

NEW YORK TIMES BESTSELLER

DRAWDOWN

THE MOST COMPREHENSIVE
PLAN EVER PROPOSED TO
REVERSE GLOBAL WARMING
EDITED BY PAUL HAWKEN



An Introduction

by

Socha Cohen

**Drawdown was created by a 70-Member
International Coalition from 22 Countries**

And Validated by a 120-Person Advisory Board

- **Geologists**
- **Engineers**
- **Agronomists**
- **Politicians**
- **Writers**
- **climatologists**
- **Biologists**
- **Botanists**
- **Economists**
- **Financial analysts**
- **Architects**
- **activists**



Global warming is a wicked problem, one requiring holistic rather than linear thinking, one that recognizes and examines interdependencies, multiple causes, conflicting goals, and most of all, forces us to examine our values.

Challenges

Population
Growth

Mass Migration

Conflict / War

Dark Money

Profit Motive

Consumerism

Politics



Too much CO2 in the
Atmosphere



Connecting the Dots
By Socha Cohen

Losses

Biodiversity/ extinction
Drinking Water
Mental and Physical Health
Community and Culture
Property/ Wealth



Increasing Severity
and Frequency of

Forest Fires/Storms
Droughts/ Heat Waves

Desertification

Sea Level Rise

Ocean Acidification

Melting of Glaciers
and Permafrost

Dead Zones in Oceans

Failing Crops

Drawdown is a 30-Year Global Plan

Reduce the amount of CO₂ in the atmosphere by 1052 Gigatons to what it was before the Industrial Revolution, using technologies already in existence.

The Plan Reduces the Levels of CO2 in the Atmosphere by **1052** gigatons

Food.....322

Energy.....247

Land Use.....149

Women and Girls.....121

Materials.....112

Buildings and Cities.....55

Transportation.....46

Total.....1052

1 Gigaton= 1 Billion tons= the volume of
400,000 Olympic-sized Swimming Pools



Savings will Outweigh the Costs

Net Cost = \$27 Trillion

Net Savings=\$74 Trillion

How much CO₂ is Safe?

350 ppm

We are at 418 ppm

CO2 Pollution affects Air, Water, Land, and People

Slows cognitive abilities and lowers test scores

Increases Alzheimer's, depression, mood and anxiety disorders, dementia, schizophrenia, PTSD, and suicides *

*The Uninhabitable Earth by David Wallace-Wells 2019

Solution

Lower Carbon Emissions
and
Increase Sequestration

Why Sequestration?

- CO₂ remains in the atmosphere for hundreds of years.
- If we do not remove the CO₂ that is already there, we will continue to suffer the consequences of global warming that we are already experiencing.

What will Sequester CO₂?

**Plants:
in Water and on Land**



Up until now, the news around global warming has been fear-based. This causes people's brains' reasoning to shut down. For that reason, the book does not blame, preach, or advocate in order to create “spaciousness around the issue” where people start to think and act.

I. Food

“Big Agriculture” Practices are Unsustainable

Wasteful

Land

Energy

Water

Destructive

Soil

Plants

Animals

Oceans

Expensive

because
Damages
are
Ignored

Hidden Costs

- Traditional agriculture and irrigation methods consume 70% of the world's fresh water resources by tapping rivers and aquifers.
- They spark competition for water rights.
- Irrigation requires energy which releases carbon emissions.

Synthetic Fertilizers

destroy the very underground bacteria and fungi needed for the exchange of nutrients and disease protection amongst plants.

Synthetic Fertilizers

- Release phosphates and nitrates
- Create dead zones in ponds, lakes, and oceans from run-off.
- Can alter genetic codes in plants and animals



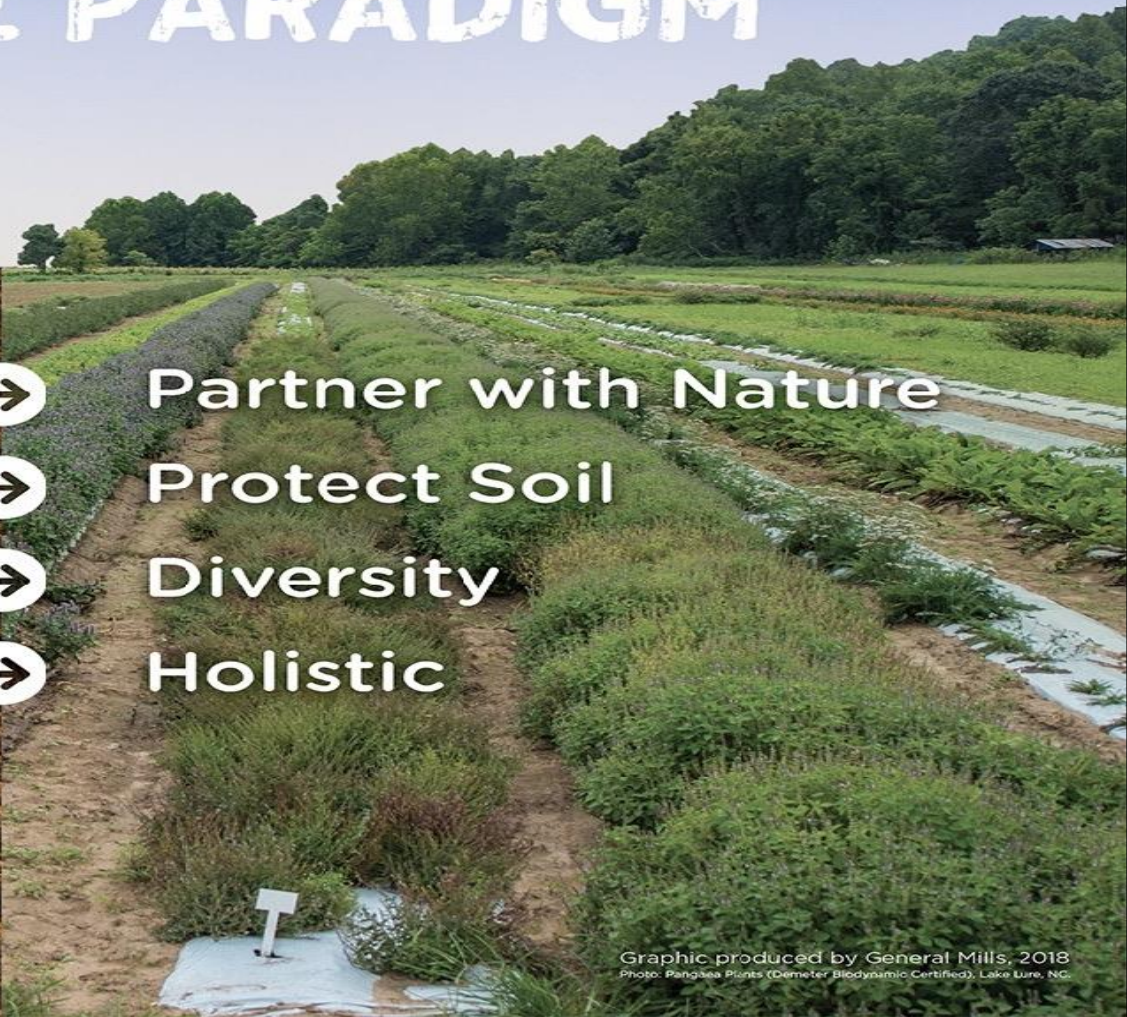
**One Billion Acres of Farmland have been
Abandoned due to Land Degradation**



REGENERATIVE AGRICULTURE SHIFTS THE PARADIGM



Compete with Nature
Disturb Soil
Monoculture
Reductionist



Partner with Nature
Protect Soil
Diversity
Holistic

Graphic produced by General Mills, 2018
Photo: Pangaea Farms (Demeter Biodynamic Certified), Lake Lure, NC.

