

David McCandless

author of  
Information is Beautiful



beautiful  
news

positive trends, uplifting stats, creative solutions

## Praise for David McCandless

‘Unbelievably brilliant’ Vogue

‘(A) terrific compendium of visual information’ Shortlist

‘In this intriguing book, David McCandless presents a cavalcade of compelling and colourful graphics, each one innovative in its attempt to offer a new perspective on some of our most pervasive twenty-first century obsessions’ Time Out

‘Stunning’ The Sunday Times

‘Thought-provoking, lovingly-crafted and informative; a handsome book that anyone would be grateful to receive’ Independent on Sunday

‘What David McCandless has done is genius... dry data is transformed into small pieces of pop art that engage so much you end up learning more, without realising it. The ideal encyclopaedia for the information age’ Red Handed

# **beautifulnews**

David McCandless



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dedicated to all those uncelebrated millions who work  
quietly and steadily to make the world a better place

# Contents

Cover

Praise for David McCandless

Title Page

Copyright

Dedication

Introduction

health

Fewer Children Are Dying

Cancer

Eleven Diseases

Everything That Kills Kids...

Vaccines

Smoking

Essential Health Coverage

Neglected Tropical Diseases

HIV / AIDS

Suicide

Tuberculosis

Numbers of Infections

Life Expectancy in Africa

Malaria

Everyone, Everywhere is Living Longer

cleaner energy

Solar Panels Every Hour

Nuclear Fission Energy

Nuclear Fusion Energy

100 Renewable Cities & Towns

Geothermal

Solar Power is Amazing!

Wind Power is Amazing!  
Renewables  
Corporate Energy Pledges  
Hydrogen Power is Amazing!

progress

World Hunger  
Nuclear Weapons  
Billions More Can Drink Safely  
Natural Disasters Less Deadly  
Children's Lives  
Access to Electricity  
Armies Everywhere Shrinking  
Famine Deaths

nature

Humpback Whales Are Recovering  
Indigenous Communities & Forests  
Canada's Forest Protection  
Fur  
Unendangered Animals  
Tree Planting  
Animals Bouncing Back  
Phytoplankton  
A Wall of Fertile Land Will Cross Africa  
Global Tree Cover is Expanding  
Land Preservation  
The Surface of The Earth  
50 countries Reduced Fertiliser

mixed

COMPILED I  
COMPILED II  
Three Things  
Up, Up, Up

COMPILATION III  
COMPILATION IV  
COMPILATION V  
Corona Good News  
Down, Down, Down  
Because Every Country Is the...

## freedom & rights

Half the World Lives in a Democracy  
Transgender Rights are Spreading  
Where It's Legal to be Homosexual  
Animal Cruelty  
Protests

## climate

Getting to Net Zero by 2050  
Global GHG Emissions  
The Paris Climate Change Agreement  
The Kigali Amendment  
Country Climate Pledges  
CO2 Removal  
Geoengineering  
Methane

## money

Foreign Aid Has Exploded  
Extreme Poverty Is Decreasing  
Getting USA to Net Zero: Costs  
The Generosity of Poorer Countries  
The World's Economy has Ballooned  
The Circular Economy  
Carbon Taxing & Pricing  
Carbon Offsets: Do They Work?  
De-investing from Fossil Fuels

nice!

What is the World Really Like?  
We've Saved Millions of Kids' Lives  
The World's Happiest Countries  
Global Flavours of Contentment  
Yay UK!  
Yay Africa!  
The EU Leads on Emissions & Recycling  
Amazing Agreements  
YAY Germany!  
YAY USA!  
YAY Australia!  
A Fourth Type of Chocolate  
China is...  
Blood Donor Texts

women & girls

Women Can Vote Everywhere  
The Education of Mothers  
More Girls Are in School  
Women  
Sanitary Products: Good News

what to do?

How to Halve Emissions by 2030  
Getting to Net Zero  
Reducing Emissions Yourself  
Food Waste  
Plastics  
Plastics: What Can You Do?  
Is it Wrong to Fly? Solutions  
The Order of Action

cool tech

Creative Ways to Deal with Emissions

Food Tech

Transport

Electric Vehicles

Batteries are Getting Better & Better

Generating & Storing Energies

Magic Materials

Fairphone 3

Curveballs to Solve Plastics

LED Bulbs

Is it Wrong to Fly? Electric Planes

Seaweed

About David McCandless

About the Publisher

# Introduction

This is Beautiful News. Some of the amazing, beautiful, positive things happening in the world that we can't see because we're fixated on the negativity of the news.

If the news is your main window on the world – as it is for me – it's difficult not to see it as an infernal hell scape of conflict, murder, disagreement, tragedy and violence.

At best that's an unfair depiction of the world. At worse it's false, distorting and mentally harmful.

A function of charts and graphics has always been to show us what we can't naturally see. In this case, the slow developments, quiet trends that go unseen, uncelebrated. Decadal increases. Generational shifts. Historic reductions. Incremental change. Subtle upticks. The slow and steady symphony of progress.

Without these views, it's easy to succumb to doom, pessimism, powerlessness. The scale and complexity of the world's problems feels overwhelming. But often \*understanding\* can be the antidote.

That's why this book is not just beautiful trends, but also full of infographic primers – visual explainers of complex but important topics – so you can better understand them as they pop up in the news.

Working closely with these topics and all the surrounding data and information over the months, I've noticed a shift in myself and my outlook. I feel less heavy. A bit brighter. Maybe even ... a little hopeful?

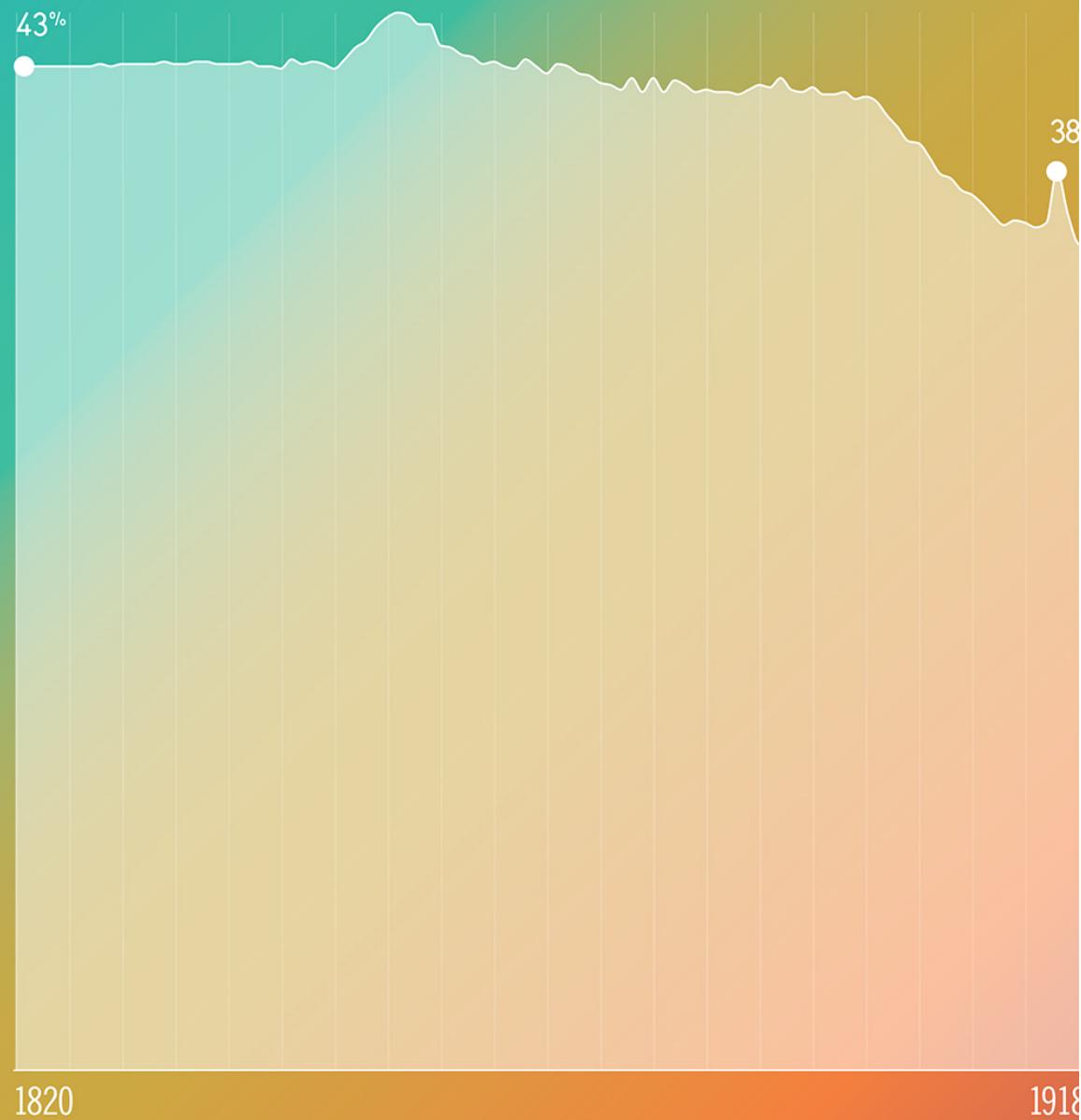
The world is not perfect. It never will be. But nor is it as bad as it looks. That's clear.

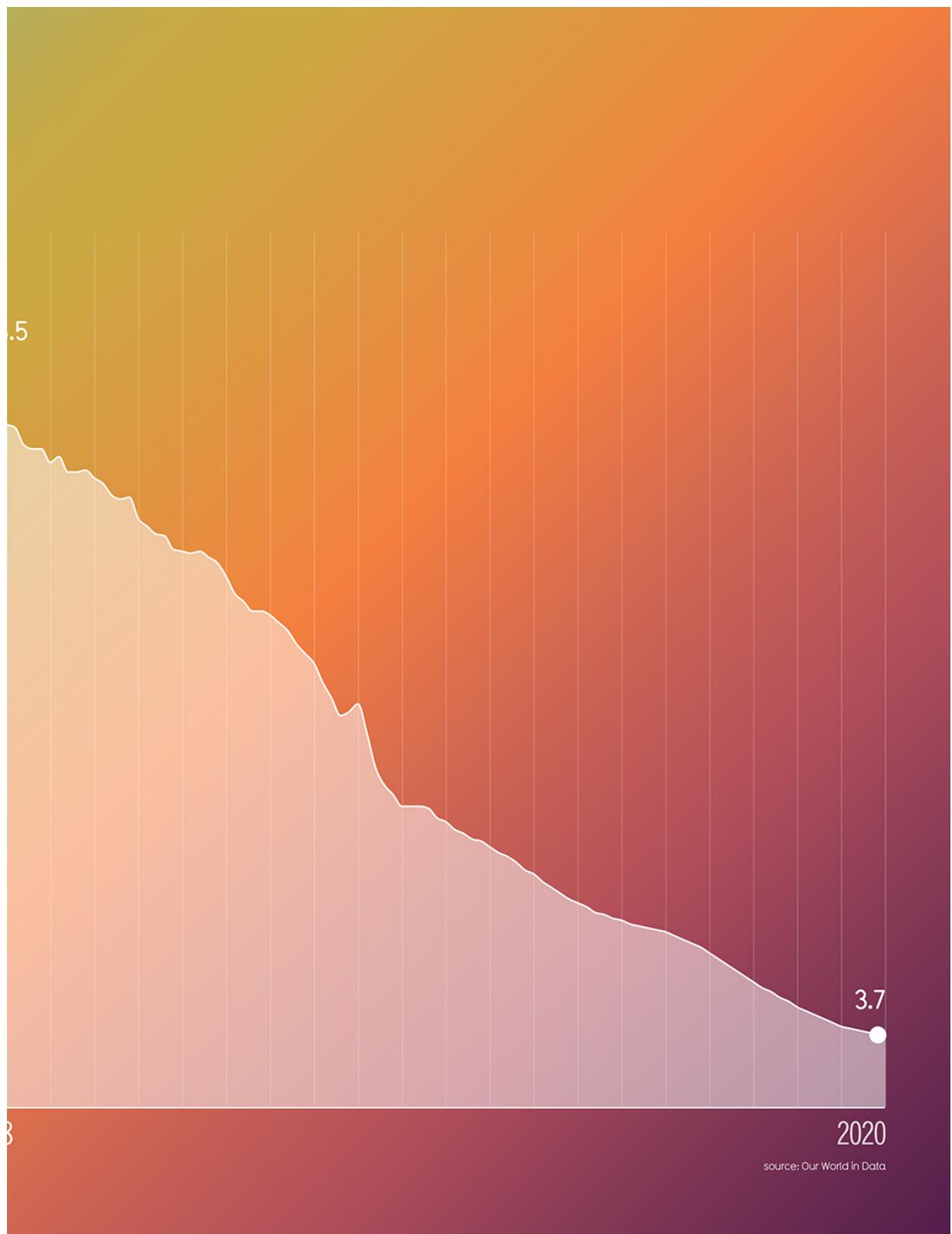
I get this feeling that optimism is a muscle. One that can be supported by regular exercise and a diet of healthy information. So if the news is fast food – tasty and moreish but unhealthy – then take this book as a beautiful salad. Full of fresh ideas and nutritious perspectives to revitalise your mind, strengthen your heart and give you something delicious to chew on...

David McCandless, June 2021

# Fewer Children Are Dying

% dying before the age of five worldwide





# Foreign Aid Has Exploded

Money given to poorer nations

SOCIAL

ECONOMIC

PRODUCTION

MULTISECTOR

\$4bn

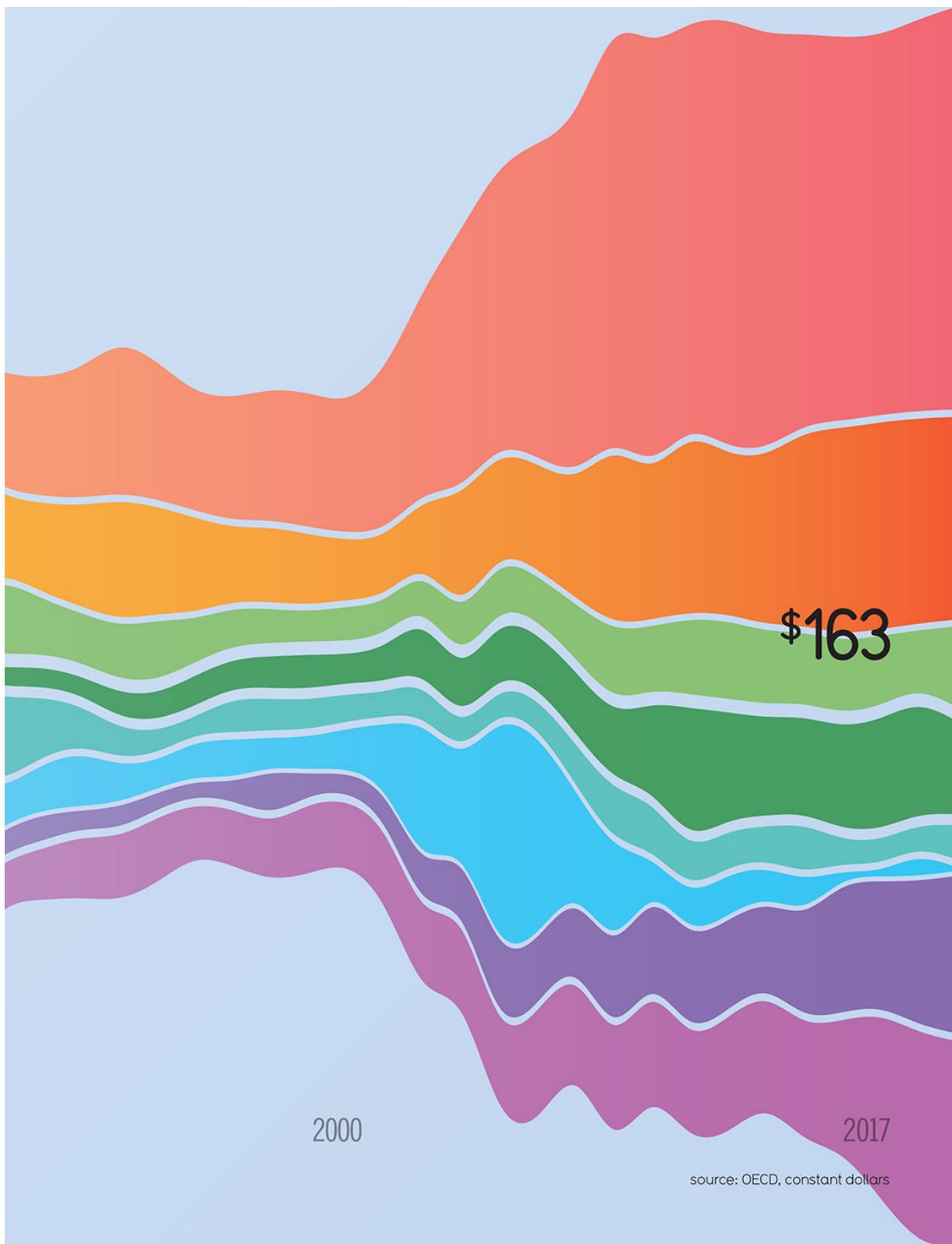
DEBT RELIEF

COMMODITY

HUMANITARIAN

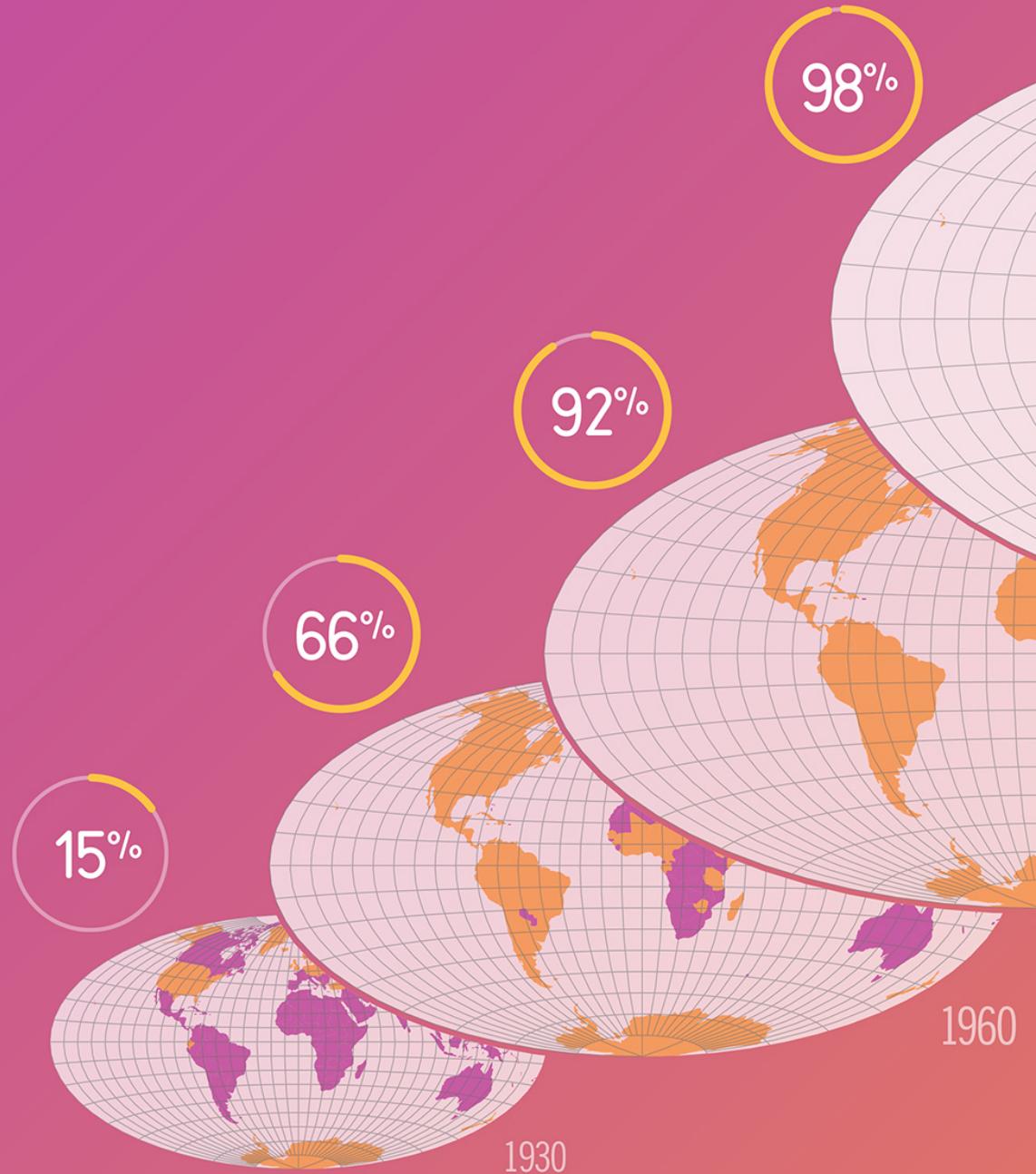
UNSPECIFIED

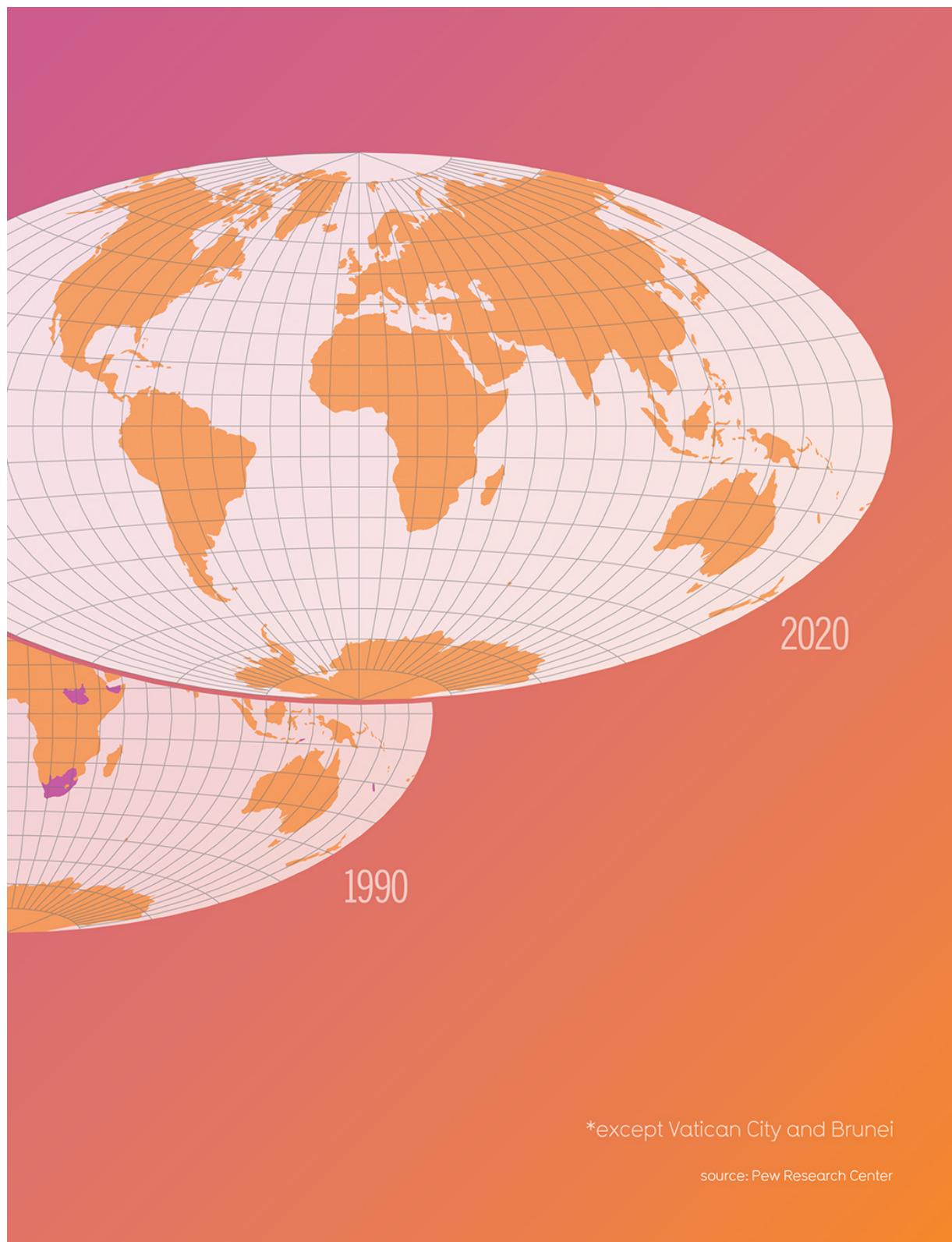
1960



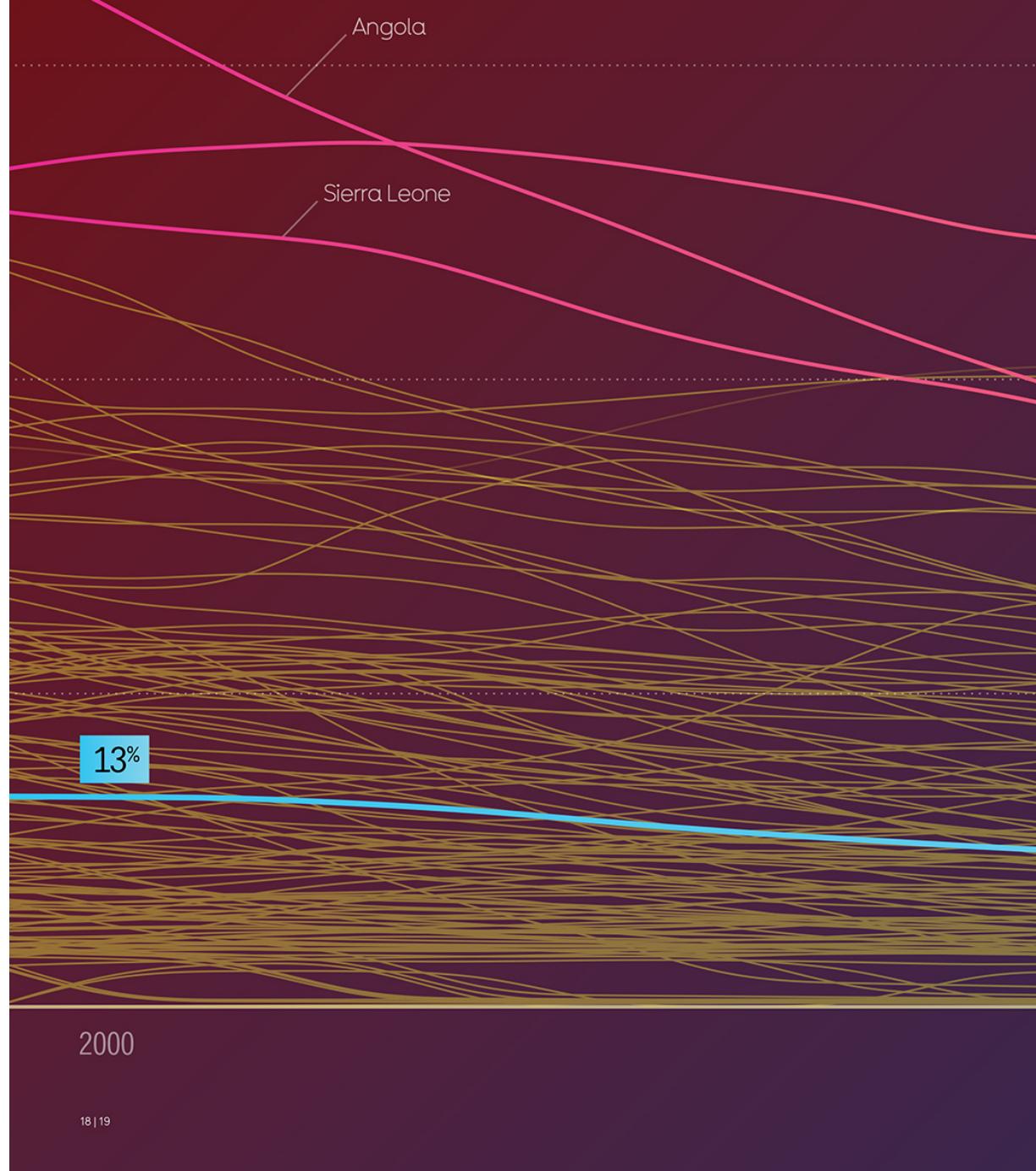
# Women Can Finally Vote Everywhere\*

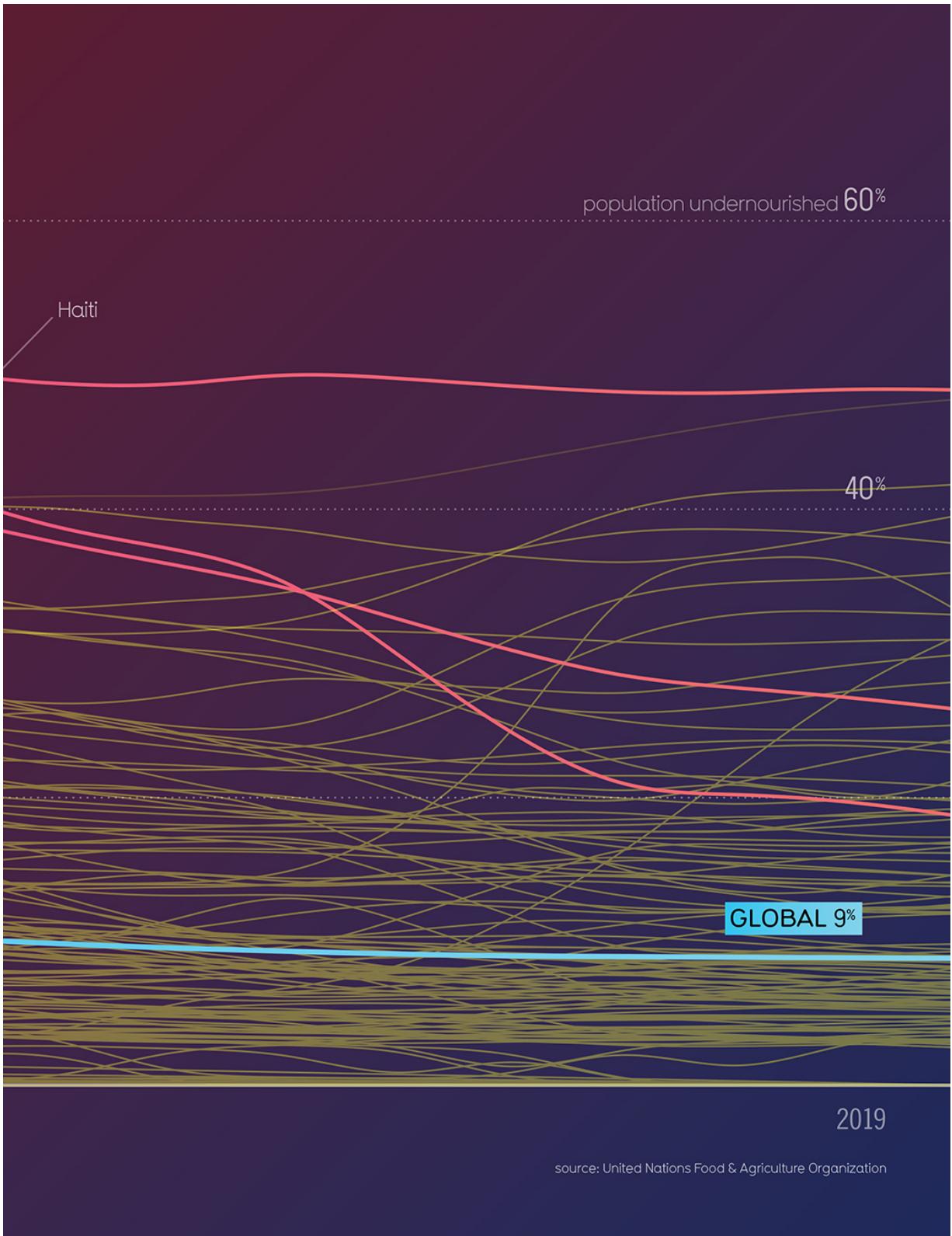
% of countries





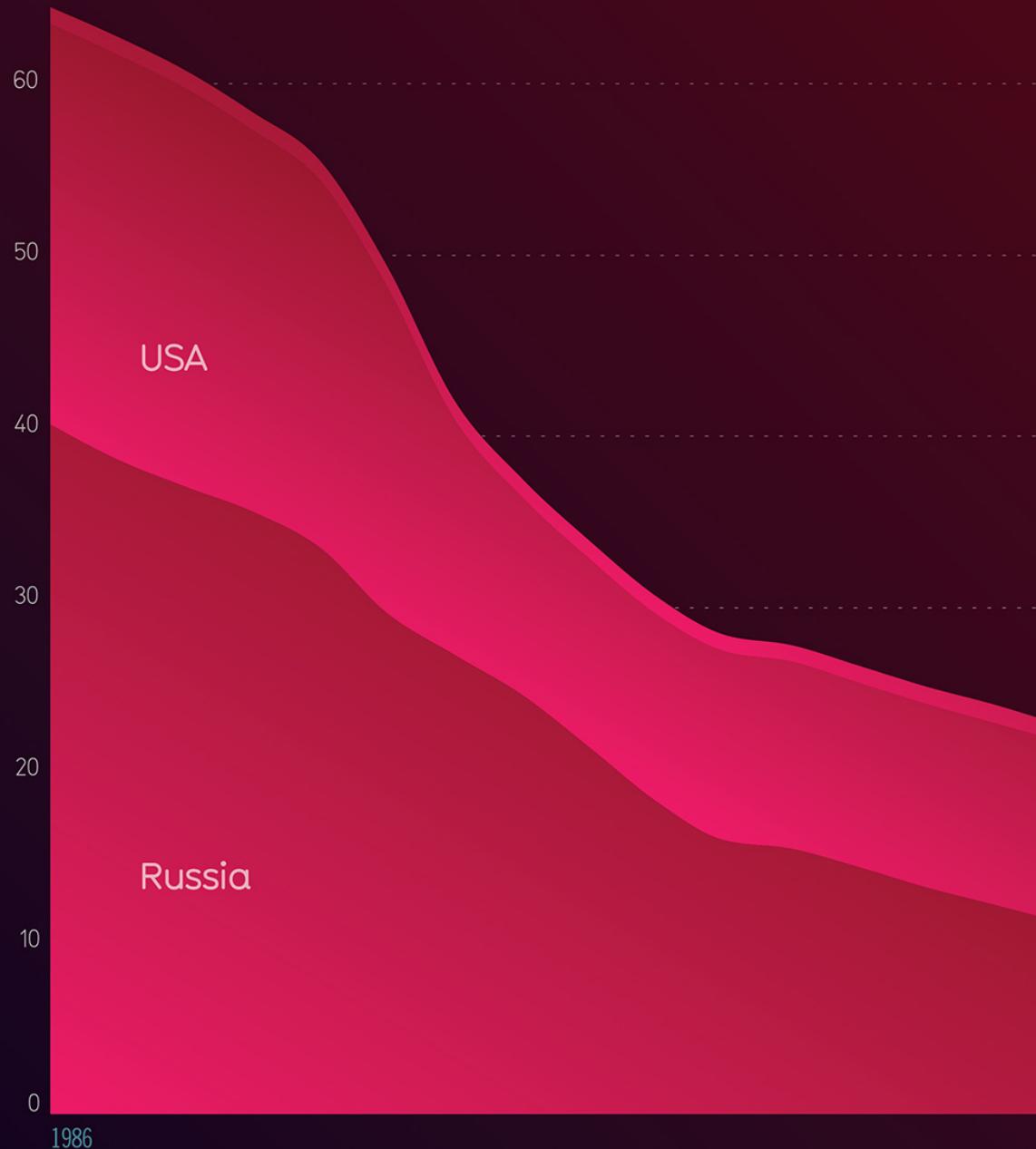
# World Hunger Has Reached Its Lowest Point in 20 Years

