



The Year We Didn't Want

...or, "193 Shades of Gray"¹

2012 Whizzed and then it Fizzed, but 2013 can be Better

To get 2013 off with a technological BANG, ETC staff are offering (what, for us, amounts to) a 'light-hearted' reflection on the year past and projections for the one already upon us.

Uppers: At the end of the year, *New Scientist* announced that we have reduced the under-5 child mortality rate by 60 % in the last 20 years.² In the United States, government studies revealed during the year that teenage pregnancies have declined 40 % since 1990;³ teenage smoking (at 10.6 %) is at its lowest level since records were first kept in 1975;⁴ the number of traffic fatalities in New York City (declining ever since 1971) are the lowest since 1910;⁵ in spite of a 50 % increase in the number of firearms, the number of US households possessing guns is continuing to drop.⁶ And, in late October, *The Economist* reported that, across most industrialized countries, the annual crime rate has been dropping steadily since the mid-1990s.⁷ In 2012, studies announced that homophobia, at least in OECD states, is declining steeply⁸ – a little short of World Peace or ending hunger but still something to celebrate.

Downers: The "Global Burden of Disease," an end-of-the-year study published in *The Lancet*, declared that obesity has now officially surpassed malnutrition as a global health issue.⁹ Some scientists concluded in 2012 that polar ice in the summer Arctic could disappear as soon as 2016, and most believe there will be ice-free summers by at least 2050.¹⁰ Governments came together in Paris late in the year to establish Natural Capital, a financialization facilitation scheme to help them put a price tag on Pachamama. Fifteen years in the breaking, the first commitment period of the Kyoto Protocol ended December 31, 2012 with its most optimistic supporters arguing only that it might have helped increase public awareness about climate change.

Reminders: 2012 marked the 50th anniversary of *Silent Spring*, the 40th anniversary of *The Limits to Growth*, the 100th anniversary of the Titanic and 200th anniversary of the Luddites – proving that folks don't pay much attention to the lessons of history. 2013 is the 50th anniversary of the UN promise that hunger will be eradicated 'within our lifetime' – unfortunately, not much success there – and marks 10 years after the

US government introduced NBIC (Nano, Bio, Info, Cogno), technological convergence at the nanoscale – what we call The Little BANG (Bits, Atoms, Neurons, Genes) Theory.

Oops Scoops: During 2012, several of the world’s most influential climate players had a little trouble with their math...Oops, China seems to have miscalculated its annual GHG emissions, underreporting by about 20 % (1.4 billion tons of carbon each year), meaning that global emissions are about 5 % higher than we thought.¹¹ Oops, it turns out that the UK’s 14 % reductions in GHG emissions between 1990 and 2008 are erased by its 20 % increase in emissions from outsourcing UK manufactures to Asia – actually, a net 6 % increase.¹² The UK’s gain is China’s loss...or vice versa? Oops, India seems to have overestimated its forest cover by about 10 %, meaning its CO₂ sequestrations are a little less than thought...or bought.¹³ Oops, Brazil’s biodiversity conservation may not be quite what it was cracked up to be – the western State of Rondonia’s “fish-bone” road architecture carved up natural habitats in ways that both reduced the anticipated deforestation but also accelerated biodiversity loss.¹⁴ Oops, the global tropical timber trade hasn’t factored in the cut for organized crime. According to a September report by UNEP, up to 30% of all timber exports are mafia-controlled and 90% of tropical deforestation is due to illegal trade.¹⁵ Oops, news that the USA has cut back its GHG emissions to 1992 levels may be premature: it seems that American natural gas production and consumption thanks to highly-problematic “fracking,” while lowering emissions, is balanced out by US coal exports to Asia.¹⁶

Dumbest Title: “The Future We Want” – the UN’s absurdly optimistic outcome document from the failed Rio+20 Summit of June 2012. (Full disclosure: Having predicted a dismal outcome more than two years ago, ETC Group is slightly embarrassed to be happy about some of the Rio results related to technology transfer/assessment, geo-engineering, and the role of the Rome-based CFS.) Although the document can be appreciated only by sadomasochists, the Secretary-General’s office ignored our alternative title proposal, “193 Shades of Gray” – the number of UN member states.

