

CELLULAR LIVESTOCK

Food is responsible for 26% of global greenhouse gas emissions (31% livestock/fisheries, 2% crop production, 24% land use and 18% supply chains). Lab-growing livestock is a proposition being tested at a small scale to serve a bulging population from the source cells of the ingredients, turning animal cells into meat food product without any of the compromises of traditional animal agriculture. Process; 1. take a small harmless sample from an animal (almond sized), 2. isolate the correct cells.

SUSTAINABLE FASHION

The fashion industry is responsible for 10% of annual CO2 emissions and are expected to surge more than 50 % by 2030. Water-intensive dyeing and wasted clothing of composite fibres take up a large component of fast fashion emissions. Many low-cost producers offer new designs weekly and less than 1 % of used clothing is recycled into new garments. Brands are searching for ways to reinvent the industry, including Reformation, through;lower-impact fabrics (vintage, deadstock, tencel, flax linen, Alpaca yarn)

ALTERNATIVE CEMENT CLINKER

The cement industry is one of the largest consumers of natural resources and accounts for 8% of global CO2 emissions as of 2018, 60% of which comes from the production of clinker, cement's main binding ingredient (clinker itself - 4.8%). One method for an alternative clinker system with respect to global reductions in concrete related CO2 emissions; Carbonatable Calcium Silicate clinkers (CCSC) is in early stages of commercialisation. It happens only by reaction with CO2, resulting that concrete be cured under a CO2-rich atmosphere which restricts its applications to factory-made concrete products.

BIOPLASTIC PACKAGING

Roughly 310 million tons of plastic is produced each year, a figure projected to quadruple by 2050. Most of the plastics

The earliest recorded windmills were created around 500 to 900 AD in Persia. The technology spread to Europe during the Middle Ages, and for centuries the Dutch fostered most windmill innovation. Fossil fuels sidelined wind energy during the mid-twentieth century. The oil crisis of the 1970s reignited interest, investment, and invention. This modern resurgence paved the way for where the wind industry is today with turbine production, lowered costs, and increasing performance. Wind energy is at the crest of initiatives to address global warming in the coming three.

WIND ENERGY

Indigenous australians skillfully mitigated large bushfires by lighting small patch fires. The earliest recorded windmills were created around 500 to 900 AD in Persia. The technology spread to Europe during the Middle Ages, and for centuries the Dutch fostered most windmill innovation. Fossil fuels sidelined wind energy during the mid-twentieth century. The oil crisis of the 1970s reignited interest, investment, and invention. This modern resurgence paved the way for where the wind industry is today with turbine production, lowered costs, and increasing performance.

3 DAY WORKING WEEK

As Nick Spiveck and Alex Williams propose in "Inventing the future", a reduction in human labour can have a positive effect on society and climate change. Based on calculations between 1970-2007 of OECD member nations, a 3 day working week (20% reduction in hours) could lead to declines in ecological footprint by 24%, carbon footprint by 29%, and CO2 emissions by 8.4% respectively. The UK Labour party proposed a 3 day working week in 16 years, if successful.

"4 PER 1000" INITIATIVE

The soil carbon sequestration initiative, announced at 2015 UNFCCC in Paris, aiming to increase soil concentration 0.4% per year, which would increase carbon sink by ~4.3gt CO2 equivalent; Policy measures could be put in place to: reduce deforestation and encourage agro-ecological practices that increase the quantity of organic carbon in soils and meet the 4 % target per year. This is a policy mitigation tool whose methods of intervention include: agroecology, agroforestry, conservation agriculture and landscape management.

FISH IN THE FIELDS

While rice feeds over half the world's seven billion people daily, the methane released in rice production is responsible for 12% of global methane, the equivalent of 1.5 billion tons of CO2, or 3% of global warming. One of fish protein can be sustainably grown in flooded rice fields feeding solely on naturally occurring plankton to ease the pressure on ocean forage fish. Plankton, the natural food source for growing fish, sequester carbon 20 to 50 times the rate that trees capture carbon.

REDUCED FOOD WASTE

The production of food is the source of labor of a third of the world's population, and all people are sustained by consuming it. Yet a third of the food raised or prepared does not make it from farm or factory to fork. That number is startling, especially when paired with this one: Hunger is a condition of life for nearly 800 million people worldwide and the food we discard contributes 4.4 gigatons of carbon dioxide equivalent into the atmosphere each year-roughly 8 percent of total anthropogenic greenhouse gas emissions.

FEMALE EDUCATION

Women with more years of education have fewer, healthier children and actively manage their reproductive health. If all nations adopted a similar rate as South Korea, and achieved 100 percent enrollment of girls in primary and secondary school, by 2050 there would be 243 million fewer people worldwide than if current enrollment rates sustain. Education is the most powerful lever available for breaking the cycle of intergenerational poverty, while mitigating emissions by curbing population growth.

URBAN ALBEDO ENHANCEMENT

Increasing the reflectiveness of clouds of the land surface so that more of the Sun's heat is reflected back into space. Urban; Painting surfaces such as roofs and pavements white or otherwise adding a reflective coating can be an effective way to increase the albedo of urban areas to reduce urban heat island effect, an experiment in Athens found these methods reduced ambient temperature by 7.5 degrees and 6.1 degrees Celsius respectively

INDIGENOUS LAND MANAGEMENT

Indigenous australians skillfully mitigated large bushfires by lighting small patch fires, resulting in a fine-scale mosaic of different vegetation types and fuel ages. This made intense wildfires uncommon and plant and animal foods more abundant. Technique involves burning a patch in mild conditions, such as cool mornings or late afternoons in late autumn and early winter, and when there is little breeze. This can germinate native seedlings unapparent before or those that require heat to break seed pods.

ELECTRIC VEHICLES

Electric vehicles have been romanticised for almost 200 years, since Ford and Edison collaborated to build a gasoline powered automobile meanwhile Edison was building better, cheaper batteries specifically designed for electric vehicles that did not come to be. There are more than 1 billion cars on the road today and 1 million electric vehicles, with the number of motor vehicles set to surpass 2 billion by 2035. Two-thirds of the world's oil is used to fuel cars and trucks, with transport emissions second to electricity generation as emissions source.

KELP ELEVATORS, MACROALGAE

The kelp farm gets moved down at night to deeper waters of richer nutrients and lifted during the day to glean sunlight in the more nutrient-depleted waters of the open ocean. Drone submarines perform vertical shifting, submerging the farms for protection from large storms and ships as well as horizontally towing kelp farms to new waters, communicating via satellite with harvesters to save labour costs.

BIOPLASTIC PACKAGING

Roughly 310 million tons of plastic is produced each year, a figure projected to quadruple by 2050. Most of the plastics fabricated today are petro-plastic, made from fossil fuels with 5-6% of global oil production feeding plastic manufacturing. It is estimated 96 percent of all plastic could be sourced from plants and other renewable feedstock. Plastics gain their malleability from Polymers - substances with chain-like structures of bound atoms or molecules - which can be bio-sourced instead of petro-sourced.

QUARANTINE URBANISM

Electric vehicles have been romanticised for almost 200 years, since Ford and Edison collaborated to build a gasoline powered automobile meanwhile Edison was building

OYSTERTECTURE BIOSEQUESTRATION

Oysters are ocean engineers, filtering up to 5 litres of water per hour. Earth's oceans absorb almost a third of global CO2 emissions. The shell of shellfish absorbs Carbon as it grows. The shellfish secretes Calcium Carbonate (CaCO3) to form its shell and research reveals that the saltmarsh fringing and shallow subtidal subsets of restored oyster reefs function as net CO2 sinks. Oystertexture is a design proposition by SCAPE to scale up such a function while cultivating water-based transit.

SINK CITIES CARBON STORING STRUCTURES

A potential solution to address rising emissions is sequestration of carbon in cementitious materials. Several studies have explored biochar as a potential material to store and fix carbon in stable form in soil and if biochar is used as admixture in cementitious materials, sequestering carbon in civil infrastructures. Another approach is to pump liquid carbon dioxide into the concrete during mixing. This can reduce the carbon emissions from concrete production when combined with a power plant or other industry that produces CO2.