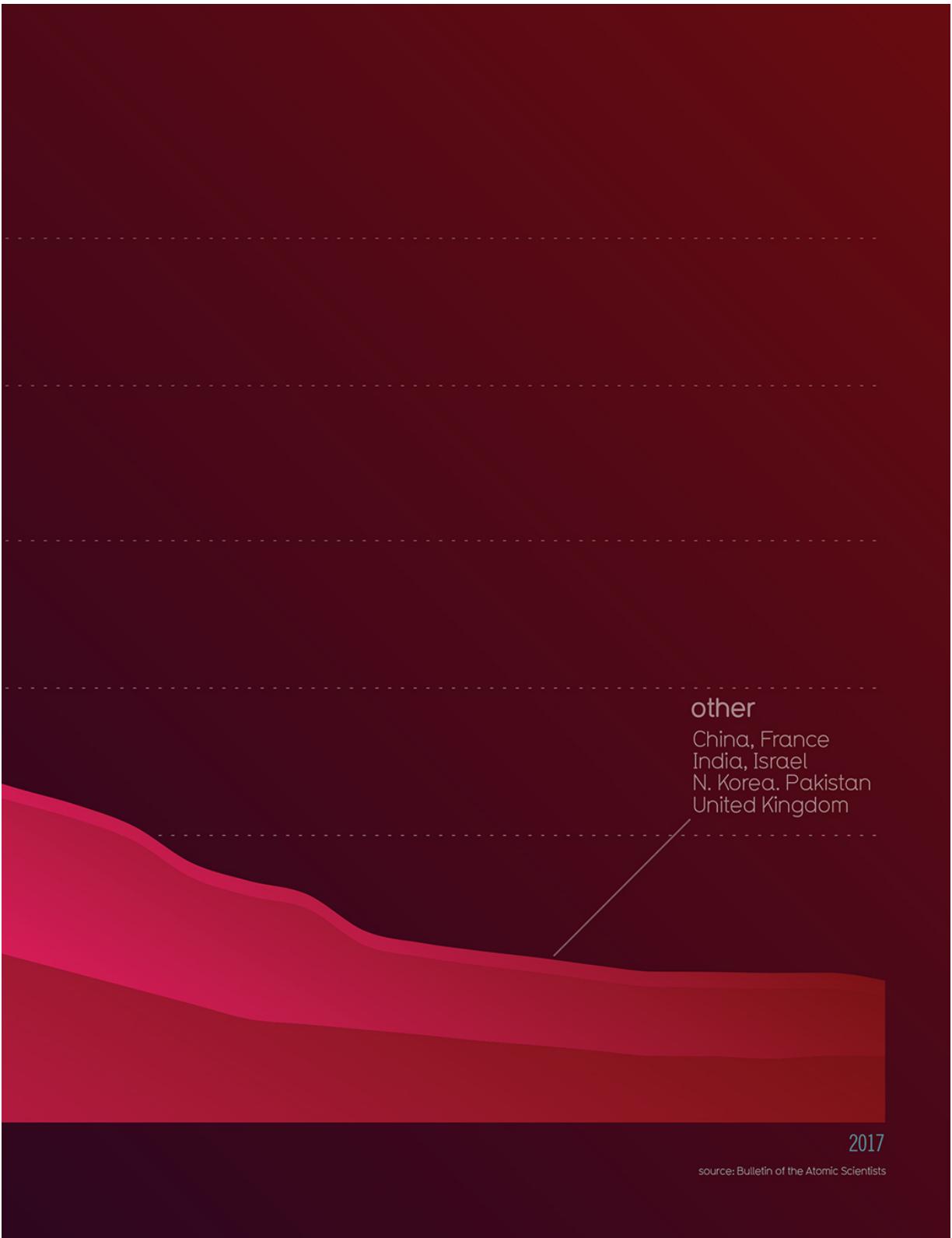




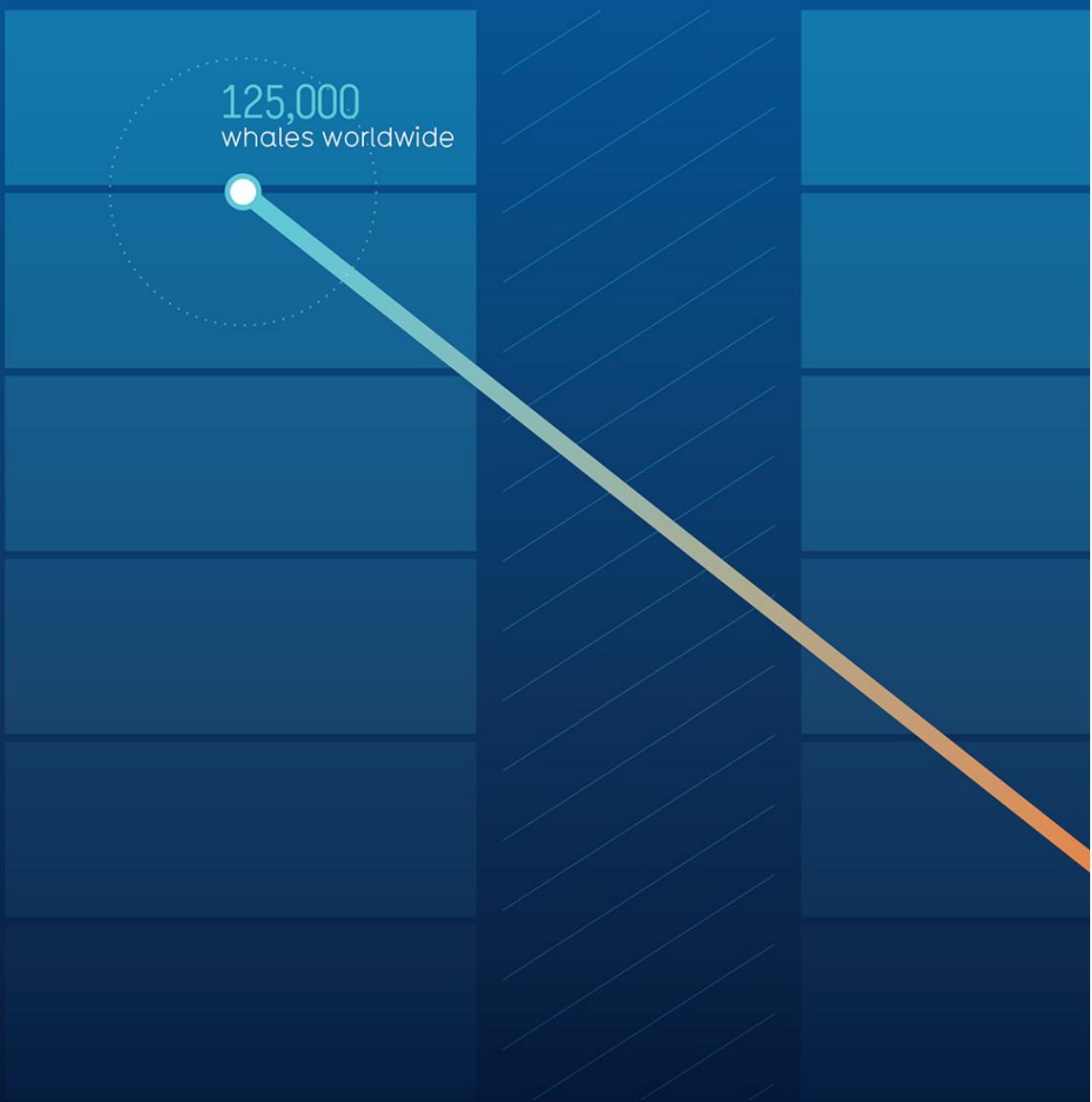
## We've Decommissioned 85% of the World's Nukes

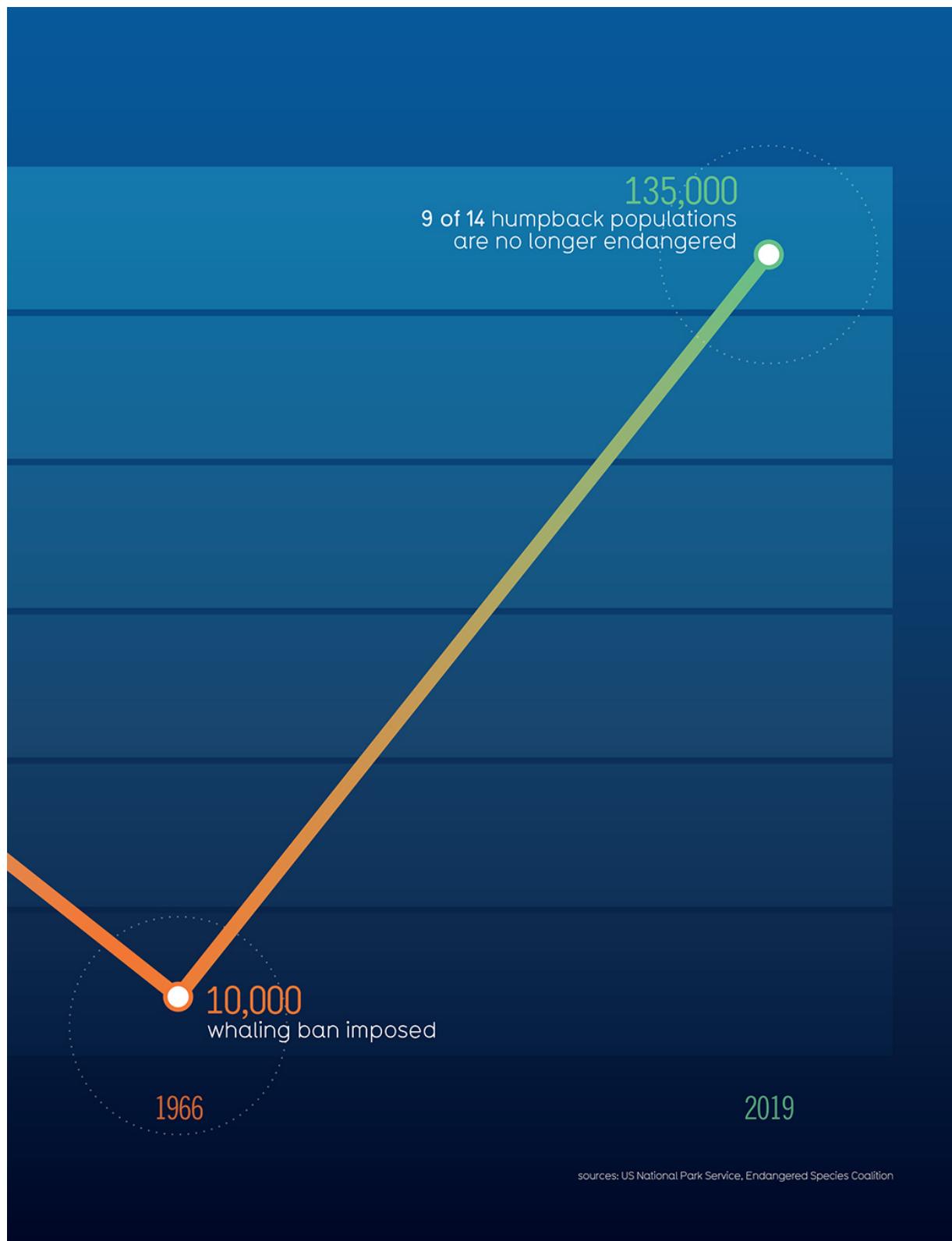
Thousands of nuclear warheads





## Humpback Whales Are Recovering





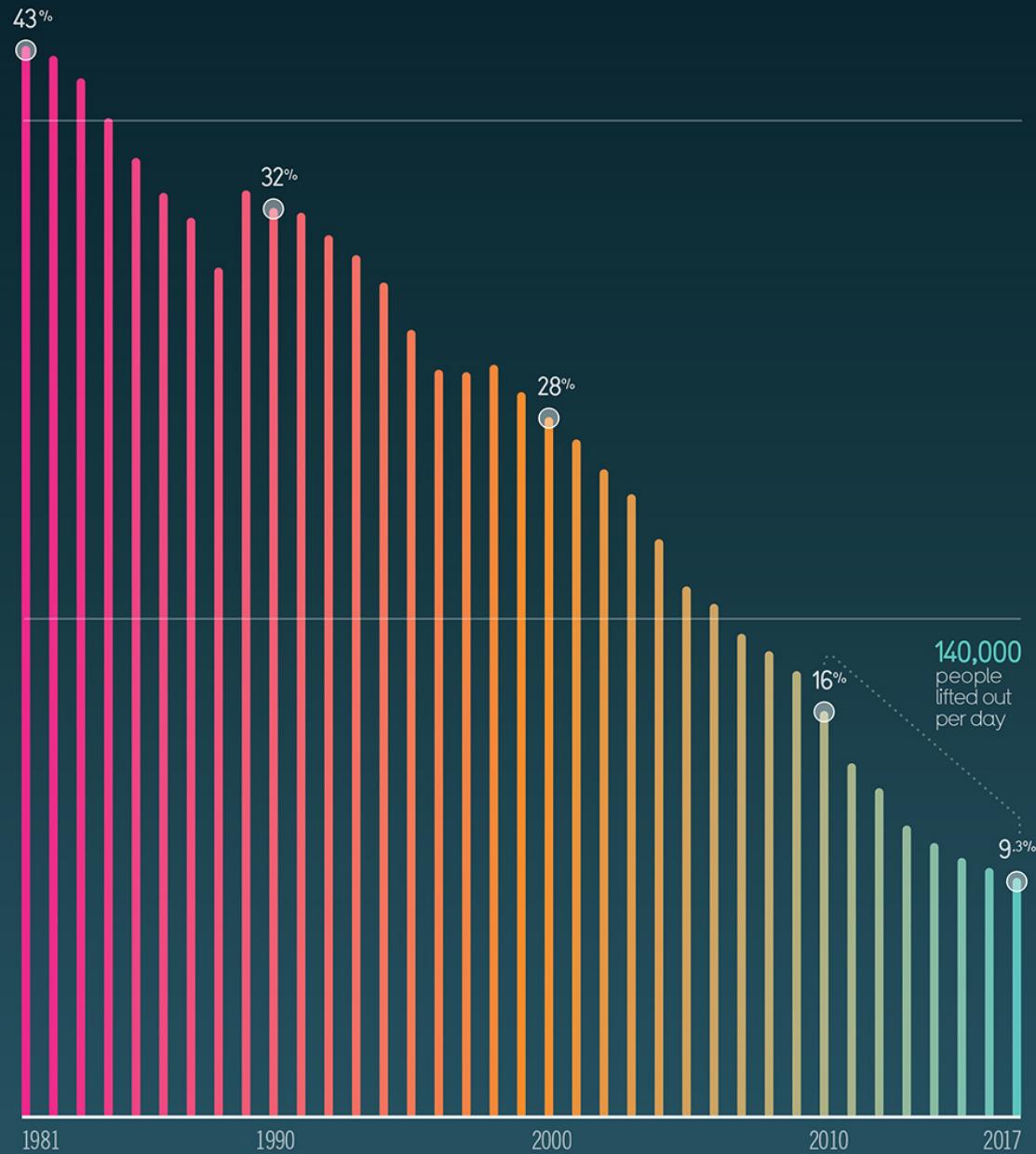
The world will  
install solar panels  
**EVERY HOUR**  
over the next  
three years

# add 70,000

source: Our World in Data

# Extreme Poverty Is Decreasing

% world population living on less than \$1.90 per day



source: Our World in Data

# More Than Half the World Now Lives in a Democracy

100% of global population



source: Our World in Data

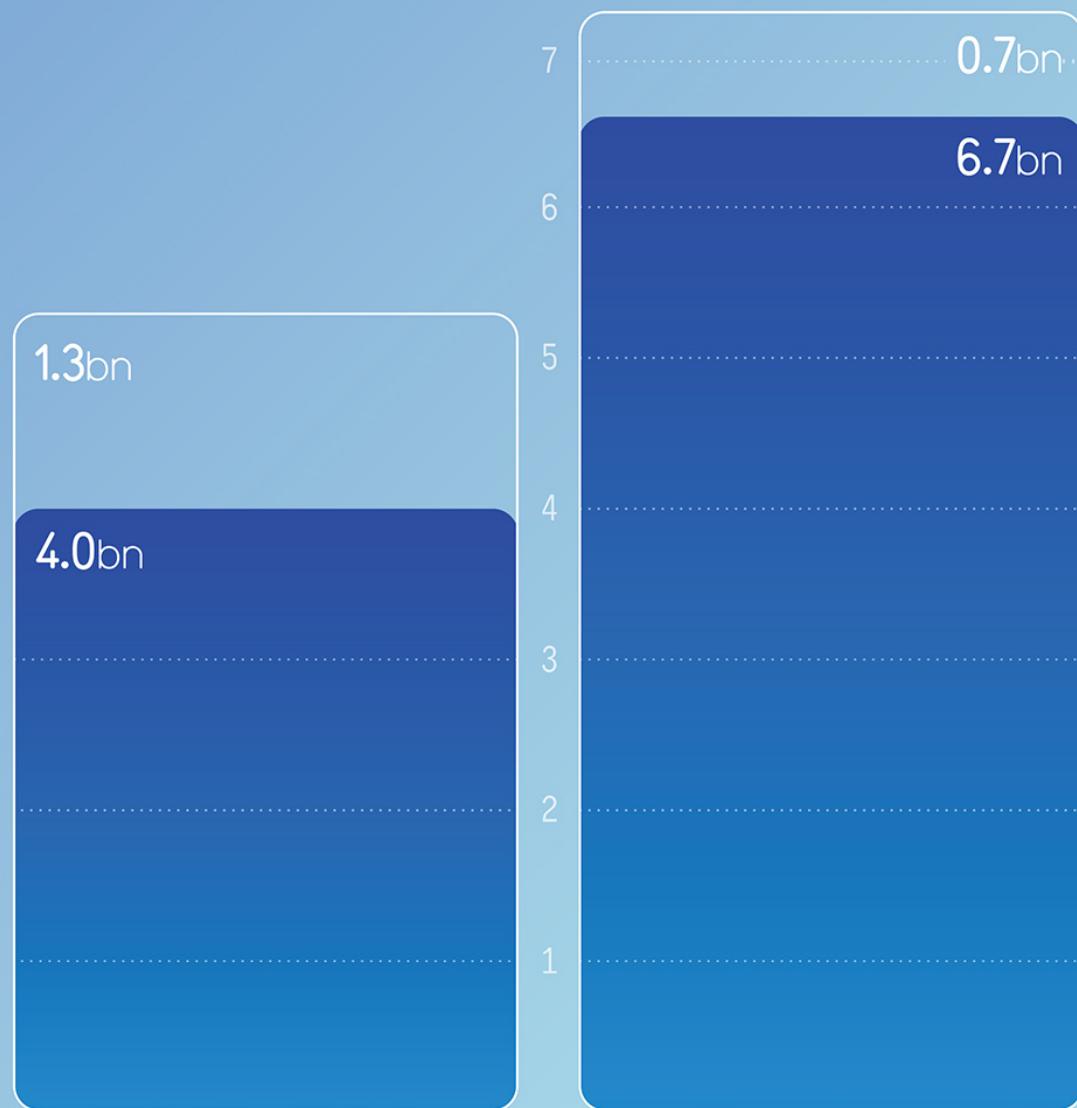
# Billions More Can Now Drink Safely

world population with access to safe water

1990

billion people

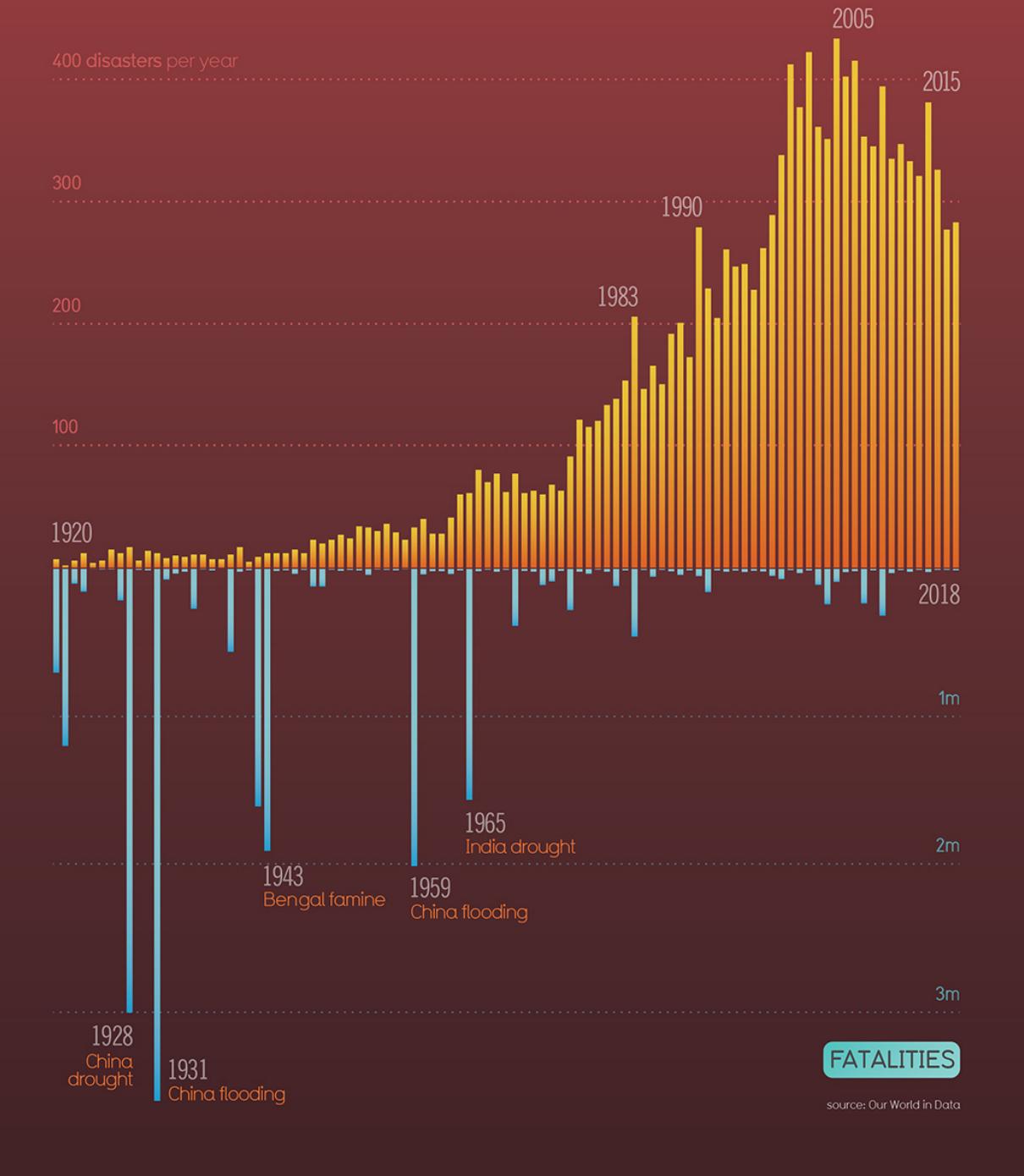
2015



sources: Our World in Data, World Water

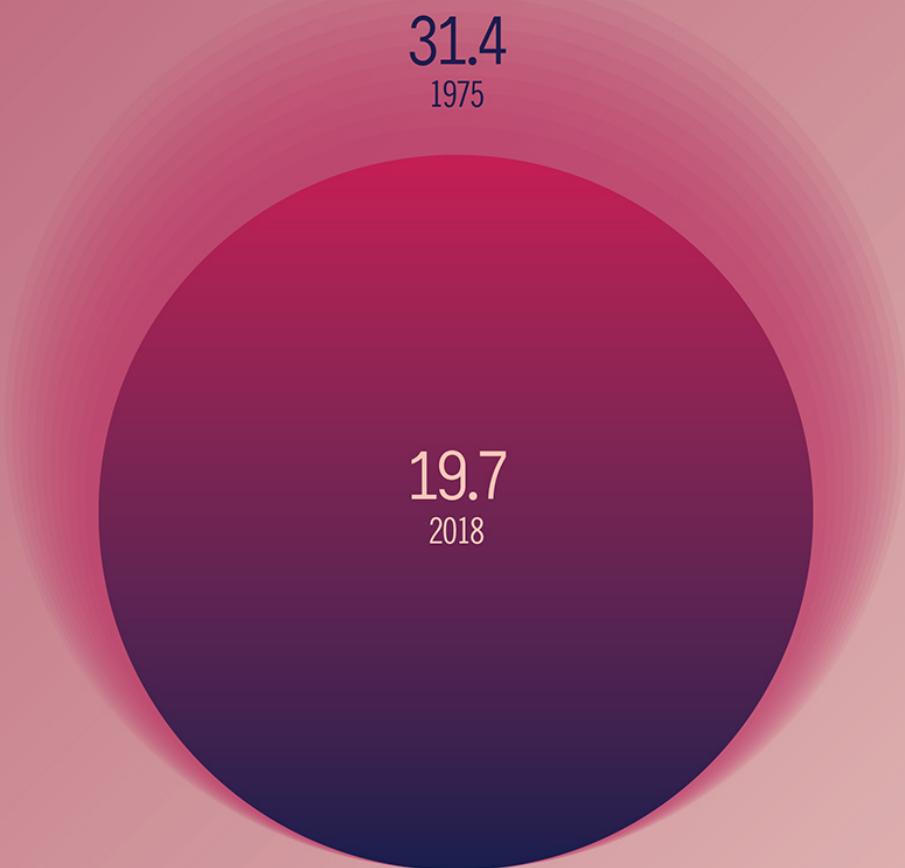
# Natural Disasters Are Far Less Deadly

Floods, droughts, hurricanes & earthquakes



## Fewer Women Are Dying of Breast Cancer

Deaths per 100,000



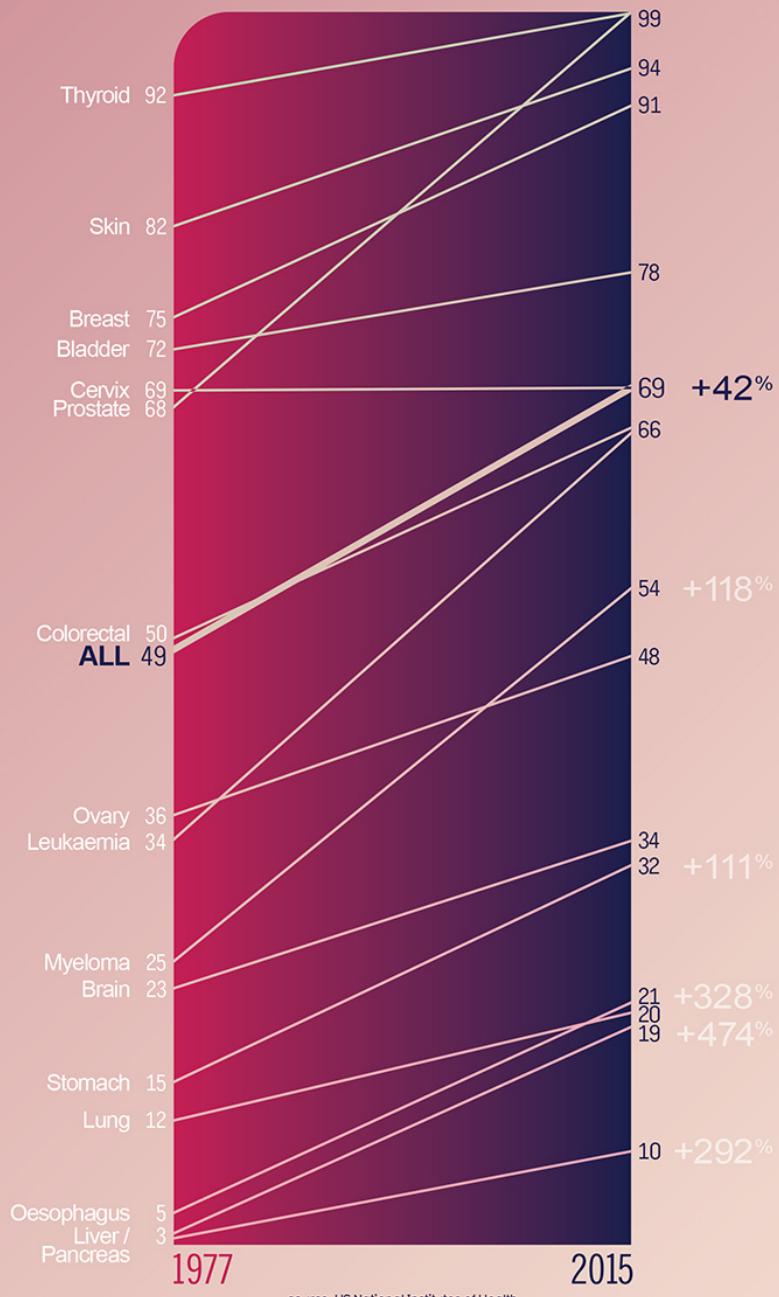
31.4  
1975

19.7  
2018

Sources: Queen Mary University London, National Cancer Institute

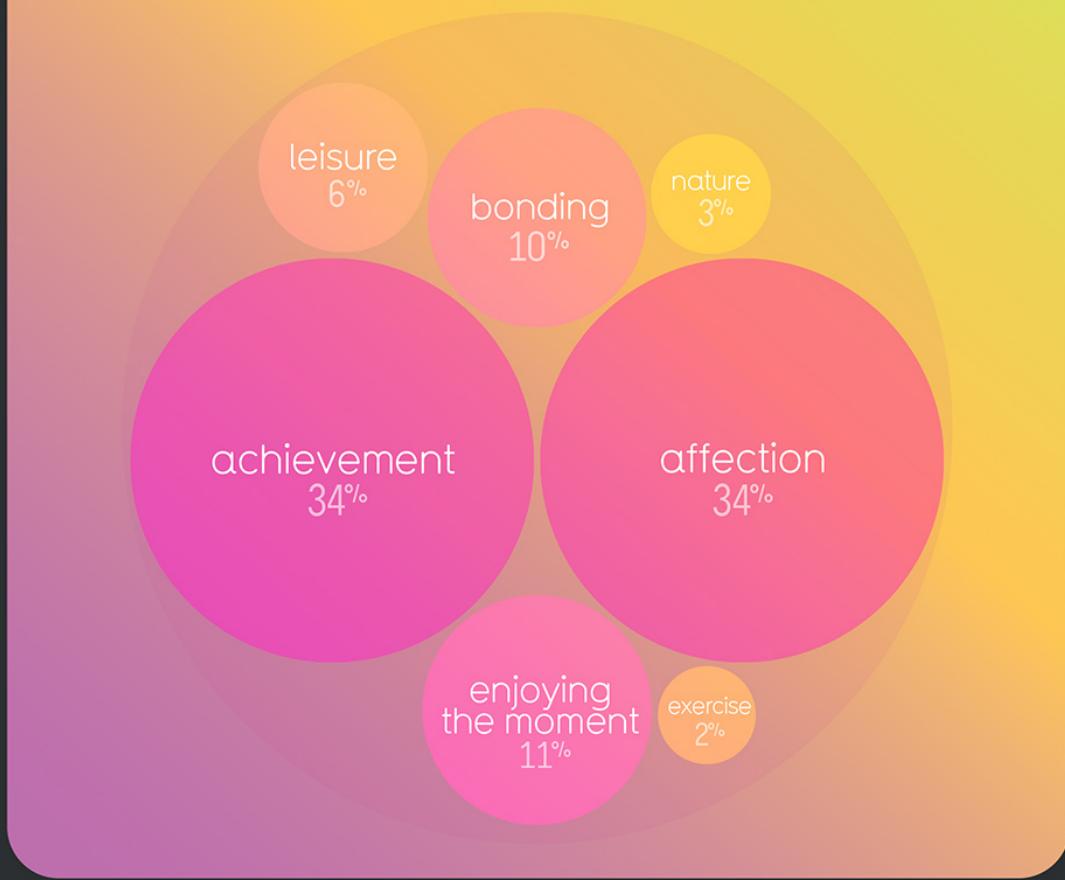
## Cancer Survival Rates Are Rising

% alive five years after diagnosis

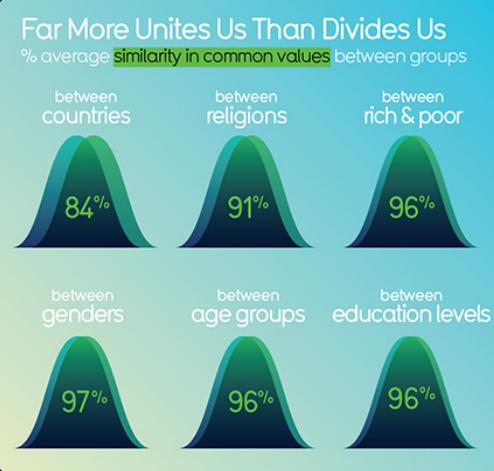


# The Best Things in Life Really Are Free

What makes people most happy, according to data?



sources: Flowing Data, Happy DB



### Britain's Woodland Cover Is Returning to Medieval Levels

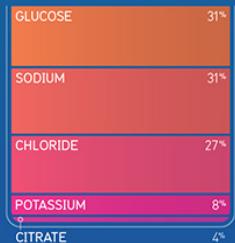
total land area coverage



sources: Royal Forestry Society, The Times

## Simple Oral Rehydration Therapy Has Saved Millions of Lives Around the World

Treating diarrhoea is **easy, cheap** (0.20\$/day) & **accessible**



given to  
**millions**  
of kids under five  
worldwide every year



And thanks to an improved formula with zinc,  
deaths are still falling around the world

2.4  
million  
under-five  
deaths from  
diarrhoea  
worldwide

880,000  
2017

Source: WHO, USAID

## Pakistan has met its climate goals one decade before the United Nations deadline



planted billions of trees in just two years!