Ignoble Lies: The EU may have won the Nobel Peace Prize but its desperate insistence that carbon trading and biofuels can somehow be made environmentally useful – or, at least non-destructive – was a tragicomedy running throughout 2012.¹⁷ Watching EU bureaucrats at intergovernmental fora making a half-hearted defense of these policy bloopers was excruciating.

Saddest Story: Arctic ice has lost 40 % of its volume since 2004.¹⁸

Most Pitiful Story: On April 8, 2012, the world’s largest earth-observation satellite, Envisat, fell silent and the US National Academies predicted that, by 2020, the number of US climate monitoring satellites could drop from 23 to 6 and the number of monitoring instruments from 90 to 20.¹⁹ We were also warned that governments’ capacity to monitor climate and weather conditions on the Indian subcontinent²⁰ and throughout the Tropics and the Southern Hemisphere has been declining steadily even before the 1992 Rio Earth Summit.²¹ *The Economist* called the collapse in global monitoring “willful blindness.”²²

Blind Justice: On other environmental fronts, just after the American Thanksgiving and barely two years after the Gulf of Mexico oil spill, US courts fined BP \$4.5 billion for its 2010 Deepwater Horizon debacle, but the company may still be on the hook for another \$21 billion in civil suits.²³ BP's spill took place in 2010 just as the legal loose ends of the 1984 Union Carbide pesticide spill in Bhopal, India were wrapping up. Dow Chemical (which bought Union Carbide) eventually paid out \$400 million and six executives are facing jail terms if they are foolish enough to holiday in India. While 11 people died in the BP oil spill, according to the Center for Science and Environment (an Indian CSO), Union Carbide's chemical spill killed several thousand; 100,000 continue to suffer from cancers and neurological disorders; and soils within a 3 km radius of the pesticide plant still record toxicities 40 times above national limits.²⁴

No Limits to Hope: If your New Year's resolution is not to have another New Year, Jorgen Randers' *2052 – A Report to the Club of Rome Commemorating the 40th Anniversary of The Limits to Growth*²⁵ will give you the steel to keep your resolve. As one of the original MIT whiz-kids that helped Dennis and Donella Meadows develop their models for the 1972 classic, Randers eventually left academia to work for WWF. Now in his 60s, Randers' book is a genuinely sincere – and desperately unsuccessful – attempt to be optimistic in the face of the ecological catastrophe he sees awaiting his grandchildren in 2052. Although convinced that our species will survive, he thinks the poor will suffer greatly but – luckily, he insists – his grandchildren will learn to appreciate the lost wonders of the great forests and extinct mammals thanks to 3-D multi-sensorial media reruns. Randers pooh-poohs our acquired need for physical contact and recommends quality-time hologram visits for children and aging parents. As an optimistic afterthought, he advises young people to rush out now to see the great historic sites before they become impossibly crowded in a world of more than 9 billion. Randers will feel vindicated to learn that, during 2012, CyArk, a California-based non-profit, began carefully constructing 3-D digital images of the world's most endangered historic sites – those especially prone to sea level rise, earthquakes and civil unrest.²⁶ Otherwise, there's always the History Channel. Kind of gives you that warm fuzzy feeling – except the “fuzzies” are extinct.

No Limits to Greed: On its 40th anniversary, *Limits to Growth* came under intense attack from techno-optimists who have no limits to greed. Some examples of the double-think: to get all our electricity from photovoltaic cells will take up almost all of the world's known copper reserves²⁷ unless, of course, nano constructions like sand can replace copper. Where does their optimism come from? They have the example of aluminum. In just seven years, a new smelting process turned aluminum – an alloy so exotic it capped the Washington Monument – from costing \$550 per pound to \$18 and, half a century later, to a “throw-away” pop can worth \$0.25 a pound.²⁸ Since the turn of the century, the cost of gold mining has climbed from \$200 per ounce to \$857, and the cost of finding new gold sources has risen from about \$500 million per year to over \$3 billion, while the grade of mined ore has fallen 30 %. So, why haven't the Limits to Growth smacked into the ceiling? Gold prices are now six times higher than in 2000.²⁹ The price is also still right for the ocean's fisheries. Measured by hours at sea, British fishers catch just 6 % of what their forebears caught in 1880 and their annual cod catch is down by half,³⁰ but