Regenerative Agriculture on 1 Billion Acres

**Will Cost: \$57 Billion
with a
Financial Return of \$1.9 Trillion**

Regenerative



Practices

Crop Diversity

Understory crops

Trees in Pastures

**No synthetic
fertilizer**

Composting

Perennial crops

Improved irrigation

Managed grazing

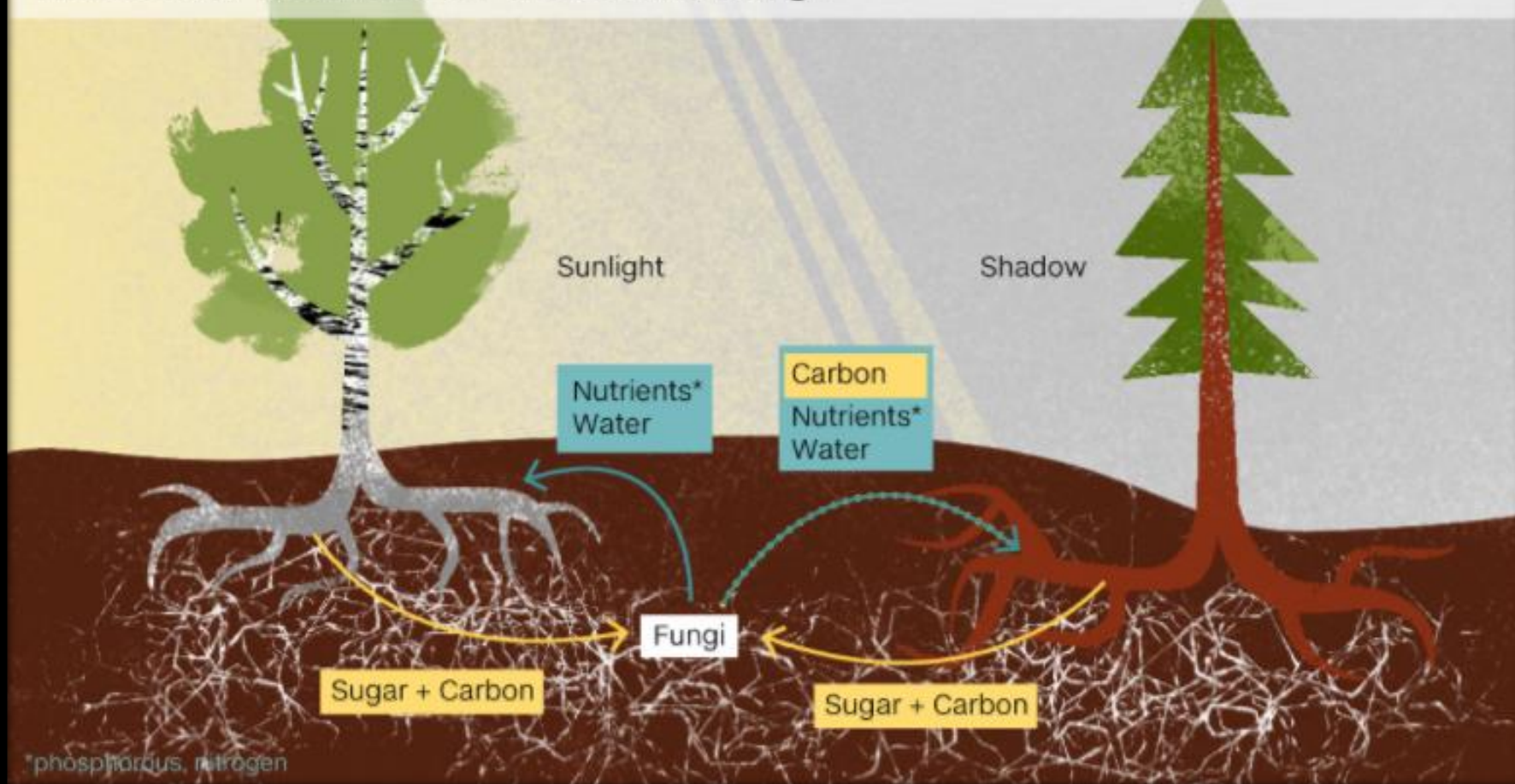
Reduced plowing

Regenerative Practices

- Reduce CO2 emissions
- Increase CO2 sequestration
- Save energy, water, and land
- Plants build resistance to droughts, storms, and pests
- Increase nutritional value of food (animals and plants)
- Increase bio-diversity

Microbes found in the soil can influence a plant's genetic structure, its health and its interaction with other plants.

'The social network' of trees and fungi



Crop Diversity

- Creates a richer exchange of nutrients and water amongst plants.
- Increases resilience to disease and pests: less need for synthetic fertilizer.
- Perennial crops are more resilient to droughts and extreme temperatures.

Understory Crops

- Mix shade-loving plants with trees.
i.e. Shade-grown coffee plants live 2 to 3x longer and produce a better product.
- Trees in pastures provide protection from wind and sun for other plants.
- Plants with deep roots provide water for those with shallow root systems.

Drip Irrigation

- Used by less than 4% of land worldwide
- Is better for the plants
- Uses sensors to monitor soil moisture
- Requires loans, subsidies, and education

AeroFarms,

one of the leading companies in the vertical farm revolution, is currently building the world's largest indoor vertical farm located in Newark, New Jersey.



It raises vegetables year-round, on a reusable substrata made of recycled plastic bottles. It saves 90% on water use and yields nearly 400% more than fields do.

When in full production it will produce over 2 million pounds of fresh lettuce and other vegetables yearly.



Food Waste

**Richer Nations Waste
35%**

Poor Nations Lack

**Imperfect
appearance**

**Over-estimate
how much to
buy**

**Misunderstand
“sell by” dates**



**Proper
infrastructure**

Refrigeration

Many fresh or prepared foods are labeled with a “Sell-By” date as a guide for how long the item should be displayed for sale before quality deteriorates. Items are generally safe for consumption after this date, but may begin to lose flavor or eye appeal.

