components with crash-impact resistant ultra-light carbon composites, a vehicle's reduced mass significantly reduces the amount of batteries required. Most of the running cost of a BEV is for the maintenance of the battery pack, and its eventual replacement. A BEV incurs low maintenance costs because it has only around five moving parts in its motor, compared to hundreds of parts in a gas-fueled internal combustion engine.

Electric drive systems are four to five times more efficient (80%) than diesel (20%) or gasoline engines (15%), respectively. According to the U.S. Environmental Protection Agency (EPA) fuel economy ratings for city driving, the 11 BEV models sold in 2012 averaged between 33 and 59 kilometers per liter-equivalent, km/l-e (77 to 138 mpg-e). By comparison, the EPA fuel economy rating for the average new (fuel combustion) car in 2012 was 9.4 km/l (22 mpg).

EPA estimated the total CO_2 emissions from a new gasoline car at 311 grams per kilometer (500 g/mile), which includes upstream gas production and tailpipe emissions. The grams of CO_2 per km for a BEV varies greatly, since it depends on how clean or dirty is the power grid. The Jacobson-Delucchi clean grid scenario would result in BEV CO_2 emissions near 10 g/km, whereas an all-coal grid would exceed 250 g/km.

xxv. This is the major impetus for both nations in promoting domestic oil shale reserves and biofuels, despite substantially increasing CO_2 emissions. China is the world's largest car producer, manufacturing 1 of every 4 cars, and the car markets in China and the U.S. jointly account for more than one-third of world sales. McKinsey Consulting noted in their recent report, Recharging China's Electric Vehicle Aspirations, that if China were to achieve U.S. levels of per-capita vehicle penetration, its demand for oil would increase 15-fold, exceeding total global production. BEVs are critical to China's economic, security, and environmental sustainable growth.

xxvi. Both governments have made multi-billion dollar commitments in developing advanced batteries, and providing consumers with incentives to purchase EVs. However, as the McKinsey EV report details, both nations are in need of substantially refined policies and incentives to ensure a steady acceleration and scaling of BEV production and sales.

BEV bicycles and scooters are an entirely different, and highly successful story. China has experienced an explosive growth of sales of BEV bicycles, scooters and motorcycles, with annual sales jumping from 56,000 units in 1998 to over 21 million in 2008. China is home to 150 million e-bikes as of 2012, with sales increasing 10% per annum. China is the global leader both in the production (22 million per year) and consumer use of e-bikes. Sales of more than 466 million e-bikes and scooters are projected by 2016, with China continuing to dominate the world market with more than 95% of sales.

Furthermore, with gas prices exceeding US$0.80 per liter ($3 per gallon) – equivalent to electricity at $0.32 per kWh – solar electric charging stations are cost-effective to power the world's e-bikes.

xxvii. What could be accomplished if the linear economy shifted to a circular one where the wastes became nutrient inputs to the consumption process, reducing the need for virgin resources? McKinsey was commissioned to assess the economic and business rationale for the circular economy as an innovation framework.

McKinsey analyzed the circular opportunities of the "fast-moving" consumer goods sector, comprised of products that have a lower unit cost, are bought more frequently, have a short service life compared to durable goods, with a total material value of US$ 3.2 trillion per year. These fast-moving consumer goods account for 35 percent of material inputs into the economy and 75 percent of municipal waste. Most notably, the consumer goods sector absorbs more than 90 percent of agricultural output.

The annual value of material savings of these circular opportunities is worth an estimated US$700 billion – or an annually recurring 1.1 percent of 2010 GDP. The consumer goods industry would save 20% of current materials input costs.

xxviii. Polman goes on to emphasize, "Most importantly for business leaders, such an economy can deliver growth. Innovative product designers and business leaders are already venturing into this space. I don't believe business can be a mere bystander in the system that gives it life. This is why decoupling economic growth from environmental impact and increasing positive social outcomes are two priority objectives that lie at the heart of my vision for corporate strategy. Businesses need to reinvent themselves, and the circular economy framework provides very promising perspectives."

xxix. As extensively detailed in the multi-volume global scientific report, Millennium Ecosystem Assessment, nature provides scores of essential services for societies such as climate stability, fresh water supplies, food security, health and medicines, protection from storms, floods and droughts, soil erosion, and a vital source for sustaining livelihoods for billions of people, etc.

xxx. The CBD's three main objectives are: 1) The conservation of biological diversity; 2) The sustainable use of its components, and 3) The fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The CBD recently adopted a strategic 10-year plan, the Aichi Biodiversity Targets, that offers opportunities for better alignment between business strategies, the CBD's main objectives and new or improved public policies and regulatory frameworks. It has also launched a Global Platform on Business and Biodiversity to promote markets that support nature conservation and sustainable use.