DIRECT AIR CAPTURE

Building machines that can remove carbon dioxide directly from ambient air and store it elsewhere. It is geographically agnostic. It does not need to be attached to anything or built in any particular place. CO2 is equally concentrated in the air everywhere in the world, so DAC can be built anywhere in the world, wherever the CO2 is needed, eliminating transportation costs. It is modular and can scale to any size, depending only on budget. Direct Air Capture (DAC) offers a range of opportunities to create environmental benefits, to produce clean fuels.

ARTIFICIAL VOLCANO "PINATUBO STRATEGY"

A climate-cooling method that eventually could deliver sunlight-reflective sulfuric acid particles into the stratosphere, mimicing a volcanic eruption. The climate intervention most commonly discussed by researchers grows out of observations made following two very large volcanic eruptions - at El Chichon in the Mexican state of Chiapas in 1982 and at Mount Pinatubo in the Philippines in 1991. In both cases, sulfur dioxide gas from the volcanoes spiraled into upper layers of the Earth's atmosphere known as the stratosphere.

CARBON DIOXIDE NANOFIBRES

A demand and supply process of converting atmospheric CO2 "waste" to commodity into high-yield carbon nanofibres (tubes) or graphene (sheet material) whose properties open diverse opportunities for future use; composites for vessels, sports equipment, wind turbine blades and components for batteries, nano-technologies and quantum computing. The system uses electrolytic synthesis to make nanofibers wherein CO2 is broken down in a high-temperature electrolytic bath of molten carbonates.

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BIOCHAR SOIL

Wood waste, primarily in the form of sawdust, can be recycled into biochar, a charcoal like substance. Unlike most biomass that breaks down within 10 to 20 years and releases its carbon into the atmosphere, Biochar is an incredibly stable material that can hold its carbon for thousands of years. A 2016 study found that increasing the global production of biochar could offset over 10 percent of the world's human-caused greenhouse gas emissions, improving soils ability to retain water and nutrients and decreasing nitrous oxide and methane emissions from soil into which it is tilled.

CARBON SEA FLOOR LAKES

Carbon Capture and Storage (CCS) is a technology that can capture up to 90% of the carbon dioxide (CO2) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere. Oceans cover 71% of the earth's surface and there have been decades of research into forming CO2 lakes on the sea floor below depths of 300metres where carbon dioxide is denser than seawater, disconnecting contact between carbon and the atmosphere though this is a time delayed approach as the CO2 will eventually dissolve in the overlying water body.

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CIRROUS CLOUD BRIGHTENING

A potential solution to address rising emissions is sequestration of carbon in cementitious materials. Several studies have explored biochar as a potential material to

OCEAN FERTILISATION

Is a proposed Carbon Dioxide Removal technique that refers to adding iron filings or other "nutrients" like Urea into seawater to stimulate phytoplankton growth in areas that have low photosynthetic production. This is intended to enhance biological productivity and/or accelerate carbon dioxide sequestration from the atmosphere. John Martin, former director of the Moss Landing Marine Laboratory, discovered in 1980 that sprinkling iron dust in the right ocean waters could trigger plankton blooms the size of a small city and in turn.

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CRISPR ENGINEERED PLANTS

CRISPR can be used to engineer harderier plants (crops) that fix more carbon and reduce greenhouse gas emissions related to agriculture; robust crops in unfavourable conditions, nitrogen fixation to end dependence on fertilizers, hardy produce to prevent waste, prevent methane emissions and fix more carbon, for example; collaboration between Synthetic Genomics and ExonMobil made headlines in 2017 for using the gene editing tool CRISPR to modify an algae strain to enhance the oil content from 20 percent to above 40 percent, accomplished by fine tuning a genetic switch that regulates

REFORESTATION AND AFFORESTATION

The two solutions spawned from the critical condition of global deforestation are; reforestation refers to planting trees on land that was previously forested while afforestation proposes the same treatment of growth where there formerly was none. Research uncovered there are 1.7bn hectares of treeless land (11% of all land) on which 1.2 trillion native tree saplings would naturally grow. The world's six largest nations, Russia, Canada, China, the US, Brazil and Australia, contain half the potential restoration sites

SPACE MIRRORS

In 1983, Russian space engineer Syromytnikov and team conducted a successful test with a 65-foot-wide space mirror (sheet of mylar) called Znamya that unfurled from a central mechanism like a fan once launched, predicting the reflector should cast light equivalent to three to five full moons over an area of Earth measuring about three miles in diameter. The idea was that providing sunshine at night could save billions of dollars each year in electrical lighting costs, extend twilight hours during planting.

PAYMENT FOR ECOSYSTEM SERVICES

Financial incentives for landownes chop down trees. Each year, some hectares of forest are lost - an than South Carolina or Austria. A most of that deforestation would release of nearly 3 gigatonnes of dioxide equivalent per year (6tCO that's comparable to the emission million passenger vehicles per year around 6% of the world's yearly CO2 PES is also considerably cheaper alternatives of lowering carbon (2.4 times).

LEXICON OF CLIMATE INTERVENTION

The foreseeable future of planet earth will unfold in response-ability not only to cool its surface but to design and embrace life beyond a countdown to ecological collapse. Atmospheric insulation is accumulating in response to the energy infrastructures of human activity, calling for a recomposition of instruments already in place. The Lexicon of Climate Intervention assembles seemingly unrelated instruments that collectively demonstrate how to bring these challenges back down to earth, mitigating future emissions and rewriting historical ones. The unifying factor of all lexicon entries, what renders them comparable to and interactive with one another is their contribution to a scale of effect. Each entry is categorised on a timeline either side of now, as a mitigation (future) or beyond-zero (past) emissions instrument.



MITIGATION

3 DAY WORKING WEEK

Scale of effect (SoE) — 2
Potential Reduction: 8.40%

As Nick Srnicek and Alex Williams propose in *Inventing the Future* a reduction in human labour can have a positive effect on society and climate change. Automated labour replacing human workers is a developing trend, with the 29% of current labour carried out by machines expected to increase to 58% by 2024. Automated labour could be designed to be more emissions-efficient by reducing commuting time and energy. Another alternative is that the global capitalism mechanism slows down uniformly. The UK Labour party proposed a national 4-day working week by 2030, if successful and, based on their calculations collected between 1970-2007 of OECD member nations, a 3 day working week (20% reduction in hours) could lead to declines in ecological footprint, carbon footprint, and Co2 emissions by 24%, 29% and 8.4% respectively. In real time, the COVID-19 pandemic has already recorded a 4% reduction in annual emissions with a steep fall attributed to business-as-usual.

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<https://theconversation.com/work-less-to-save-the-planet-how-to-make-sure-a-four-day-week-actually-cuts-emissions-124326>

<https://www.theguardian.com/environment/2019/may/22/working-fewer-hours-could-help-tackle-climate-crisis-study>

<https://www.versobooks.com/books/2315-inventing-the-future>

4 PER 1000 INITIATIVE

Scale of Effect: 2

Potential Emissions Reduction: 8.60%

The soil carbon sequestration initiative, announced at 2015 UNCCC in Paris, aiming to increase soil concentration 0,4% per year, which would increase carbon sink by ~4,3gt CO₂ equivalent; Policy measures could be put in place to: reduce deforestation and encourage agro-ecological practices that increase the quantity of organic matter in soils and meet the 4 % target per year. This is a policy mitigation tool whose methods of intervention include; agroecology, agroforestry, conservation agriculture and landscape management.