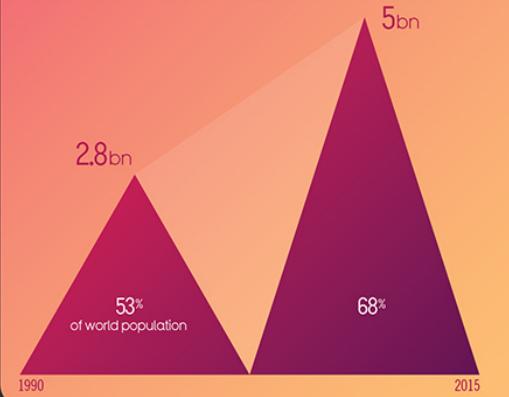
ranked & rewarded its cleanest cities



protected up to 15% of its parks & wildlife areas

Source: Good News Network

## Over Two Billion More People Have Gained Access to Improved Sanitation



source: Our World in Data

## The EU has banned bee-harming pesticides

IMIDACLOPRID  
CLOTHIANIDIN  
THIAMETHOXAM

Source: European Food Safety Authority

## Land Devoted to Producing Meat & Milk Is Beginning to Shrink Again



Source: United Nations Food & Agriculture Organization

## Healthy Life Expectancy Is Increasing in Almost Every Country

years of healthy life  
(women)

2000–2018

75

70

65

60

55

50

45

40

35

30

25

20

15

10

5

0

years of healthy life (men)

Africa  
Asia  
Europe  
N. America  
Oceania  
S. America

source: World Health Organization

## Homicides Are Falling Around the World % decrease 1998–2018

World Average -15%

Albania -89%

China -75%

Estonia -85%

Greece -41%

Japan -57%

Italy -64%  
Kyrgyzstan -75%

Pakistan -49%

Poland -63%

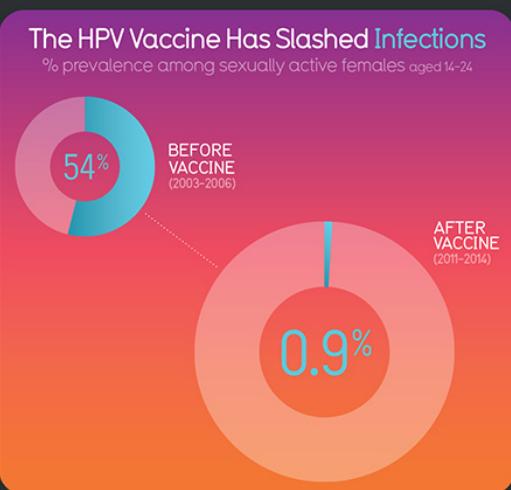
Russia -64%

Singapore -85%

Spain -52%

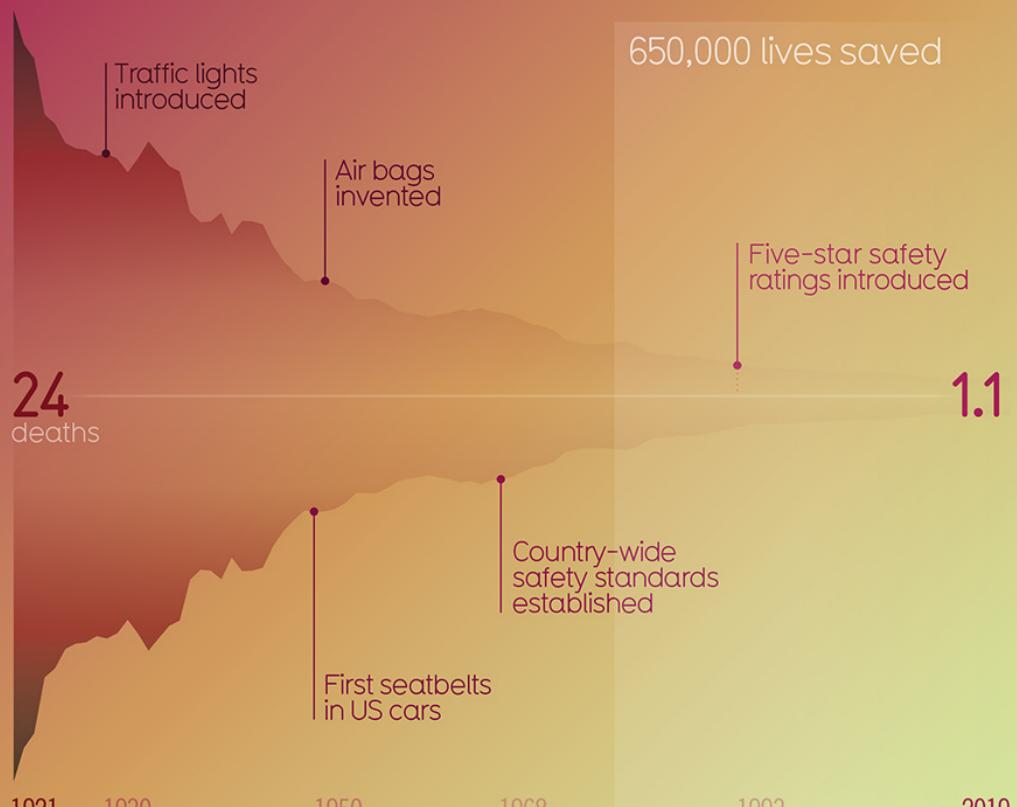
West Bank & Gaza -67%

source: World Bank



## Road Travel in the US Is Safer than Ever

Fatalities per 100m vehicle miles travelled



# Eleven Diseases We've Nearly Controlled or Eradicated

on our way

cases decreased by 15% from 2009 to 2018

leprosy

malaria

rubella

over half the countries on Earth are now malaria-free

progress!

AKA 'elephantiasis'  
a lesser-known tropical disease  
spread by mosquitoes

onchocerciasis

rabies

yaws

India was the first country to eradicate this terrible disease of childhood in 2016

lymphatic filariasis

Chronic parasitic disease caused by microscopic, thread-like worms spread by mosquito bites

nearly...

'sleeping sickness'  
spread by tsetse flies

African trypanosomiasis

polio

guinea-worm disease

terrible affliction spread by contaminated drinking water

eradicated

smallpox

 size = global impact of disease

sources: World Health Organisation, Our World in Data

## Quick Quiz

What % of people in the world....

PTO for answers

...live in extreme poverty?

...can now read and write?

...live in high- or middle-income nations?

...have some access to electricity?

Overall, compared to 25 years ago,  
do you think the world today is

worse ?

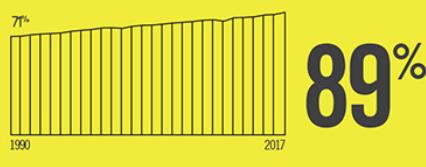
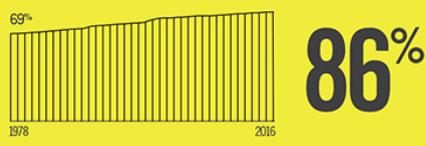
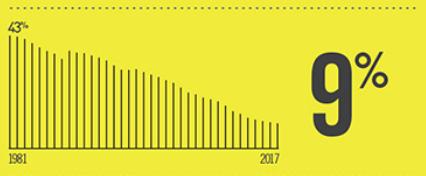
the same ?

better ?

\*substantially\* better ?

## Quick Quiz: Answers

How close were you?



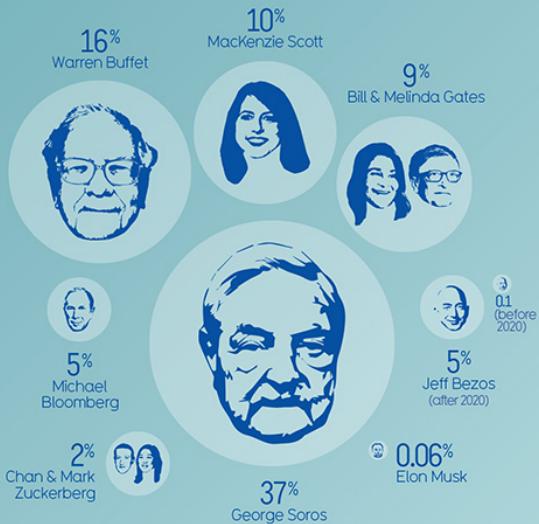
source: Our World in Data

38 | 39

## These People Donate \$1 Billion Every...

	61 DAYS	Mackenzie Scott	EX-WIFE OF JEFF BEZOS
	126	Warren Buffet	FAMOUS INVESTOR
	184	Bill & Melinda Gates	
	227	Chan & Mark Zuckerberg	
	586	George Soros	
	606	Michael Bloomberg	
	7.5 YEARS	Jeff Bezos	
	20 YEARS	Elon Musk	

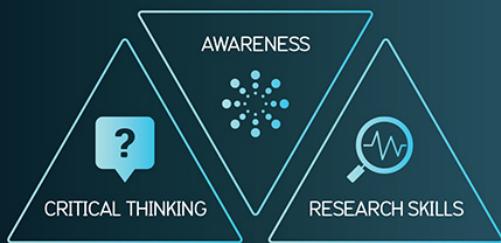
### % of Net Worth Given Away



sources: World Economic Forum, EcoWatch, New York Times

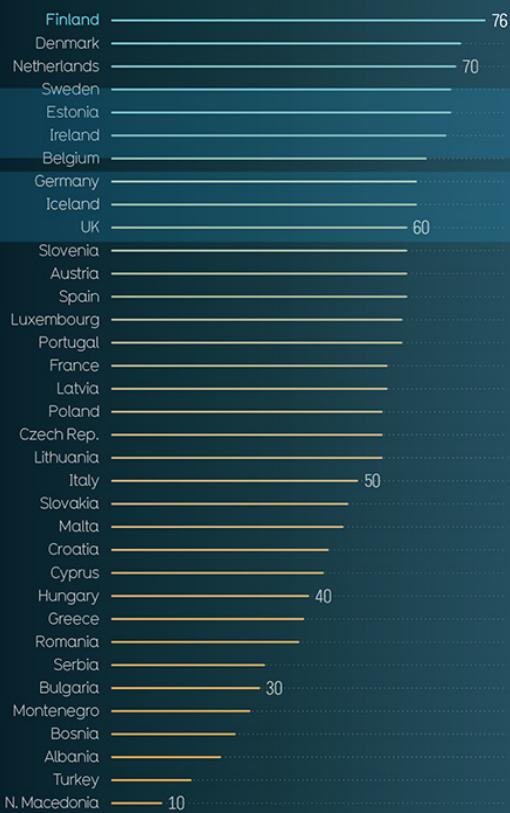
# Finland Is Teaching Kids to Identify Fake News

Professional methods are taught across all subjects



Finland Has Europe's highest media literacy

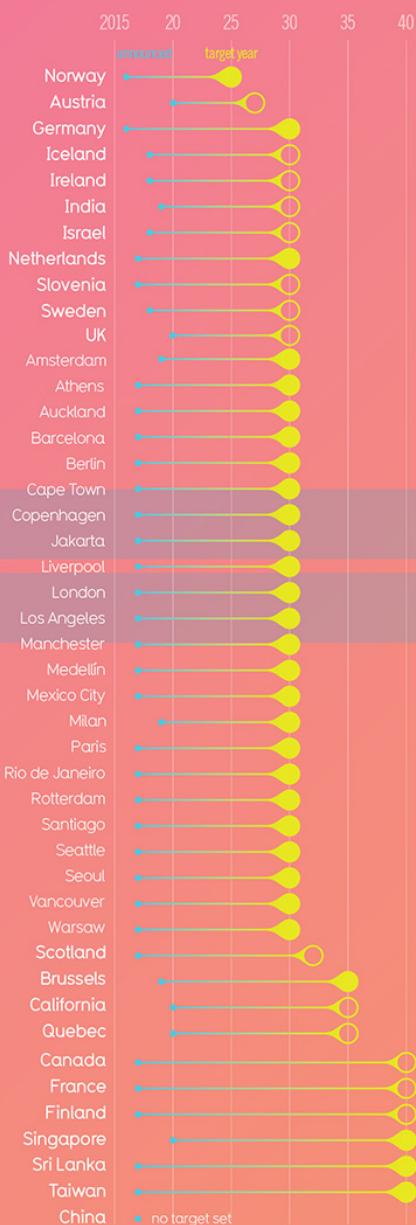
Index on how resilient a country's population is to fake news



source: Open Society Institute (Bulgaria)

# We Are Starting to Ban Fossil-Fuel Vehicles

● all cars ○ new cars



sources: Guardian, BBC, Independent and others

# Millions of Childrens' Lives Have Been Saved

East Asia & Pacific

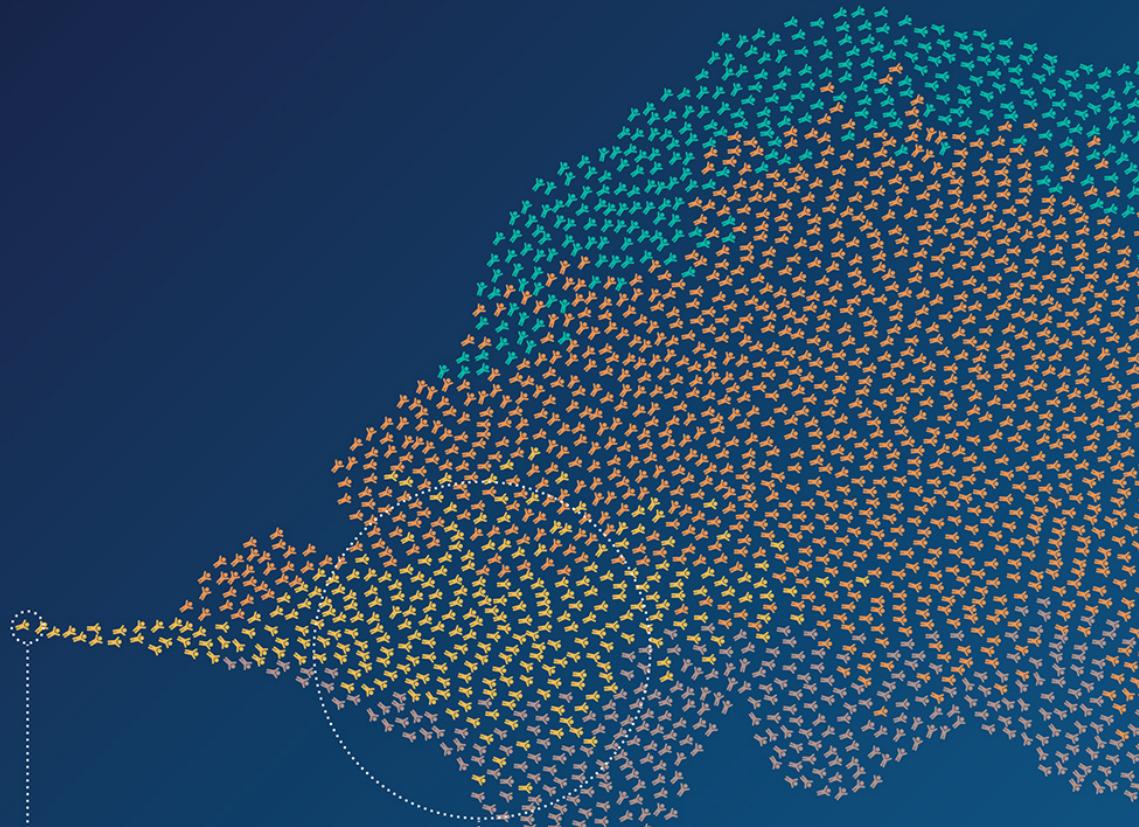
Europe & Central Asia

Latin America & Caribbean

Middle East & North Africa

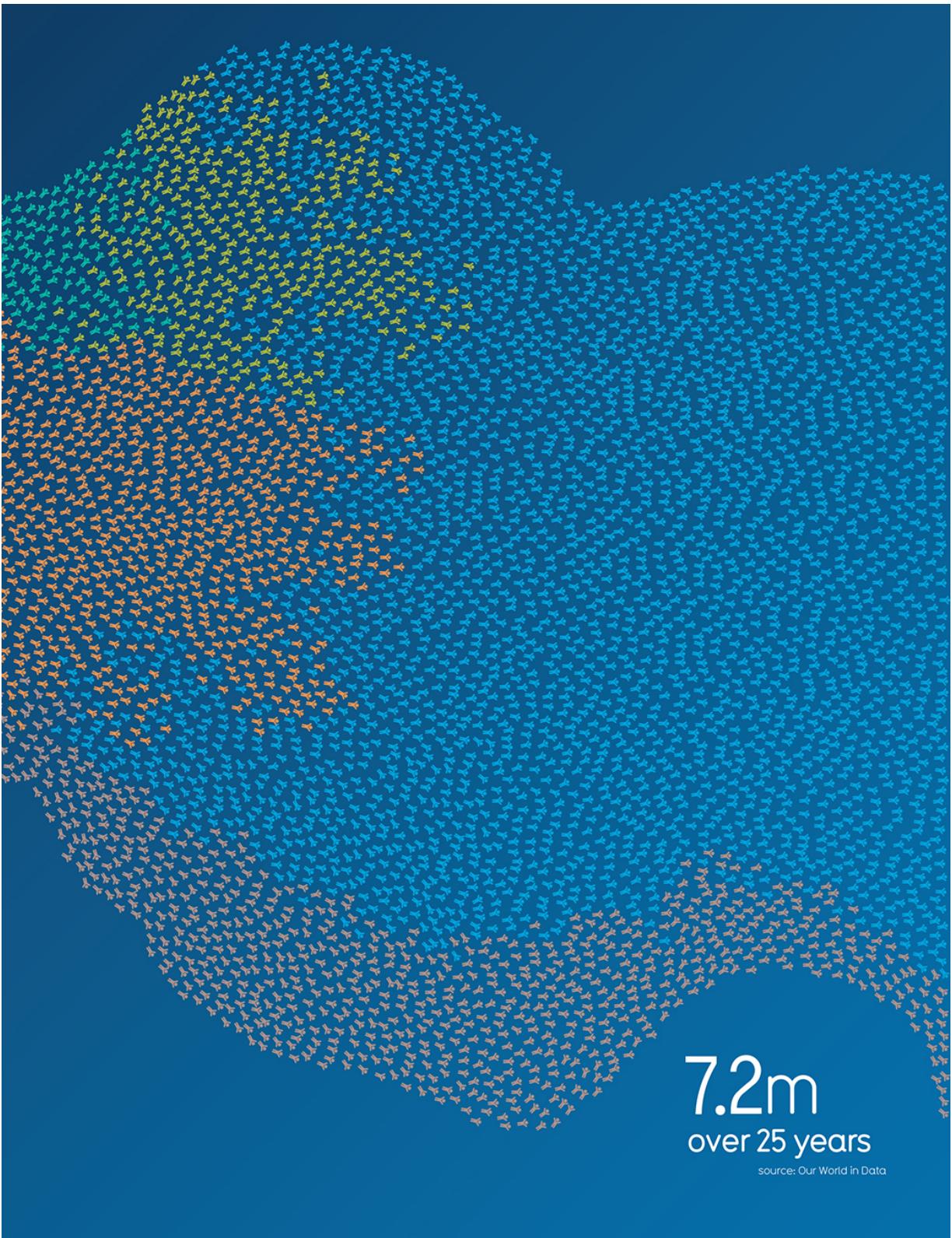
South Asia

Sub-Saharan Africa



725  
per day

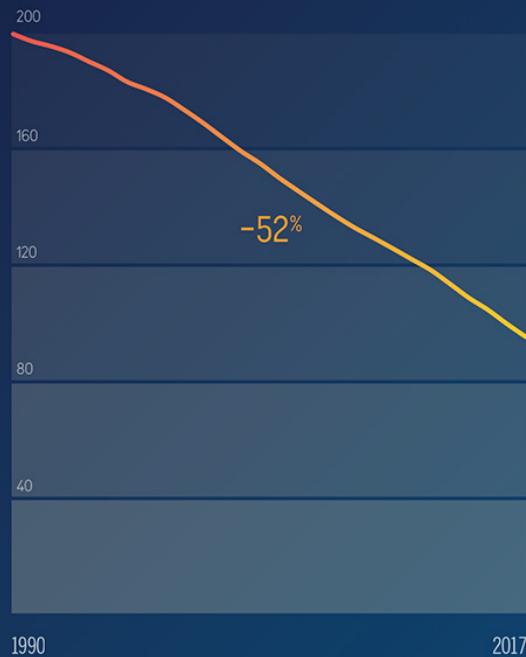
265,000  
per year



## Millions of Childrens' Lives Are Being Saved

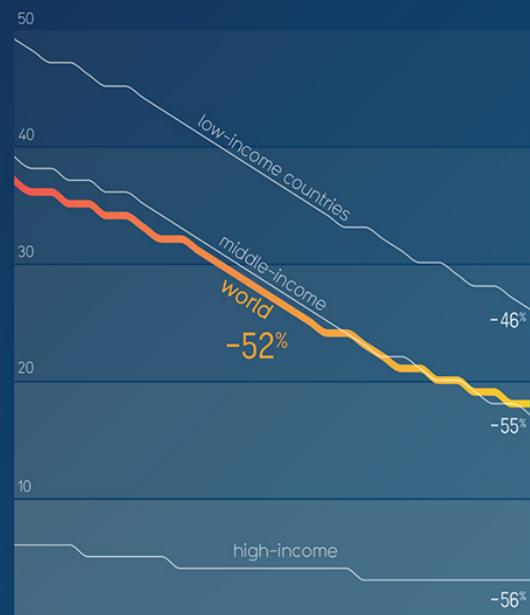
### Preterm Infant Deaths Are Down

Deaths per 100,000 babies



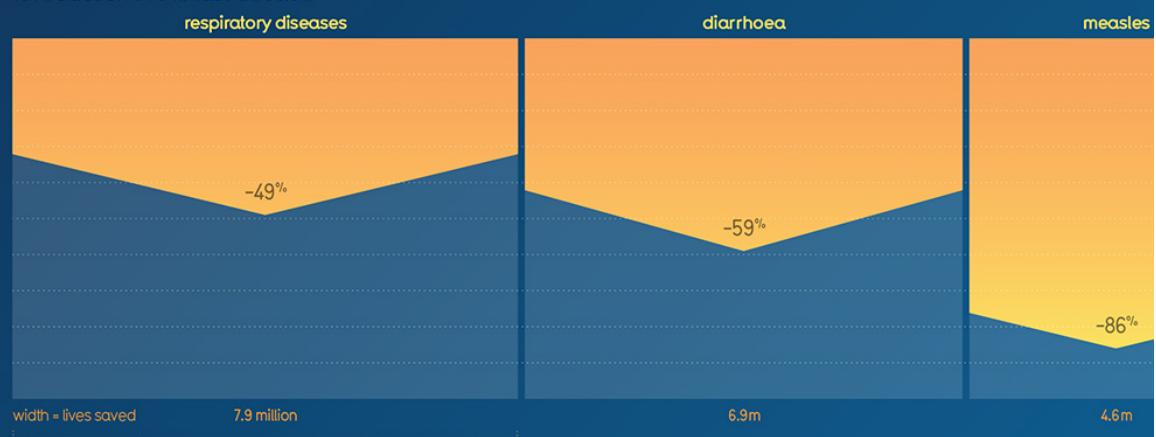
### Newborn Deaths Have Halved

Deaths per 1,000 live births

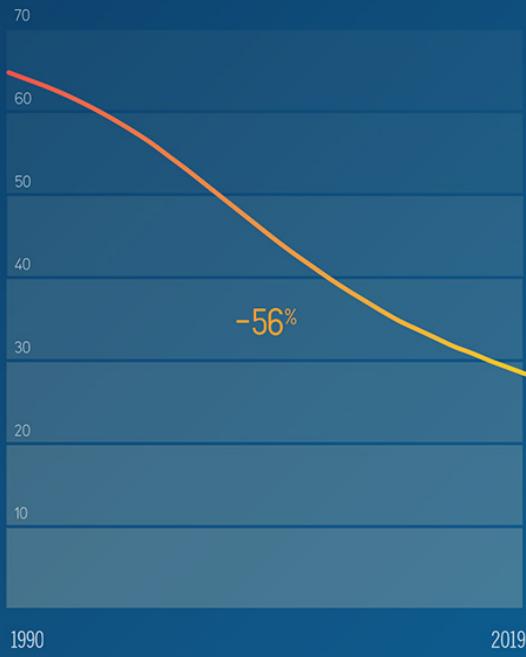


### Every Disease that Kills Children Is Declining

% reduction in the last decade

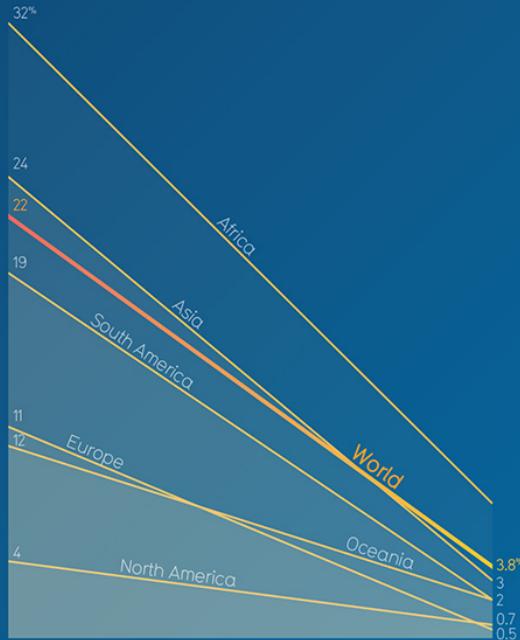


### Infant Deaths Have More than Halved Deaths per 1,000 births worldwide



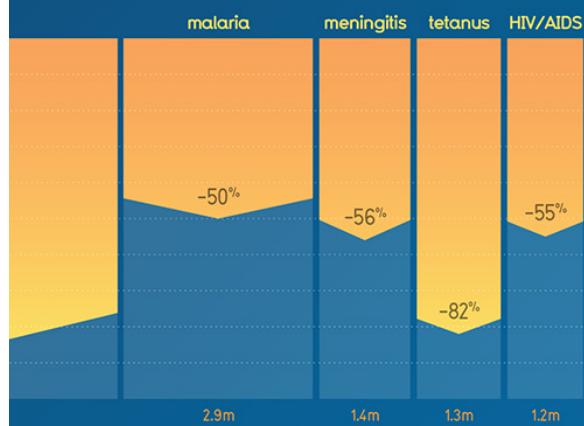
source: World Bank

### Kids Deaths Declined Worldwide % of children dying before five years old



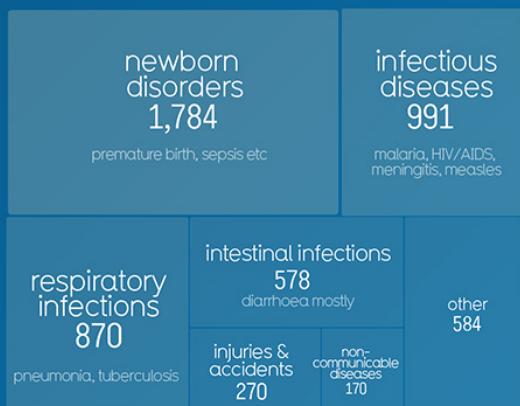
source: Our World in Data

### 26 million lives saved



source: World Health Organization

### What Children Die From Thousand deaths per year



source: Our World in Data

## How Have Child Death's Been Reduced?



better education of women



increasing spending



higher-quality healthcare



improving health knowledge

## Child Deaths & the Education of Mothers are Inter-Related

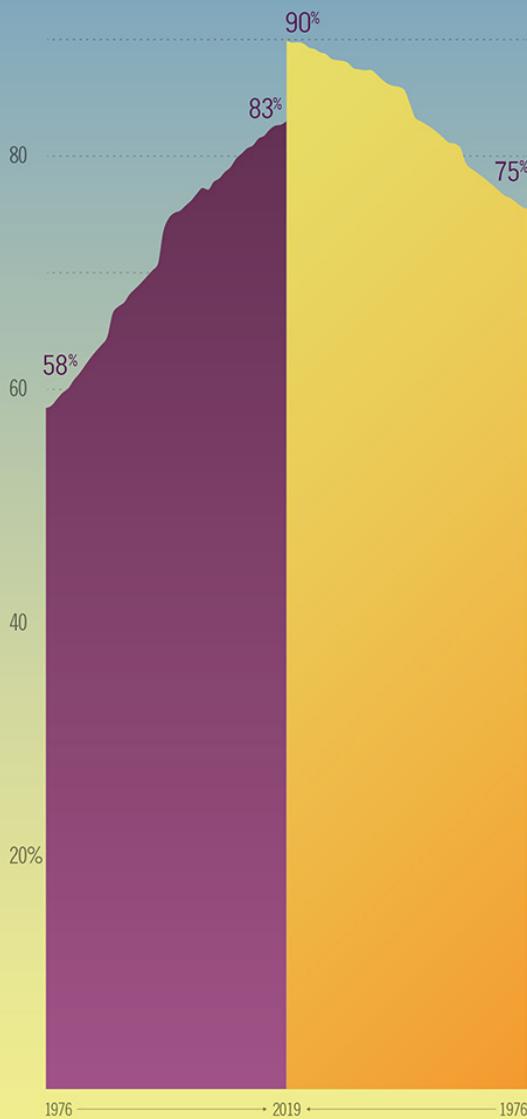




# More Girls Are in School

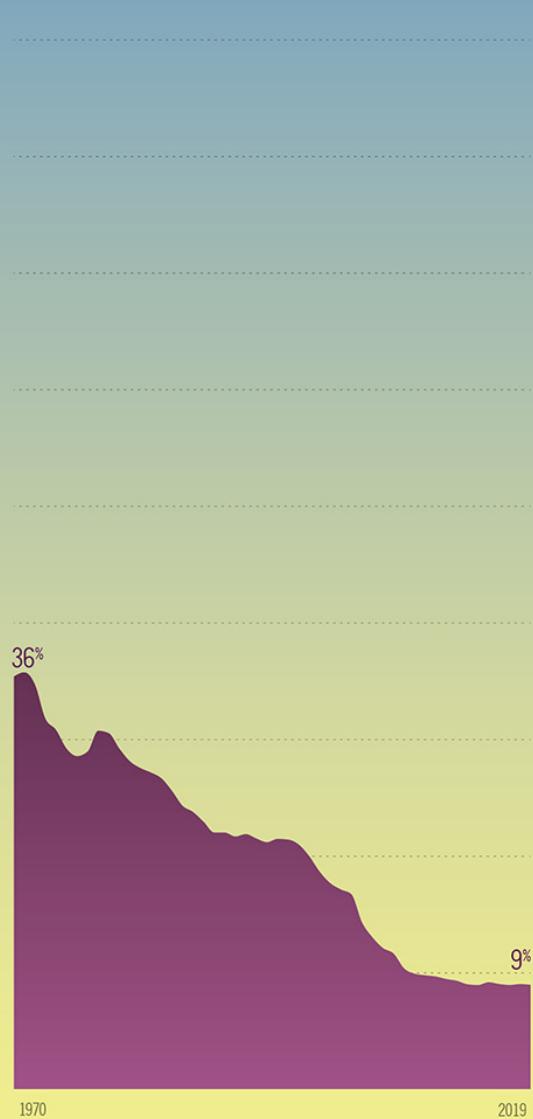
Female & Male Literacy Rates Have Almost Equalised Worldwide