Imperfect food can be upcycled

Soups

Fruit drinks

Ketchup

Relishes

Chutneys

Snack chips

Household cleaner.

A company called Mori has developed natural edible coatings to prevent spoilage that can be applied to whole produce, cut fruits and vegetables, protein and processed foods. They slow down oxidation, dehydration, and microbial growth.

-

Expand your Diet

There are more than 73 species of trees that produce edible food. i.e. the fast-growing moringa tree is a drought-tolerant species that can thrive on degraded land. Its leaves are 30% protein and richer in vit. A and C, calcium, and potassium than carrots, oranges, milk, and bananas respectively.



There are more than 561 species of edible seaweed around the world, 387 types of ferns, 275 edible bamboo species, and 2050 mushroom species

Reducing Food Waste by 50% by 2050

- Will avoid emissions equal to 26 gigatons of CO₂.
- It also avoids deforestation for additional farmland, preventing 44 gigatons of additional emissions.

Elsewhere

- **Denmark has not sent organic waste to landfills in 25 years.**
- **In Holland, grocery stores and farmers sell unwanted food to restaurants.**

France outlaws waste: must go to charities, animal feed, or composting.

- In Germany, pig manure digested by microbes, produces biogas fuel used for electricity production.**

Rice is the Essential Staple of 3 Billion People

System of Rice Intensification

Reduces Seed use by 80-90%

Offers 50-100% higher Yields

Reduces water input by 25-50%

Plants are more resistant to drought, flooding, and storms.

6 Main Practices of SRI

1. Single plant /hill
2. Transplant young seedlings (2 leaf stage)
3. Adopt wide spacing - planted in a grid
4. Minimum water application during vegetative growth
5. Assure soil aeration
6. Use organic amendments as base fertilization



Aquaponic Farms

Edible fish
and
vegetables



The fish waste
found in tank
water is used to
feed the
vegetables

3 billion people worldwide live in households that burn wood and other biomass in rudimentary, inefficient, traditional stoves.

This practice contributes to forest depletion. It releases carbon dioxide, methane, and black carbon, which contribute to climate change.

Increase the Use of Clean Cookstoves

They are made of lightweight metal. A metal alloy combustion chamber maximizes the lifetime of the stove, quality control, safety, and heat transfer while minimizing emissions.



Eat a Plant-rich Diet

Livestock accounts for 25% of global methane pollution which is **34x** more powerful than CO₂.



Cattle

- Raising cattle depletes fresh water sources and increases CO2 emissions from energies used.
- Rapid shifts in grazing patterns and longer rest periods improve the nutritional value of the plants, soil, and thus the meat itself.
- Intermixing trees and shrubs with a variety of grasses improves the nutrients in the soil producing better milk and meat.

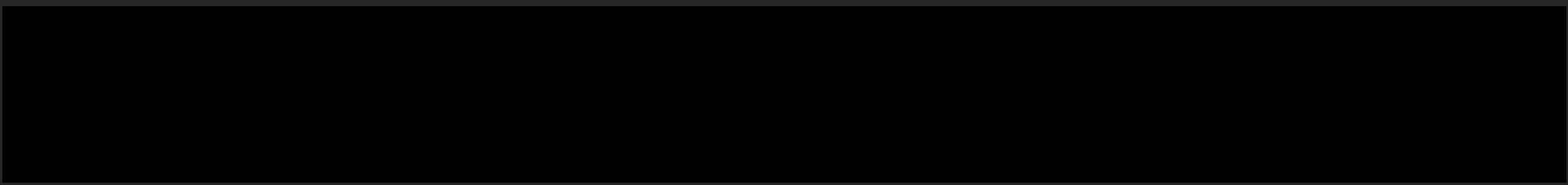
Seaweed

holds many health
benefits for cattle

New Study:

Adding seaweed to
a cow's diet may
reduce methane
emissions by 99%





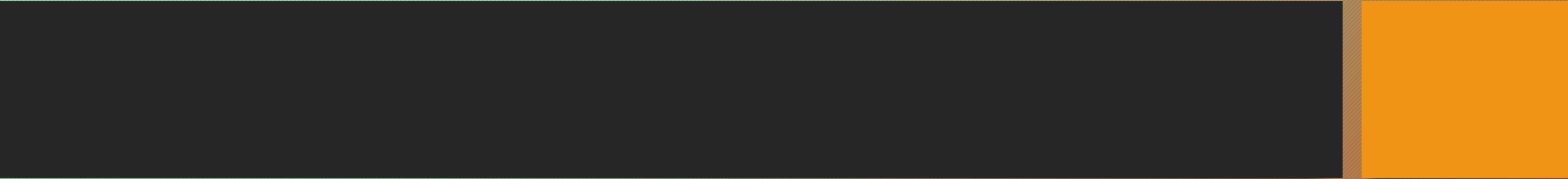
Feeding cows seaweed as part of their diet is better for digestion, lowers release of methane, and produces healthier cows and more milk.

Australia's On-going Research

Asparagopsis taxiformis, a species of red algae, reduced methane production by 99% in artificial rumen (essentially small fermentation tanks) and required a dose of just 2% of feed to do so.

Ocean Farming

initially harmful, has been improved by combining species that feed on each other.