#policy

<https://www.4p1000.org>

ALTERNATIVE CEMENT CLINKER

Scale of Effect: 2

Potential Emissions Reduction: 1.5 - 3.5%

The cement industry is one of the largest consumers of natural resources and accounts for 8% of global CO₂ emissions as of 2018, 60% of which comes from the production of clinker, cement's main binding ingredient. (clinker itself = 4.8%). One method for an alternative clinker system with respect to global reductions in concrete-related CO₂ emissions; Carbonatable Calcium Silicate clinkers (CCSC) is in early stages of commercialisation. It hardens only by reaction with CO₂, requiring that concretes be cured under a CO₂-rich atmosphere which restricts its applications to factory-made concrete products. Currently offers CO₂ savings of 30–40%, but savings could be as high as 70% if a circular CO₂ economy develops.

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<https://www.sciencedirect.com/science/article/pii/S000888461630775X>

<https://qz.com/1748561/%E2%80%A8reducing-cements-carbon-footprint-is-critical-to-climate-fight/>

BIOPLASTIC PACKAGING

Scale of Effect: 1

Potential Emissions Reduction: 0.26%

Roughly 310 million tons of plastic is produced each year, a figure projected to quadruple by 2050. Most of the plastics fabricated today are petro-plastic, made from fossil fuels with 5-6% of global oil production feeding plastic manufacturing. It is estimated 90 percent of current plastic could be derived from plants and other renewable feedstock. Plastics gain their malleability from Polymers - substances with chain-like structures of bound atoms or molecules - which can be bio-sourced instead of petro-sourced. Cellulose is a polymer in the cell walls of plants and one of the most abundant organic materials on earth and chitin is another polymer derived from the shells of crustaceans and insects. Currently, a third of plastics end up in ecosystems, 5% are successfully recycled and the remainder burned or landfilled - causing emissions. Production of plastics is modelled to grow from 311 million tons in 2014 to at least 792 million tons by 2050. This is conservative, with other sources estimating over 1 billion tons if trends continue and aggressive growth of bioplastics could capture 49 percent of the market by 2050, avoiding 4.3 gigatons of emissions.

#policy

<https://drawdown.org/solutions/bioplastics>

Project is produced under the scope of The New Normal education programme

ARTIFICIAL VOLCANO “PINATUBO STRATEGY”

Scale of Effect: 3

Potential Emissions Reduction: 0.3 - 0.5 degrees celsius

A climate-cooling method that eventually could deliver sunlight-reflective sulfuric acid particles into the stratosphere, mimicing a volcanic eruption. The climate intervention most commonly discussed by researchers grows out of observations made following two very large volcanic eruptions — at El Chichon in the Mexican state of Chiapas in 1982 and at Mount Pinatubo in the Philippines in 1991. In both cases, sulfur dioxide gas from the volcanoes spiraled into upper layers of the Earth’s atmosphere known as the stratosphere. There, the gas combined with hydrogen and produced the fine droplets or powder that scientists called “aerosols.” Those particles reflected enough sunlight back into space to cool Earth’s surface by 0.3 to 0.5 degrees Celsius (nearly 1 degree Fahrenheit). In the case of Pinatubo, the cooling lasted for about a year.

#policy

<https://www.theguardian.com/environment/2011/aug/31/pipe-balloon-water-sky-climate-experiment><http://climate.org/wp-content/uploads/2019/04/Albedo-Enhancement-Localized-Climate-Change-Adaptation-with-Substantial-CoBenefits.pdf><https://www.versobooks.com/books/2315-inventing-the-future>

<https://www.bloomberg.com/news/articles/2015-11-30/how-to-slow-climate-change-with-a-fake-volcano>

<https://www.nbcnews.com/news/us-news/last-ditch-global-warming-fix-man-made-volcanic-eruption-n918826>

CARBOT CREDIT / EMISSIONS TRADING SCHEME (ETS)

Scale of Effect: 3

Potential Emissions Reduction: 20.00%

External costs of carbon emissions, costs the public pays for long term, include; damage to crops, health care costs from fire, heat waves or droughts, property damage from flooding and sea level rise. Climate change is a market failure economically, because the market prices do not reflect costs and risks imposed on future generations who will suffer consequences. Credits / emissions trading scheme (ETS) or cap-and-trade is a quota scheme where total emissions budget is capped in advance and permits to pollute are allocated /auctioned to companies that can trade (amount is fixed, price is uncertain). On the basis of economic models of climate change including uncertainty, this method is empirically and theoretically outperformed by carbon tax, due to public distaste for fluctuating carbon prices, easier administration and more transparent and there are equity issues (e.g. clean-tech firms may not be rewarded for prior pro- environment investments). Disregards location in that negative externality may be worse in some places than others (e.g. air pollution is more harmful near big cities); Examples: Kyoto-protocol, EU emissions trading system, California cap-and-trade emissions trading, UN- REDD (Reducing Emissions

#economy #policy

https://www.investopedia.com/terms/c/carbon_credit.asp<https://qz.com/1748561/%E2%80%A8reducing-cements-carbon-footprint-is-critical-to-climate-fight/>

https://icapcarbonaction.com/en/?option=com_attach&task=download&id=575

CONTRACEPTION, FAMILY PLANNING

Scale of Effect: 2

Potential Emissions Reduction: 3.60%

Take this entry with a grain of salt, as family planning and contraception should be a basic human right and not a calculable figure, but let's do the math. 44% of all pregnancies are unplanned, in large part due to insufficient availability and acceptance of contraception. That's a total of 99 million pregnancies that could be prevented every single year. A 2012 study showed that slowing population growth could potentially reduce future emissions by 40% or more in the long term. Two hundred and twenty-five million women in lower-income countries say they want the ability to choose whether and when to become pregnant but lack the necessary access to contraception—resulting in some 74 million unintended pregnancies each year. Increased adoption of reproductive healthcare and family planning is an essential component to achieve the United Nations' 2015 medium global population projection of 9.7 billion people by 2050. This figure, according to Drawdown, is half of a total split equally with educating women and can be viewed as complementary.

#culture #policy

<https://populationmatters.org/news/2019/10/16/scientists-call-improving-contraceptive-use-fight-climate-change>

<https://www.drawdown.org/solutions/health-and-education>

CARBON TAX

Scale of Effect: 3

Potential Emissions Reduction: 14.50%

A fee imposed on the burning of carbon-based fossil fuels (example: Pigouvian Tax) that, if set high enough, becomes a powerful monetary disincentive that motivates switches to clean energy across the economy, simply by making it more economically rewarding to move to non-carbon fuels and energy efficiency. External costs of carbon emissions, costs the public pays for long term, include; damage to crops, health care costs from fire, heat waves or droughts, property damage from flooding and sea level rise. Climate change is a market failure economically, because the market prices do not reflect costs and risks imposed on future generations who will suffer consequences. A government can levy a carbon tax on distribution, sale or use of fossil fuels based on their content of CO₂, designed to increase the cost of polluting energies and encouraging renewables and alternative, lower-emission methods of production and consumption (price is fixed, amount is uncertain). The United Kingdom's adoption of a carbon tax in the power sector produced a 58 percent drop in emissions from 2012 to 2016, annual average of 14.5%

#economy #policy

<http://www.cooking-sections.com/Offsetted>

<https://www.e-flux.com/architecture/positions/153904/the-offsetted/>

<https://www.carbontax.org/whats-a-carbon-tax/>

CELLULAR LIVESTOCK

Scale of Effect: 2

Potential Emissions Reduction: >10%

Food is responsible for 26% of global greenhouse gas emissions (31% livestock/fisheries, 27% crop production, 24% land use and 18% supply chains). Lab-growing livestock is a proposition being tested at a small scale to serve a bulging population from the source cells of the ingredients, turning animal cells into meat food product without any of the compromises of traditional animal agriculture. Process; 1. take a small harmless sample from an animal (almond sized), 2. isolate the correct cells. 3. encourage those cells to grow and differentiate in exactly the same way they would naturally, 4. those cells are brought together to create rich food products. If all meat were grown by lab and not by agriculture, that land could be made available to reforestation / afforestation.