100

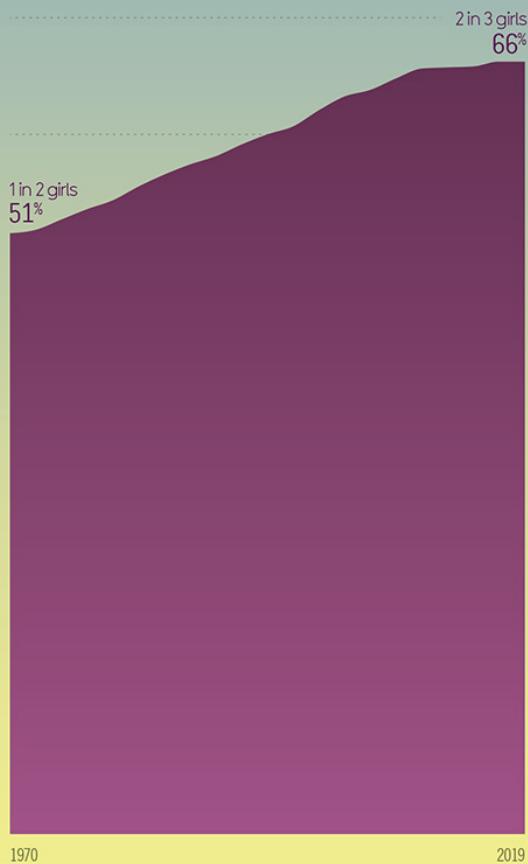


Girls Not in Primary School Have Fallen to an All-Time Low

100

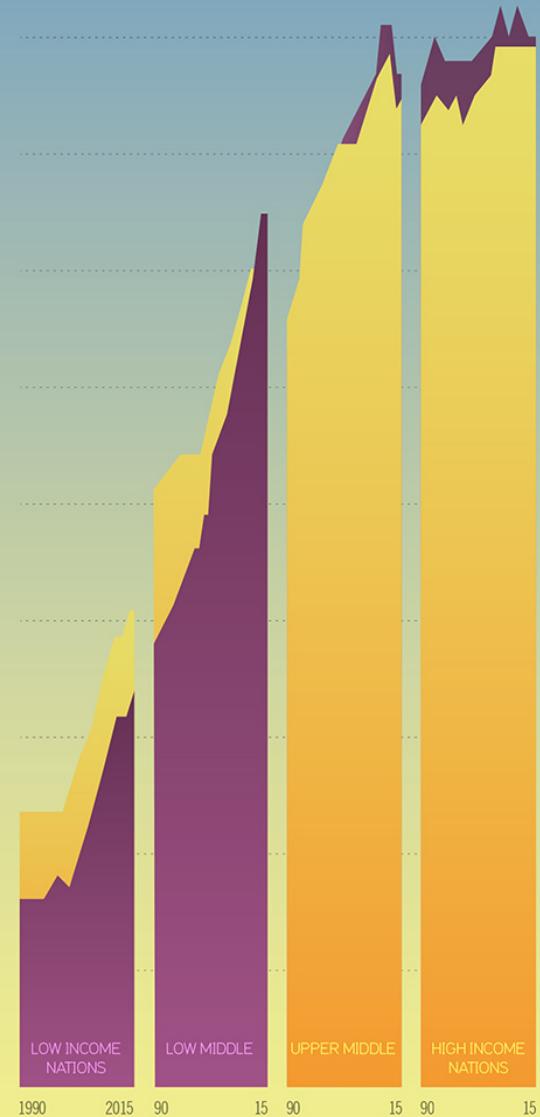


## Even More Girls Are Enrolling in Secondary School



## The Education Gender Gap between Girls & Boys Is Closing

% completing school

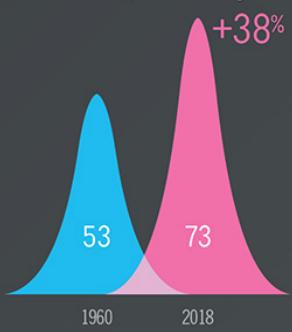


source: World Bank

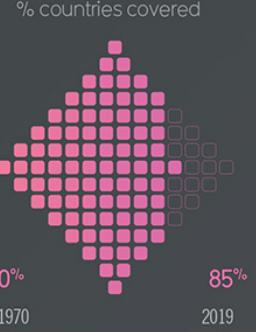
# Things Going Up! Up! Up!

improving substantially, globally

## Life Expectancy



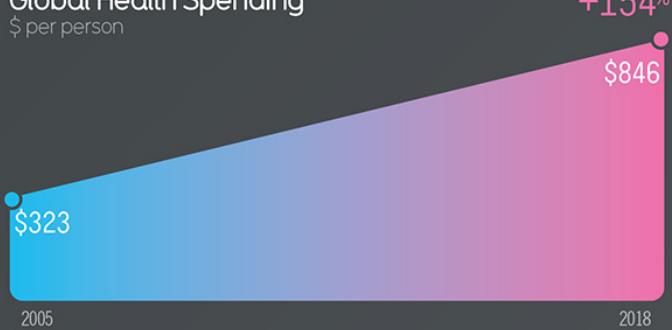
## Domestic Violence Laws



## Leaf Area



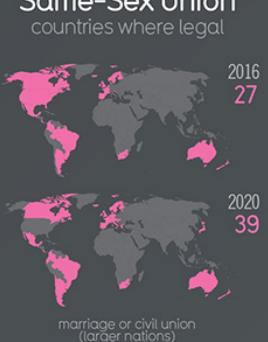
## Global Health Spending



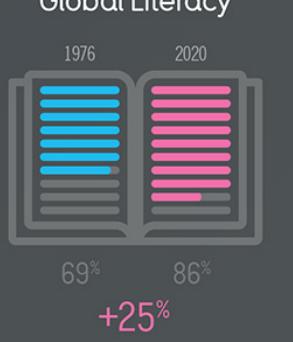
## Meat Substitutes



## Same-Sex Union



## Global Literacy



sources: NASA, Our World in Data, World Bank

# The Happiest Countries in the World?

But these ratings use a Western definition of 'happiness'

↑ Which centres more on 'vertical' feelings of individualism & 'independence'  
known as **independent happiness**

FACTORS



**freedom**  
autonomy to do what I want, when I want, how I want



**thrilling experiences**  
pleasure-seeking, novelty, intensity, variety



**positive emotions**  
intense high-arousal feelings like excitement, cheerfulness



**achievement**  
success, recognition, material gains, often linked to hard work



**individualism**  
\*my\* journey  
\*my\* story  
\*my\* life



**positivity**  
preferably full or overflowing with no negative feelings



**development**  
growth, self-improvement in a linear fashion with an individualised 'purpose'



**self-esteem**  
an ongoing internal feeling of personal value

Different cultures have differing definitions of 'happiness'

← For instance, Eastern happiness is more 'horizontal', →  
focusing on relationships & connections  
known as **interdependent happiness**

FACTORS



**social harmony**  
synchronising with others, not causing problems or stress for others



**relationships**  
meaning & purpose through nurtured social connections



**low arousal**  
stability, absence of major anxieties or concerns



**interpersonal goals**  
improving relationships, focus on making others happy



**collectivism**  
feeling of being part of a much larger whole



**ordinariness**  
similarity with others, just catching up with others



**equity**  
equality of accomplishment with one's peers



**'obedience'**  
being able to meet other's expectations of oneself

source: Hitokoto 2014, JICA Ogata Sadako Research Institute for Peace & Development

# The Happiest Countries in the World

in terms of 'interdependent happiness'

countries highly ranked on both scales

Lithuania France  
Germany Switzerland  
Slovakia Netherlands Pakistan  
Sweden Estonia Malaysia Palestine  
Vietnam Chile Nigeria Bulgaria  
Greece Turkey Serbia Thailand  
Canada Romania USA South Africa  
Jordan Italy Bolivia Peru UK Japan  
Uganda Slovenia China Norway Czechia  
Poland Israel Mexico Croatia Colombia  
Ukraine Taiwan India Senegal Kenya  
Hungary Denmark Brazil Russia Philippines  
Latvia Spain Indonesia S.Korea Georgia  
Austria Argentina Belgium Hong Kong  
New Zealand Australia Singapore  
N.Macedonia

note: not all nations have been rated for interdependent happiness, so may be missing

source: Cross-Cultural Happiness, Gardiner et al, 2020

## Global Flavours of Happiness & Contentment



**putuwa**

Warming one's hands by the fire  
while gently squeezing  
someone else's hands

GADIGAL  
(aboriginal)

ةرشع  
**eshra**

Connectedness and obligations  
arising from people having  
known each other a long time

ARABIC

정

**jeong/jung**

Deep affection, affinity,  
connectedness  
(not necessarily romantic)

KOREAN



**Gjensynsglede**

“goodbye happiness”  
the joy of meeting someone you  
haven't seen in a long time

NORWEGIAN



**gemas**

A feeling of love or affection, the  
urge to squeeze someone because  
they are so cute

INDONESIAN



**gadugi**

Cooperative labour,  
working together for the  
common good

CHEROKEE



**Freudentaumel**

“joy swash”  
being giddy or delirious with  
happiness

GERMAN



**Arbejdsglaede**

“work gladness”  
Pleasure and satisfaction derived  
from work

DANISH



# Transgender Rights Are Spreading

Legend:

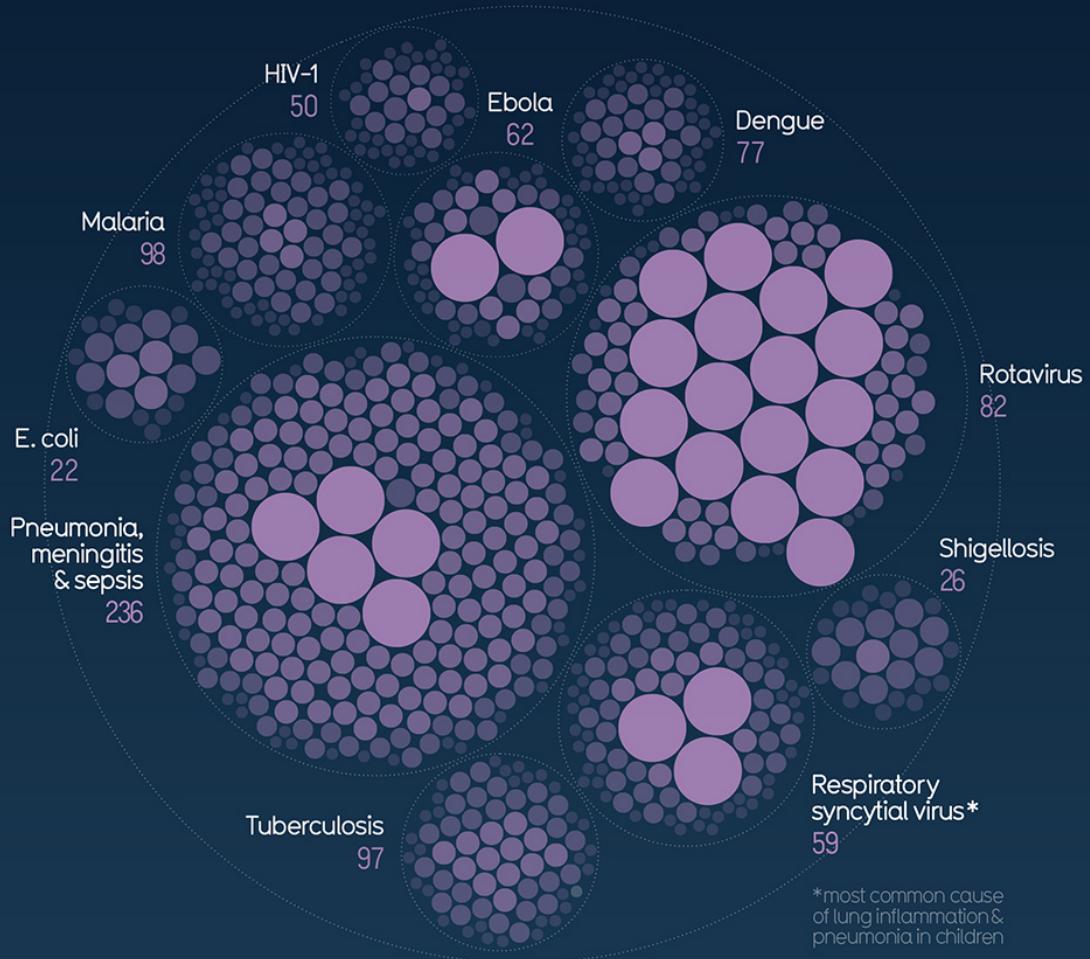
- Legal change of gender registration possible
- Hormones taken with medical supervision
- Gender reassignment surgery/treatment available
- Faded shapes mean some restrictions apply



Lithuania		Lithuania
Luxembourg		Luxembourg
Nepal		Nepal
Peru		Peru
Singapore		Singapore
Tajikistan		Tajikistan
Taiwan		Taiwan
United Kingdom		United Kingdom
USA		USA
Uzbekistan		Uzbekistan
Venezuela		Venezuela
Vietnam		Vietnam
Thailand		Thailand
Tanzania		Tanzania
Slovenia		Slovenia
Solomon Islands		Solomon Islands
South Africa		South Africa
South Korea		South Korea
Spain		Spain
Romania		Romania
Puerto Rico		Puerto Rico
New Zealand		New Zealand
Malta		Malta
Moldova		Moldova
Nicaragua		Nicaragua
Nigeria		Nigeria
N. Macedonia		N. Macedonia
Moldova		Moldova
Mongolia		Mongolia
Montenegro		Montenegro
Namibia		Namibia
Pakistan		Pakistan
Papua New Guinea		Papua New Guinea
San Marino		San Marino
Serbia		Serbia
Switzerland		Switzerland
Sweden		Sweden
Suriname		Suriname
Turkey		Turkey
Uganda		Uganda
Ukraine		Ukraine
Zambia		Zambia
Zimbabwe		Zimbabwe

source: transrespect.org

## Hundreds of New Vaccines Are in the Pipeline



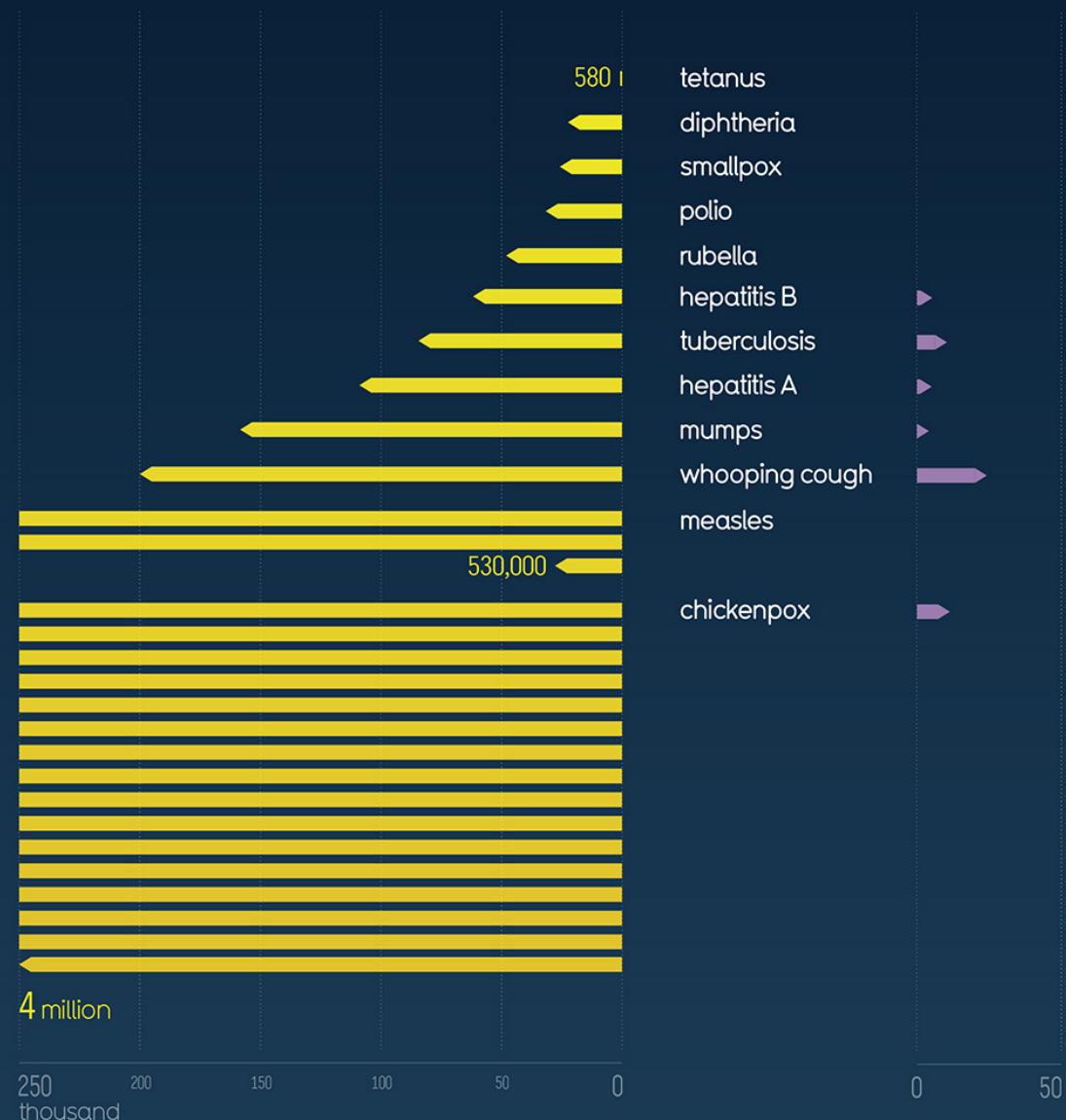
### VACCINE TRIAL PHASES average development time

#### stage



# Vaccines Work!

Thousand cases per year before and after vaccine introduction



sources: World Health Organization, EU Vaccine Initiative, Global Burden of Disease Collaborative Network, US Centers for Disease Control

# Lives Saved by Vaccines in the Last 25+ Years

Global deaths from vaccine-preventable diseases

3.6 million deaths

→ 1.6m

TUBERCULOSIS

MEASLES

MENINGITIS\*

TETANUS

WHOOPING COUGH

HEPATITIS B

DIPHTHERIA, H INFLUENZAE, YELLOW FEVER

1990

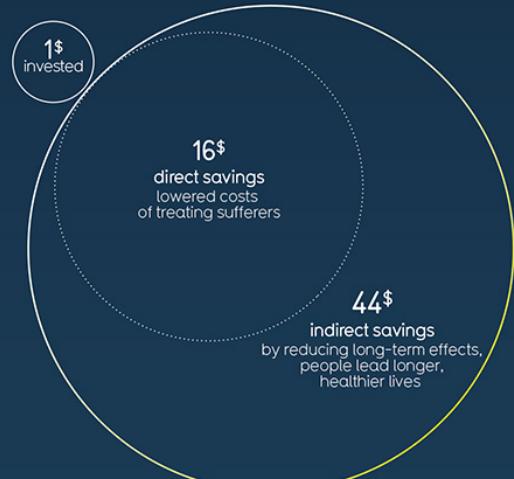
\* Menningicoccal

→ 2016

two  
million  
lives  
saved

## They Are a Great Economic Investment

For every dollar invested in lower-income countries



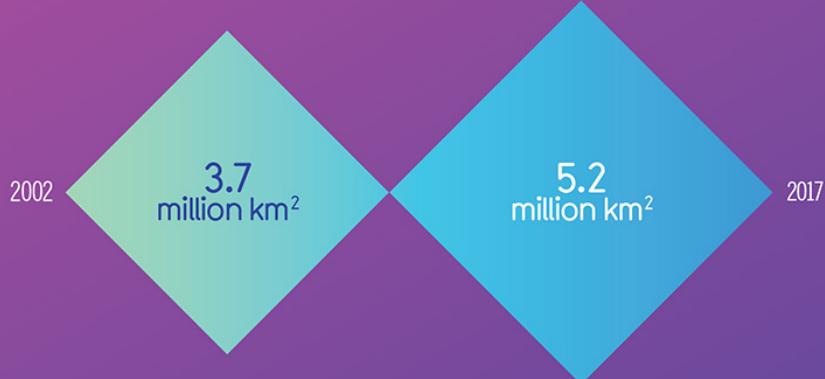
## COVID Vaccines Save Millions of Lives

Estimated 75%-80% reduced death rate worldwide



# Indigenous Communities Safeguard the Forests of the World

Forest owned by native peoples has risen 40%



Good thing, because forests like these are storing  
1,080 billion tonnes of CO<sub>2</sub>

Humanity's yearly CO<sub>2</sub> emissions: 32bn...

Deforestation emissions are much lower on these lands, meaning forests are now safer

Bolivia



Brazil



Colombia



Ecuador



sources: RightsandResources.org, ForestLivelihoods.org

# Creative Ways to Deal with Our Emissions

## Iceland Is Injecting Carbon Emissions Deep Underground

Forming minerals that last millions of years

CONCENTRATED CO<sub>2</sub>  
from geothermal power plant

FRESH WATER

BASALT ROCK  
most common stone in  
the world, full of metals

CARBONATED WATER

STORED 700M UNDERGROUND  
CO<sub>2</sub> forms into minerals  
over two years

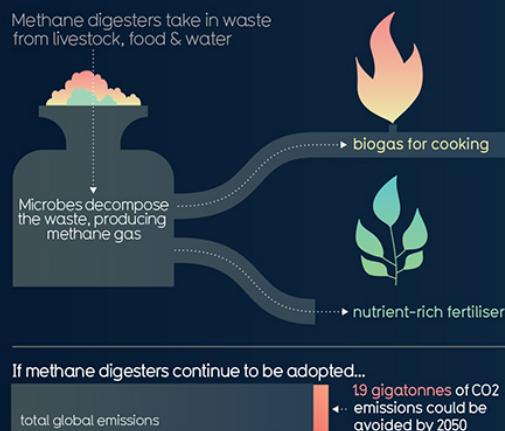
COST per tonne CO<sub>2</sub>

\$30

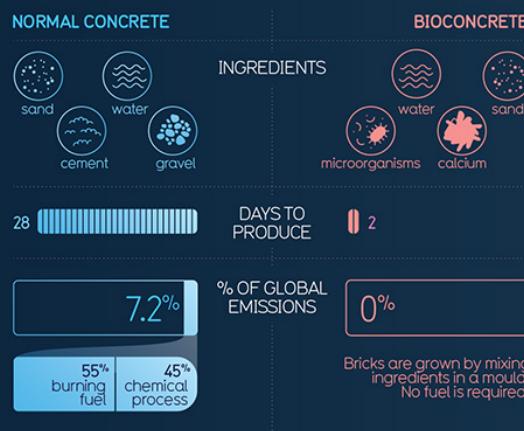
\$60-\$100  
normal air capture

sources: BBC, RTE

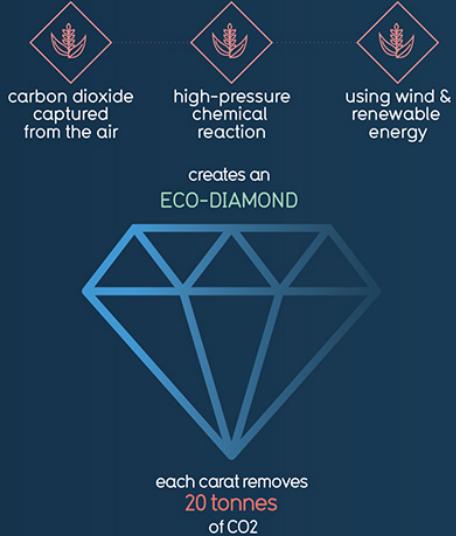
## Home Methane Digesters Can Replace Inefficient Cookstoves



## Coral-Like Bioconcrete Generates Zero Emissions



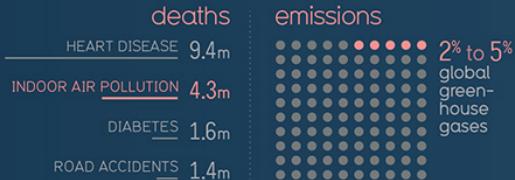
## 'Bling without Sting' Storing CO<sub>2</sub> as Diamonds



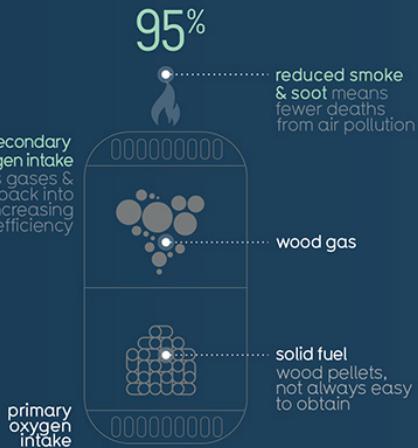
## New Cookstoves Are Safer, Last Longer & Reduce Emissions



smoke from these fuels has negative effects



1.5 million households already use a new improved stove that cuts emissions by



## The 'Whale Pump' Could Be the Ultimate Natural Carbon Sink

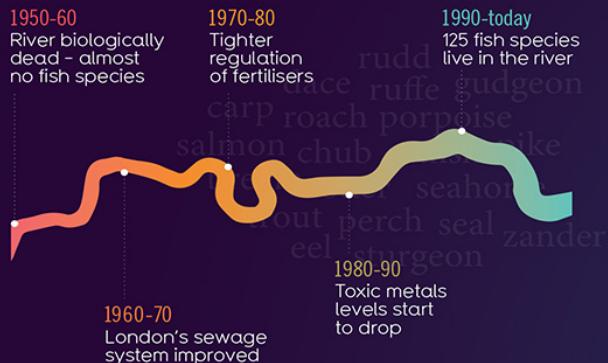


sources: Scientific American, International Monetary Fund

sources: Project Drawdown, Scientific American, energypedia.info

# Yay UK!

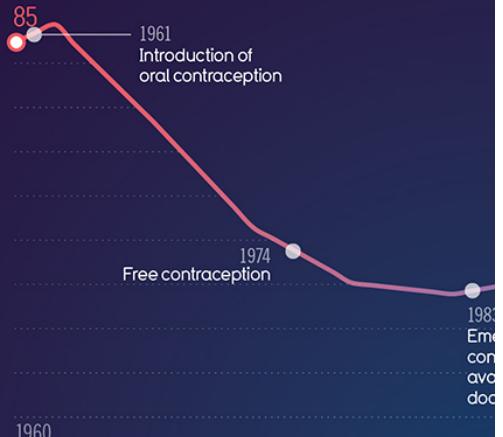
## Biodiversity Is Flourishing in the Thames