nobody's stopping until the final fin is filed. Then, too, how does oil reach its "peak" if the Deepwater Horizon oilrig can drill 35,000 feet (more than 6 km) through ocean and rock to suck up the worst human-made disasters ever to strike the Gulf of Mexico?³¹ What the authors of *The Limits To Growth* didn't get is that when the energy industry is ready to sink so low the peak gets higher. Fracking also lowers the bar to subterranean levels – but who cares about contaminating groundwater with a carcinogen cocktail if it means we can pump gas out of the ground, which was previously out of reach? And, thanks to the Green Economy, garbage dumps are now clean tech's strategic reserve. The 500 billion plastic bottles used annually by the soft drink industry – equivalent to 16 million tons of PET chemicals, are just waiting to be born again – along with another 15.3 billion tons of solid waste produced by industrial manufacture each year.³² And, although uranium is running out on land, there are 4.5 billion tons of the stuff floating in the world's oceans; US government researchers, in 2012, managed to double the extraction rate and cut the cost in half (to \$660 per kilo) bringing it to just five times the expense of uranium mining on land. There is sufficient uranium in the ocean to power all present-day reactors for 6500 years.³³ Are you feeling the glow yet? If all else fails, there's still hope in better living through chemistry. 2012 announced the birth of Chemica, dubbed a collective "chemical brain," which predicts and provides synthesis pathways for molecules. The database contains information on 7 million different substances and, according to its creator, is already revealing faster and cheaper ways to produce fuels, drugs and plastics.³⁴

The Limits to Growth Meet DIY Manufacturing: In the era of technological convergence, the challenge to resource limitations is not just nanotechnology or synthetic biology, but also the new manufacturing process of 3D desktop printing, also called "additive manufacturing." During 2012, the number of US households purchasing firearms may have declined (see "Uppers" above), but – for the first time since the bow and arrow – DIY group, Defense Distributed, is proving that a typical American household with a \$2000 desktop manufacturing printer can print their handguns without anyone being the wiser.³⁵ They probably got the idea from news stories that the US military's Rapid Equipment Force has dispatched 3D printers to some bunkered outposts in Afghanistan so that soldiers can print their way out of any supply line shortfalls.³⁶ This should be old news: in 2011, a handful of students at Southampton University spent two days designing – and five days printing – a drone aircraft that they manufactured by hooking up their laptops to some desktop 3D printers. The aircraft flew and utilized sophisticated design features that had previously been too expensive for even Boeing and Airbus. 2013 may be the year policymakers and traders take their heads out of the sand and come to grips with the fact that the cost and speed of 3D printing could render Asia's cheap labour and Africa's abundant resources commercially irrelevant. We have to give it to *The Economist*, putting desktop manufacturing on the front cover as the sign of the New Industrial Revolution but also its April Fools' Joke – excitedly describing how 3D DNA printing could allow people to create their own pets...or boyfriends.³⁷

No Limits for Star-grazers: Most of us agree that the Club of Rome got it right when they warned about the scarcity of many critical minerals. If, for example, all the world's