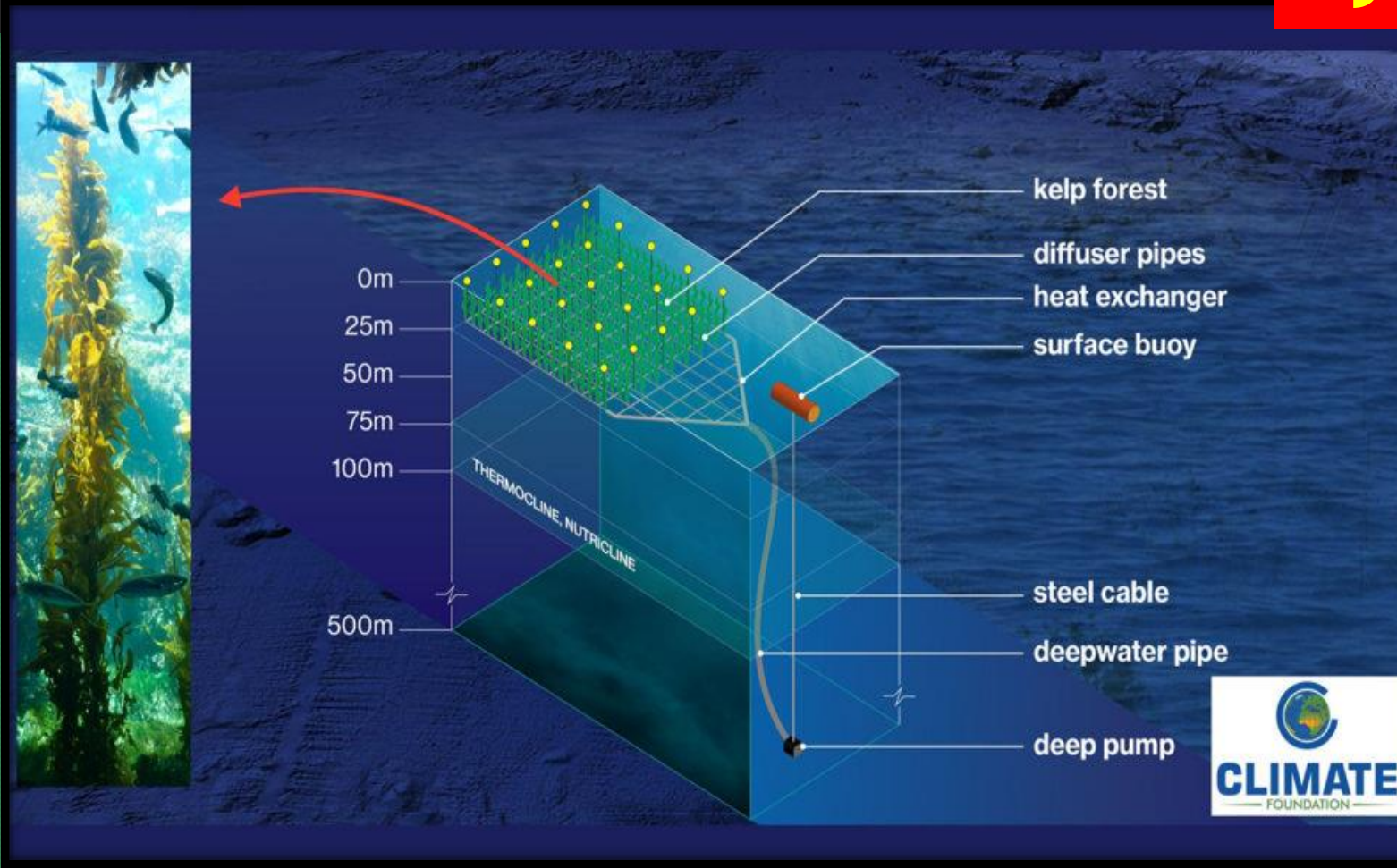


Unfortunately, warming surface water reduces natural upwellings, causing phytoplankton and seaweed to drop and the aquatic food chain to decline.

Marine Permaculture Arrays

.4 square miles in size

Pumps are powered by wave action.



Kelp forests are improved by pumping up cold nutrient-rich water from the deep below.

Oyster Farms absorb Nitrogen and are Buffers during Storm Surges



II. Land Use

Forests

**Rainforests may
Disappear in 40 Years**

We lose 48 football fields Every Minute



Forests are Organisms

- * Moderate heat and cold
- * Help protect against storms and disease
- * Provide nutrition
- * Store water and carbon

Preservation and Restoration

through International and Governmental Support



- Technical Assistance + Funding
- Protect Land, Human Rights, and Indigenous Knowledge
- Enforcement Policies
- Community Efforts

Bamboo: grows 1 inch per Hour

Good for restoring degraded land: eroded slopes, wastelands, highway medians, and abandoned mines.

Regrows when cut.

Has many uses.



Preservation Policies

- International funding programs reward forested nations for conserving and increasing forests.
- Brazil and Germany use world-class monitoring including satellite photos.
- Amazon meatpackers ban purchases from suppliers who deforest.

Wetlands

Mangroves Marshes
Seagrasses



Marshes store 5x more Carbon than Forests

Nurseries Filtration System Bird Migration

Protect against Storm Surges and Flooding

Marshes suffer from

Sediment run-off

Sea Level Rise

Timber extraction

Invasive species

Fossil fuel operations

Farming/Pollution

Construction

Mosquito spraying

Peatlands sequester 2x more Carbon than Forests

- They comprise of dead and decomposing plant matter.
- In 2014 a bog the size of England was discovered in the Congo.
- They can be 2-60 feet deep.

50% of Peatlands is Carbon



Threatened by

- Timber and Palm oil Plantations
- Use for fuel
- Grazing
- Horticulture



Major paper and palm oil companies use slash and burn methods to clear the land. Peat forests burn as zombie fires, nearly impossible to extinguish as ignition can burrow deep underground and tunnel sideways, consuming belowground fuel supply built up over 5 to 10,000 years.

Future Land Use Practices

One Cotton Shirt = 80 lbs. of CO2

Replace Cotton with Hemp:

Cotton is the dirtiest crop in the world due to use of chemicals, including insecticide, and fossil fuel.



The fiber of the cannabis plant, extracted from the stem is used to make rope, strong fabrics, fiberboard, clothing, and paper.

Organic cotton

Organic cotton is grown without the use of toxic and persistent pesticides and synthetic fertilizers. In addition, federal regulations prohibit the use of genetically engineered seed for organic farming.

Repopulate the Mammoth Steppe

After 50 species of large mammals were hunted to extinction, the grasses were replaced by trees and shrubs unsuitable for grazing.

Permafrost covers 24% of the Northern Hemisphere and stores 2x more Carbon than all the forests on the planet combined.

As global temperatures are rising, the melting soil allows organic matter and microbes to release the stored Carbon.

Solution

Return grasses in the subpolar regions to protect permafrost by re-introducing herbivores.

Sergey and Nikita Zimov, Father and Son Directors of the NE Science Station in Russia



60 Minutes Interview

They created Pleistocene Park in Siberia



Bison



Moose



Musk Ox

Elk



Yakut Horses

Tolerate temperatures of minus-100 degrees Fahrenheit



Reindeer



By re-introducing the species of herbivores that once populated the subpolar region of the Arctic, permanent frost melting can be prevented.



It would be the single largest potential solution of the one hundred described in this book.

III. Women and Girls

Population Growth

- In 1800, the world population was **1 Billion**
- It is estimated that it will reach well over **9 Billion** by 2050.

- As the world's population continues to grow, humanity will need to increase the yield of each plot of farmland.
- Family planning programs receive only 1% of all overseas assistance.

In the 1990's, Iran's Fertility Rates were Reduced by 50%



alamy

Image ID: M3W635
www.alamy.com



- 
- **Voluntary Program**
 - **Involved Religious leaders and Public Education**
 - **Free Access to Contraception**

As more men migrate to cities seeking non-farm income, women are increasingly central to cultivation in low-income countries.

Women in Poor nations are 43% of the labor Force producing **60-80%** of Food



Due to the gender gap, women in developing nations, are hindered from making decisions about investments in improving the land they farm, resulting in less productivity of the land.

Women Lack Access to

Land ownership

Land inheritance

Education

Finance

Markets

Birth control

Legal protections for women are missing in 30 low- and middle-income countries, according to a new report from Rights and Resources Initiative (RRI).