sources: BBC, Zoological Society of London, Port of London Authority

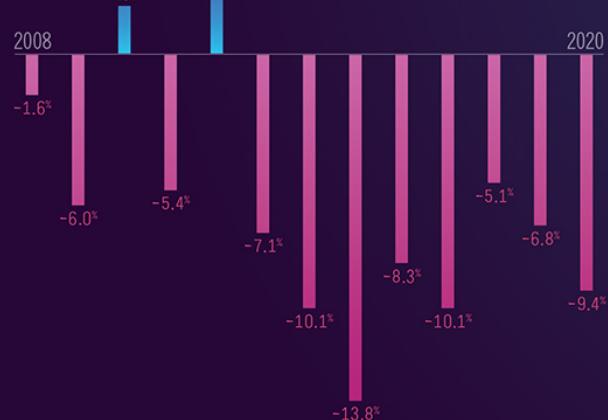
## UK Teen Pregnancies Hit a Record Low

Births per 1,000 women aged 15-19



## UK's Carbon Emissions Are Falling Fast

Thanks to cleaner electricity and declining energy use

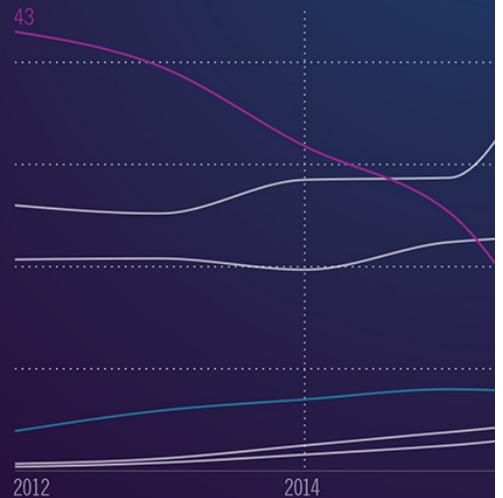


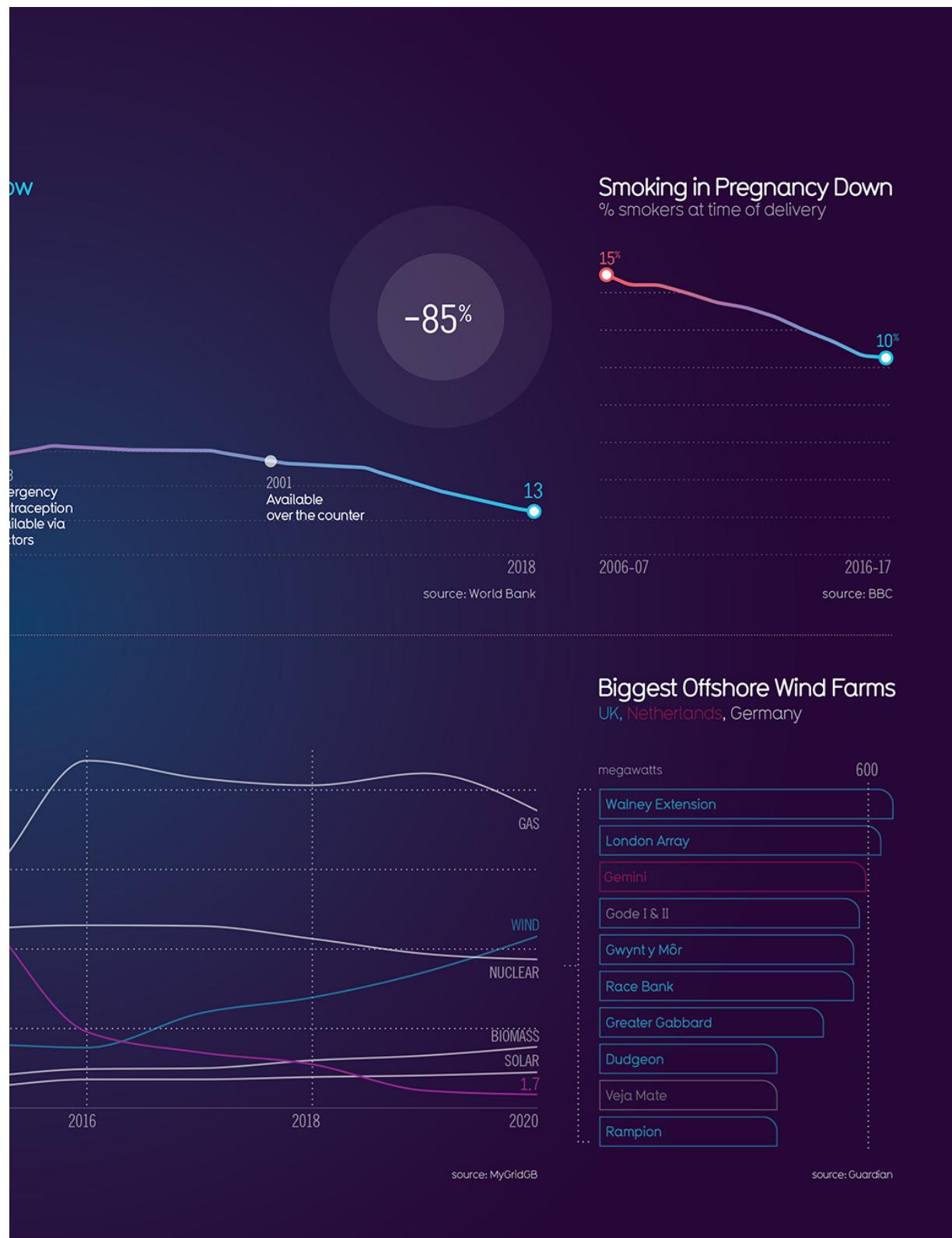
source: mygridGB

62 | 63

## Coal Use Is Being Cut, Fast

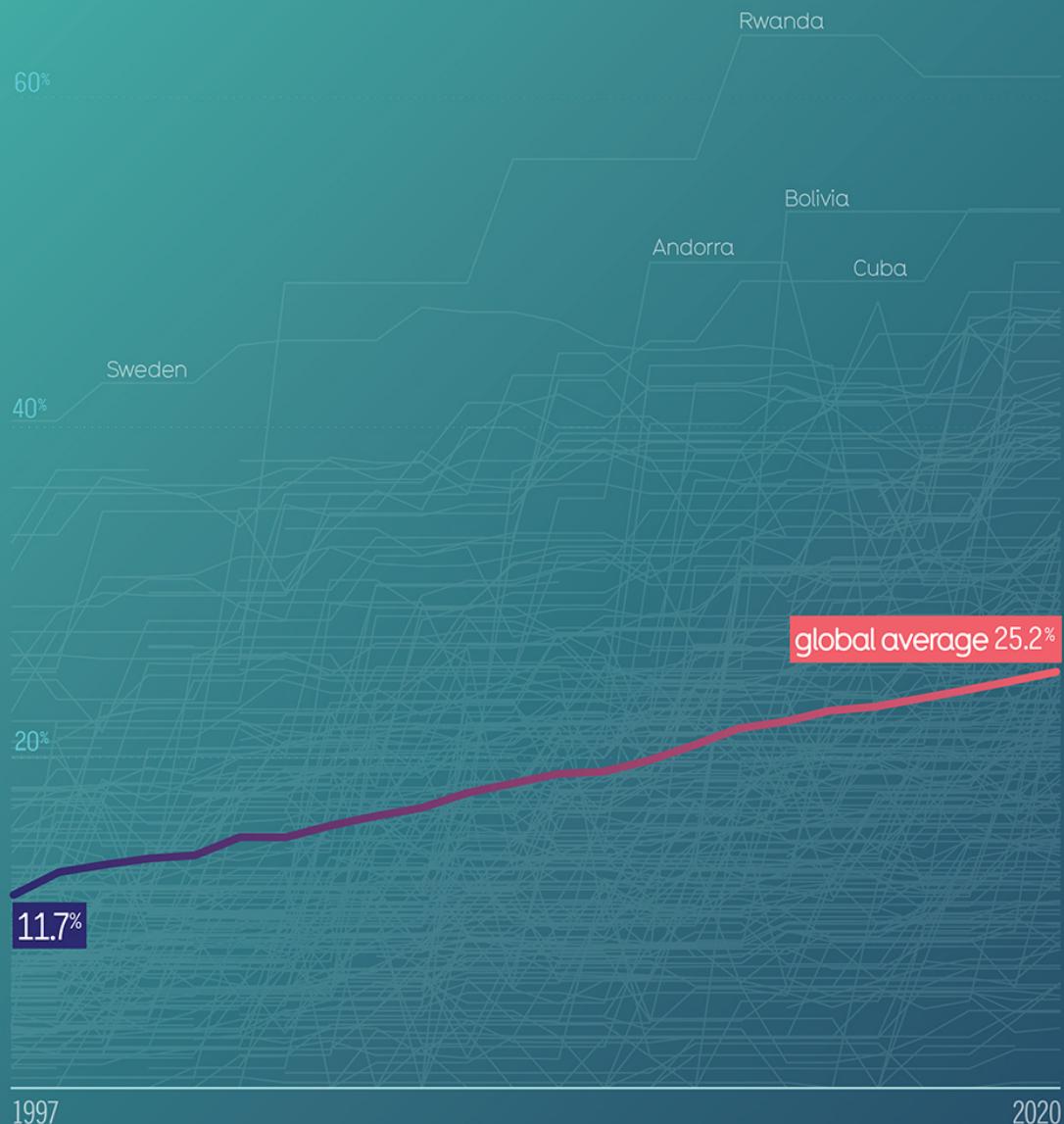
% of energy mix





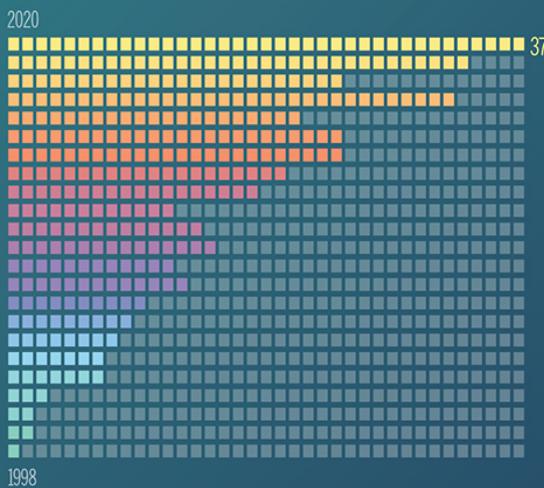
# Women

More Women Are in Parliament Around the World



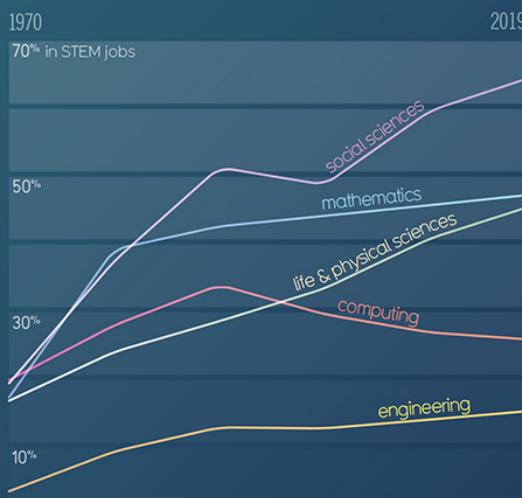
source: World Bank

## There Have Never Been More Female CEOs In the Fortune 500



source: Fortune

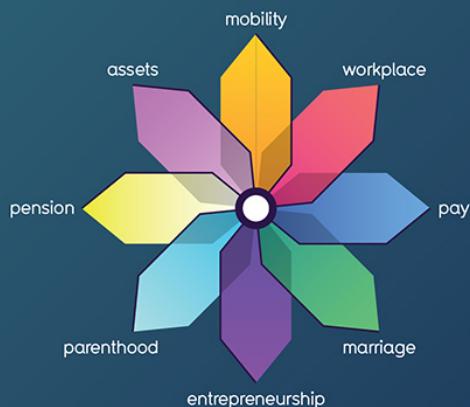
## More US Women Are Moving into Science, Tech, Engineering & Math



source: United States Census Bureau

## Women's Economic Freedom Is Protected Almost Everywhere

**Women, Business & the Law Index**  
assigns a score based on laws that affect women's economic opportunities across 8 key areas



## Overall Freedom Score by Country



source: World Bank

## Can Next-Gen Nuclear Energy Get Us to Carbon Zero?

PROS	CONS	RESPONSES
 <b>zero carbon</b> global-scale electricity with no greenhouse gas emissions	 <b>radioactive waste</b> average plant creates 27 tonnes yearly, active for 24,000 years	 <b>waste storage is possible</b> nations like Sweden have safe, established storage of plutonium
 <b>consistent energy</b> backup when intermittent power like wind can't deliver	 <b>hugely expensive</b> More than \$10bn to build. Can't compete with renewables on \$\$\$	
 <b>established industry</b> already generates ~10% of the world's electricity	 <b>old, aging tech</b> many reactors are 30-40 years old & beset with reliability issues	
 <b>small footprint</b> very little land required vs vast space for solar & wind	 <b>big fear</b> the public is afraid of nuclear - accidents, waste, weapons...	 <b>some fear is irrational</b> nuclear is much safer than coal (kills 500K a year from pollution)
 <b>quickest route</b> slash CO <sub>2</sub> , decarbonise in years not centuries	 <b>reactors slow to build</b> takes 6-10 years - we'd need 100s now to replace fossil fuels	
 <b>need it now</b> difficult to imagine net carbon zero by 2050 without it	 <b>regulatory holdups</b> approving, insuring and testing new plants is a massive block	

## Current State of Nuclear Energy Around the World



UK France  
South Korea  
**China**<sup>UAE</sup>  
Finland Russia  
India Turkey  
Argentina

436  
reactors

31  
countries

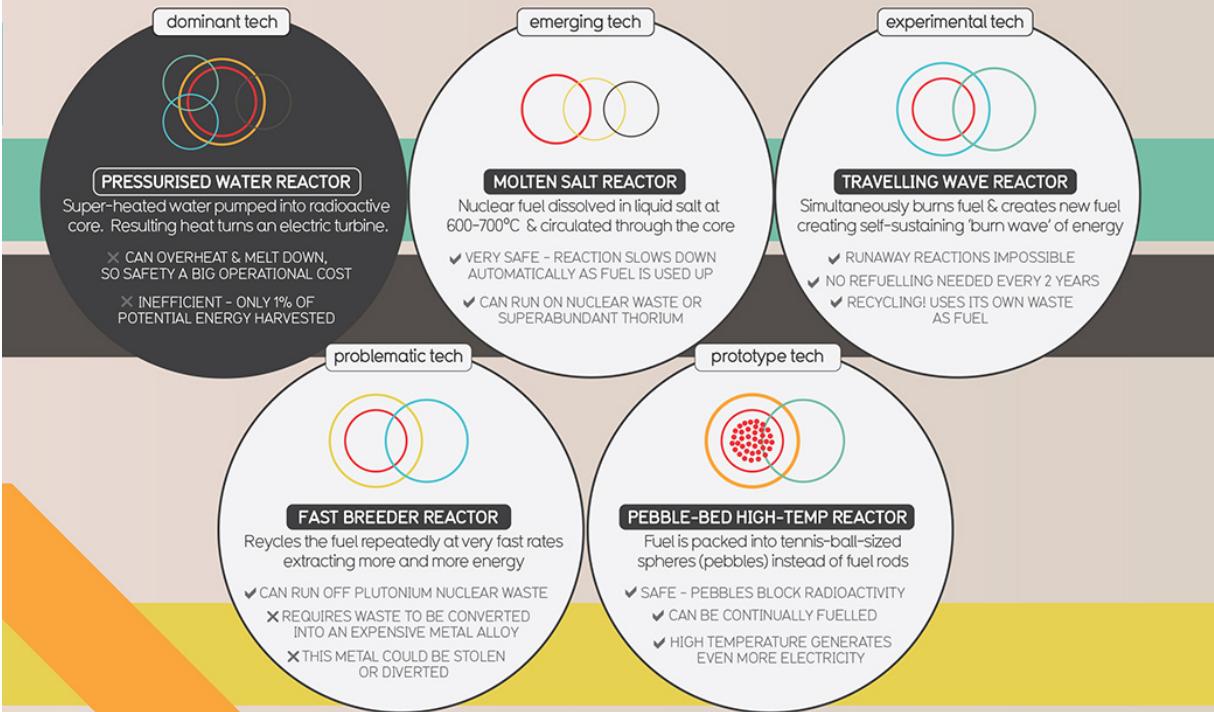
50  
more being built

**TOSHIBA** Spain  
**Germany**  
**Japan**  
**Italy** Belgium  
Westinghouse **EDF**  
Switzerland

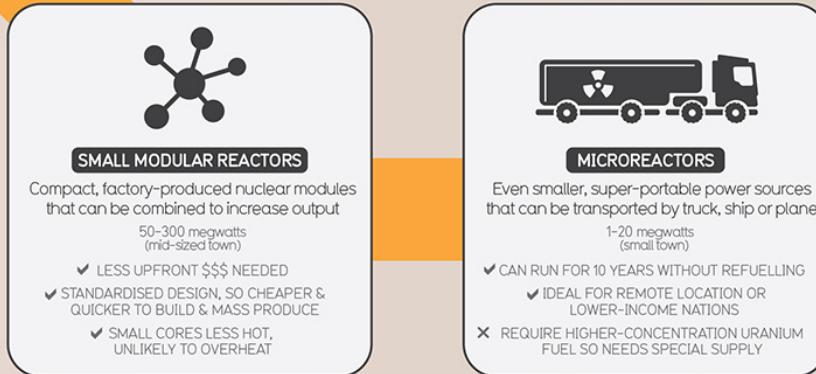
several  
countries & companies phasing out

# Next-Gen Nuclear

## ADVANCED REACTOR TYPES



## SIZE VARIATIONS



Canada China Russia UK USA  
all building SMRs

sources: Yale School of Environment, New York Times, Asia Times, IIS Office of Nuclear Energy.

# Nuclear Fusion Could Supply Clean, Limitless Power

The Holy Grail of energy - if only we can make it happen

## HOW IT WORKS



existing nuclear reactors  
create energy by splitting  
atoms apart (**fission**)



fusion smashes atoms  
together to reproduce  
the energy of the stars



creating a 'miniature sun'  
that generates more  
energy than it consumes



the hydrogen in a  
glass of water is  
enough energy for  
one person's lifetime



**zero emissions**, no  
carbon, no green-  
house gases, no  
global heating



much less **radioactive  
waste** vs traditional  
fission reactors  
(100s of years vs 1,000s)

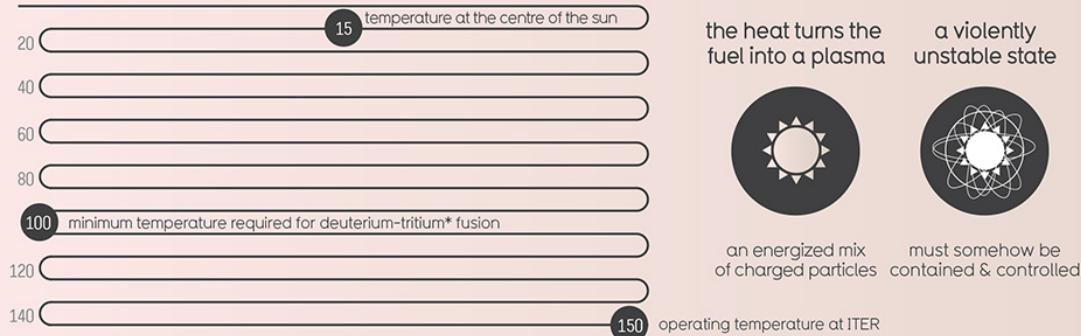


**very safe** - there's no  
chance of melt down;  
plasma just cools if  
disrupted

## IT'S NOT EASY

the fuel must be heated up to unbelievably high temperatures

MILLION DEGREES CENTIGRADE



## WHEN IS IT COMING?



new ultra-powerful  
superconducting  
magnets

CREATE VASTLY STRONGER  
CONTAINMENT FIELDS



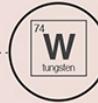
innovative liquid  
nitrogen cooling  
processes

MUCH CHEAPER THAN  
CURRENT LIQUID HELIUM



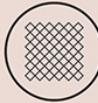
years is  
finally a credible  
ETA

AFTER 50 YEARS  
OF FALSE STARTS



novel materials  
able to withstand  
the plasma

REDUCED-ACTIVATION  
STEEL & TUNGSTEN



next-gen fusion  
techniques  
already emerging

STELLARATORS &  
LATTICE-CONFINEMENT

# International Thermonuclear Experimental Reactor

ITER is the world's largest fusion megaproject



## LEADING CONTENDER

23,000  
TONNES OF  
BUILDING  
MATERIALS

\$26  
BILLION  
BUDGET

60  
SOCCER  
FIELDS

200  
KM OF  
CABLING

30  
YEARS  
PLANNING

7  
YEARS TO  
BUILD

5  
MORE TO  
ASSEMBLE

2025  
ACTIVATION  
DATE

3,000  
TONNES OF  
SUPER-CONDUCTING  
MAGNETS  
AT -269°C  
(near absolute zero)

2030  
GENERATING  
ENERGY

huge, helium-cooled  
super-magnets  
contain the plasma

plasma swirls around  
a doughnut-shaped reactor  
(a "tokamak")

magnet confinement  
stops the plasma from  
touching anything

particles accelerate,  
collide & fuse,  
releasing energy

EXTRAORDINARY  
COLLABORATION  
BETWEEN  
35  
NATIONS  
including  
European Union  
China  
India  
Japan  
Russia  
S. Korea  
USA

## CREDIBLE ALTERNATIVE

Field Reverse Configuration (FRC) using hydrogen-boron as a fuel



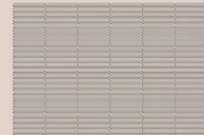
hydrogen-boron  
produces 3-4x  
more energy



with virtually  
zero waste



but requires  
extraordinary  
temperatures



5.4 BILLION  
DEGREES!  
but actually feasible



in FRC, the hotter  
the plasma,  
the more stable

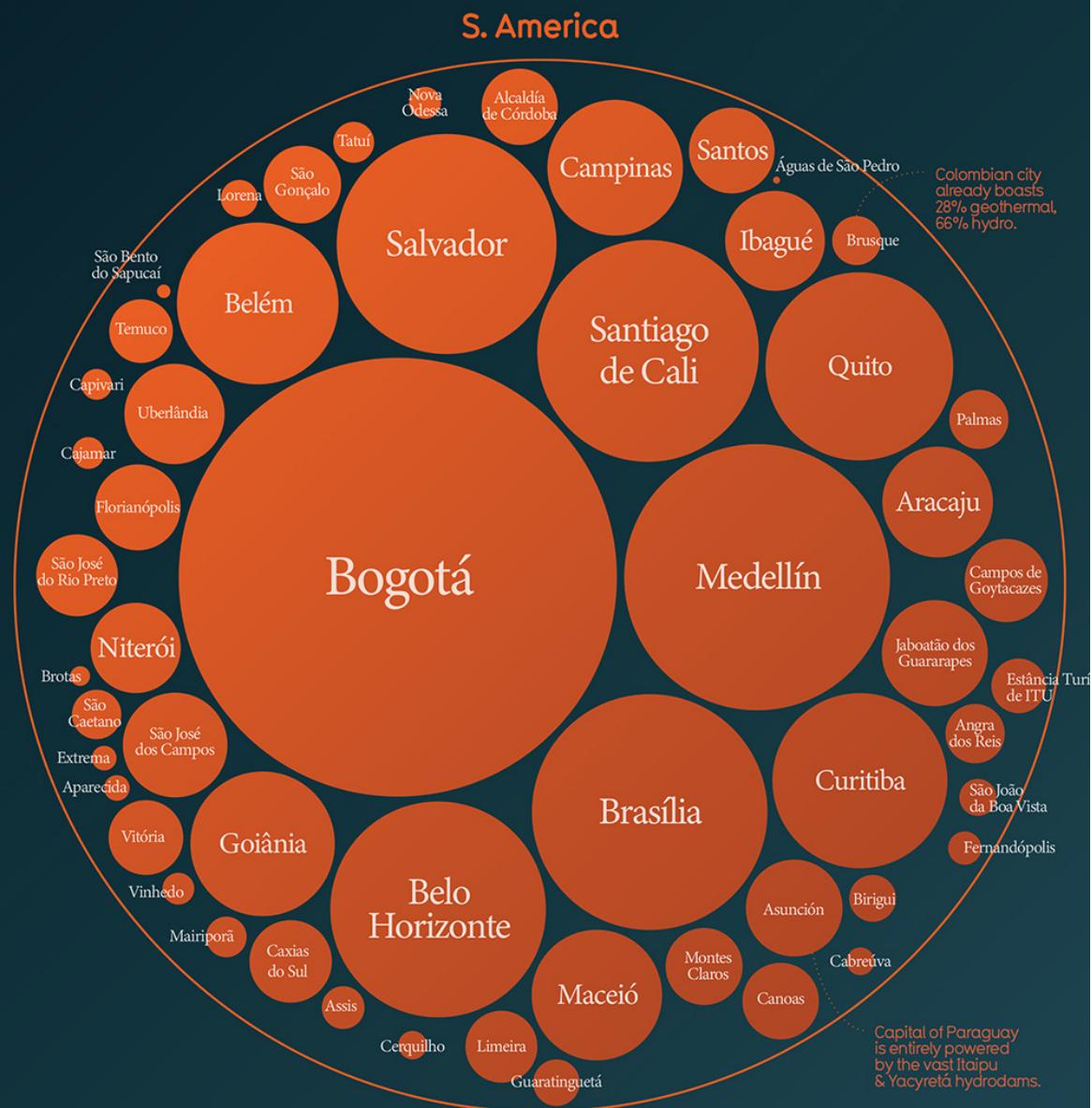


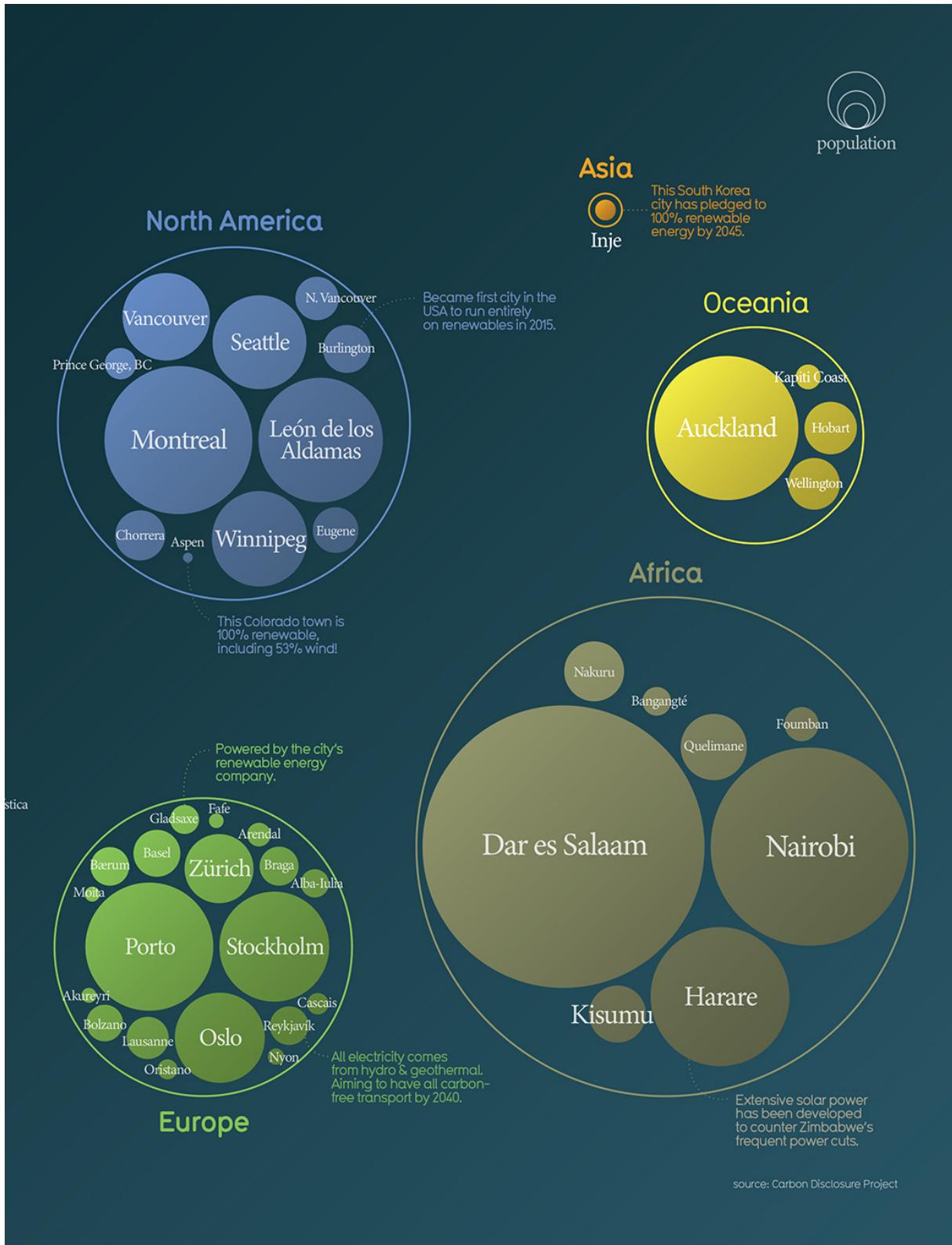
complete  
opposite of a  
tokamak

sources: World Economic Forum, EcoWatch, New York Times, BBC, Wikipedia, Bill Gates "How to Avoid A Climate Disaster"

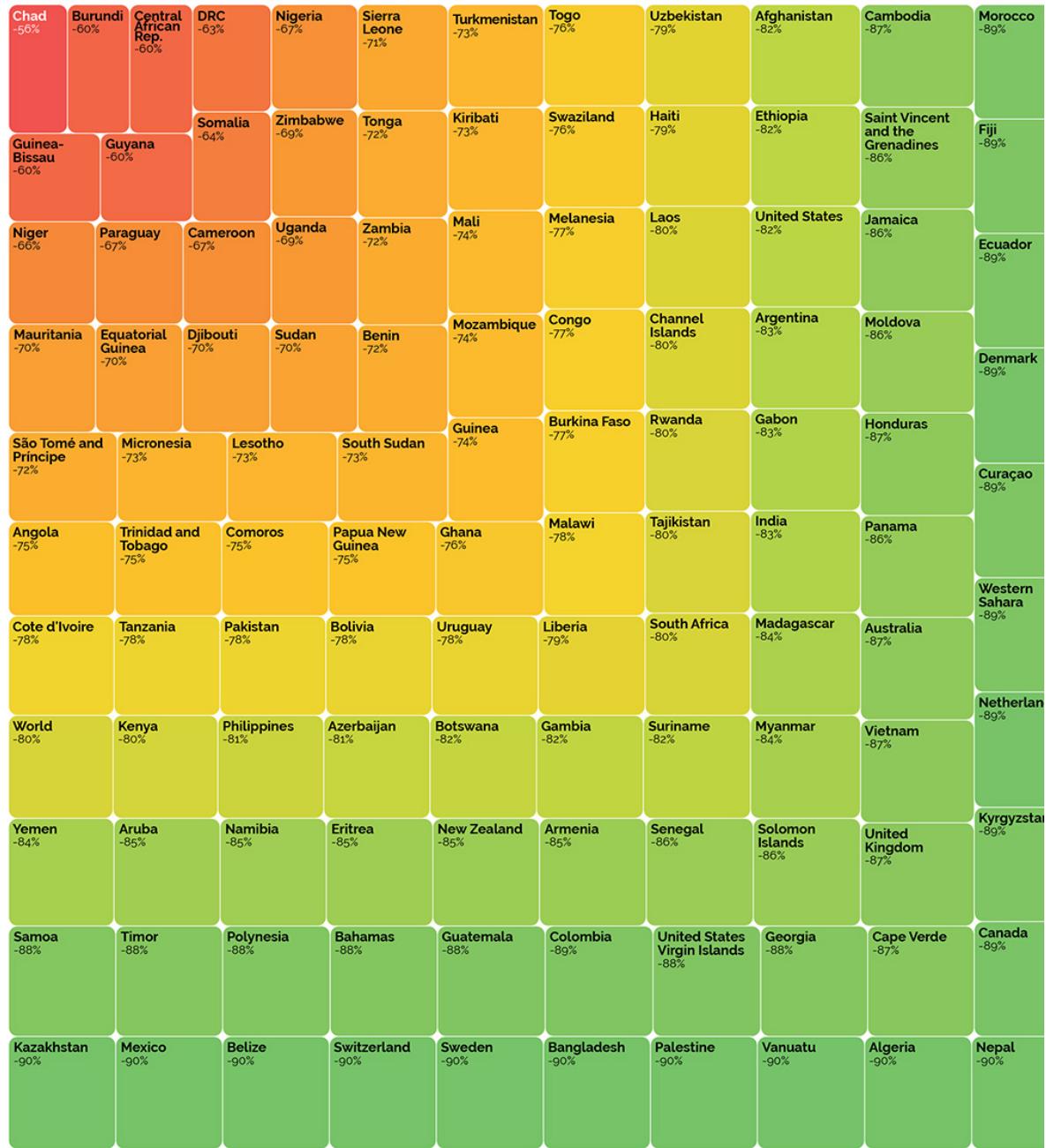
# At Least 100 Towns & Cities Now Get Most of Their Energy from Renewables