vehicles went electric, we would run out of platinum for the batteries within a year. The extractivists aren't alarmed, though; new start-up (way up) asteroid mining companies like Planetary Resources, Asteroid Mining Group³⁸ and Moon Express Inc. (bankrolled by Google and Yahoo founders and space cadets like James Cameron and staffed with MIT and ex-NASA scientists) say they will soon be able to steer the most promising of an estimated 8800 stellar stones into near-earth orbit in order to mine scarce minerals.³⁹ Watch out for the meteor's tailings! Planetary Resources, which calls asteroids "the low-hanging fruit of the Solar System," expects to deliver precious metals to earth by 2016.⁴⁰ During 2012, the star-struck Enterprisers got a boost from the rediscovery of an 11th century Buddhist statue carved from an iron meteorite and the market-busting stockpile of industrial diamonds recovered from a meteorite that struck Siberia back in the 1970s⁴¹ along with the discovery that Vesta, a 530 km broad asteroid, is awash in fresh water.⁴² Much to the chagrin of starry-eyed extractivists, however, the only telescope dedicated to tracking errant (and potentially valuable) asteroids in the Southern Hemisphere ran out of money and was scheduled to be shut down just after the grand finale of the Rio+20 summit.⁴³

Most Cringe-Worthy Quote: Amyris's board chair describing the synbio start-up's forced withdrawal from the biofuels business as a cause for "humility." Also in the running: "He's sitting under a mountain of data" – that was John Disney, CEO of the so-called Haida Salmon Restoration Corporation, explaining the whereabouts of rogue geoengineer Russ George, who couldn't make it to a press conference to defend his illegal ocean fertilization experiment off Canada's West Coast.⁴⁴

Geoengineering in 2012 – SPICE Jocks: In 2012, ETC Group published the first ever map of more than 500 experiments in geoengineering and weather modification and helped stop a high profile atmospheric geoengineering experiment in the UK, the SPICE (Stratospheric Particle Injection for Climate Engineering) experiment. But, oops, we also missed two real world experiments. First, E-PEACE (Eastern Pacific Emitted Aerosol Cloud Experiment) deploying stratospheric aerosols was quietly conducted in 2011 off the California coast and then, in July 2012, Russ George of Planktos boondoggled a small Haida community off the west coast of Canada to conduct the world's largest-ever ocean fertilization deployment. When ETC found out (3 months later) we worked with the Haida leadership to demand that the Canadian government defend the UN moratorium against ocean fertilization. In the midst of a media firestorm, the Canadian Environment Minister labelled the dump "rogue science" but, at the end of the year, no charges had been filed.

Food Sovereignty in 2012 – Algo trading and food commodities: When one of the world's largest stockbrokers, Knight Capital, lost \$440 million in 45 minutes in late July 2012, everyone who is worried about global food prices should have taken notice. What prompted Knight Capital's meltdown – and also the more famous "Flash Crash" of May 6, 2010 when the Dow Jones Industrial Average fell 600 points in a matter of minutes – is the exponentially growing number of lightning-fast automatic trades carried out by computers, sometimes placing and cancelling trades thousands of times per second, far faster than a human stock trader can order an espresso. High Frequency

Algorithmic Trading (dubbed “algo trading”) already accounts for most of the trading on equity markets such as the New York Stock Exchange, and now commodity markets such as the Chicago Board of Trade are the target for algo traders. Super high-speed connections allow computers to scan headlines as they are published in New York and then stuff orders on the trading floor 8-10 milliseconds later in Chicago. The rising influence of algo trading on food speculation has become cause for increasing concern as crude oil trades jumped from under 1 million in 2005 to almost 42 million in 2011, and in maize from 133,000 trades to 10.7 million. If algo trading causes a flash crash or rapid artificial inflation of prices in the food-related commodities exchanges in 2013, it’s not just stockbrokers on Wall Street who may be out of luck, but billions of the world’s poor.

Carbon Trading in 2012 – carbon dumping for carbon diggers: You might think that the geoengineering technique of ‘direct air capture’ (mechanically extracting CO₂ from the atmosphere) was intended to counter climate change but that idealistic aim now seems passé. At a much heralded Direct Air Capture Summit in Calgary last March, four new commercial Direct Air Capture companies revealed that their business plans depend on helping *increase* fossil fuel production. The buzz at DACS was that a new direct air capture market may be viable by selling captured CO₂ to oil companies for ‘enhanced oil recovery’ – pumping CO₂ underground to literally squeeze every little bit of oil out of the ground for commercial use. Those who see the irony argue that it’s just a stepping stone to a better business plan where they will instead feed their CO₂ to synthetic algae that can turn the CO₂ into high risk biofuels to...er...burn as well.