Together these 30 countries contain **three-quarters of the world's forests**, which remain critical to mitigating global warming and natural disasters, including droughts and land degradation.

Women In Meghalaya, India, own land and have always decided what is grown on it and what is conserved.





The state not only has a strong climate-resistant food system but also some of the rarest edible and medicinal plants, researchers said.

Planting Seeds of Resilience in Southern India



The Program

- Preserves traditional knowledge
- Promotes indigenous seed saving practices
- Supports climate adaptation and mitigation
- Furthers the rights of women farmers

Soul Fire Farm, NY State



The Farm

- **Revives African Indigenous systems**
- **Combats food deserts in Albany, NY**
- **Advocates for at-risk youth**

- If all women smallholders receive equal access to resources, their farm yields will rise by 20 to 30 percent.
- Pressure to deforest for additional ground will decrease.
- 100 to 150 million people will no longer be hungry.

IV. Energy

Energy Sources in 2018

Fossil Fuels - 64%

Nuclear Energy - 19%

Renewable Energies - 17%

Subsidies

- In 2015, fossil fuel received **\$5.3 Trillion** in direct and indirect subsidies
- Between 2000 and 2017, wind energy received **\$12.3 Billion**

Wind Energy: 4% of Global Electricity

**Least Expensive
Energy Source by 2030**

**If increased to 20%, by
2050, will **also** reduce
water usage by 62
trillion gallons:
(99% less)**



Block Island Wind Farm, built in 2016

- America's first off-shore wind farm
- 30 MW can power 17,000 homes (3400 homes per turbine)
- Reduces emissions by 40,000 tons per year

- Ten million homes in Spain are powered by wind.
- Denmark now supplies more than 40% of its electricity needs with wind power.

Haliade-X can power up to 16,000 homes

12 MW capacity

220-meter rotor

107-meter long blades

260 meters high

67 GWh gross AEP

63% capacity factor

38,000 m² swept area

Wind Class IEC: IB

Generates **double the energy**
as previous GE Haliade model

Generates almost **45% more energy** than most
powerful wind turbine
available on the market today

Will generate enough clean
power for up to **16,000**
European households per
turbine, and up to **1 million**
European households in a
750 MW configuration windfarm



HALIADE-X 12 MW

GE Renewable Energy is developing **Haliade-X 12 MW**, the biggest offshore wind turbine in the world, with **220-meter rotor**, **107-meter blade**, leading capacity factor (**63%**), and **digital capabilities**, that will help our customers find success in an increasingly competitive environment.

1063 ft
324 m



Eiffel Tower

853 ft
260 m



Haliade-X 12 MW

1046 ft
319 m



Chrysler Building



Increasing onshore wind from 4% to 21%, and offshore wind from .1% to 4% will cost \$1.8 trillion, but deliver a savings of \$8.2 trillion over 30 years of operation.

Solar Energy

- **Currently, .4% of global electricity generation comes from solar power.**
- **An increase to 10% will save \$5 trillion in operational costs by 2050.**

Solar Energy

Rooftop and
Water Heater



Solar Farms



Concentrated Solar
in Spain and Nevada

Mirrors create heat
stored in molten salt
tanks.

Less expensive
storage than batteries

Future for Solar: Smart Highways

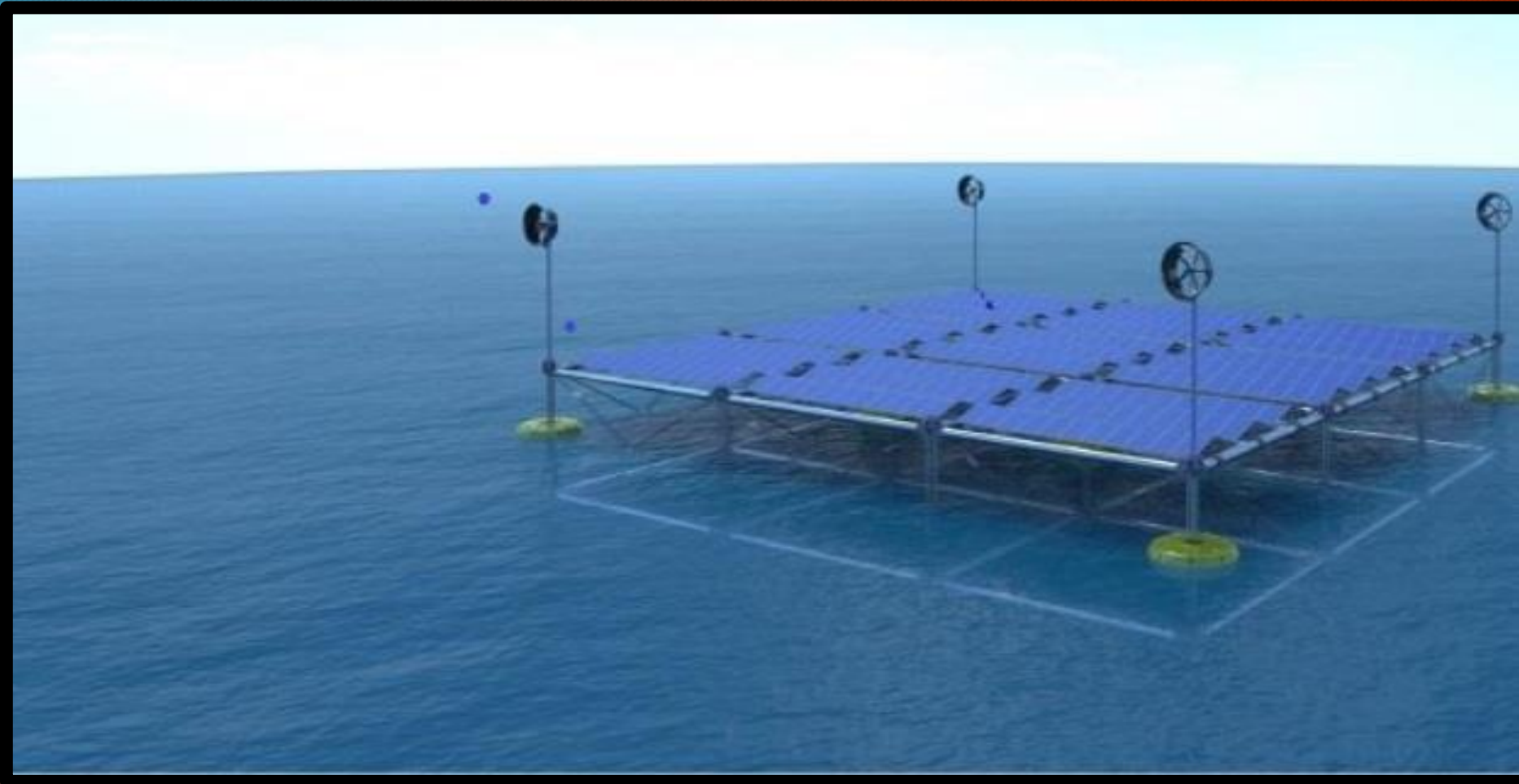
Developed in France

One 10 x 20 foot solar tile can supply the electricity for an average home.