Reporting more than 70% green energy

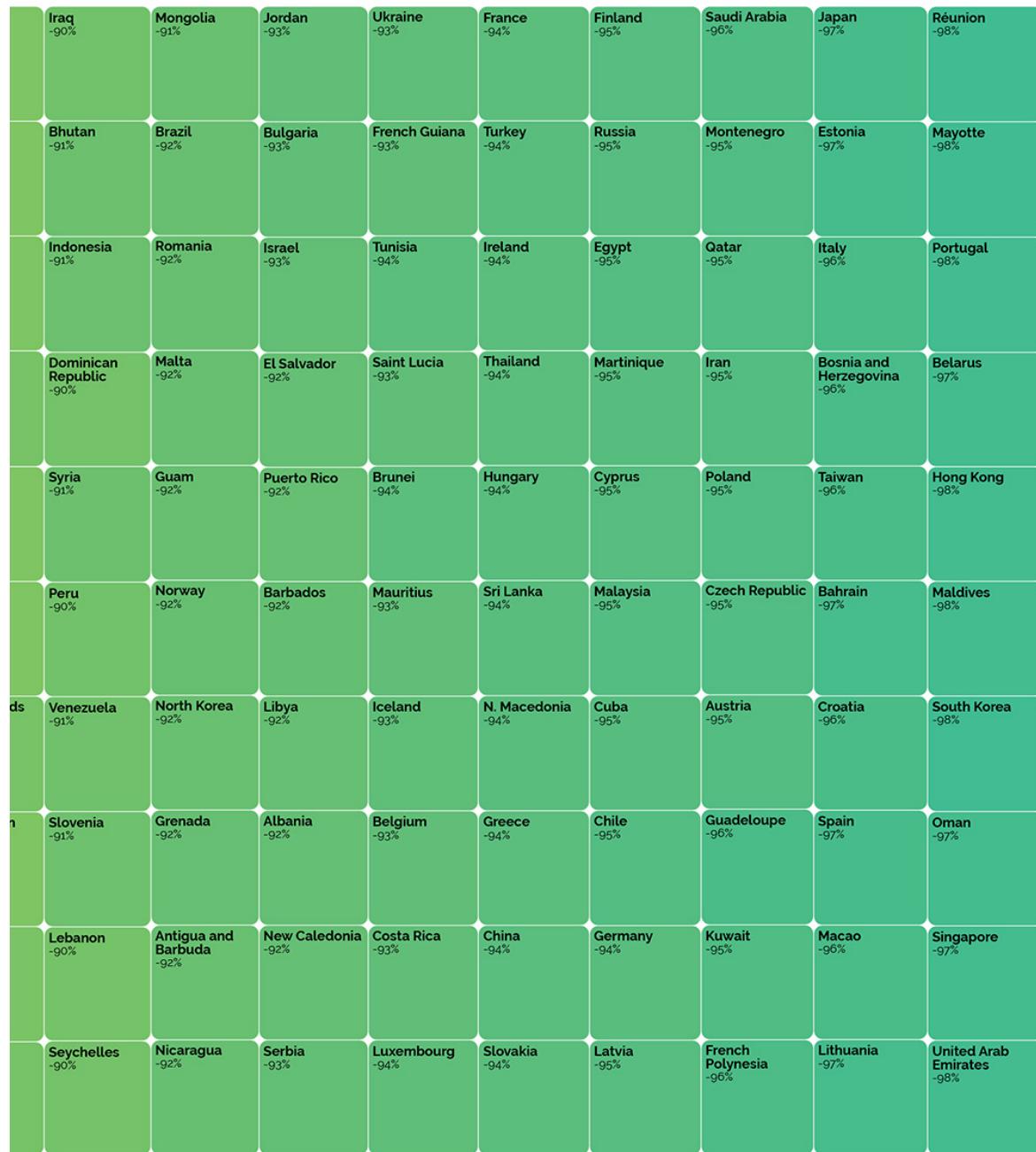




# Every single country in the world has seen di



# rops in infant and child mortality since 1950

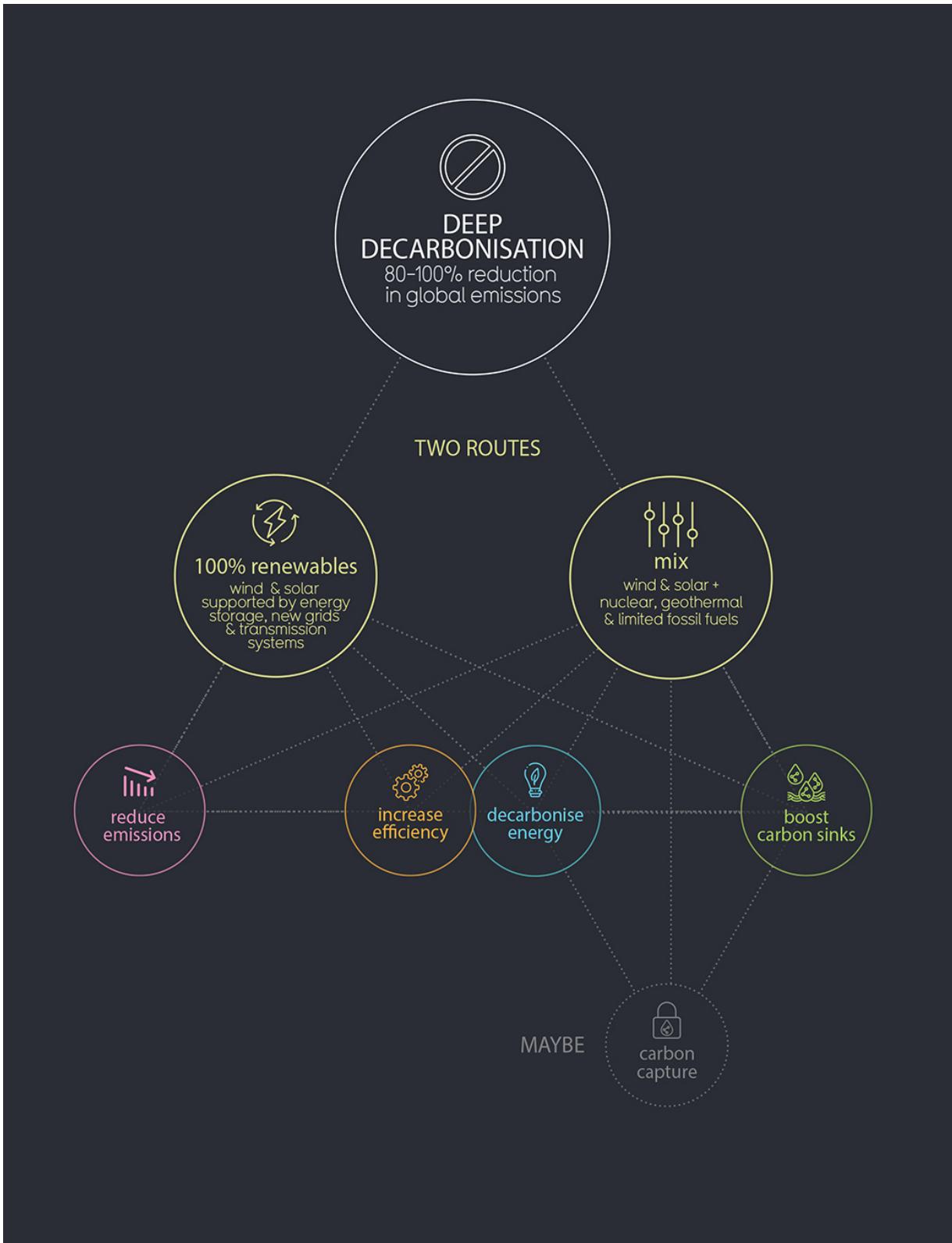


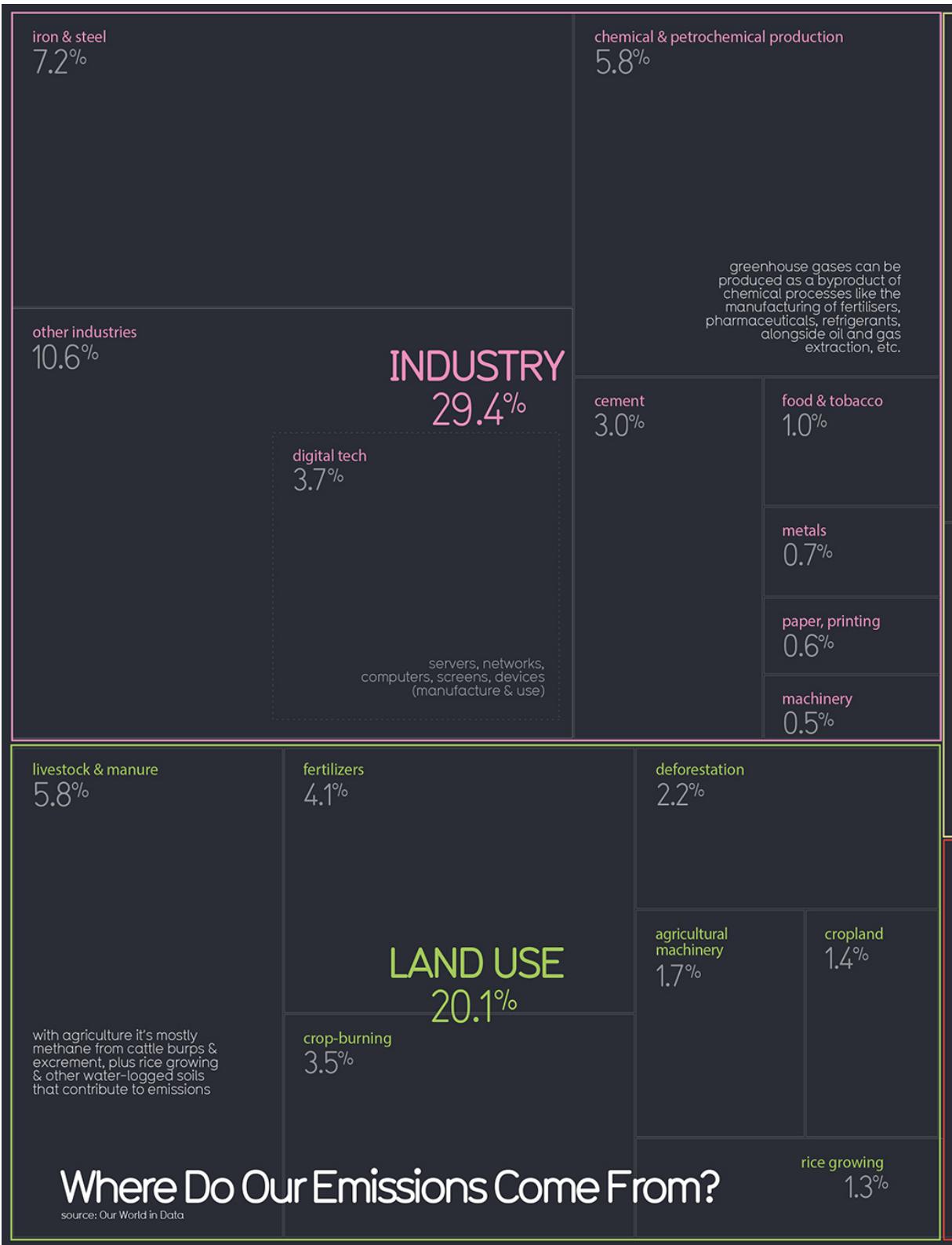
source: Our World in Data

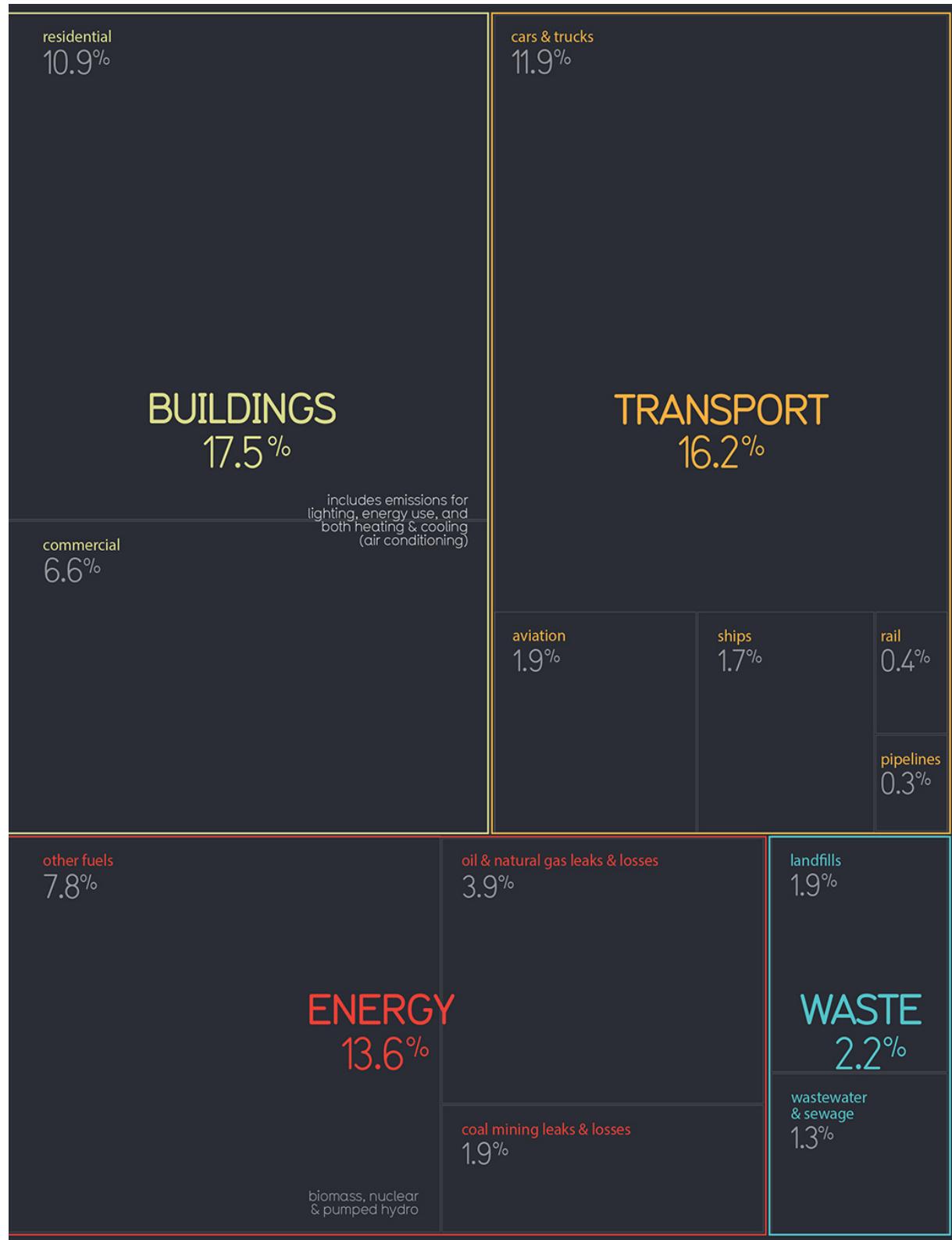
# How to get the world to **NET** **CARBON** **ZERO \*** by 2050

\*net carbon zero

Doesn't necessarily mean zero emissions. There will still be some emissions—though massively reduced. But CO<sub>2</sub> capture, offsetting and other methods will mean the overall emissions in the global or national system will be zero.





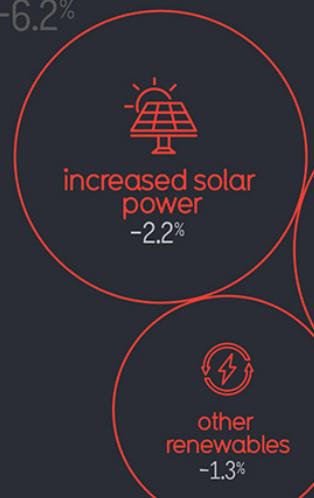


# How to Halve Emissions by 2030

## ENERGY

DECARBONISE ELECTRICITY

-6.2%



## LAND USE

SUPPORT CARBON SINKS

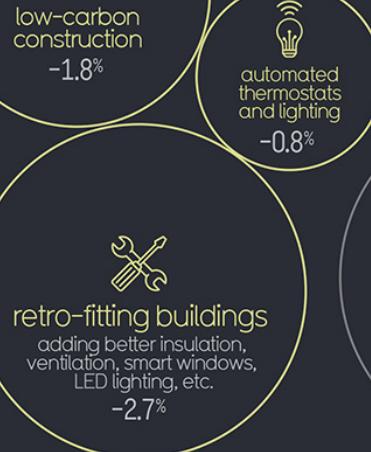
-6.5%



## BUILDINGS

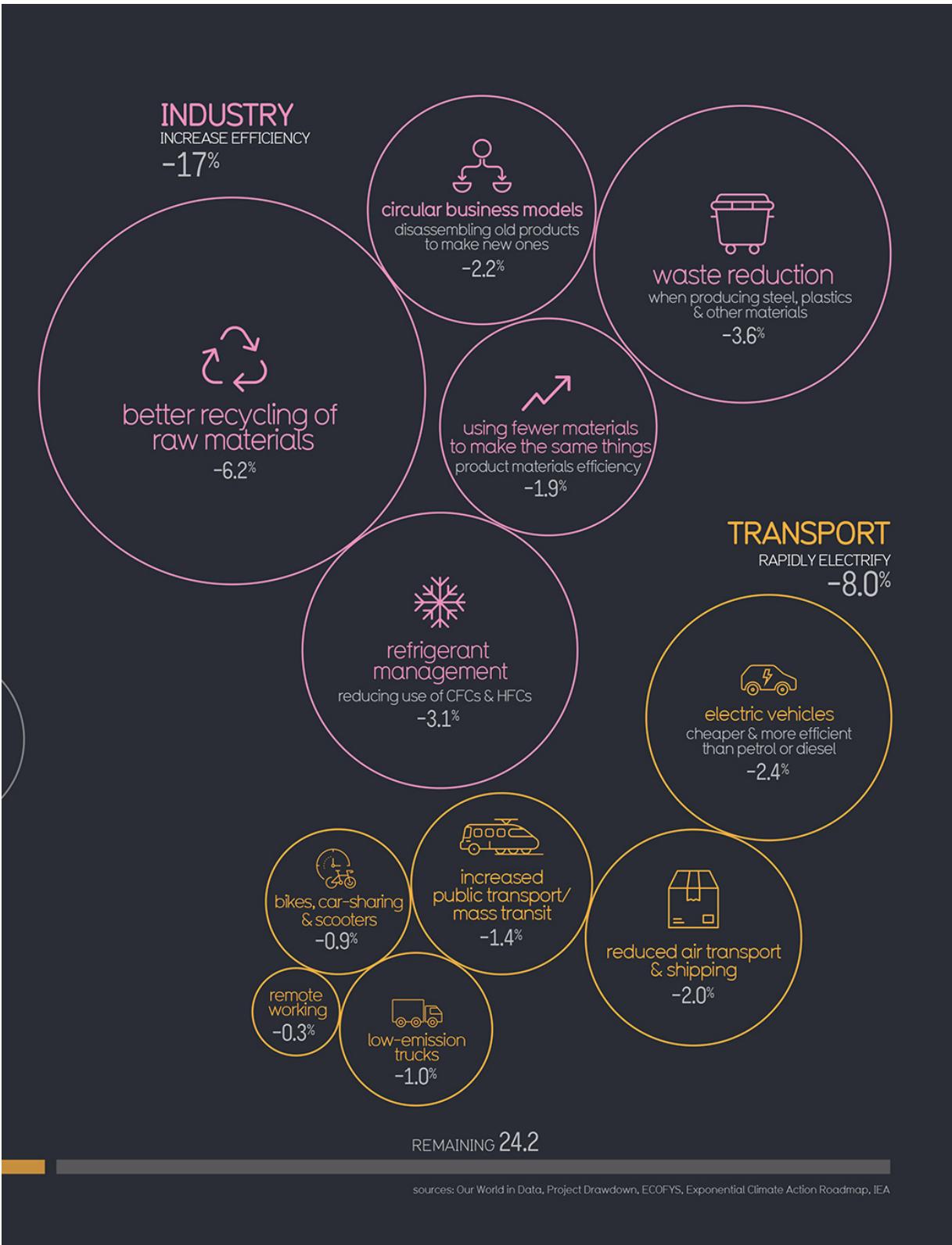
ELECTRIFY HEATING

-9.6%



EMISSIONS REDUCED 27.6 gigatonnes of CO<sub>2</sub>e

CO<sub>2</sub>e = carbon dioxide equivalent = a way of combining all greenhouse gas emissions in one measure



# Carbon Zero by 2050 Project Plan

## ENERGY

**renewables!**  
rapid upscale of renewable carbon-free electricity  
(solar, wind, wave, geothermal)

►174

**install advanced smart- & micro-grids**  
so we can use the variable power of renewables

**develop grid-scale electrical storage**  
big-ass batteries, basically

**improve efficiency**  
so much energy is lost through inefficiency

**extend electricity transmission networks**  
especially high voltage both above- and underground

**expand clean 'firm' power**  
nuclear, hydro, geothermal

**increase biofuel & hydrogen use**  
adding carbon capture

**retire fossil-fuel power plants early**

**burn waste & convert it to power, capturing emissions**  
waste-to-energy

**reduce individual consumption in richer nations**

## TRANSPORT

**electric vehicles dominate the roads**  
+ widespread charging grids



**phase out fossil-fuel vehicles**

**reduce vehicle use, adding diverse alternatives**  
public transport, scooters, bikes, car & taxi pooling, walkable cities, high-speed rail, pooled ride-hailing

**taxes on inefficient fuel & vehicles**

**higher fuel economy & emissions standards**

**more efficient aviation**

**switch to advanced biofuels**  
to power 'electrification-resistant' trucks, ships, and airplanes



## BUILDINGS

**electrification**  
**heating, stoves & furnaces**

**zero-carbon buildings go mainstream**

**aggressive electrical appliance standards**  
to increase efficiency & lighten demand on the grid

**establish & police higher energy-efficiency standards**

**supply carbon-neutral fuels for older buildings**  
that cannot be retro-fitted

**increase air-conditioning efficiency**  
could reduce overall building energy demand by 45% global

## LAND USE

**methane (natural gas) capture and destruction**  
landfill-captured methane used to produce electricity

►228

**reforestation**  
even more tree planting and land restoration

►126

**enhance sustainable land sinks in agriculture**  
sinks absorb CO<sub>2</sub> naturally

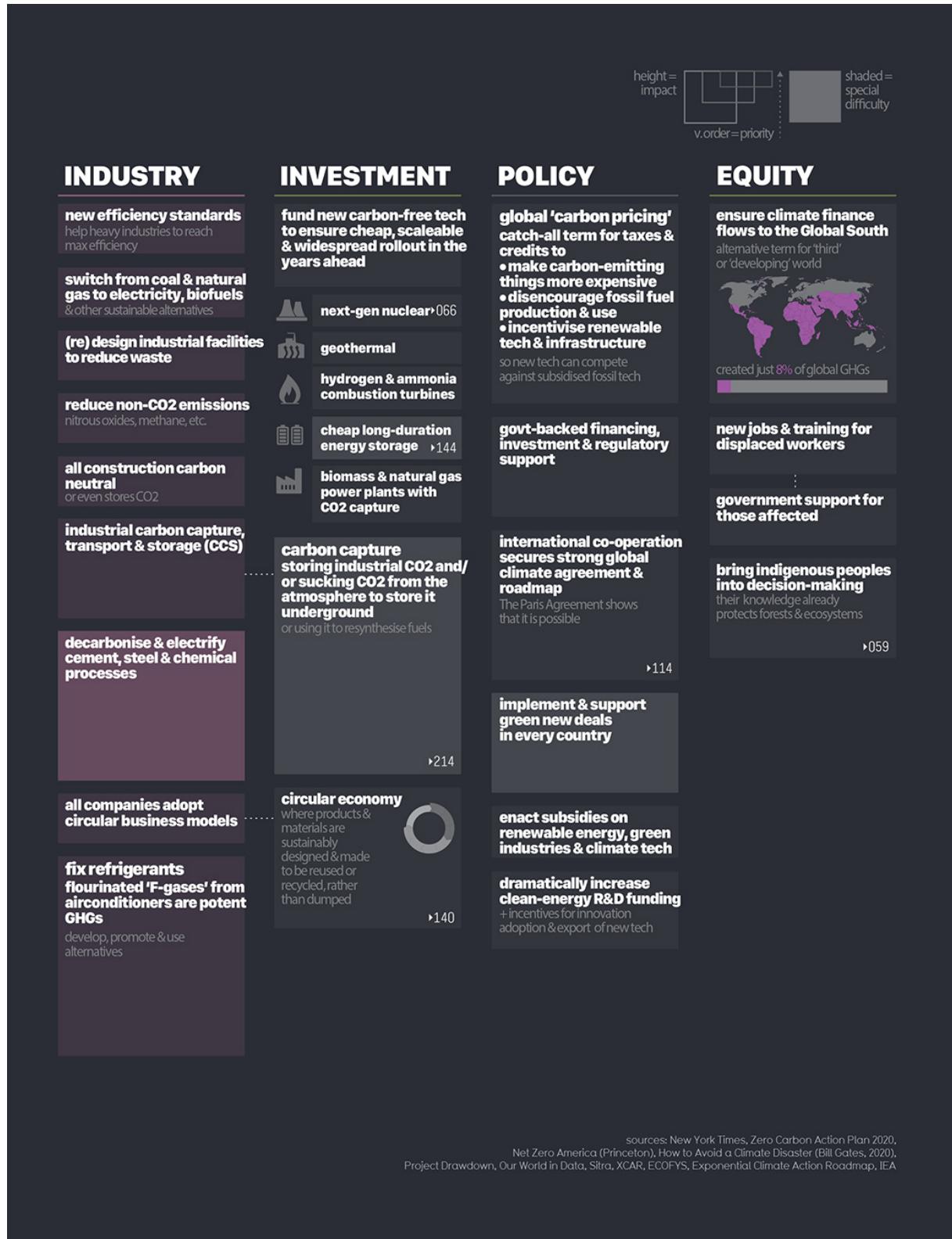
**improve rice production**  
flooded rice paddies produce large quantities of methane

**agriculture sector globally on track to store more carbon than it emits**  
agroforestry & precision agriculture widely adopted

**enhance land protection**  
increases natural carbon storehouses in soils



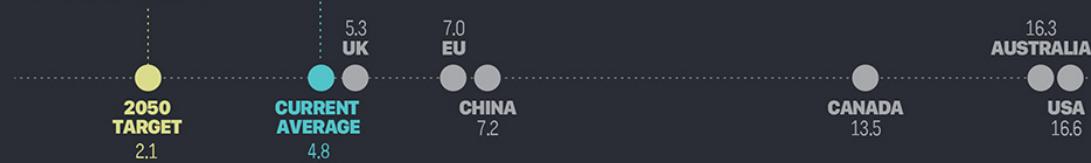
**plant-rich diets**  
widespread adoption of low-carbon diets



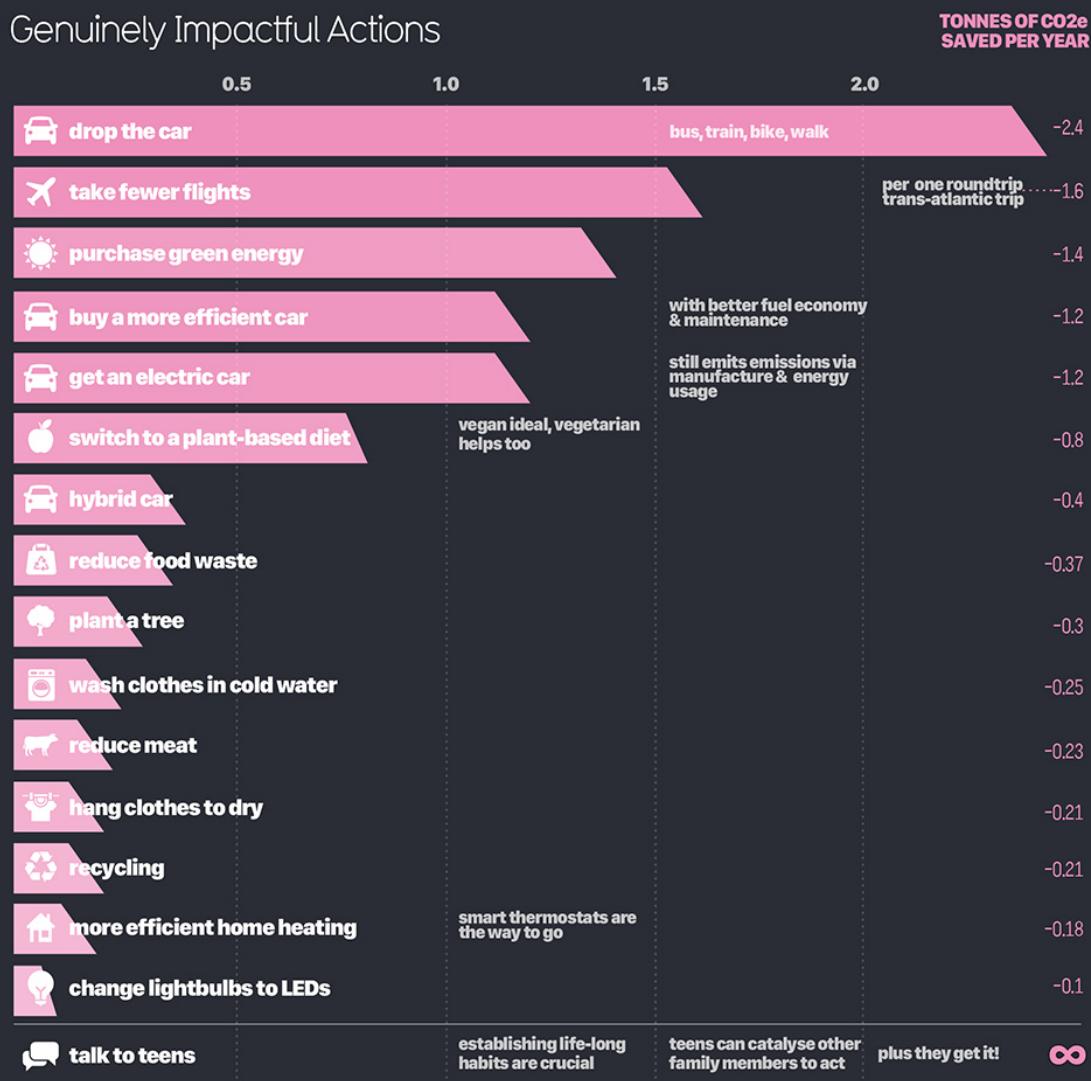
sources: New York Times, Zero Carbon Action Plan 2020, Net Zero America (Princeton), How to Avoid a Climate Disaster (Bill Gates, 2020), Project Drawdown, Our World in Data, Sitra, XCAR, ECOFYS, Exponential Climate Action Roadmap, IEA

## What can we do personally?

We need to get average yearly global emissions per person down to 2.1 tonnes CO<sub>2</sub>e



### Genuinely Impactful Actions



source: 'The climate mitigation gap' (Wynes and Nicholas), Environmental Research Letters 2017

CASE STUDY

# Getting the USA to Carbon Zero by 2050



## affordable

less than 1% of GDP required  
per year to transition



## feasible

the technology already exists  
- and is getting better



## starting now

needs to happen now to lay  
groundwork & infrastructure



## working together

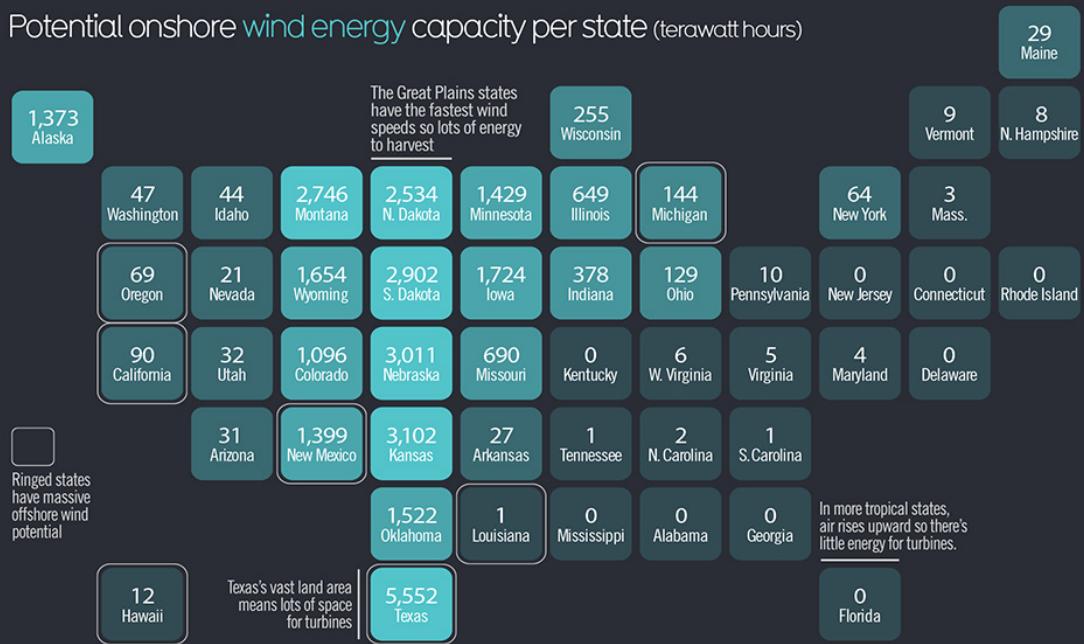
everyone participating - individuals,  
corporations, government, institutions

# The USA Is Ripe for Solar & Wind Power

Potential utility-scale solar energy capacity per state  
(terawatt hours)



Potential onshore wind energy capacity per state (terawatt hours)



source: US Renewable Energy Technical Potentials, Lopez et al. (2012)