Synthetic Biology in 2012 – Syn Cream? Dance move of the year goes to “The Amyris Pivot.” 2012 was the year when the whole synbio industry shifted focus from production of biofuels to synthesizing high value natural commodities – or, to put it another way, it was the year synbio’s *raison d’être* changed from solving the energy crises to flavoring ice cream and making moisturiser. The stock price of synbio darling Amyris fell to pennies in spring and then recovered as they admitted that they were not going to be a biofuels business after all. As a ‘recovering alcoholic’ (they also closed their ethanol business), Amyris is now chasing perfumes, cosmetics, soaps and other means of cleaning up their financial mess. Meanwhile, the chase is on to monopolize metabolic pathways and Amyris is well out ahead on that, having locked up a genetic pathway known as the isoprenoid pathway, which produces 55,000 different natural compounds.

Other Signs of the Times, or little items we shouldn’t forget:

- **Fast Living:** It took researchers 13 years to map the first complete human genome; in 2012, sequencing a human genome can be done in as little as 27 hours (and the cost has dropped tenfold in the past five years).⁴⁵
- **Fast Lying:** Within three weeks of its publication in a peer-reviewed journal, a study by Gilles-Eric Séralini et al. linking Monsanto’s Roundup Ready maize and Roundup to cancer in rats came under vicious and orchestrated attack by biotech advocates, including regulatory agencies that had approved the GM maize based on little to no safety data.
- **Look Ma, No DNA!** In 2012, scientists discovered that there are six molecules other than DNA that are able to store genetic information and pass it on.⁴⁶

- **Look Ma, No Shit!** In September, the international Encode Project confirmed what anyone with a shred of humility suspected all along: long stretches of DNA previously dismissed as “junk” are, in fact, crucial to the way our genome works.⁴⁷
- **Look, Two Mas!** In the last months of 2012, the UK’s Human Fertilisation and Embryology Authority launched a public consultation on the controversial technique known as “3 person IVF,” which combines mitochondria from a female donor along with an egg from another female and sperm from a male. The donated mitochondria replace faulty mitochondria of the egg donor in order to prevent the passing on of a genetic mutation that would result in a child with mitochondrial disease. Although the amount of DNA from the secondary, mitochondria-donating “mom” would be minimal (about 36 genes), the resulting child would technically have three biological parents. David King of the UK watchdog Human Genetics Alert rang the alarm, arguing that UK approval could remove the regulatory barrier to genetically-modified humans.

Lost in 2012: 30-50 indigenous languages and the ecological wisdom and knowledge they encompass; 2 % of the world’s crop genetic diversity; 5 % of livestock genetic diversity; and, geneticist Erna Bennett, retired chief scientist of the FAO’s original Crop Ecology Unit who cared deeply about each of these losses.

ETC’s Forecasts for 2013:

Food Sovereignty Forecast #1 – Brazil will try to approve Terminator for Amazon: It’s a perfect “Green Economy” storm. As it was in 2012, Brazil will be in the green limelight in 2013 when the world realizes the implications of EMBRAPA’s (Brazil’s large public sector research system) aluminum-tolerant GM Eucalyptus program. Aluminum soils dominate in the Cerrado and the degraded Amazon. GM Eucalyptus requires Brazil to scrap its law against Terminator technologies. Two bills are already working their way through the Congress seeking approval in early or mid-2013. Without Terminator (sterile or suicide seeds), proponents will argue, the pollen spread from GM Eucalyptus could contaminate Africa or Asia. The preparation of GM Eucalyptus for aluminum soils means that Brazil is expecting to pave over the immense biodiversity of the Cerrado and the Amazon with GM tree plantations. GM trees, Terminator and the financialization of nature all come together in the world’s most important center of terrestrial biological diversity.