Floating Power Plants in Singapore and China



Sinn Power Maritime Platform in Germany uses sun, wind, and wave energy to produce energy



Heat, created by the decay of radioactive materials in the Earth's core and mantle, produces

Water Energy

- Underground hot water drives Turbines
- Found between tectonic plates
- Could supply 100% electricity to 39 countries



Geothermal Energy

Geothermal energy can supply
400 Billion times the world's
heating consumption.

In-Stream Hydro Power

- Good for Remote mountainous Areas
- Can be used in underground city pipes (Portland, Oregon)



Wave Energy: currently the most expensive of all renewables

70% of Scotland's energy comes from wave energy.

Power



© MLBanner.com

Grids

- Need Greater Flexibility in adapting to Wind and Solar Power
- Increase cogeneration: i.e. capture wasted Heat

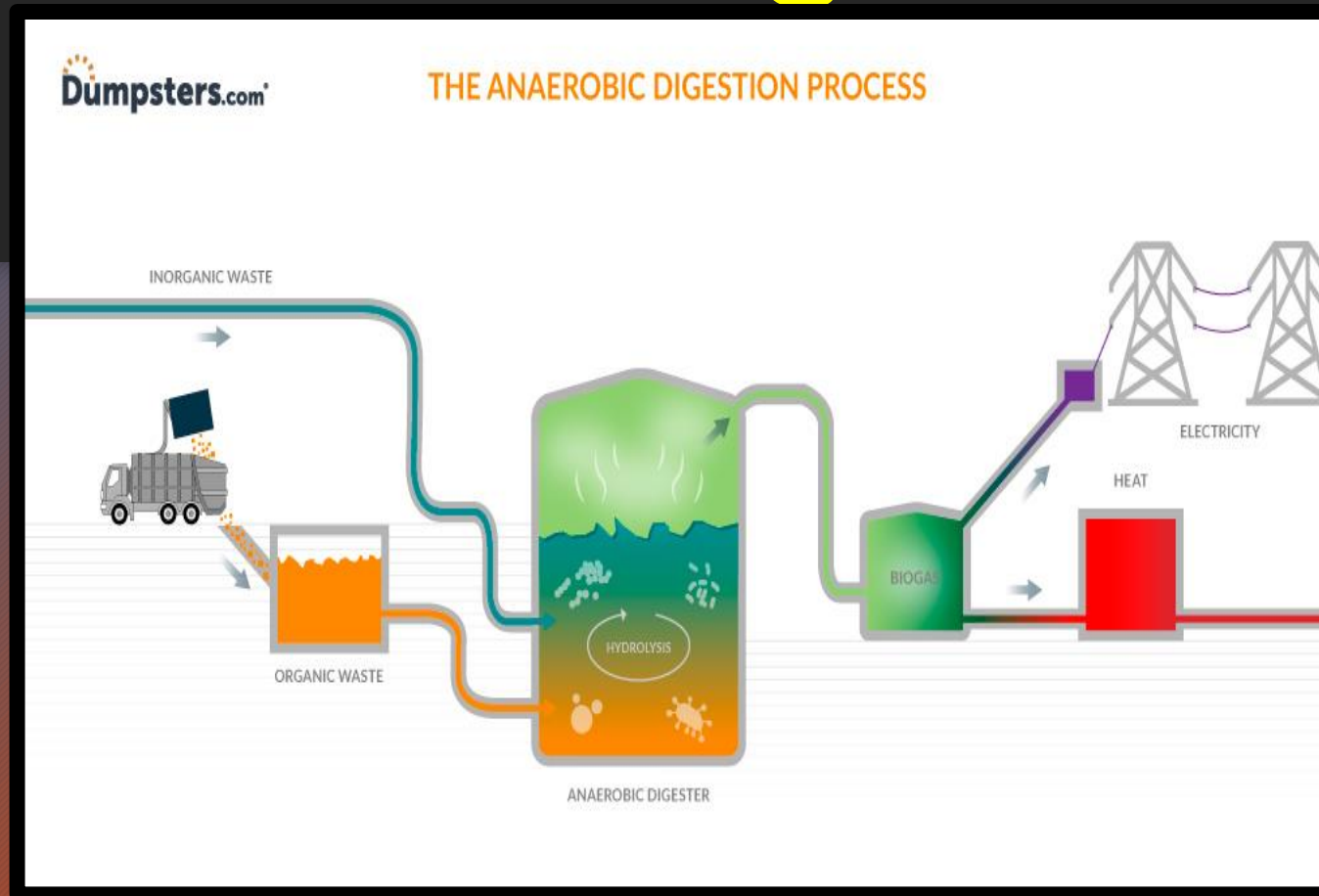
- Require improved apps, sensors, and software needed for storage and efficiency
- Need to enable more consumers to produce and sell power to the grid

Energy: Bridge Solutions

Biomass: Perennial Woody Crops Turn
heat to Electricity releases CO₂

Nuclear: 440 reactors highly controversial

Methane Digesters



Microbes produce biogas and fertilizer from organic waste in sealed tanks.

Methane is 34x more Powerful than CO₂ in Warming the Atmosphere

- Germany produces nearly 4000 MW using methane digesters.
- Small digesters could replace 57.5 million inefficient cookstoves in low-income economies.

Waste to Energy: Incineration

saves on landfill space and
release of energy but

also releases toxic compounds

Goal

Is to make waste so valuable that the last thing you would want to do is burn or bury it.

Wildpoldsried, Germany produces 5x the energy it needs



- **In Freiburg, Germany**, a 59-home community, is the first to have a positive energy balance due to high energy-efficient construction.
- **Kaupani Village** , in **Hawaii**, is a net-zero affordable housing project.
- **Portland, Oregon**, now requires all homes provide an energy score when listed for sale.

V. *Materials*

Materials: Rising Incomes and Consumption

Reduce

Repurpose

Recycle



Waste

- **2/3** of what we produce ends up as waste.
- Only **9%** is recycled or re-used.
- Increasing world population and rising incomes increase consumption.

Fashion Industry

- Consumes 21 Trillion gallons of water per year
- Generates 203 Trillion lbs. of waste
- More than 60% is synthetic and remains in dumps for hundred of years

30% Manufactured is Never Used

- Fashions change rapidly
- Imperfections
- Over-production



Solutions

- Buy secondhand/ Rent
- Upcycle into new
- Buy durable
- Buy organic cotton, hemp, and recycled materials

Industrial Waste needs Policy Change

Extend Producer Responsibility:
hold companies responsible for
products' post-use i.e.
disassembly

**Match companies: waste =
resource**

Extend Product Life



Cement is the second most used substance next to water.