Both nations also need to develop and enforce important policies on reducing the over exploitation and trade of biodiversity. China and the U.S. are signatory parties to CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

As affluence spreads and transport and trade links improve worldwide, the cases of illegal animal trafficking continue to rise. According to Global Financial Integrity, illegal trade in wildlife, timber and fish amount to US$25 billion a year, and ranks among the top five most valuable illicit markets globally, after counterfeiting and the illegal trafficking in drugs, humans and oil. Levels of exploitation of some animal and plant species are soaring and the trade in them, together with massive habitat loss, is depleting populations and driving some species close to extinction.

xxxi. A 2011 biodiversity survey by the Union for Ethical Biotrade indicated 80 percent of consumers desire to be better informed about companies' sourcing practices. An even higher proportion indicated they would cease purchasing goods if they knew the brand failed to respect ecological or ethical practices. Three-quarters of consumers surveyed scrutinize environmental and ethical labels when buying food and cosmetic products.

In a PwC survey of global CEOs in 2009, more than one-quarter expressed concern about the impacts of biodiversity loss on their business growth prospects. The Economics of Ecosystems and Biodiversity (TEEB) Report for Business, emphasizes that business commitment to manage biodiversity and ecosystems begins with corporate governance and involves integration into all aspects of management. This involves integration across the company of goals and targets for biodiversity and ecosystem services – into business risk and opportunity assessment, operations and supply chain management, financial accounting, audit and reporting, and communication.

xxxii. Puma is assessing the benefits of their business against ecological and social costs by developing an Environmental, Social and Economic profit & loss statement. The process should reveal what is required to achieve a net positive impact.

xxxiii. Four main types of conservation actions are being implemented by Rio Tinto to mitigate project impacts on key habitats and species. These are:

- Avoidance Zones have been established. They represent a cost to Rio Tinto of 8% of foregone ilmenite minerals, as well as the management cost of maintaining these areas, and protect 27% of the best quality remaining forest cover on the deposit;
- Minimization – reduction of the likelihood or magnitude of biodiversity impacts from mining activities that cannot be avoided;
- Rehabilitation and restoration – re-establishment of littoral forest on areas that have been completely cleared, by replacing topsoil (stored during the mining process) and planting with appropriate

native species propagated in Rio Tinto's nursery;
- Biodiversity offsets – Rio Tinto is investing in biodiversity offsets at several forest sites in the region, with the aim of reducing the high background rate of deforestation.

In addition, Rio Tinto QMM is carrying out a number of additional conservation actions (e.g. environmental education, capacity-building, livelihoods alternatives, etc.) with the aim of making a positive contribution to sustainable development in the region and reducing human pressure on biodiversity.

xxxiv. The full potential of conservation carbon offsets (REDD+) awaits an actionable commitment of all nations, hopefully led in a joint effort by the U.S. and China, to live within the carbon budget essential for staying below 2°C temperature rise. Such a commitment could tap into additional new markets for biodiversity 'credits', watershed protection, pollination services, providing new environmental assets with both local and international trading opportunities.

xxxv. Key Action points for Business to address biodiversity and ecosystem services:

1 Identify the impacts and dependencies of your business on biodiversity and ecosystem services (BES), both direct and indirect.
2 Assess the business risks and opportunities associated with these impacts and dependencies; economic valuation of BES impacts and dependencies can help to clarify risks and opportunities.
3 Develop BES information systems, set SMART targets, measure and value performance, and report your results; a key step for building trust with external stakeholders, while creating peer pressure within industry, is for business to measure and report their BES impacts, actions and outcomes
4 Take action to avoid, minimize and mitigate BES risks, including in-kind compensation ('offsets'); BES targets may build on the concepts of 'No Net Loss', 'Ecological Neutrality' or 'Net Positive Impact' and include support for biodiversity offsets where appropriate.
5 Grasp emerging BES business opportunities, such as cost-efficiencies, new products and new markets; such opportunities may be facilitated by engaging with public agencies, accountancy and financial standard setting bodies, conservation organizations and communities
6 Integrate business strategy and actions on BES with wider corporate social responsibility initiatives; there is potential to enhance both biodiversity status and human livelihoods, and help reduce global poverty, through the integration of BES in corporate sustainability and community engagement strategies.
7 Engage with business peers and stakeholders in government, NGOs and civil society to improve BES guidance and policy; business needs to participate more actively in public policy discussions to advocate appropriate regulatory reforms, as well as developing complementary voluntary guidelines.