Food Sovereignty Forecast #2 – Mexico will try to license massive GM maize planting: Although local and global protests have forced the Mexican government to back down for the moment, political pressure from Monsanto, DuPont and Dow will, in 2013, likely let the companies plant millions of hectares of GM maize in the crop’s Center of Diversity – a precedent-setting move that will open the way to GM rice in Asia also in 2013. So far, the UN Biodiversity Convention has expressed its concern. FAO has made lackluster tweaks to a form letter it has been sending to inquirers ever since the contamination threat first appeared in 2009 explaining why the UN agency isn’t going to do anything.

Food Sovereignty Forecast #3 – Get ready for the Great Diversification: It's not all bad news for 2013. Peasant movements around the world have been developing new strategies and cultivating old strategies in seed-saving and community plant breeding to respond to climate change. Proposals are circulating that could see indigenous peoples and peasants conducting not only local but also regional and global seed exchanges on a much bigger scale than ever before. The question is whether the world's leading gene banks and UN agencies will support this grassroots response to climate change or get in the way.

Governance Forecast #1 – Watch out for UN Foraplay: Rio+20 follow through: Unfortunately, the dangerous notion of a Green Economy limped through Rio despite fierce opposition from a few brave G-77 countries, civil society and social movements. One possible jewel in the mud was agreed language calling for technology assessment capacity at national, regional and international levels. The idea of Sustainable Development Goals also got past Rio and remains to be negotiated. **UNEP:** Watch out for the March meeting of the United Nations Environment Programme, which didn't get the boost it wanted and is going to have to sort out what it does next in the light of potentially major changes at the UN in New York.

Governance Forecast #2 – Watch for 3 Acronyms: CFS, IPBES, HLPF...WTF?

CFS, the Rome-based UN/FAO Committee on World Food Security, survived its tumultuous first years and, in 2012, won a battle with the United States and gained grudging acceptance as the UN's premier negotiating forum for food and agriculture. Basically the news is good news: a more open meeting of all the food and agriculture agencies with seats at the table for farmers, fisher folk, indigenous peoples and civil society. Much could happen when the still-growing body meets in October 2013. **IPBES** (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) decided that it is "for real" this year and began setting up house in Bonn. The jury is still out on whether the UN's unpronounceable GM (governmentally-modified) platform is being bred to guide or to guillotine global scientific debate among the Rio treaties and FAO on crosscutting, controversial issues. A critical meeting may decide some of this at the end of January.

HLPF (high-level political forum): the bitter pill swallowed at the end of Rio+20 by countries that wanted a Sustainable Development Council to replace the Commission on Sustainable Development and by those that did not want any vestige of governance structure in the UN dealing with that illusion called sustainable development. The concept is notably written in lowercase letters in the Rio+20 outcome document, intentionally not defined elsewhere and obviously meant as a "placeholder" for further political arm-wrestling at the UN General Assembly until it takes some shape by the end of 2013. The HLPF has the potential to become a genuinely high-level body at the UN that can take on strategic issues that impact sustainable development such as new and emerging technologies. Or, it could end up worse than the lousiest years of the CSD only that it gets to meet only 2-3 days every two years, enough for a "high-level" representative of every government to deliver a five-minute speech with full webcast coverage.

Governance Forecast #3 – June will see a governance meeting without governments:

The most important – certainly the most productive – governance meeting of 2013 will be held without governments and will take place in June in Indonesia when La Via Campesina convenes its sixth Congress and lays out its strategies for the next few years. Over the last two decades, the global peasants movement has grown from scattered dreams to a strong movement that can't be ignored by UN agencies or governments.

Climate Forecast #1 – Expect new “Son of SPICE” experiments: Geoengineer David Keith of Harvard is proposing what we're calling “son-of-SPICE” – another atmospheric geoengineering test, this time using aerosols in the atmosphere over the New Mexican desert. Geoengineering needs a post-SPICE Act Two, and it looks like Keith is ready to take the helm of the geoengineer's Starship Enterprise as “Dr. Spocc” – “Stratospheric Piracy of Climate Commitments.”