The Pantheon in Rome, built 2000 years ago, was made with unreinforced concrete no longer available.



One Ton of Cement = One Ton of CO₂

Substituting with a blend mix of conventional Portland cement and 45% fly ash (residue of coal burning plants) results in longer cement life span and reduced decarbonizing of limestone used in the making of cement.

Refrigeration: Hydrofluorocarbons Warm the Atmosphere 9000 x More than CO2

Increasing temperatures= increased demand

- Montreal Protocol calls for a mandatory phase-out by 2018
- 170 countries agreed to get rid of 90% of HFC's
- Mandatory targets with trade sanctions used for violators



Paper

Three Second Meditation by Chris Jordan 2011

9600 mail order catalogs are created every 3 seconds; 97% are thrown out upon arrival.



Paper use is on the Rise

- Especially for packaging of which only 50% is recycled.
- Emissions are higher than those of aviation.

Alternatives

- In NY, fungi filaments are used to create compostable packaging.
- Recycling paper uses 75% less water, 20 to 50% less energy, and saves on trees that would otherwise be cut down.

Plastics:

Projected to increase from **311** M tons in 2014 to over **800** M tons by 2050



Only 5% is Recycled

- Fossil fuel is cheaper.
- Plastics will **outweigh fish** in the ocean by 2050.
- Plastic bags can last 1000 years in nature.

40% of Plastics is used for Packaging

The water in plastic bottles costs 1000 x more than tap water and uses 10's of millions of barrels of oil. It requires 3x the water to make than they contain.

Challenges

- Not all bio-based plastics are biodegradable: Polyethylene shopping bags made from sugarcane or corn are not.
- Others may be biodegradable but only in very high temperatures requiring special chemical recycling.

Goal: Move Towards Closed-Loop Industrial Waste

- Aim towards making materials that can either be recycled indefinitely, or be biologically safe to eat or compost.
- Holland has pledged to go fully circular by 2050.

Companies that Need each other's Waste should be Located nearby each other

In Denmark, an insulin producer uses steam from nearby power plant to sterilize equipment. The slurry is trucked to a bio-energy plant where microbes convert it to biogas for 6000 homes and enough fertilizer for 50,000 acres of farmland.

In 2015, the **US Material Market Place** was created to match the waste of one industry with the “food” for another.



VI. Buildings and Cities

Net Zero Buildings Use As much Energy as they Produce

- Maximize use of daylight

- Better insulated

- LED Lighting

- Heat Pumps



Encourage walking between floors

Natural convection and cooling

On-site Composters

Electromagnetic Glass “Smart Glass”

- Reduces glare when needed.
- Sensors and weather data can automatically override settings.
- Single panes can be controlled by a smart phone.

Smart Thermostats

- Automatically adjust settings based on your lifestyle and peak energy use/price
- Can save up to 12% in heating and 15% in AC

Water-Saving Strategies for Homes

Alternatives

Capture
Rainwater

Use Drip
Irrigation

Grow different
plants

Efficient Appliances



Change Habits

5-Minute Showers

Only wash full
loads

Green Roofs

and

Cool Roofs

Living Insulation

Sequester CO2
Reduce runoff



Reflect Heat

Relieve Urban Heat



Bamboo

has greater tensile strength than steel, and greater compressive strength than concrete. It is a good substitute for steel, cement and building materials. If treated for rot and insects, it can last 50 to 100 years.



Bamboo



Cannabric - makes bricks, insulation, boards, and panels out of biofiber

hemp bricks



hemp insulation



hemp bricks



HoHo Tower in Vienna, Austria is the World's tallest Wooden Skyscraper



Urbanites are expected to make up two-thirds of the world population by 2050.

Studies show a strong correlation between car-free mobility and feelings of neighborliness and a sense of belonging.

**Walkable Cities
Are Successful
when walking is**

**Useful
Attractive**

**Safe
Interesting**

Comfortable

Ggggg



**They make for Healthier and
Happier people while Reducing
CO2 Emissions.**

Opposite of Sprawl

- Homes, cafes, parks, shops, and offices are intermingled at a density that makes them reachable by foot.
- Sidewalks are wide, well lit, and tree-lined.
- Walking can easily be combined with cycling or mass transit

Austria charges 3 Euros per day to pay for unlimited access to all public transportation



Brooklyn Grange



Largest roof-top Vegetable Farm

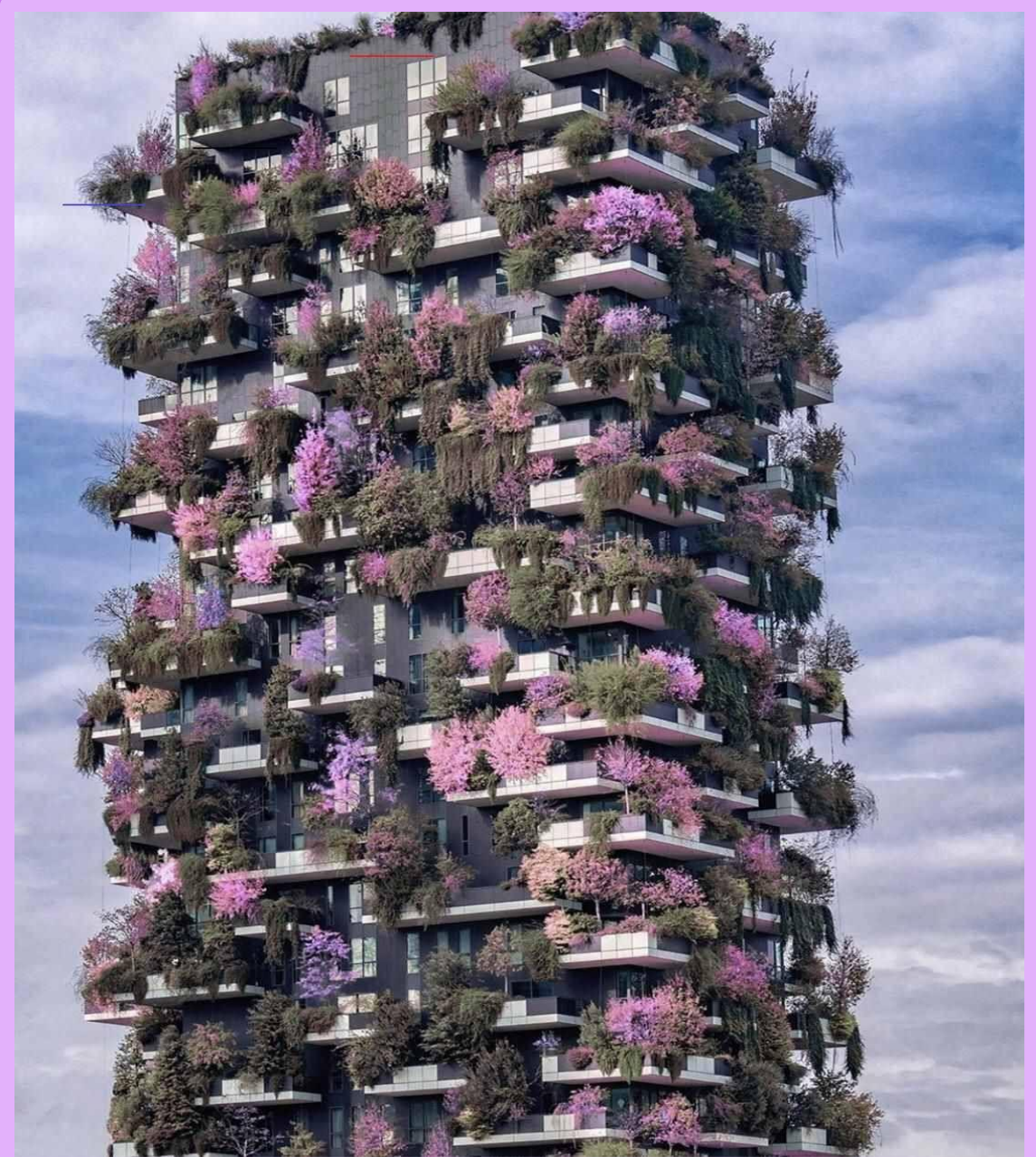
- On top of 3 commercial buildings
- Produces 100,000 lbs. of organic vegetables