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<https://www.vowfood.com/about-cellular-agriculture><https://www.e-flux.com/architecture/positions/153904/the-offsetted/>

<https://ourworldindata.org/environmental-impacts-of-food>

CURB GASSEOUS CATTLE (ASPARAGOPSIS)

Scale of Effect: 3

Potential Emissions Reduction: 80.00% (methane)

Methane from cattle burps and farts is a greenhouse gas 28 times more powerful than carbon dioxide. More than 20 per cent of the world's entire total of greenhouse gas emissions come from livestock production. CSIRO Australia is on the cusp of commercialising a seaweed product, Asparagopsis, which when sprinkled into feed, makes cattle grow faster and cuts their greenhouse gas emissions to near zero well before 2050. This is a significant discovery that cancels out methane emissions from cattle, and, as a bonus, has the waste in digestion – normally associated with burps and farts – converted into faster growth rates.

#policy

<https://www.afr.com/companies/agriculture/csiro-seeks-investors-for-super-seaweed-fix-to-cattle-emissions-20200301-p545pg>

<https://www.csiro.au/en/Research/AF/Areas/Food-security/FutureFeed>

<https://research.csiro.au/futurefeed/>

ENHANCED GEOTHERMAL ENERGY

Scale of Effect: 2

Potential Emissions Reduction: 01.00%

“Earth heat” is a constant primordial flow of heat moving towards the crust that generates 100 billion times more than current global energy consumption. Geothermal energy harnesses these currents, pumping hot water and steam from within hydrothermal reservoirs to produce electricity. Most of the world’s 13 gigawatts of geothermal electricity generation are located along boundaries between tectonic plates, where liquid bodies made themselves apparent on the surface in some way. Prime geothermal conditions are found on less than 10 percent of the planet but enhanced geothermal systems (EGS) which targets deep underground cavities and creates hydrothermal pools where there is heat but no water by injecting high pressure water to make porous rock where water can be recirculated. Geothermal is reliable, efficient, and the heat source itself is free.

#economy #policy

<https://drawdown.org/solutions/geothermal-power>

<https://www.sciencedirect.com/science/article/pii/>

ELECTRIC VEHICLES

Scale of Effect: 1

Potential Emissions Reduction: 0.65%

Electric vehicles have been romanticised for almost 200 years, since Ford and Edison collaborated to build a gasoline powered automobile meanwhile Edison was building better, cheaper batteries specifically designed for electric vehicles that did not come to be. There are more than 1 billion cars on the road today and 1 million electric vehicles, with the number of motor vehicles set to surpass 2 billion by 2035. Two-thirds of the world's oil is used to fuel cars and trucks, with transport emissions second to electricity generation as emissions source. Electric vehicles are 60% efficient compared to 15% efficiency of their gasoline-powered predecessors. In 2014, 305,000 EVs were sold. If EV ownership rises to 16 percent of total passenger miles by 2050, 10.8 gigatons of carbon dioxide from fuel combustion could be avoided. Lithium mining increase 58% in the past decade and these projections factor in lowered cost and increased availability of EV with proliferation of battery manufacture.

#culture #economy

<https://theconversation.com/climate-explained-the-environmental-footprint-of-electric-versus-fossil-cars-124762>

<https://drawdown.org/solutions/electric-cars>

Project is produced under the scope of The New Normal education programme

FEMALE EDUCATION

Scale of Effect: 2
Potential Emissions Reduction: 3.60%

Women with more years of education have fewer, healthier children and actively manage their reproductive health. If all nations adopted a similar rate as South Korea, and achieved 100 percent enrollment of girls in primary and secondary school, by 2050 there would be 843 million fewer people worldwide than if current enrollment rates sustain. Education is the most powerful lever available for breaking the cycle of intergenerational poverty, while mitigating emissions by curbing population growth. A 2013 study found that educating girls “is the single most important social and economic factor associated with a reduction in vulnerability to natural disasters.” In 2017, 62 million girls are denied the right to attend school. according to the United Nations Educational, Scientific, and Cultural Organization, by closing an annual financing gap of \$39 billion, universal education in low- and lowermiddle- income countries can be achieved. It could result in 59.6 gigatons of emissions reduced by 2050. The return on that investment is incalculable.This figure is half of a total split equally with Family Planning, and can be viewed as complimentary.

#culture #policy

<https://whatsyour2040.com/educating-girls/>
<https://drawdown.org/solutions/health-and-educationS1876610213008382W1siZiIsIjIwMTkvMDYvMTcvMTkvMDMvMjQvZWU5ZjJiZDUtZWZkZSooMT RmLWJkODYtNDUoMWVlMTAoYzFiL1JlZlNjYWxlLU1ldGhvZG9sb2d5LnBkZiJdXQ/RefScale-Methodology.pdf?sha=58f76967cecd9cc>

FISH IN THE FIELDS, PLANKTON

Scale of Effect: 2

Potential Emissions Reduction: 3.00%

While rice feeds over half the world's seven billion people daily, the methane released in rice production is responsible for 12% of global methane, the equivalent of 1.5 billion tons of CO₂, or 3% of global warming. Tons of fish protein can be sustainably grown in flooded rice fields feeding solely on naturally occurring plankton to ease the pressure on ocean forage fish. Plankton, the natural food source for growing fish, sequester carbon 20 to 50 times the rate that trees capture carbon. New research demonstrates that the introduction of small fish can drastically cut methane released from freshwater. Widespread adoption of Fish in Fields methods could reduce methane emissions from rice by 90%. FIF is designed to work towards large-scale adoption of fish/rice co-cultivation in viable areas and to become financially independent within 3-5 years.

#culture #economy #policy

<https://www.rrri.org/fish-in-the-fields>

FUELWOOD HARVEST ALTERNATIVES

Scale of Effect: 1

Potential Emissions Reduction: 0.002%

Improved cook stoves to burn more efficiently would reduce the amount of wood taken from forests, storing more carbon in trees; In Bhutan, farmers are given access to electricity through a national program to avoid the use of biofuel sourced from otherwise forested areas. Globally, 2.8 billion people burn wood for basic energy needs. The majority of that fuelwood is used for cooking in developing countries, so Reducing fuelwood harvest could prevent the release of 110 million tonnes of carbon dioxide equivalent per year (Gigatons of carbon dioxide emissions per year).

#policy #culture

<https://nature4climate.org/science/n4c-pathways/forests/avoided-fuelwood-harvest/>

INDIGENOUS LAND MANAGEMENT

Scale of Effect: 1

Potential Emissions Reduction: 0.40%

Indigenous Australians have skillfully mitigated large bushfires throughout history by lighting small patch fires, resulting in a fine-scale mosaic of different vegetation types and fuel ages. This made intense wildfires uncommon and plant and animal foods more abundant. Technique involves burning a patch in mild conditions, such as cool mornings or late afternoons in late autumn and early winter, and when there is little breeze. This can germinate native seedlings unapparant before or those that require heat to break seed pods. This type of historical intuition regarding ecological flows is evident in Indigenous cultures all over planet earth, Australia is merely an example.