Climate Forecast #2 – DIY geo-engineering: Local Jocks

Taking a move from the green movement, geoengineers are hoping their new “think globally, act locally” stance will inspire confidence. A study in *Nature*, signed off by leading geoengineering advocates, used computer modeling to suggest it should theoretically be possible to selectively engineer regional climates separate from each other. Doing so moves discussions away from the diplomatic dead-end notion of controlling ‘the global thermostat’ to the diplomatically even more complex but supposedly suave and sophisticated approach of differentially managing a suite of regional climates in different parts of the globe separately. As the ‘local geoengineer’ oxymoronic meme gains steam in 2013, expect to hear more about how large technofix schemes to cool the Arctic or defend New York from future hurricanes don't need international agreement since they are local interventions. Indeed, as Russ George pioneered with his “local” ocean fertilization dump, the geoengineers hope they can forget the UN and international governance altogether and just apply for village council permits to reengineer the planet.

Climate Forecast #3 – Natural Capital will make bid for center stage: As Rio+20's Green Economy put the commodification of nature firmly on the international agenda, 2012 saw the carbon market start to take bites at agriculture. It was the year that agricultural carbon offsets first got approved at the UNFCCC's Clean Development Mechanism and that the World Bank's flagship Biocarbon Fund approved a methodology for verifying soil carbon sequestration opening the door to soil carbon offset projects. As for 2013 and beyond: carbon will soon be so last decade! Check out ecosystemmarketplace.com to see how the expansion of ecosystem markets allows everything to be put up for sale – water, biodiversity, species banking, wetland banking, nitrogen credits, payments for ecosystems services and much more – and the likes of Goldman Sachs are sniffing around to see what else they can turn into tradable markets.

Tech Forecast #1 – Getting high with a little help from their friends: With good reason, much of the public's attention has been focused on the use of drones in the wars in Afghanistan, Pakistan, Yemen, Iraq, Libya and elsewhere. According to one

investigation, the United States alone launched over 7600 drone sorties in 2012, and the US and Britain have authorized at least 1200 drone attacks in the past 5 years. Since George W. Bush lifted a ban on assassinations 10 years ago, between 2800-4100 people have been killed by military drones. When combined with the upsurge in other military robots on the battlefield, 2013 may be the year that more people are killed by fighting machines than by fighting soldiers. However, the increased civilian use of drones should also be giving civil society, and particularly labour, pause, as a burgeoning DIY drones movement is finding new uses for drones, including media reporting and delivering pizza. Taxi drivers and transport workers might, in particular, start to worry about job security as car and truck drones move into wider service. Three US States (Nevada, Florida and California) now allow for driverless cars following heavy lobbying by Google Inc., which in August 2012 announced that their driverless car fleet has already completed over 300,000 autonomous-driving miles accident-free and that they typically have about a dozen cars on the road at any given time. Meanwhile, during 2012, a fleet of driverless trucks began work in Australian mines operated by Rio Tinto. The company plans to bring 150 autonomous trucks online over the next four years – a first step towards changing the face of road haulage and making all-night truckstops even lonelier places.

Tech Forecast #2 – Getting bio with a little help from their friends. 2012 was a hard time to be a biofuels company and so too will 2013. In the last few years it was mostly government money and the military that kept next-generation biofuel companies afloat – most famously the \$8.5 million dollars paid by the US Navy for 20,000 gallons of algae-based fuel from Solazyme, Inc. (that’s a whopping \$425/gallon). As politicians attempt to reduce military budgets and EU action against food-based biofuels begins to take effect, expect a scramble for new sources of biomass. The first cellulosic biofuel refineries will come online and 2013 may be the year that algae and seaweed biofuels come out of the shadows and into the marketplace. Already car drivers in California are able to pump algal fuels into their tanks, thanks to a partnership between Solazyme and Propel Fuels. Meanwhile, synbio company Bio Architecture Lab, which already has deals with Statoil, DuPont and BP to turn seaweed into fuel, just inked an agreement with China’s Xunshan Group (the world’s largest producer of brown seaweed), to build a large refinery and a dedicated seaweed farm in Shandong province. After the land grab for biofuels, are we seeing the beginning of a coastal ocean grab?