Vertical Forest in Cairo, Egypt



Bosco Verticale

Milan, Italy



Forest City in Guangxi, China



Improved Water Distribution

- The impact of pressure management and active leakage control will result in water losses to be reduced by 20% by 2050.
- Savings for utilities could be \$903 Billion while 215 quadrillion gallons of water would also be saved.

VII. Transportation

Mass Transit

is projected to decline from 37% to 21% as low-income world gains wealth and can afford to buy more cars.

Trains: Energy consumption and Emissions have declined by 48-63% since 2013



- Tier 4 Locomotive: Hybrid
- Regenerative braking systems re-use heat
- Lighter, larger and More aerodynamic
- Improved software
- Lubrication of rails

Mass Transit Needs to increase to 40%

Less congestion
Safer
Saves energy
Saves on land use
Less pollution
Equitable



High-Speed Rail

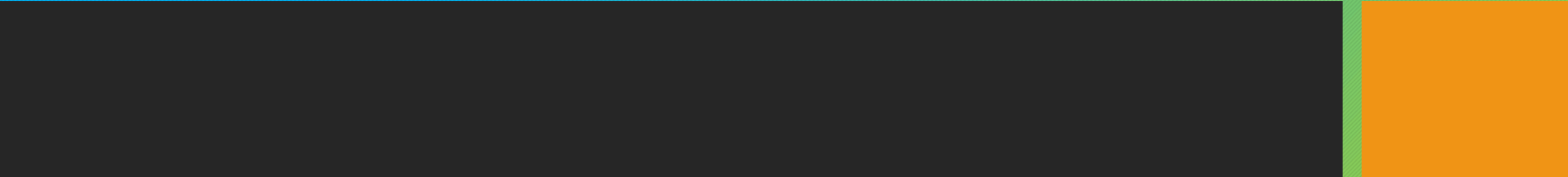
Reduces CO2 emissions by 90%

- Electric
- Travels at 270 m/p/h
- US has 28 miles of track vs 18,500 worldwide



Elsewhere

- China, Japan, and South Korea have a high-speed train , the maglev, which uses magnets to levitate. This creates less friction, thereby saving on energy use.
- High-speed trains run from London to Paris, Paris to Lyon, and from Madrid to Barcelona.



**Imagine autonomous pods traveling
760 mph through steel conduits
from San Francisco to LA in 35
minutes at the cost of a bus ticket.**

Coming Attraction: Hyperloop



Pods, powered by solar and wind energy, travel in vacuum tubes. They are levitated by magnets acting as stabilizers.

The system would use up to 95% less energy than planes, trains, or cars because the absence of air reduces resistance.

Shipping produces 800 Million Tons of CO₂ per Year and Supports 80% of Global Trade



60,000 deaths in Port Cities are a result from pollution emitted by ships. (Nitrous and Sulfur Oxides cause lung and heart disease)

Emissions standards are NOT included in any climate change agreements.

Emissions can be Reduced by 55%



- **Larger and Longer**
- **Lightweight Materials**
- **Compressed Air
in bottom hull
reduces resistance**

- **Solar Panels**
- **Improved Maintenance -
lowers drag i.e.
sharkskin-like coating on
hull**
- **Reduced Speed saves
30% in fuel**

**Due to a Lack of mandatory Standards,
a Rating System is used by Banks,
Insurers, and Port Authorities as an
incentive for ships to Burn Less Fuel.**

CARS

Cars will double in number by 2035.

In the US there are more cars than people.

**2/3 of the world's Oil is used
for Cars and Trucks**

**Traffic congestion, made
worse by longer commutes,
has wasted 7.3 Billion gallons
of fuel over the past 20 years**

Electric Vehicles

Edison - Ford Electric Car



- Simple to Make:
fewer moving parts
- Range Anxiety
- Government subsidies

Savings

When powered by wind turbines at today's prices, the electrical equivalent of gasoline is 30 to 50 cents per gallon.

If electric use rises to 16% of total passenger miles by 2050, 10.8 gigatons of CO₂ from fuel combustion could be avoided.

Lightyear One: Prototype

The Netherlands

Solar cells under
safety-glass-roof

Can drive 43 miles
without charging

Has a 450-mile range
when fully charged



Trucks can be made 85% More Efficient

Costs Equal Savings

Improved
Engines

Lighter
Weight

Hybridization

Automatic
Shutdown

Better
Transmissions

Retrofit old Trucks

Build Larger
Trucks

Avoid Empty Loads



Airplane Fuel Efficiency can improve by 60%

Air Travel is Growing Faster than any other Mode



Fuel Savings for Airplanes

**Move towards
Hybrid Engines**

Later descent

Add winglets

**Lighter interior
and engines**

Towing

**Single engine
landing**

**Move engine
to rear**

Jet bio-fuels

**Retire old
aircrafts
sooner**

Telepresence



**Saves on fuel, time, and cost
(\$1.3 Trillion)**

Reduces grueling schedules



Conclusion

Need for Long-Range Policy Change

Nationally

+

Internationally

Develop strong Bi-Partisan Regulations

The Next Industrial Revolution

1. “Waste” is Eliminated by Design
2. Economically Viable
3. Socially Fair
4. Environmentally Safe



The End

[Drawdown.org](https://drawdown.org)

Good Books

- Drawdown and Regeneration by Paul Hawkin
- Uninhabitable Earth by David Wallace-Wells
- Rising by Elizabeth Rush
- The Right to be Cold by Sheila Watt- Cloutier

Positive proof of global warming