xxxvi.
- RESOURCE EFFICIENCY – steadily reducing energy intensity through aggressive and continuous "deep dive" efficiency gains in the way we deliver utility services to the point of use, derive mobility access, perform industrial processes, design physical infrastructure, etc;
- ZERO EMISSIONS AND WASTES – encouraging deep reductions in carbon intensity through a wide variety of technological measures and shifts to zero emission energy options, notably solar and wind, and other ecologically sustainable renewable energy options; as well as shifting from an economy based on one-way, resource-intensive throughput to a prosperous economy based on knowledge-intensive throughput (infor-

mation bits displacing molecules of energy and materials), in a circular closed-loop resource and waste-as-nutrient system;

- SOURCING OFFSETS – Sourcing multiple-benefits, standards-based conservation carbon offsets protecting threatened intact ecosystems (e.g., rain forests, mangroves, peatlands, grasslands) to offset current emissions, essentially incorporating the cost of negative externalities of CO_2 emissions caused by carbon combustion.

xxxvii. One touted carbon mitigation technology, Carbon Capture and Storage (CCS) of fossil fuels, will not be available at any meaningful scale for decades to come. Even if, hypothetically, CCS was suddenly available overnight and applied to the 2.3 billion tons of CO_2 emissions from U.S. fossil-fired electricity generation in 2010, this would amount to a staggering US$115 billion, increasing electricity by 3 cents per kWh (assuming the future projected CCS cost of US$50 per ton of CO_2).

In sharp contrast, ecological carbon storage (ECS), or reducing emissions from deforestation and degradation plus protection (REDD+) as it is referred to in climate negotiations, is immediately available at an average cost of US$7.50 per ton of CO_2. This is nearly seven times lower than future CCS cost projections, adding just US$0.004 per kWh to utility costs (four-tenths of one cent). When mixed in with the end-use efficiency gains captured through a comprehensive IRP utility planning process, it would reduce utility bills well beyond this slight increase.

Hypothetically, how much could be raised for ECS/REDD+ financing if the U.S. offset the fossil emissions from both the utility sector and the highway transportation sector? U.S. highway fuel consumption in 2010 amounted to 170 billion gallons, emitting 1.5 billion tons of CO_2. Sourcing ECS/REDD+ offsets for this sum would amount to about US$11 billion, adding 6.5 cents per gallon (1.7 cents/liter). Sourcing offsets for the combined utility and highway vehicle emissions would generate US$28 billion per year. It is equivalent to the amount estimated necessary for incentive payments to prevent virtually all tropical deforestation worldwide. This is as politically likely to happen as ending slavery was at the time of adopting the U.S. Constitution in 1787. Yet, it remains a least-cost-and-risk benchmark for one of the fastest mitigation options for achieving deep CO_2 reductions while accruing multiple globally significant benefits.

xxxviii. CCB standards are analogous to green building standards such as LEED. LEED certification requires going beyond just making a building energy efficient. Similarly, CCB standards require offset projects to go beyond just doing carbon mitigation and encompassing community sustainability, improved local livelihoods, and protecting or restoring the health and integrity of ecosystem services and functions.

xxxix. Scientifically solid and globally respected, the OHI reveals variations and trends in ocean health and offers a new way of looking at both the interests of people and the needs of the oceans and marine life by: offering a working assessment of the oceans, reflected in scores at the global and country level for 10 public ocean goals based on approximately 100 indicators; emphasizing opportunities for improving ocean health, evaluating trade-offs and highlighting successful actions; and, undertaking annual updates that will keep the Index in the news and highlight progress toward improved ocean health.

xl. The Seascapes approach integrates and encompasses a network of Marine Protected Areas, recognizing that many marine species migrate over long distances between their breeding, nursing and feeding locations. The Seascapes approach addresses this need for connecting spatially separated distances over migrating species' life cycles.

xli. Two-thirds of the world's farmed seafood production – aquaculture and mariculture – occurs in China, and 90 percent in Asia. The upper estimate of 50% for aquaculture is FAO's nominal figure, whereas the lower estimate of 20% takes into account by-catch and discards, illegal, unregulated or unreported catches, and generally subsistence and recreational catches, which may be substantial in some places.