Tech Forecast #3 – Losing jobs with a little help from a robot: If 3D printing doesn’t leave the manufacturing workers of the world idle, the swelling army of robots and drones could. Historically, much of the money flowing into robotics has been defense funding, but that’s changing. In July 2011, electronics manufacturing giant and iPhone maker Foxconn (China’s largest private sector employer) announced that it will double the global robot population by deploying a million new robots in their Chinese factories by 2014. Foxconn previously employed 1.2 million humans – a number that may drop dramatically as they replace people with ‘foxbots.’ In March 2012, the world’s largest online retailer, Amazon.com, purchased robot maker Kiva Systems to begin ‘botsourcing’ the roughly 50,000 jobs in Amazon distribution warehouses. Then in September 2012 the inventor of the popular Roomba vacuuming robot announced his new creation, Baxter – a cheap, flexible, adaptive assembly line robot intended for large-

scale rollout in manufacturing facilities to reduce labour costs. The job security of so-called knowledge workers may not be much better. IBM has announced that it's looking to commercialize its artificial intelligence program "Watson" fresh from winning the TV game show Jeopardy. According to IBM, Watson can be deployed to analyze data and make decisions in finance, healthcare and other sectors, reducing the need for human analysts and experts. Meanwhile 2013 could see the beginning of the squeeze for nursing and care workers as Hoaloha Robotics, founded by the former head of Microsoft Robotics, is expected to unveil its mass market "elder care" robot.

Tech Forecast #4 – 3D printing will go prime time: With desktop 3D printers now selling for as little as \$350 and office supply big box store Staples starting to offer 3D printing services, 2013 may mark the year that "additive manufacturing" becomes a consumer hobby to rival downloading music and videos (see "The Limits to Growth Meet DIY Manufacturing," above). Digital libraries of downloadable 3D printable designs such as the online "thingiverse" are set to become the iTunes or Napster of physical/digital stuff. Meanwhile "maker culture" types are busy hacking 3D printers to churn out stuff more interesting than plastic key fobs and figurines, inventing 3D printers that turn cellulose, food, even living cells into printed 3D objects. Plans are underway to use 3D printing to print cheap houses. Famously described by a Google executive as "having China on your desktop," 3D printing's impact on global manufacturing patterns and the workers who currently produce goods is yet to be reckoned – meanwhile, prepare for a rising tide of DIY plastic junk.

Tech Forecast #5 – Watch for biofuels to bounce back: While the synthetic biology industry and the biofuels industry have been inseparable partners for the past few years, expect to see the synbio crowd court new energy suitors in 2013. In October 2012 Calysta, the latest synbio start-up to emerge from stealth mode, revealed that it had engineered microbes that would efficiently turn the methane in natural gas into liquid fuels and chemicals. Natural gas reserves have been increasing due to the controversial fracking techniques being applied to shale deposits. Calysta's new biological gas-to-liquids technology may be a perfect microbial partner for methods recently patented by Craig Venter's Synthetic Genomics Inc., which is exploring with BP how to pump methane-generating microbes into coal seams via fracking operations. Meanwhile, Canadian Tar Sands majors Suncor, Conoco and Statoil are collaborating to see how synthetic biology can get their bitumen flowing more easily into oil markets.

¹ If you got through 2012 without hearing anything about *50 Shades of Gray*, consider yourself very lucky; on the other hand, one of your New Year's resolutions for 2013 should probably be to get out more!

² "The end of the world is an opportunity, not a threat," *New Scientist*, No. 2896/97, December 21, 2012, p. 5.

³ "Teenage pregnancy. Setting aside childish things. America's teenage-pregnancy rate has hit a 40-year low," *The Economist*, July 28, 2012.

⁴ Johnston, L. D. et.al., "Decline in teen smoking continues in 2012," University of Michigan, press release, December 19, 2012: <http://www.monitoringthefuture.org/pressreleases/12cigpr.pdf>.

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