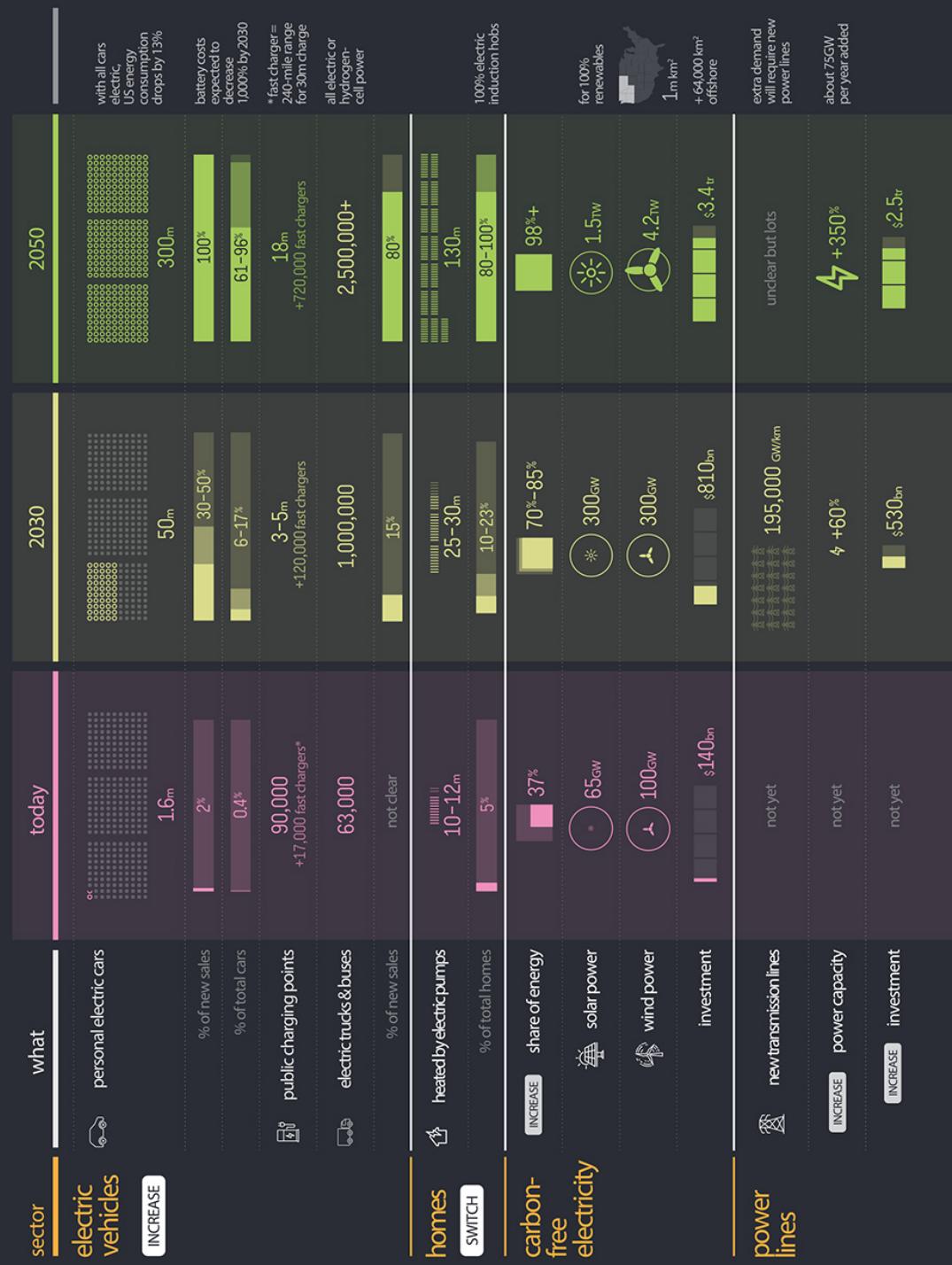
Total Potential Solar Energy

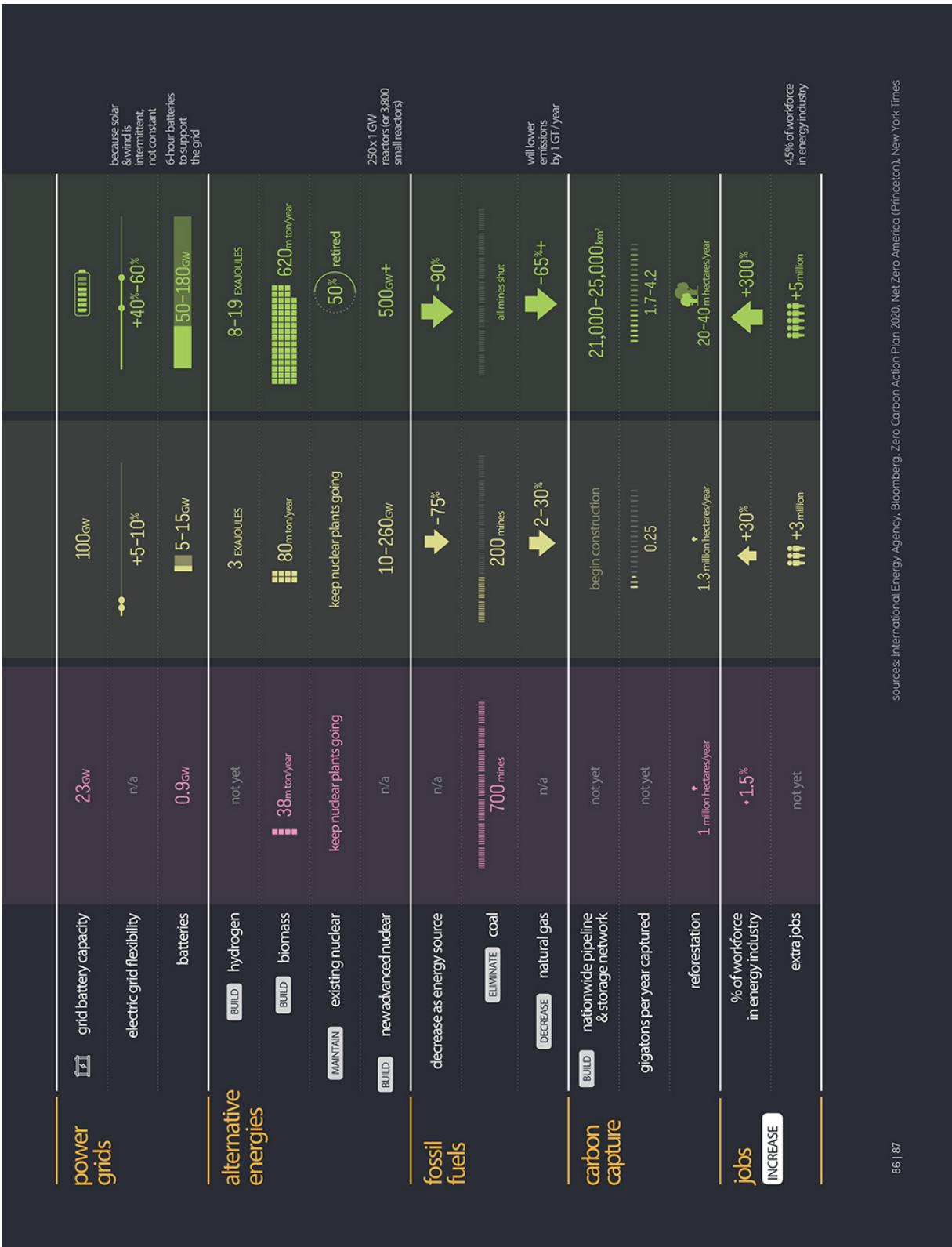
**282,845**  
terawatt hours

Potential Onshore Wind Energy  
**32,780**

US yearly  
electricity  
use  
**4,127**

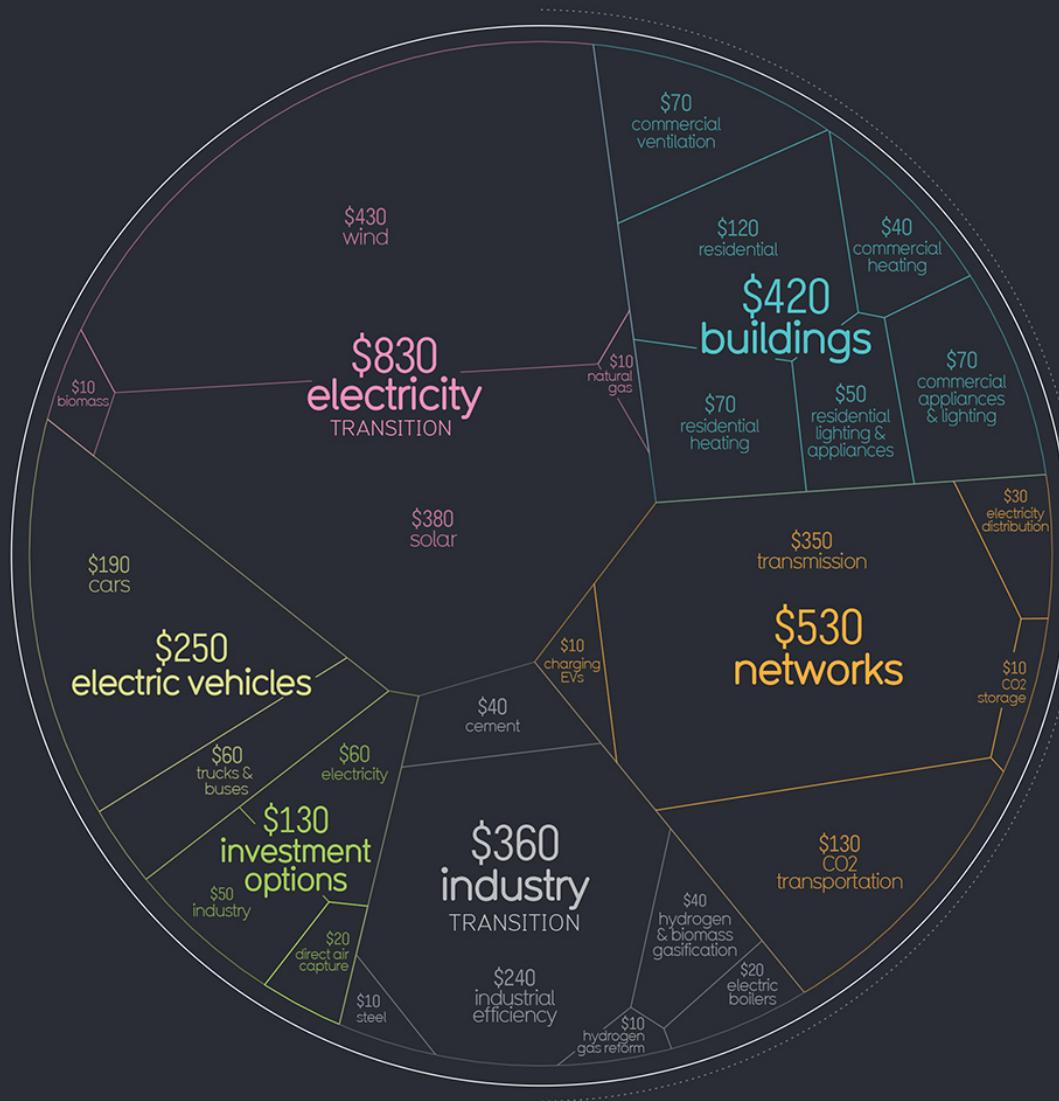
# Netzero Timeline





# Net Zero Costs to 2030

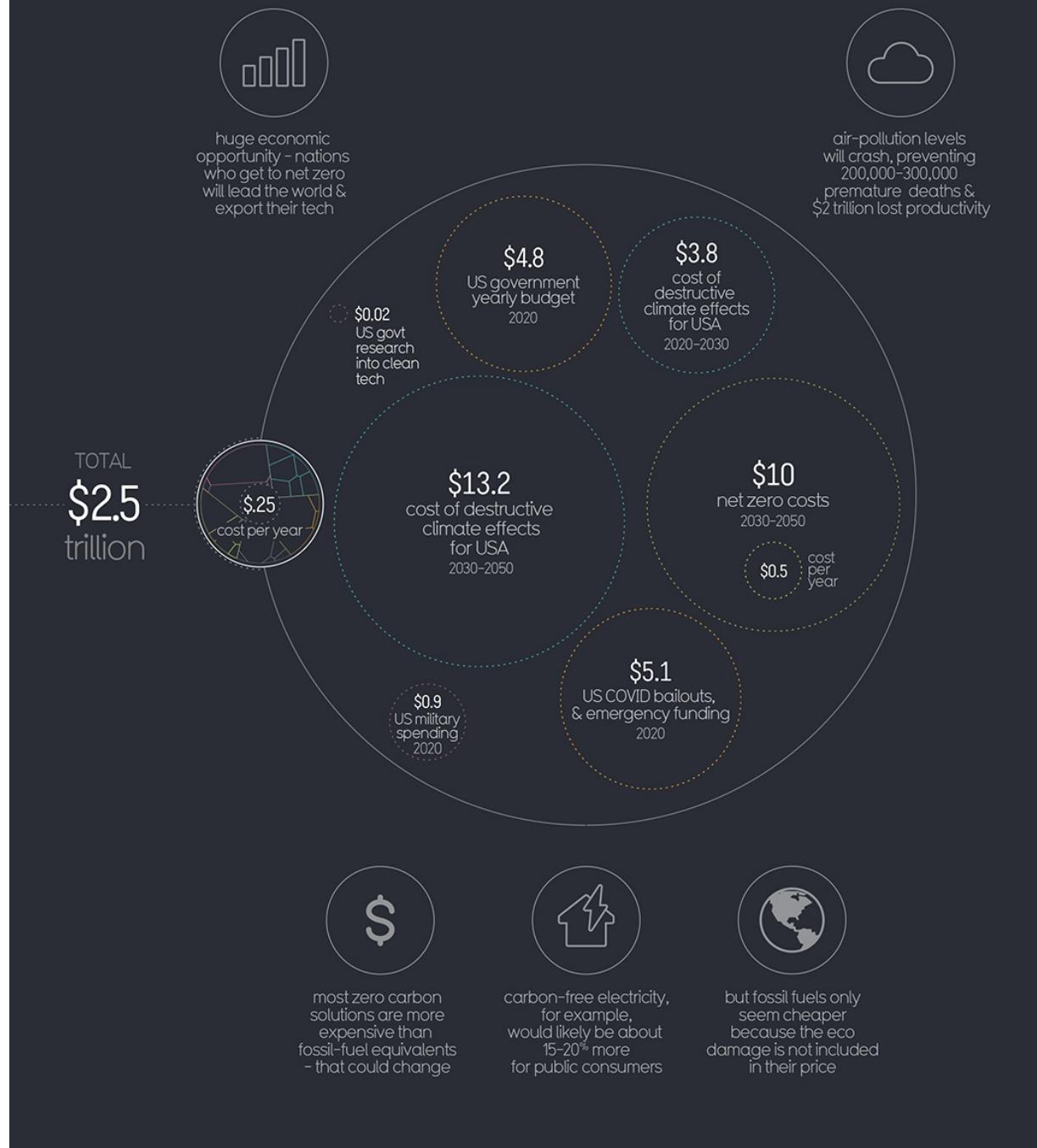
\$billions



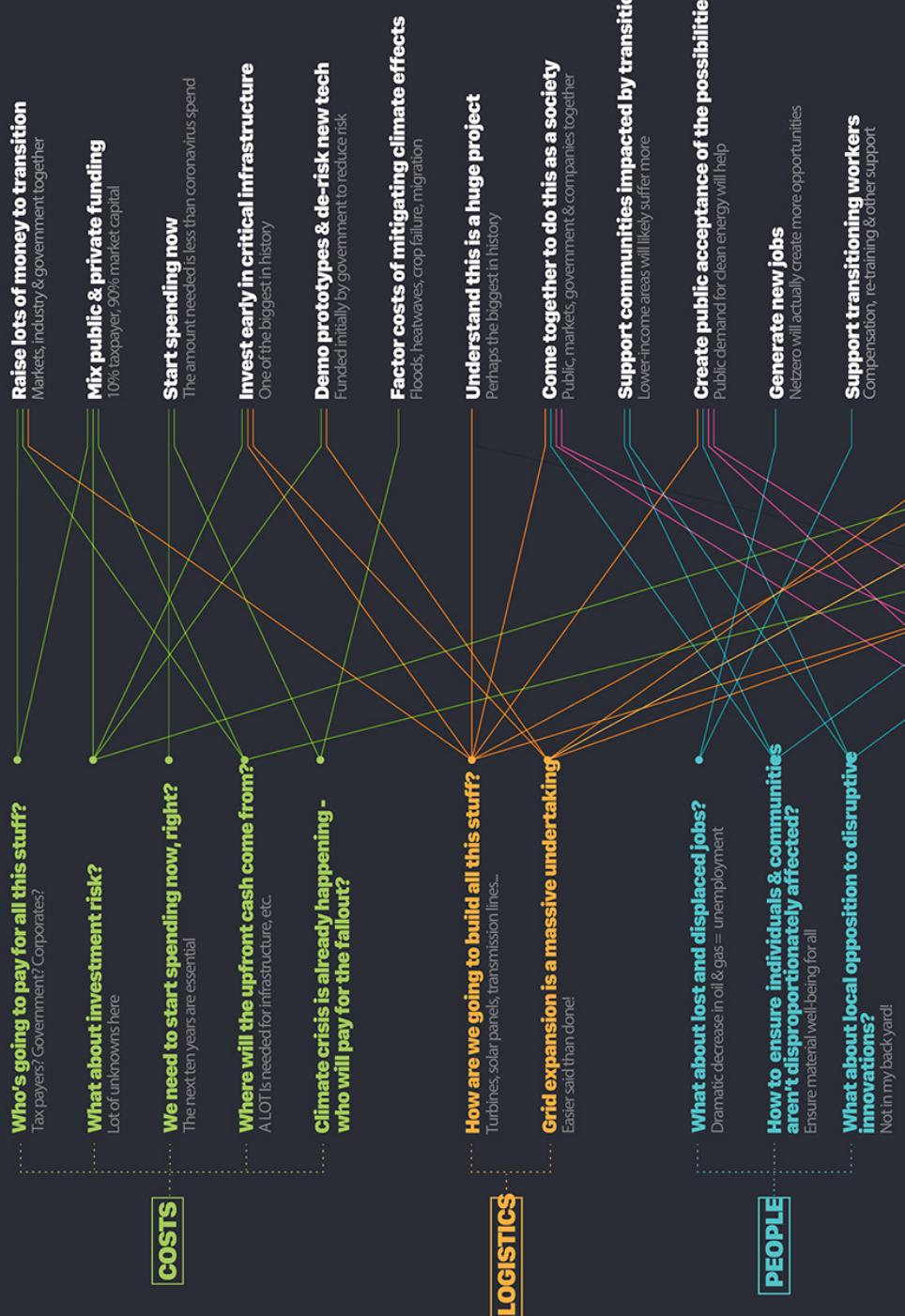
source: Net Zero America (Princeton)

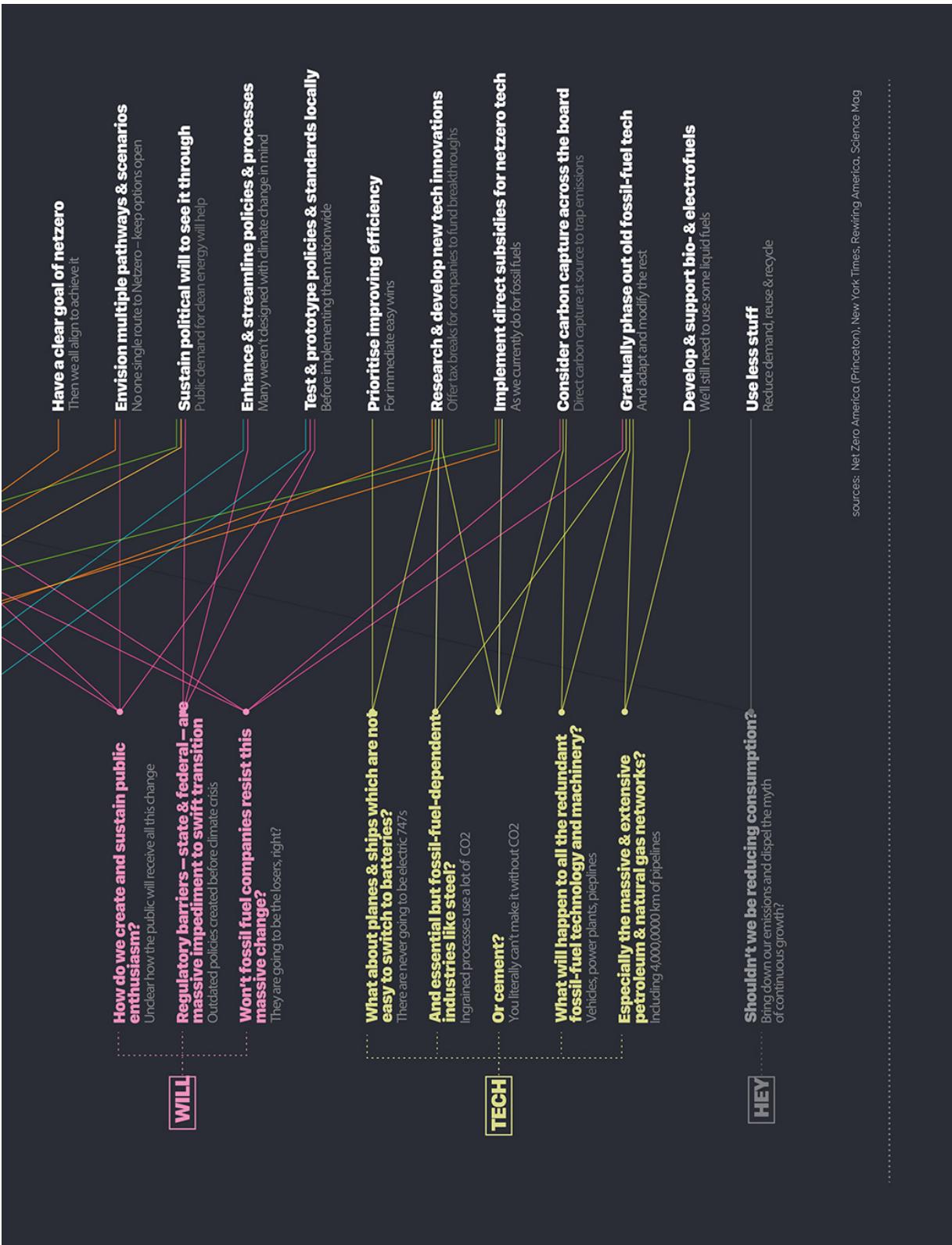
# Comparison Costs

\$trillions



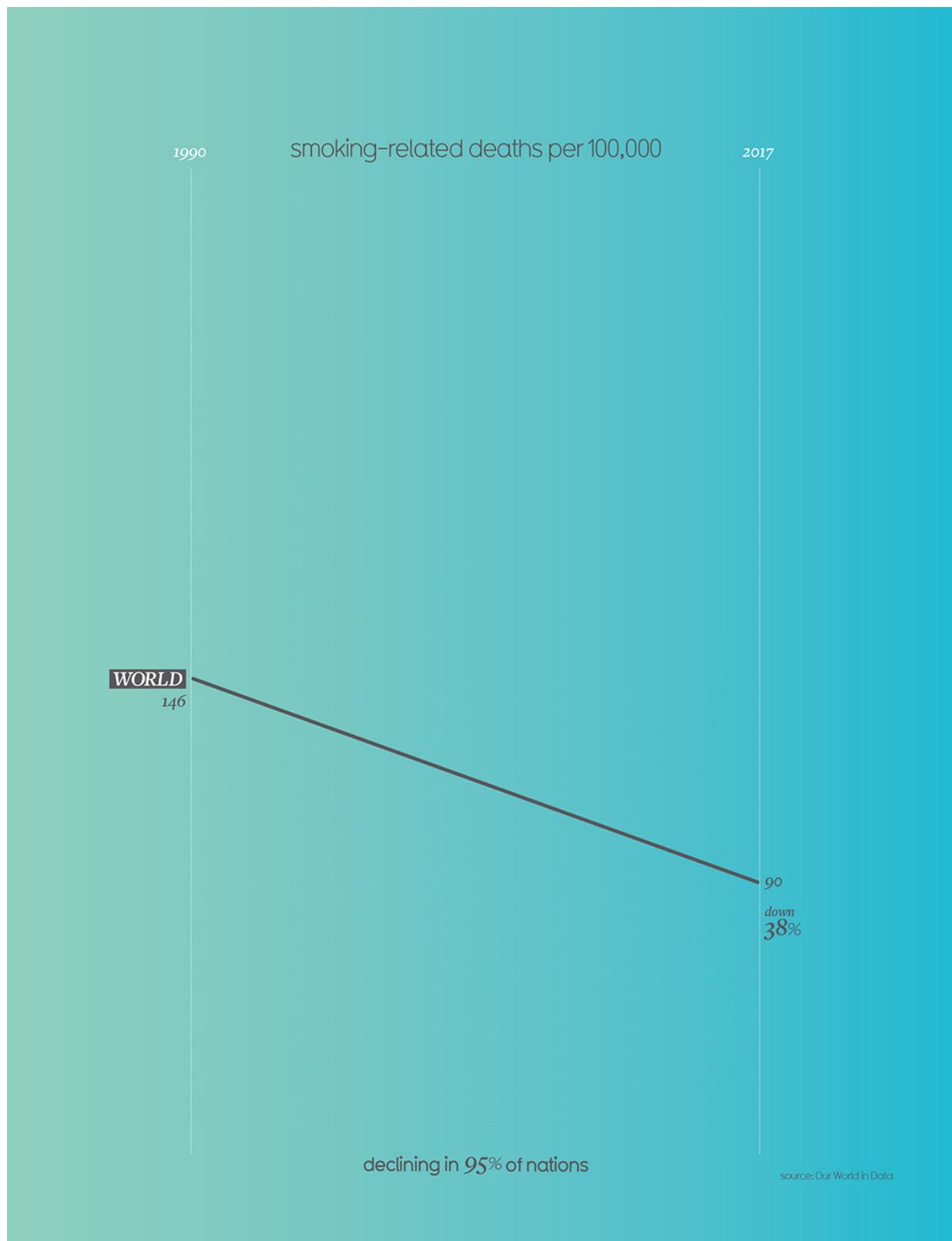
# Netzero Problems, Challenges, Responses, Solutions





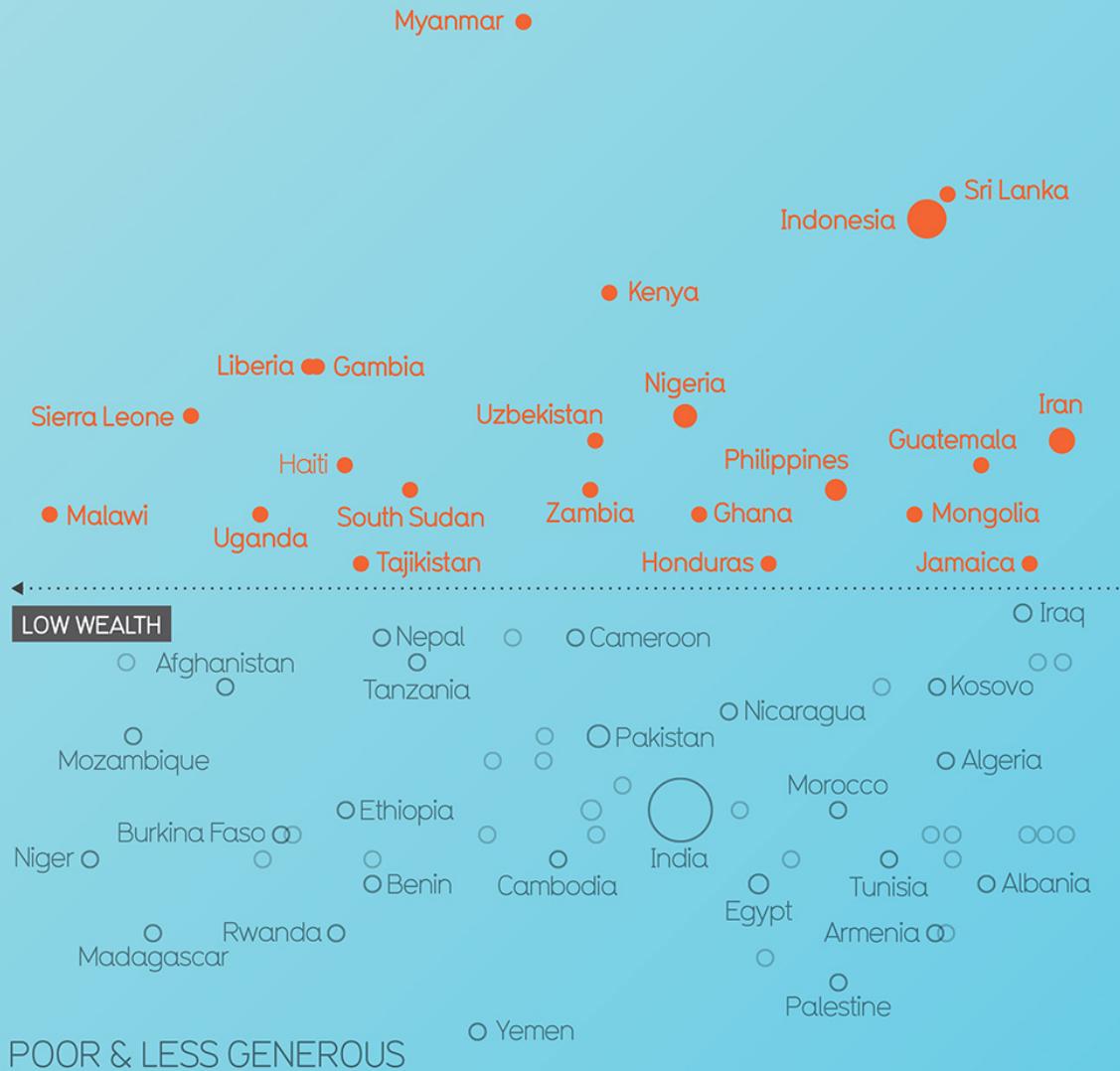
## Smoking Is Declining in Nearly Every Country

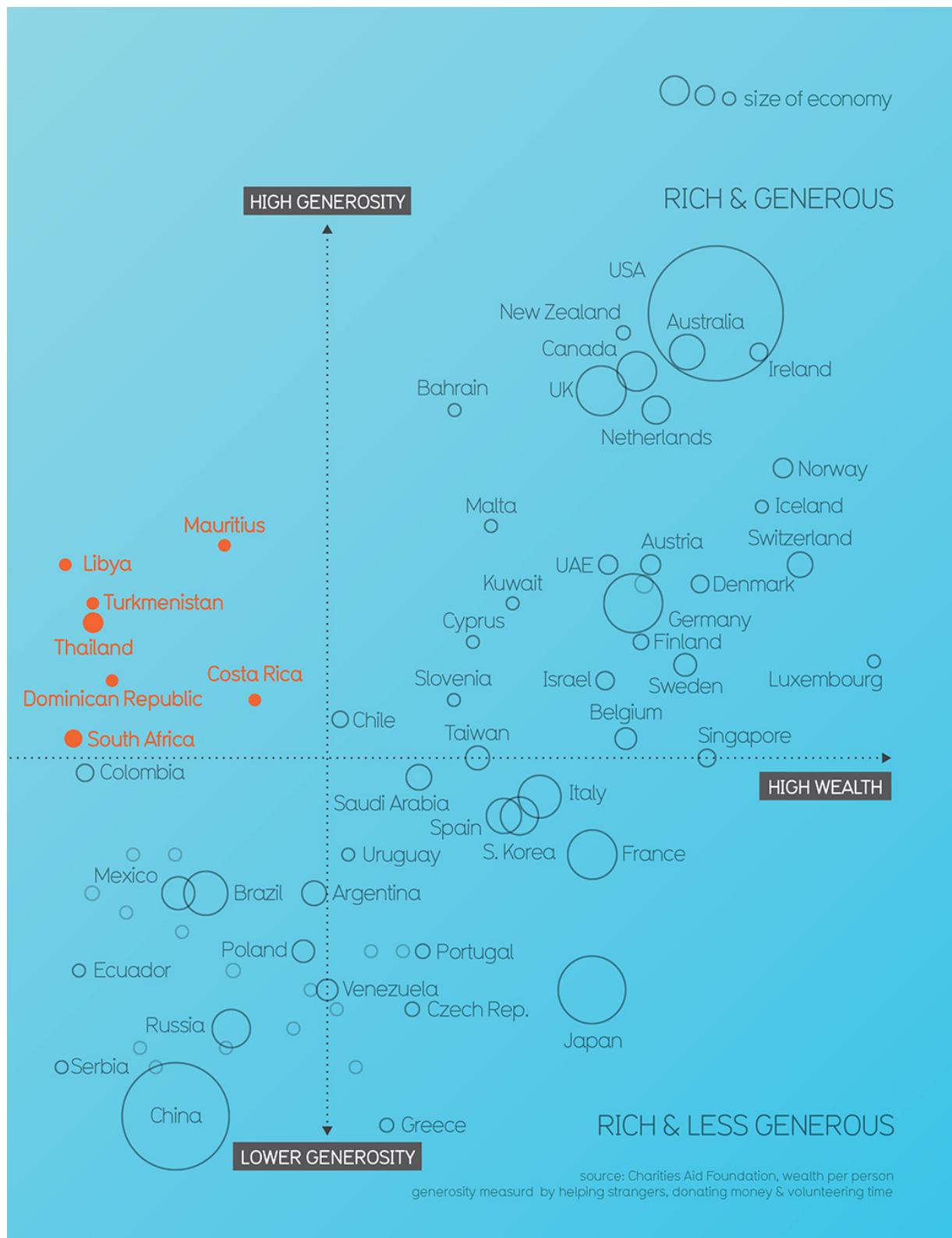




# Some of the World's Poorest Nations Are Also The Most Generous

## POOR & GENEROUS COUNTRIES





## We're Hacking Photosynthesis to Feed Our Growing Population

Improving the molecular efficiency of plants

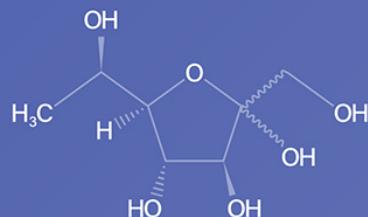


technology is being used on:  
  
 and distributed free to small farms

source: Illinois University

## A Natural Substance Could Replace Controversial Herbicide Roundup

Newly discovered sugar stops weed growth  
7-deoxy-sedoheptulose



early tests show it's harmless to humans & animals



**Roundup (Glyphosate)**  
is the most commonly used herbicide in the USA  
Discovered & brought to market by Monsanto  
(taken over by Bayer in 2018)  
Controversial due to evidence of possible toxicity in  
humans and animals

source: Nature Journal

## Food Tech

96 | 97

## Biofortified Cassava Is Set to Transform the Health of Millions

nearly  
**HALF A BILLION**  
Africans rely on  
cassava for  
**50%**  
of their calories



but cassava is

NUTRIENT POOR

which contributes to

anaemia  
diarrhoea  
deaths  
cognitive problems

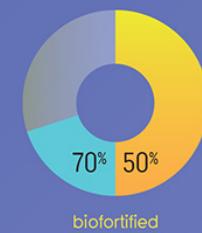
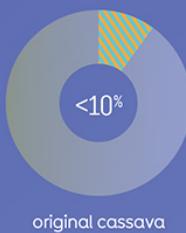
### Hacking the genes

Biologists inserted two genes  
from thale cress...  
...into cassava



### Transforming the nutrient profile

% of requirements of **zinc** and **iron**  
for women and young children



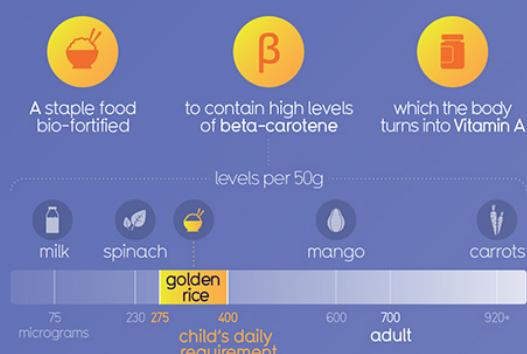
Sources: American Council on Science and Health, Nature

## Biofortified Golden Rice Could Reduce Lethal Vitamin A Deficiency

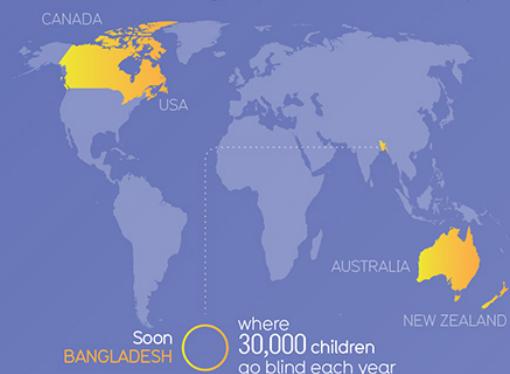
250m children worldwide suffer deficiency