#culture #policy

<https://theconversation.com/our-land-is-burning-and-western-science-does-not-have-all-the-answers-100331>

KELP ELEVATORS, MACROALGAE

Scale of Effect: 1

Potential Emissions Reduction: 0.35%

The kelp farm gets moved down at night to deeper waters of richer nutrients and lifted during the day to glean sunlight in the more nutrient-deserted waters of the open ocean. Drone submarines perform vertical shifting, submerging the farms for protection from large storms and ships as well as horizontally towing kelp farms to new waters, communicating via satellite with harvesters to save labour costs. “the kelp elevator”: Researchers at Pacific Northwest National Labs have devised a process to convert kelp into biocrude (a hydrothermal liquefaction and catalytic hydrothermal gasification process) that takes about an hour in a reactor and doesn’t require fermentation; in theory, methane output from the process itself could be used as power source. A recent study in Nature Geoscience estimated that seaweed floating down to the depths of the ocean naturally sequesters 173 million metric tons of carbon a year

#economy #policy

<https://www.sciencefocus.com/planet-earth/marine-cultivation-technology-opening-the-door-to-the-rich-sources-of-clean-energy-in-our-oceans/>

<https://dornsife.usc.edu/news/stories/3026/usc-dornsife-research-innovations-to-heal-planet-boost-economy/>

MONTREAL PROTOCOL

Scale of Effect: 4

Potential Emissions Reduction: 25.00% saved

An international agreement made in 1987 that was designed to stop the production and import of ozone depleting substances and reduce their concentration in the atmosphere to help protect the earth's ozone layer. These substances include; Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Methyl bromide (CH₃Br) and Hydrofluorocarbons (HFCs) will be frozen in 2024. The Montreal Protocol is widely considered as the most successful environment protection agreement. It sets out a mandatory timetable for the phase out of ozone depleting substances. Climate change would have been far worse by mid-century because the chemicals that “eat” ozone are also super-greenhouse gases, thousands of times more potent than CO₂. The global climate would be at least 25 per cent hotter today without the Protocol. It was agreed on 16th September 1987, and entered into force on 1st January 1989.

#policy

<https://www.environment.gov.au/protection/ozone/montreal-protocol>

<https://www.nationalgeographic.com/news/2017/09/montreal-protocol-ozone-treaty-30-climate-change-hcfs-hfcs/>

<https://theconversation.com/how-we-traced-mystery-emissions-of-cfcs-back-to-eastern-china-117545>

MYCELLIUM BIOFABRICATION

Scale of Effect: 3

Potential Emissions Reduction: >11.60%

Researchers are exploring Mycelium, the subsoil component of mushroom, as a wide scale material replacement for livestock (domesticated animals) and plastic for packaging and industrial use. Plastics are a leading cause of physical pollution introducing durable toxins into our environment, emissions as of 2015, 1.8 billion metric tons of CO₂ (3.6% global GHG emissions) Most of this pollution is related to single-use materials, like Styrofoam. Animal Agriculture is the biggest user of arable land planet-wide and contributes 8% to global GHG emissions. Even if only half of these activities were overtaken by Mycelium production, annual emissions could be cut by 6%. Ecovative Design is a biotech company focusing on mycelium to build these materials through biofabrication. In 2017, Ecovative was awarded with \$9.1 million from DARPA to build a foundation of research around mycelium and using it to grow structures that can be rapidly deployed in an environment.

#culture #economy

<https://www.greenbiz.com/article/fungi-inspired-companies-could-play-new-role-sustainability><https://ourworldindata.org/environmental-impacts-of-food>

<https://mushroompackaging.com/>

<https://ecovatedesign.com/why>

<https://www.sciencedaily.com/releases/2019/04/190415144004.html>

PERMAFROST PROTECTION

Scale of Effect: 4

Potential Emissions Reduction: 20.00 - 200.00%

“what happens in the Arctic does not stay in the Arctic.” Globally, permafrost holds up to 1,600 gigatons of carbon, almost double that in the atmosphere. it is estimated 1 year of permafrost melt could equate to 5 or 6 years of emissions. 20 years of methane measurements from Arctic lakes suggest new lakes created by abrupt thaw could nearly triple the greenhouse gas emissions expected from permafrost. Grasslands, especially when snow covered, reflect more sunlight than does dark forest. Grazing animals tamp down deep snow, allowing heat to escape the soil, as evidenced in Pleistocene Park in Russia. Both things cool the land. If wildlife could restore grasslands, it would slow permafrost thaw and thus climate change.

#policy

<https://pleistocenepark.ru/ru/>

<https://www.nationalgeographic.com/environment/2018/08/news-arctic-permafrost-may-thaw-faster-than-expected/>,

<https://arctic.ru/climate/20180312/723915.html>

<https://www.weforum.org/agenda/2020/02/irreversible-emissions-permafrost-tipping-point/>

PLANT BASED DIET

Scale of Effect: 2

Potential Emissions Reduction: 4.00%

Of the 26% of global greenhouse gas emissions worldwide from food, meat, eggs and dairy are responsible for 15%, which includes the packaging containers and transportation to bring those products from farms to stores then homes. While not everyone is capable of reducing or eliminating animal products from their culture or diets, a reduction of 50% consumption could still have a massive impact of around 8%.

#culture

<https://blueandgreentomorrow.com/lifestyle/infographic-environmental-impact-of-plant-based-diets/>

REDUCED FOOD WASTE

Scale of Effect: 2

Potential Emissions Reduction: 4.27%

The production of food is the source of labor of a third of the world's population, and all people are sustained by consuming it. Yet a third of the food raised or prepared does not make it from farm or factory to fork. That number is startling, especially when paired with this one: Hunger is a condition of life for nearly 800 million people worldwide and the food we discard contributes 4.4 gigatons of carbon dioxide equivalent into the atmosphere each year—roughly 8 percent of total anthropogenic greenhouse gas emissions. Basic laws of supply and demand also play a role. If a crop is unprofitable to harvest, it will be left in the field. And if a product is too expensive for consumers to purchase, it will idle in the storeroom. If 50 percent of food waste is reduced by 2050, avoided emissions could be equal to 26.2 gigatons of carbon dioxide. Reducing waste also avoids the deforestation for additional farmland, preventing 44.4 gigatons of additional emissions.

#culture

<https://drawdown.org/solutions/reduced-food-waste>

REFRIGERATION

Scale of Effect: 2

Potential Emissions Reduction: 5.98%

Keeping bodies, homes and products in situ or on the move cool by air conditioning and refrigeration is a chemical process of absorbing and releasing heat. Refrigerants, specifically chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), have and still are being phased out under policy of the 1987 Montreal Protocol. The ozone is beginning to heal but huge volumes of CFCs and HCFCs remain in circulation and countries still using these must turn toward natural refrigerants including propane and ammonia, with support from wealthier countries under the 2016 Kigali deal (Over thirty years, 87 percent of refrigerants that may be released can be contained, avoiding emissions equivalent to 89.7 gigatons of carbon dioxide.) On a warming planet, 700 million AC units will come online by 2030, causing potential emissions in their production, filling, service, leaking and decommissioning.

#policy

<https://www.drawdown.org/refrigeration>

SOLAR ENERGY

Scale of Effect: 3

Potential Emissions Reduction: 02.00 - 80.00%

The sun beams free energy daily, making an increase in its capture - solar energy - a sensible and practical component of any climate change energy response. Small, distributed clusters or microgrids of rooftop panels are the most conspicuous evidence of the renewables revolution powered by solar photovoltaics (PV). Another iteration of PV is large-scale arrays of hundreds, thousands, or in some cases millions of panels that achieve generating capacity in the tens or hundreds of megawatts. The Longyangxia Dam Solar Park plant in Qinghai, China is the largest in the world, 850MW plant covers an area of 27-square-kilometre and has capacity to power up to 200,000 households. It was built at a cost of about 6bn yuan (£721.3m) and in almost constant expansion since construction began in 2013 (began operation in 2017). Analysis by Drawdown estimates distributed solar photovoltaics can grow from 180 TWh of current electricity generation globally to a wide range between 6,235-10,100 TWh by 2050.