xlii. Over the past 200 years the oceans have absorbed 525 billion tons of CO_2 from the atmosphere, or nearly half of the fossil fuel emissions over this period. The ocean continues to capture one-third of CO_2 emitted to the atmosphere. This natural process of absorption has benefited humankind by significantly reducing the CO_2 levels in the atmosphere and thus minimizing some impacts of climate destabilization. However, the ocean's daily uptake of 22 million tons of CO_2 is starting to take its toll on the chemistry of seawater. At present, ocean chemistry is changing at least 100 times more rapidly than it has changed during the 650,000 years preceding our industrial era.

xliii. In the Sacramento-San Joaquin Delta, California, 1,800 km^2 of wetlands have been drained for agriculture over the last century, resulting in the release of massive amounts of CO_2 into the atmosphere. Each year, carbon equivalent to the emissions from more than one million cars continues to be released from the Delta.

xliv. Several countries are developing policies and programs in support of sustainable development through initiatives that reduce the carbon footprint associated with the growth of their economies, including actions to conserve and sustainably manage natural systems relevant to the United Nations Framework Convention on Climate Change (UNFCCC) and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism.

xlv. The importance of coastal carbon management for climate change mitigation is not yet fully recognized by international and national climate change response strategies. Climate change financing opportunities are currently untapped for supporting mitigation actions for conservation, restoration and sustainable use of coastal ecosystems.

The Blue Carbon Policy Framework has five specific Policy Objectives:

1 Integrate Blue Carbon activities fully into the international policy and financing processes of the UNFCCC as part of mechanisms for climate change mitigation;
2 Integrate Blue Carbon activities fully into other carbon finance mechanisms such as the voluntary carbon market as a mechanism for climate change mitigation;
3 Develop a network of Blue Carbon demonstration projects;
4 Integrate Blue Carbon activities into other international, regional and national frameworks and policies, including coastal and marine frameworks and policies;
5 Facilitate the inclusion of the carbon value of coastal ecosystems in the accounting of ecosystem services.

xlvi. As the TEEB reports, the Millennium Ecosystem Assessment, and a large body of documentation by illustrious and highly respected commissions have strongly argued, governments have an essential role to play in providing an efficient enabling and fiscal environment. As highlighted in this article, such actions encompass removing biosphere-harmful and damaging subsidies; offering tax credits or financial incentives for conservation investment, establishing stronger environmental liability (e.g., performance bonds, offset requirements); developing new ecosystem property rights and trading schemes (e.g., water quality trading); encouraging increased public access to information through reporting and disclosure rules; and facilitating cross sector collaboration.

xlviii. One month prior to Rio+20, ten African Heads of State participating at the Summit for Sustainability in Africa held in Gaborone, Botswana, became the first formal signatories of the Communiqué on Natural Capital Accounting, which they nested in The Gaborone Declaration of the Summit for Sustainability in Africa.

Africa is a natural resource-rich, cash-poor continent that will face some of the most severe catastrophes inflicted by the unchecked rise in CO_2 emissions. Protecting and restoring their biodiversity and ecosystem services natural capital is critical for mitigating and adapting to climate destabilization. As such, Africa's leaders are at the forefront in raising the call for global leadership to help resolve these twin challenges of stabilizing the planet's climate and recognizing the immense value of nature's capital assets.

xlviii. Australia, Japan, Norway, the United Kingdom, and Canada are developed countries in which efforts towards environmental accounting is taking place and are, as a result, important WAVES partners. Other important partners include international organizations such as United Nations agencies (UNEP, UNDP, and the UN Statistical Commission), as well as many supporting research and non-governmental organizations. WAVES seeks to foster the implementation of natural capital accounting with the ultimate goal of incorporation in policy analysis and development planning, while supporting the development of internationally agreed-upon guidelines for ecosystem accounting.

The WAVES demonstration project in Madagascar, for example, conducted an in-depth assessment of the contribution of key ecosystem services from the Ankeniheny-Zahamena Forestry Corridor, the largest remaining contiguous patch of humid forest in eastern Madagascar. The project demonstrated the relevance of methodologies for the assessment of economic dimensions of ecosystem services and their benefits, as well as the detailed, spatially-explicit and dynamic methodology for ecosystem services – provided, for example, by the Artificial Intelligence for Ecosystem Services (ARIES) tool.