#economy #policy

<https://www.drawdown.org/solutions/distributed-solar-photovoltaics>

<https://www.theguardian.com/environment/2017/jan/19/china-builds-worlds-biggest-solar-farm-in-journey-to-become-green-superpower>

SUSTAINABLE FASHION

Scale of Effect: 2

Potential Emissions Reduction: 05.00%

The fashion industry is responsible for 10% of annual Co2 emissions and are expected to surge more than 50 % by 2030. Water-intensive dyeing and wasted clothing of composite fibres make up a large component of fast fashion emissions. Many low-cost producers offer new designs weekly and less than 1 % of used clothing is recycled into new garments. Brands are searching for ways to reinvent the industry, including Reformation, through;lower-impact fabrics (vintage, deadstock, Tencel, flax linen, Alpaca yarn),Domestic suppliers whenever possibleThird-party certifications (Bluesign, Oeko-Tex) for low-impact and safe dye practices when available, Manufacturing in our own factory or a nearby factory in LA, Purchase of renewable energy credits for factory operations (100% wind), Lower-impact, 100% recycled-content & recyclable packaging, Carbon neutral shipping program, Lower-impact garment care labels and recommendations, End-of-life recycling service

#culture

<https://www.worldbank.org/en/news/feature/2019/09/23/costo-moda-medio-ambiente>

<https://www.thereformation.com/pages/sustainable-practices>

<https://thereformation-weblinc.netdna-ssl.com/media/>

TROPHIC CASCADES

Scale of Effect: 3

Potential Emissions Reduction: 10.00 - 30.00%

“trophic cascades” propagate down through food webs and can be triggered when predators eat prey in aquatic or terrestrial ecosystems, result in different proportions of biomass sequestration. When a wolf kills a moose, the moose no longer consumes woody plants, thus indirectly increasing woody plant abundance in Boreal Forests, with an estimated increase in carbon storage between 46 million and 99 million metric tons. The introduction of sea otters to control the sea urchin population, indirectly allow for more carbon-storing kelp could make a difference of between 44 and 87 million metric tons (carbon in grams of carbon per square meter.) The complexity of relationships within trophic cascades addresses the indirect effect of plants and their arrangement on the resulting atmospheric temperature. It is necessary to maintain balance during the design of trophic cascade intervention. Support of biodiversity also stimulates stability and richness of the ecosystem, and generates possibilities for the increase of volumes of living biomass for carbon storage.

#policy

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5877955/>

URBAN ALBEDO ENHANCEMENT

Scale of Effect: 1

Potential Emissions Reduction: 0.003%

Increasing the reflectiveness of clouds or the land surface so that more of the Sun's heat is reflected back into space. Urban: Painting surfaces such as roofs and pavements white or otherwise adding a reflective coating can be an effective way to increase the albedo of urban areas to reduce urban heat island effect, an experiment in Athens found these methods reduced ambient temperature by 7.5 degrees and 6.1 degrees Celsius respectively. A study conducted in Andalusia found that widespread implementation of cool roofs would lower carbon dioxide emissions by 135,000 metric tons annually as a result of the reduced energy use.

#policy

<https://climate.org/albedo-enhancement-localized-climate-change-adaptation-with-substantial-co-benefits/>,<https://www.theguardian.com/environment/2019/may/22/working-fewer-hours-could-http://climate.org/wp-content/uploads/2019/04/Albedo-Enhancement-Localized-Climate-Change-Adaptation-with-Substantial-CoBenefits.pdf><https://www.versobooks.com/books/2315-inventing-the-future>
<https://iopscience.iop.org/article/10.1088/1748-9326/7/2/024004/pdf>

WIND ENERGY

Scale of Effect: 2

Potential Emissions Reduction: <10.00% (onshore & offshore combined)

The earliest recorded windmills were created around 500 to 900 AD in Persia. The technology spread to Europe during the Middle Ages, and for centuries the Dutch fostered most windmill innovation. Fossil fuels sidelined wind energy during the mid-twentieth century. The oil crisis of the 1970s reignited interest, investment, and invention. This modern resurgence paved the way for where the wind industry is today with turbine production, lowered costs, and increasing performance. Wind energy is at the crest of initiatives to address global warming in the coming three decades. In 2017, 314,000 wind turbines supply nearly 4 percent of global electricity. And it will soon be much more. Wind Turbine potential by 2050 could be massive; onshore 84.6 gigatons and offshore 14.1 gigatons. Wind farms have small footprints, typically using no more than 1 percent of the land they sit on it takes a year or less to build a wind farm, quickly producing energy and a return on investment. “wind provides the lowest cost source of new capacity.”

#economy #policy

<https://drawdown.org/solutions/offshore-wind-turbines>

<https://drawdown.org/solutions/onshore-wind-turbines>

WORK-FROM-HOME, QUARANTINE URBANISM

Scale of Effect: 2

Potential Emissions Reduction: 04.00% (so far)

COVID-19 has temporarily reduced global emissions, largely due to the temporary ceasure of local and international ground, sea and aviation transportation. Many education platforms, social groups and businesses have shifted their operations to online platforms like zoom, which has called to question the necessity of physically being in a meeting (and the travel required to do so). As past examples show, emissions tend to bounce back fairly shortly after a global disturbance ends though this might enable new modes of energy-saving practices.

Project is produced under the scope of The New Normal education programme

#culture #economy #policy

<https://www.carbonbrief.org/analysis-coronavirus-set-to-cause-largest-ever-annual-fall-in-co2-emissions>

https://www.technologyreview.com/s/615338/coronavirus-emissions-climate-change/?truid=d787e3c6c3487da756447793e40f77b6&utm_source=the_download&utm_medium=email&utm_campaign=the_download.unpaid.engagement&utm_content=03-10-2020



BEYOND ZERO

BIO-ENERGY, CARBON CAPTURE AND SEQUESTRATION (BECCS)

Scale of Effect: 2

Potential Emissions Reduction: 6.60%

BECCS is the process of extracting bioenergy from biomass and capturing and storing the carbon, thereby removing it from the atmosphere.[1] The carbon in the biomass comes from the greenhouse gas carbon dioxide (CO₂) which is extracted from the atmosphere by when the biomass grows. Energy is extracted in useful forms (electricity, heat, biofuels, etc.) as the biomass is converted. Carbon in the biomass is converted to CO₂ or biochar which can be stored by geologic sequestration or land application, respectively, enabling carbon dioxide removal and making BECCS a negative emissions technology.

#economy #policy

<http://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>

https://www.globalccsinstitute.com/wp-content/uploads/2019/03/BECCS-Perspective_FINAL_18-March.pdf

BIOCHAR SOIL

Scale of Effect: 2

Potential Emissions Reduction: <10.00%

Organic waste, primarily in the form of sawdust, can be recycled into biochar, a charcoal-like substance. Unlike most biomass that breaks down within 10-20 years and releases its carbon into the atmosphere, Biochar is an incredibly stable material that can hold its carbon for thousands of years. A 2010 study found that increasing the global production of biochar could offset over 10 percent of the world's human-caused greenhouse gas emissions, improving soils ability to retain water and nutrients and decreasing nitrous oxide and methane emissions from soil into which it is tilled.

#economy #culture

<http://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/><https://www.chathamhouse.org/sites/default/files/publications/2018-06-13-making-concrete-change-cement-lehne-preston-final.pdf>, <https://newatlas.com/biochar-to-offset-greenhouse-gas-emissions/16006/>
<http://www.biochar-industry.com/biochar/>

CARBON SEA FLOOR LAKES (CCS)

Scale of Effect: 2

Potential Emissions Reduction: 8.00%

Carbon Capture and Storage (CCS) is a technology that can capture up to 90% of the carbon dioxide (CO₂) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere. Oceans cover 71% of the earth's surface and there have been decades of research into forming CO₂ lakes on the sea floor below depths of 3000metres where carbon dioxide is denser than seawater, disconnecting contact between carbon and the atmosphere though this is a time-delayed approach as the CO₂ will eventually dissolve in the overlying water body. (lab tests only)

#policy

<http://www.ccsassociation.org/what-is-ccs/><https://www.dezeen.com/2019/06/11/radical-architecture-climate-change-opinion-phineas-harper/> [https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO₂%20from%20buildings_SustCitiesSoc.pdf](https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO2%20from%20buildings_SustCitiesSoc.pdf)
https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf
<https://www.versobooks.com/books/3091-after-geoengineering>

CARBON DIOXIDE NANOFIBRES (CCU)

Scale of Effect: 2

Potential Emissions Reduction: <10.00%

A demand and supply process of converting atmospheric CO₂ “waste” to commodity into high-yield carbon nanofibres (tubes) or graphene (sheet material) whose properties open diverse opportunities for future use; composites for vessels, sports equipment, wind turbine blades and components for batteries, nano-technologies and quantum computing. The system uses electrolytic syntheses to make nanofibers wherein CO₂ is broken down in a high-temperature electrolytic bath of molten carbonates. Atmospheric air is added to an electrolytic cell where the CO₂ dissolves, subjected to heat and direct current through electrodes of nickel and steel. The carbon nanofibers build up on the steel electrode, where they can be removed for use. Licht says. “We calculate that with a physical area less than 10 percent the size of the Sahara Desert, our process could remove enough CO₂ to decrease atmospheric levels to those of the pre-industrial revolution within 10 years”. Graphene is a first 2-dimensional crystal based on transformation of carbon, invented in 2010.

#economy

<https://www.acs.org/content/acs/en/pressroom/newsreleases/2015/august/co2.html>

<https://en.wikipedia.org/wiki/Graphene>

https://en.wikipedia.org/wiki/Chemical_vapor_deposition

CIRROUS CLOUD BRIGHTENING

Scale of Effect: 3

Potential Emissions Reduction: 1.5 degrees celsius reduction

Currently 30% of solar rays that reach earth are reflected back to space by light surfaces (polar ice reflects 90% whereas the ocean absorbs 94%) and it is believed increasing cloud cover which currently reflects 30% of solar radiation, could lower emissions and cool the ocean beneath. “marine cloud brightening” is an automated, unmanned hydro-foil ship, computer and wind controlled that pumps an ultra-fine mist of sea salt towards the clouds. Salter calculates that a fleet of 300 autonomous ships could reduce global temperatures by 1.5dc, as well as reducing intensity of storms. Other suggestions include fleets of airborne drones that crisscross the upper latitudes of the atmosphere spraying tiny ice crystals in cirrous clouds to form larger ice crystals than normal (this is used to produce artificial rain in wildfires, deployed by the military in central Russia in 2019).

#policy

<https://www.technologyreview.com/s/604081/the-growing-case-for-geoengineering/>

<https://www.sciencemag.org/news/2018/01/does-cloud-seeding-really-work-experiment-above-idaho-suggests-humans-can-turbocharge>

CRISPR ENGINEERED PLANTS

Scale of Effect: 3

Potential Emissions Reduction: 46.00%

CRISPR can be used to engineer hardier plants (crops) that fix more carbon and reduce greenhouse gas emissions related to agriculture: robust crops in unfavourable conditions, nitrogen fixation to end dependence on fertilizers, hardy produce to prevent waste, prevent methane emissions and fix more carbon, for example: collaboration between Synthetic Genomics and ExxonMobil made headlines in 2017 for using the gene editing tool CRISPR to modify an algae strain to enhance the oil content from 20 percent to above 40 percent, accomplished by fine-tuning a genetic switch that regulates the conversion of carbon dioxide to oil in *Nannochloropsis gaditana*. The Ideal Plant concept basically splices the genes of regular crops and everyday plants like beans, corn and cotton, with a new compound that makes them absorb more carbon. Their roots then transfer it to the soil where it is retained. Salk Institute believe their solution, the Harnessing Plants initiative, can achieve as much as a 46% annual reduction in excess CO₂ emissions produced by humans

#economy #policy

<https://allianceforscience.cornell.edu/blog/2019/12/five-ways-crispr-plants-can-combat-climate-change/>

<https://www.theguardian.com/environment/2019/apr/16/super-plants-climate-change-joanne-chory-carbon-dioxide>

<https://www.salk.edu/harnessing-plants-initiative/>

<https://www.wired.com/story/gene-editing-food-climate-change/>

DIRECT AIR CAPTURE (DAC)

Scale of Effect: 3

Potential Emissions Reduction: <100.00%

building machines that can remove carbon dioxide directly from ambient air and store it elsewhere. it is geographically agnostic. It does not need to be attached to anything or built in any particular place. CO₂ is equally concentrated in the air everywhere in the world, so DAC can be built anywhere in the world, wherever the CO₂ is needed, eliminating transportation costs. It is modular and can scale to any size, depending only on budget. Direct Air Capture (DAC) offers a range of opportunities to create environmental benefits, to produce clean fuels, and potentially to manufacture more sustainable concrete, plastics, and chemicals. At CE, we are focused on two main use cases: permanently storing the captured carbon dioxide (CO₂) deep underground to create negative emissions, and utilizing captured atmospheric CO₂ to produce clean synthetic transportation fuels. A single plant can be built to capture 1million tons of Co₂ annually.

#economy #policy

<https://www.greenbiz.com/article/case-investing-direct-air-capture-just-got-clearer>

<http://www.geoengineeringmonitor.org/2018/05/direct-air-capture/>

<https://carbonengineering.com/uses/>

OCEAN FERTILISATION

Scale of Effect: 3

Potential Emissions Reduction: 6.00 - 25.00%

Ocean Fertilisation is proposed Carbon Dioxide Removal technique that refers to adding iron filings or other “nutrients” like Urea into seawater to stimulate phytoplankton growth in areas that have low photosynthetic production. This is intended to enhance biological productivity and/or accelerate carbon dioxide sequestration from the atmosphere. John Martin, former director of the Moss Landing Marine Laboratory, discovered in 1988 that sprinkling iron dust in the right ocean waters could trigger plankton blooms the size of a small city and in turn, the billions of cells produced might absorb enough heat-trapping carbon dioxide to cool the Earth’s warming atmosphere. Early climate models hinted that intentional iron fertilization across the entire Southern Ocean could erase 1 to 2 billion tons of carbon emissions each year—10 to 25 percent of the world’s annual total.

#policy

<https://www.whoi.edu/oceanus/feature/fertilizing-the-ocean-with-iron/>

OCEAN ALKALINITY ENHANCEMENT (OAE), ENHANCED WEATHERING (EW)

Scale of Effect: 2

Potential Emissions Reduction: 6.00%

The idea is to accelerate natural rock weathering e.g., by spreading large amounts of pulverized silicate and/or carbonate minerals onto warm and humid land areas (EW) or onto the sea surface (OAE). Large amounts of CO₂ absorbed by oceans have caused a slight decrease in pH levels, a process known as “ocean acidification.” Global carbon cycle modelling suggests that the ocean has the capacity to store carbon on this scale with minimal global environmental impact. The idea of dissolving minerals to sequester CO₂ has been around since the early 1990s, by dissolving silicate rocks in high temperature/pressure reactors to form mineral carbonates. There are three methods of enhancing ocean alkalinity; enhanced weathering (application of rock powder to terrestrial, coastal and ocean environments), accelerated weathering of limestone (promoting limestone dissolution in a reactor with seawater and CO₂ rich gas to increase pH) and electrochemistry (acidic conditions are created around the anode).

#policy

<http://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>

<https://eos.org/editors-vox/preventing-climate-change-by-increasing-ocean-alkalinity>

<https://www.frontiersin.org/articles/10.3389/fclim.2019.00007/full>

OYSTERECTURE BIOSEQUESTRATION

Scale of Effect: 1

Potential Emissions Reduction: <1.00%

Oysters are ocean engineers, filtering up to 5 litres of water per hour. Earth's oceans absorb almost a third of global CO₂ emissions. The shell of shellfish absorbs Carbon as it grows. The shellfish secretes Calcium Carbonate (CaCO₃) to form its shell and research reveals that the saltmarsh fringing and shallow subtidal subsets of restored oyster reefs function as net CO₂ sinks. Oystertecture is a design proposition by SCAPE to scale up such a function while cultivating water-based transit, aquatic education and new models for living on water and sequestering emissions. Baby oysters are transplanted on a matrix of fuzzy rope and fixed pylons that assemble to form a blue park emerging above the high-water line and inviting recreation and interaction of citizens with the aquatic ecosystems of the City. The oysters mature and aggregate over time to form a subtidal and intertidal reef armature that calms wave energy and over time cleanses the harbour water through natural oyster filtration. Scientists in Australia have engineered a species of Sydney Rock Oyster that are resistant to ocean acidification. The sequestration rate (tons of carbon per hectare per year ranges from 0.7-1.26, Typical sequestration

#policy #[aqua]culture

http://baybackpack.com/blog/how_does_an_oyster_filter_water

<https://www.scapestudio.com/projects/oyster-tecture/>

<https://thefishsite.com/articles/carbon-sequestration-potential-of-shellfish>

<https://royalsocietypublishing.org/doi/pdf/10.1098/rspb.2017.0891>

<https://www.sydney.edu.au/news-opinion/news/2019/09/27/sydney-rock-oysters-adapt-to-climate-change.html>

OPTIMISED PLANTATIONS

Scale of Effect: 1

Potential Emissions Reduction: 0.50%

Longer rotations in timber plantations that would maximize yield for optimal broader economic and environmental benefits. Extending harvest rotation cycles would allow trees to absorb more carbon from the atmosphere while also increasing timber yields in tropical, subtropical, temperate and boreal forests; Timber plantations cover some 257 million hectares globally – an area about the size of the US state of Oregon; Extending harvest cycles to increase carbon uptake in timber plantations would sequester an additional 266 million metric tons of carbon dioxide equivalent per year (MtCO₂e/year).

#economy #policy

<https://nature4climate.org/science/n4c-pathways/forests/improved-plantations/>

PAYMENT FOR ECOSYSTEM SERVICES (PES), CARBON SUBSIDY

Scale of Effect: 2

Potential Emissions Reduction: 6.00%

Financial incentives for landowners not to chop down trees. Each year, some 9 million hectares of forest are lost – an area larger than South Carolina or Austria. Avoiding most of that deforestation would prevent the release of nearly 3 gigatonnes of carbon dioxide equivalent per year (GtCO₂e/year). That's comparable to the emissions from 620 million passenger vehicles per year and around 6% of the world's yearly CO₂ budget. PES is also considerably cheaper than alternatives of lowering carbon emissions (2.4 times). Initially implemented nationwide in Costa Rica (1997), has been adopted by Mexico, China, Bolivia, and other nations. PES' challenges are mainly monitoring, due to high costs of verifying the continuous existence of trees through traditional methods (i.e. ground tree counting), and the Spillover Effect of landowners rigging the system (i.e. chopping the neighbour's tree). Novel Startups such as Pachama aim to tackle these through tech-based verification systems where machine learning, satellite and LiDAR (Light Detection and Ranging) verify and monitor forests.

#economy #policy

<https://www.theatlantic.com/science/archive/2017/07/paying-people-to-preserve-their-trees/534351/>

<https://pachama.com/about>

<https://nature4climate.org/science/n4c-pathways/forests/avoided-forest-conversion/>

PLANT BASED ARCHITECTURE

Scale of Effect: 1

Potential Emissions Reduction: 0.02 - 0.04%

Plants absorb carbon dioxide and atmospheric gasses via photosynthesis and when a plant dies or is burned as fuel, those are released back into the atmosphere. This is quite simple, plant-based building materials could be widely used to forever store those natural sequestration methods for the lifetime of a structure. Materials of this application include not only timber but also straw, hemp, cork, bamboo, mycelium and recycled fibres. If all residential buildings were to take this approach, 200,000 structures built at an average size of about 205m² we'd be sequestering around 1.1 million metric tons of CO₂-e per year. Add other building types (commercial and industrial) into the mix, and the construction industry could lead in carbon sequestration at approximately 27 metric ton per m².

#culture #economy #policy

<https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth>

<https://www.dezeen.com/2019/06/11/radical-architecture-climate-change-opinion-phineas-harper/> [https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO₂%20from%20buildings_SustCitiesSoc.pdf](https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO2%20from%20buildings_SustCitiesSoc.pdf)

REFORESTATION, AFORESTATION, TREE PLANTING

Scale of Effect: 3

Potential Emissions Reduction: 1.40 - 50.00%

The two solutions spawned from the critical condition of global deforestation are; reforestation refers to planting trees on land that was previously forested while afforestation proposes the same treatment of growth where there formerly was none. Research uncovered there are 1.7bn hectares of treeless land (11% of all land) on which 1.2 trillion native tree saplings would naturally grow. The world's six largest nations, Russia, Canada, China, the US, Brazil and Australia, contain half the potential restoration sites. Typical sequestration rates for afforestation/ reforestation, in tonnes of carbon per hectare per year, are: 0.8 to 2.4 tonnes in boreal forests, 0.7 to 7.5 tonnes in temperate regions and 3.2 to 10 tonnes in the tropics. IPCC reported that restored forests (reforestation) could capture 57 billion metric tons of carbon by the end of the century, just one-sixth of the carbon in the atmosphere. One of the critical components is that a forest takes up to 10 years to reach a mature state where it is capable of sequestering a significant amount of CO₂.

#culture #policy

<http://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>

SINK CITIES: CARBON STORING STRUCTURES

Scale of Effect: 1

Potential Emissions Reduction: 0.01%

A potential solution to address rising emissions is sequestration of carbon in cementitious materials. Several studies have explored biochar as a potential material to store and fix carbon in stable form in soil and if biochar is used as admixture in cementitious materials, sequestering carbon in civil infrastructures. Another approach is to pump liquid carbon dioxide into the concrete during mixing. This can reduce the carbon emissions from concrete production when combined with a power plant or other industry that produces CO₂. Biochar creates lightweight, high strength, insulating and water-absorbent alternatives to bricks and concrete elements at an additive ratio of 80%.

#culture #economy #policy

<https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth>

<https://www.dezeen.com/2019/06/11/radical-architecture-climate-change-opinion-phineas-harper/> [https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO₂%20from%20buildings_SustCitiesSoc.pdf](https://architecture.mit.edu/sites/architecture.mit.edu/files/attachments/lecture/Reduce%20CO2%20from%20buildings_SustCitiesSoc.pdf)

SPACE MIRRORS, SUNSHADES (SRM)

Scale of Effect: 3

Potential Emissions Reduction: 3.0 degrees celsius reduced

In 1993, Russian space engineer Syromyatnikov and team conducted a successful test with a 65-foot-wide space mirror (sheet of mylar) called Znamya that unfurled from a central mechanism like a fan once launched, predicting the reflector should cast light equivalent to three to five full moons over an area of Earth measuring about three miles in diameter. The idea was that providing sunshine at night could save billions of dollars each year in electrical lighting costs, extend twilight hours during planting and harvesting seasons to aid farmers, allow more working hours on large construction projects and help in rescue and recovery operations after natural disasters like earthquakes and hurricanes. In reverse, the Space Mirror as a geoengineering tool would reflect light by sending it back out to space while a sunshade would absorb that light, either way protecting earth from solar radiation. SRM directly affects a lower global mean temperature but does not necessarily equate to lower emissions, and requires partnership with mitigation. An object big enough to block out enough light would likely span at least 500,000 sq km

#policy

<http://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>

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SUPERCRITICAL BASALT ANKERITE (CCS)

Scale of Effect: 2

Potential Emissions Reduction: 6.00 - 8.00%

Carbon Capture and Storage (CCS) is a technology that can capture up to 90% of the carbon dioxide (CO₂) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere. Captured carbon can be stored via injection in a variety of geological formations, including; depleted oil and gas reservoirs, in active oil sites to enhance recovery, in deep unused saline water-saturated reservoir rocks, deep unmineable coal seams or in basalts, oil shales or cavities in the lithosphere. This is an artificial, fast-forward of the Geological storage of CO₂ that has been a natural process in the Earth's upper crust for hundreds of millions of years. To geologically store CO₂, it must be compressed to a dense fluid supercritical state in which it can be transported from industrial sites to basaltic sites. Basalt and CO₂ combine to form the carbonate mineral ankerite (process takes approximately 2 years, after which the CO₂ is stored forever).

#policy #economy

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