Golden rice can counter this

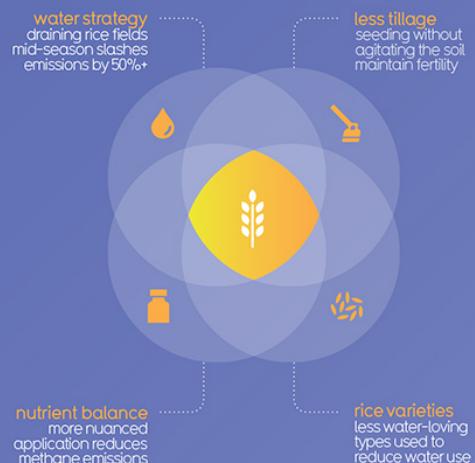


Golden rice is being approved for consumption



sources: World Health Organization, US National Institute of Health

## Rice Production is Improving, Boosting Food Security & World Health



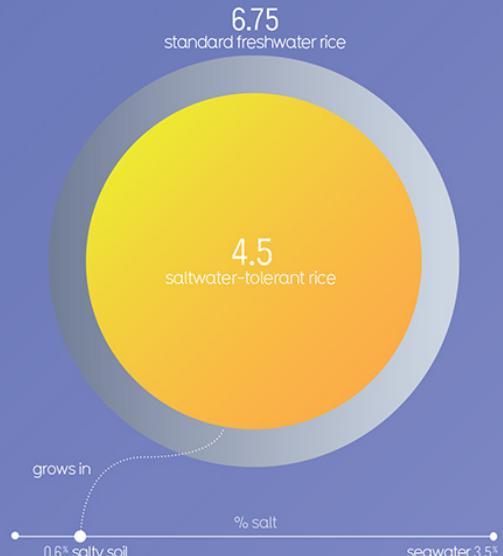
Wider adoption could save 13.8 gigatonnes of CO<sub>2</sub>



source: Project Drawdown

## Rice Can Now Be Grown in Salty Water

Tonnes yielded per hectare



source: South China Morning Post

Canada has  
the largest  
protected  
boreal forest  
on the planet

boreal = high-latitude forests consisting mainly of conifers

# created



source: BBC

# The World Economy Has Ballooned

Trillion dollars

1968

2

\$700  
per person

2019

88

\$11,400  
per person

source: World Bank

## The Potential of Geothermal Power Is Amazing

63,300,000 daily megawatt hours  
Humanity's entire electricity usage

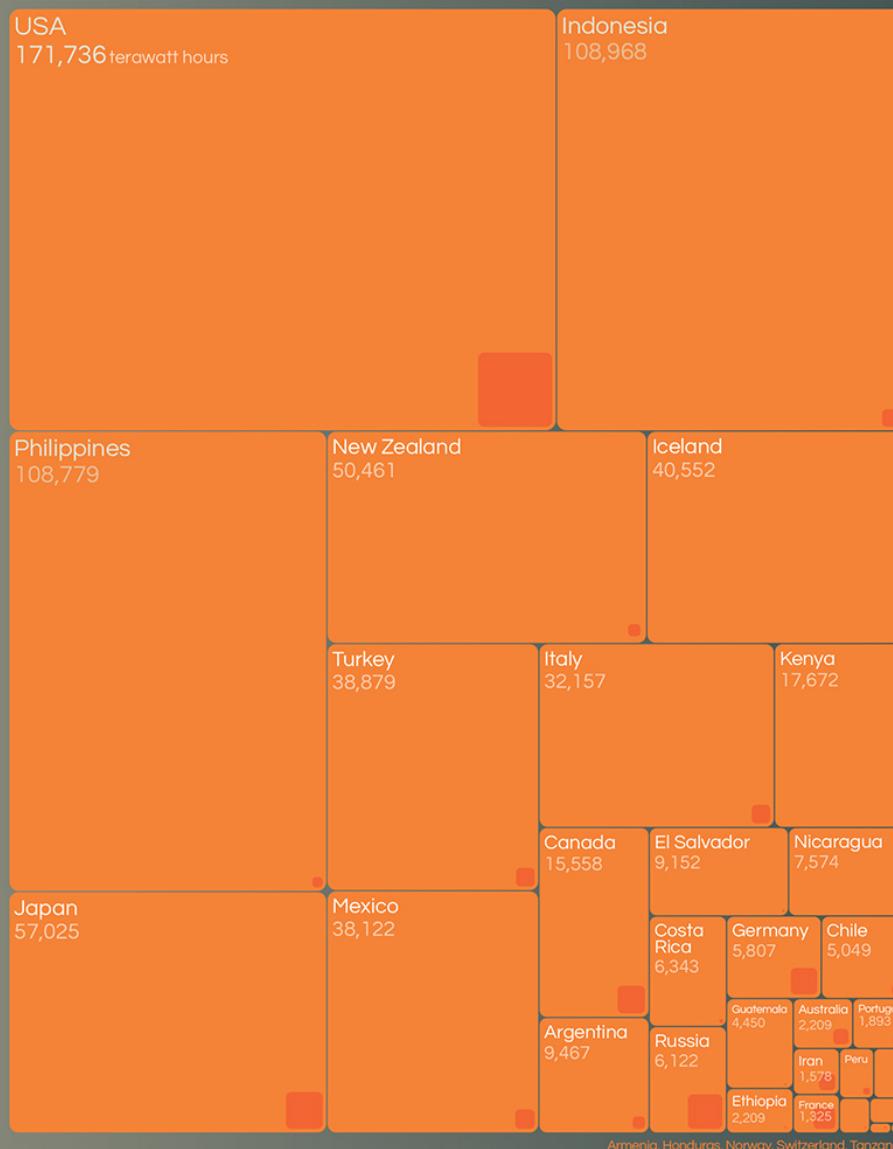
48,800,000  
Global geothermal  
energy potential

0.4

% we're currently using

# 30 Countries Could be 100% Powered by Renewable Geothermal Energy

Yearly potential vs current electricity use



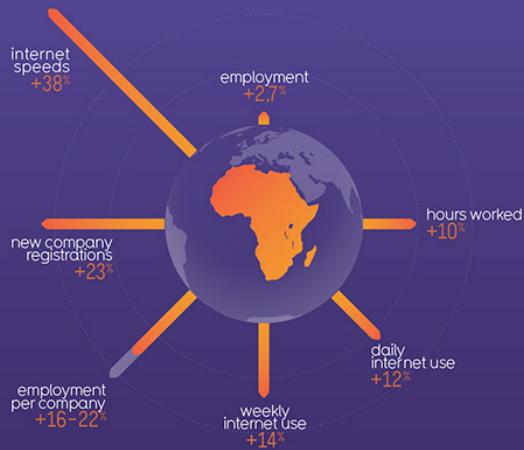
source: International Renewable Energy Agency

# Yay Africa!

The new African Union passport allows visa-free travel between 55 countries

source: Washington Post

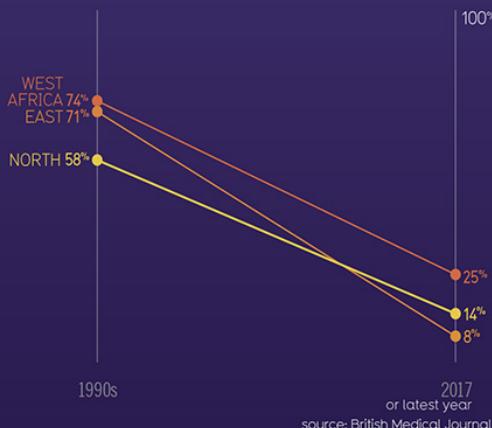
## When Submarine Internet Cables Arrived in Africa...



source: American Economic Review

## Female Genital Mutilation Is Declining Across Most of the Continent

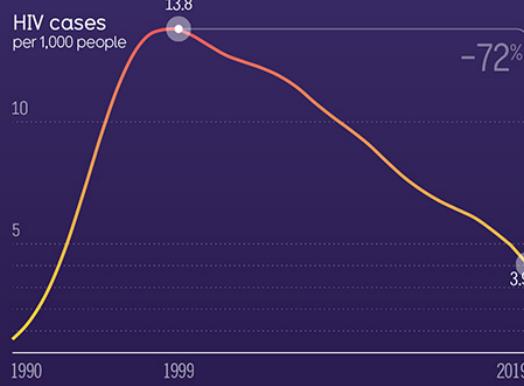
Prevalence by region %



source: British Medical Journal

## South Africa Is Cutting HIV Infections

Despite suffering the world's biggest epidemic



sources: UNAIDS, Avert.org

Drones Have Revolutionised Medical Deliveries in Rwanda



with drone vs pre-drone



of blood supply delivered

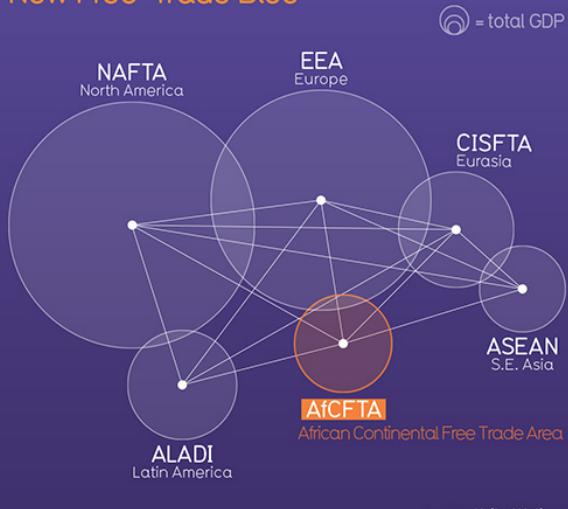


MAX LOAD



CRUISE SPEED  
in ideal conditions

## African Countries Have Agreed to a New Free-Trade Bloc



(○) = total GDP

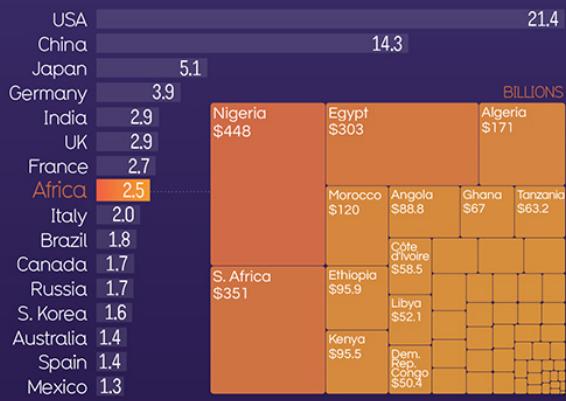
source: United Nations

## Africa Leads the World in Mobile Money Transactions



## United Africa Is an Economic Powerhouse

Yearly GDP \$US Trillions



## Access to Electricity Is Rising Across The Continent



### COVERED AREA



### EFFECTIVE RANGE

22,500 km<sup>2</sup>  
covered area



source: Guardian

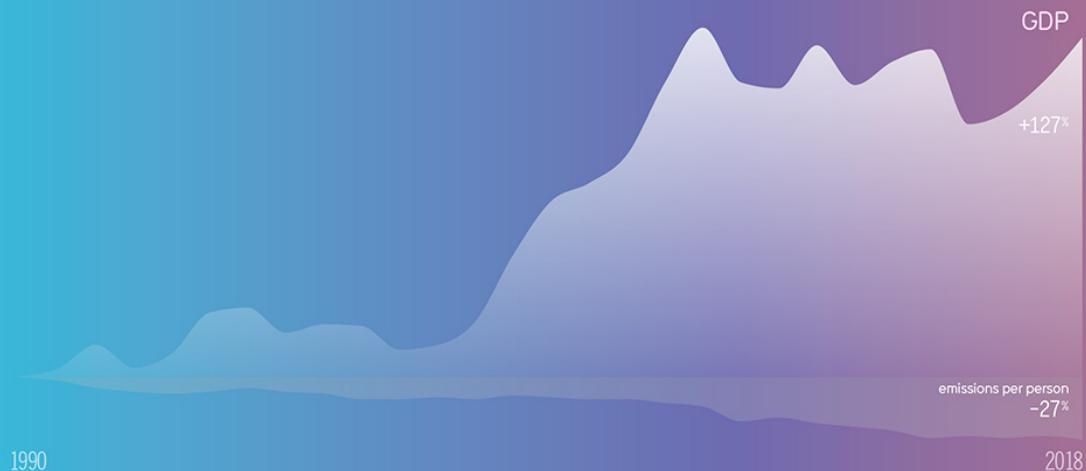
millions gaining  
electricity per year



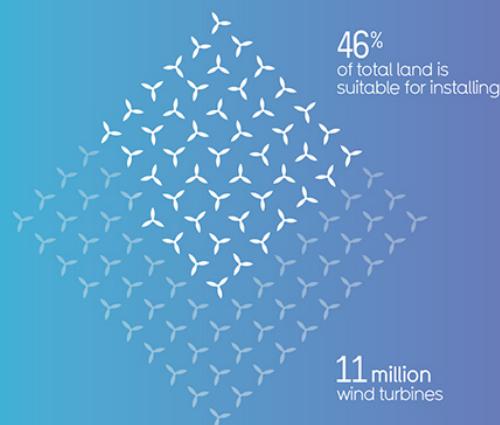
source: International Energy Agency

# The EU Is Leading on Recycling & Emissions

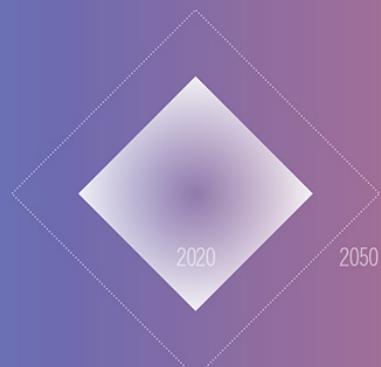
Its Economy Is Growing While Emissions Are Falling



It Could Power the Entire World with Wind



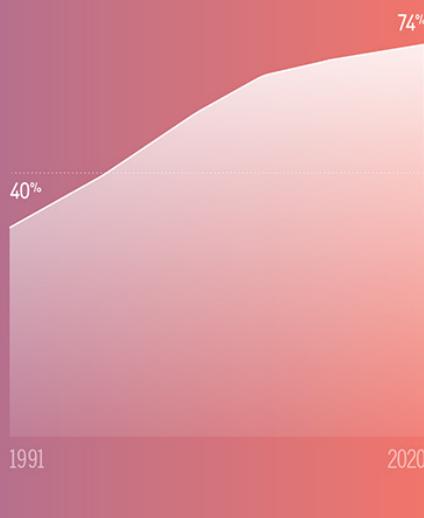
Will Increase Its Offshore Wind Capacity by 250%



expected global demand 2050

EU wind energy generating potential

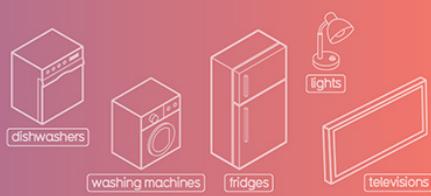
Paper Recycling Has Doubled over the Last 25 Years



Some European States Are Recovering Almost All Plastic Packaging Making it into new industrial products\*



The EU has required all key electronic appliances to be easier to repair



\*wall insulation, slurry, lubricants, etc.

430 exajoules

497

sources: Independent, Energy Policy Journal, European Paper Recycling Council, Eurostat



source: World Bank      sources: Aviation-Safety.net, World Bank, commercial passenger crashes only

## Atmospheric Acidity Is Back to Normal

Clean air acts begin to appear across the EU and US

ice core acidity (pH)

5.25

5.5

1930

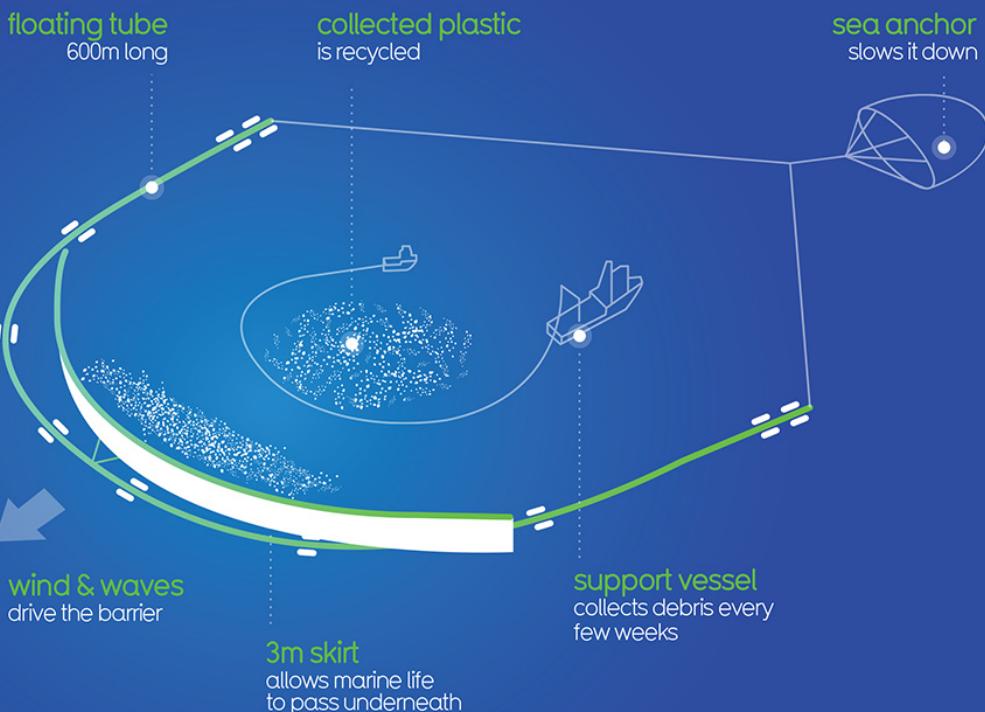
1970

2004

source: Kjær, Helle Astrid et al (2016), global

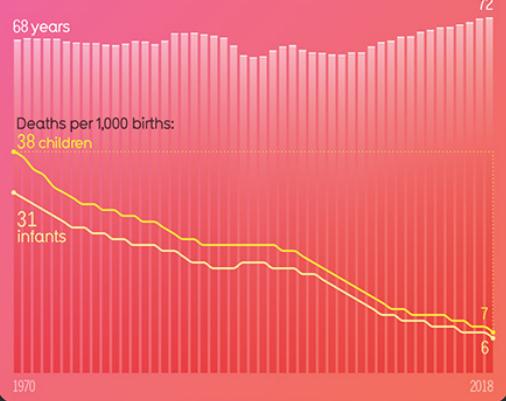
# A New Device Uses Ocean Forces To Clean Plastic From Our Seas

From giant objects to microplastics



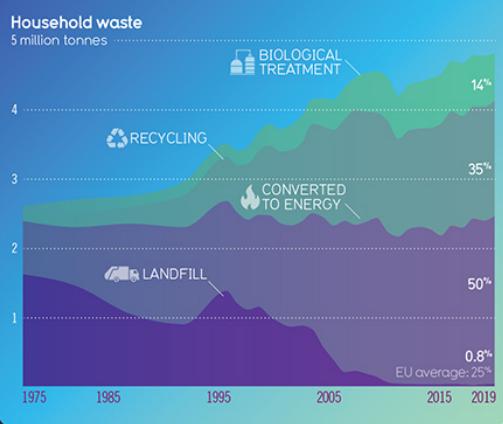
source: Guardian

## Russia's Child Mortality Is Down, Life Expectancy Is Up

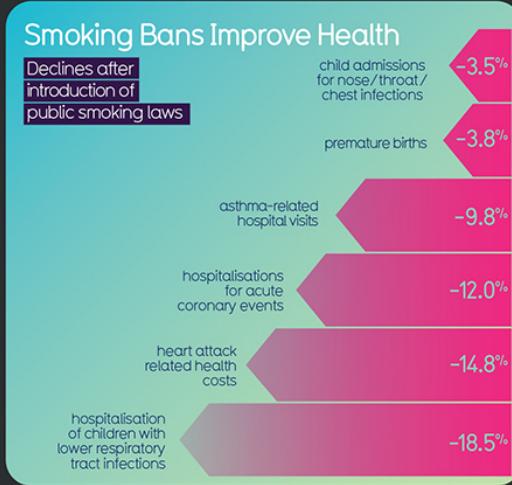
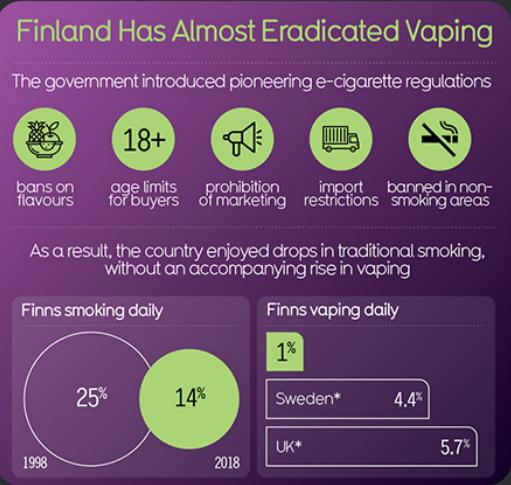
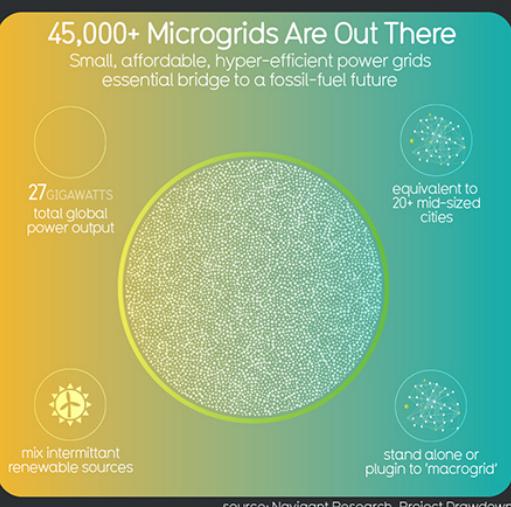
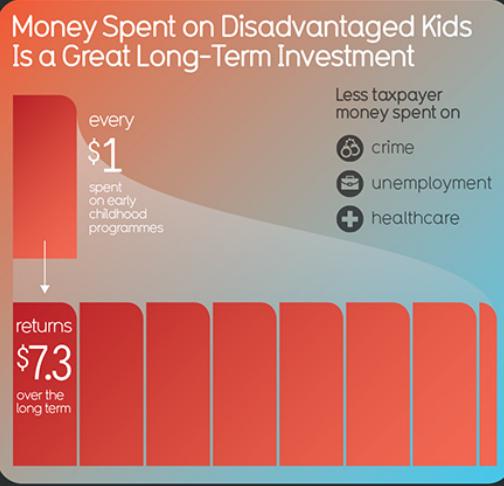


source: World Bank

## Sweden Sends Almost No Trash to Landfill



source: Avfall Sverige

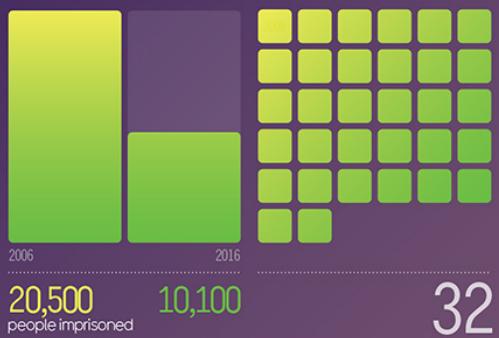


## Dutch Prisons Are Closing

And being turned into housing for refugees

Incarceration rates are down

Prison closures 2009-2016

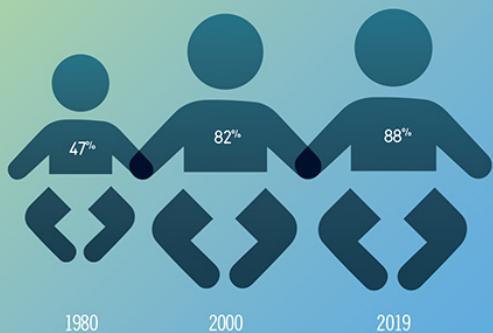


Sources: World Economic Forum, Fast Company

## Most One-Year-Olds Are Vaccinated Against Three Lethal Diseases

Diphtheria, tetanus & whooping cough

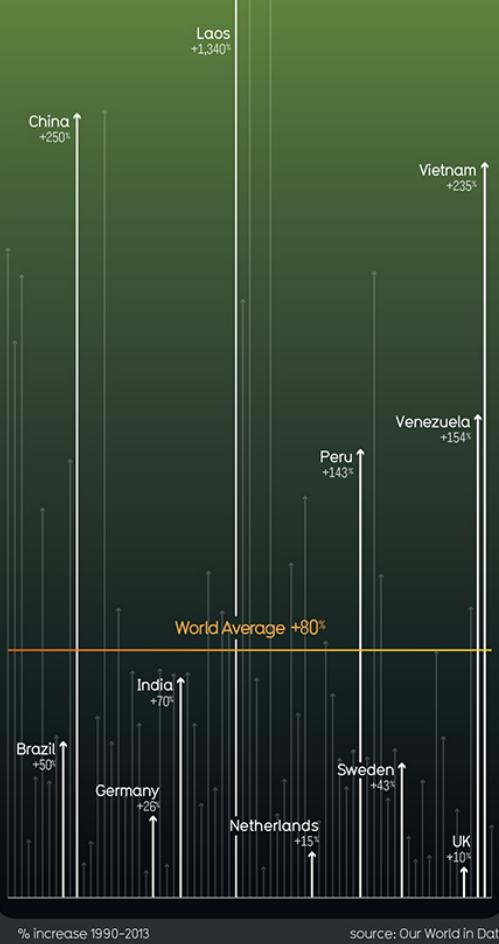
source: World Health Organization, global figures



source: World Health Organization, global figures

## World Vegetable Intake Almost Doubled

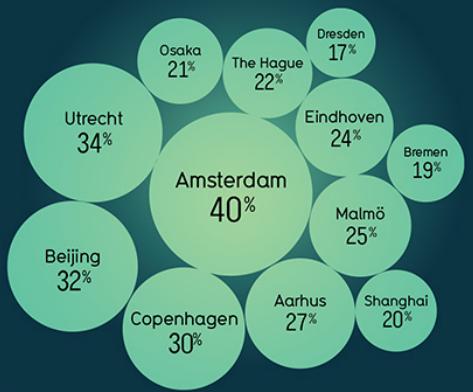
% increase in consumption per person



Sources: Our World in Data

## Cycling to Work Is on the Up

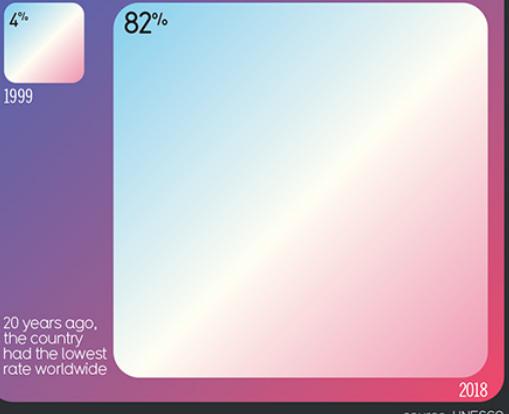
Cities with most bicycle commuters



Sources: Urban Audit, LTA Academy, Jane Jacobs Japan

## More Afghan Girls Are Being Educated

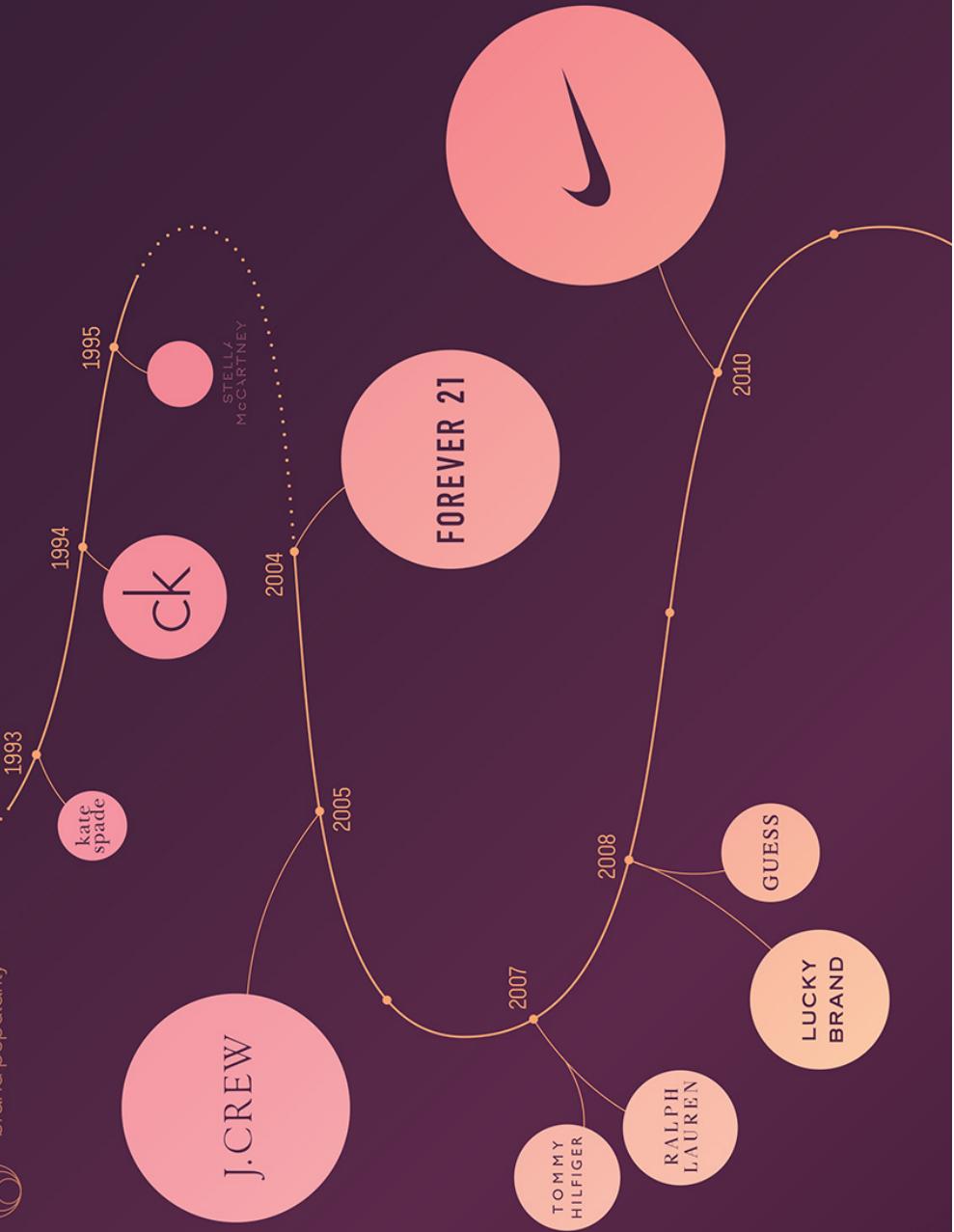
Primary school enrolment rates

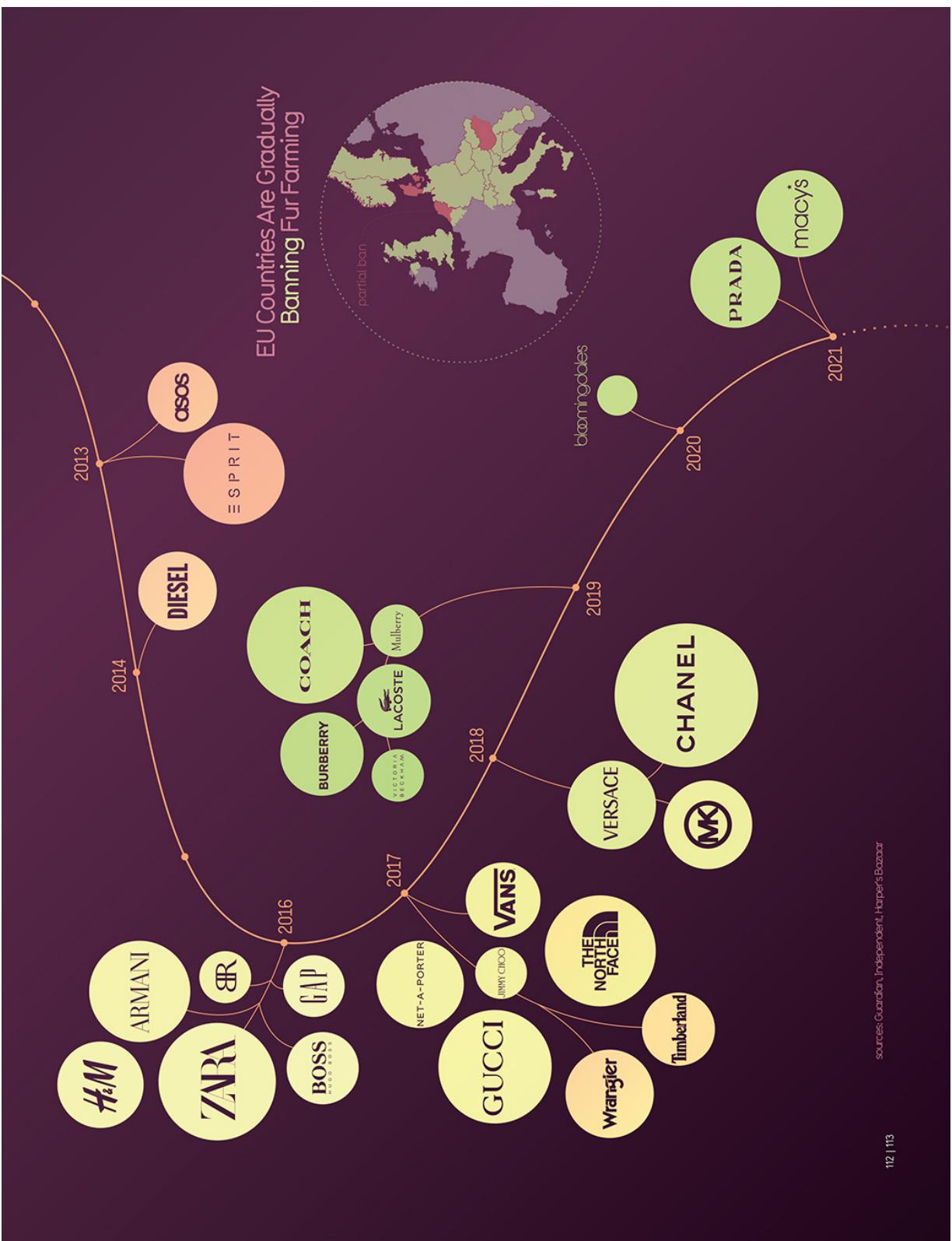


Source: UNESCO

# Major Fashion Brands Are Going Fur-Free

◎ = brand popularity





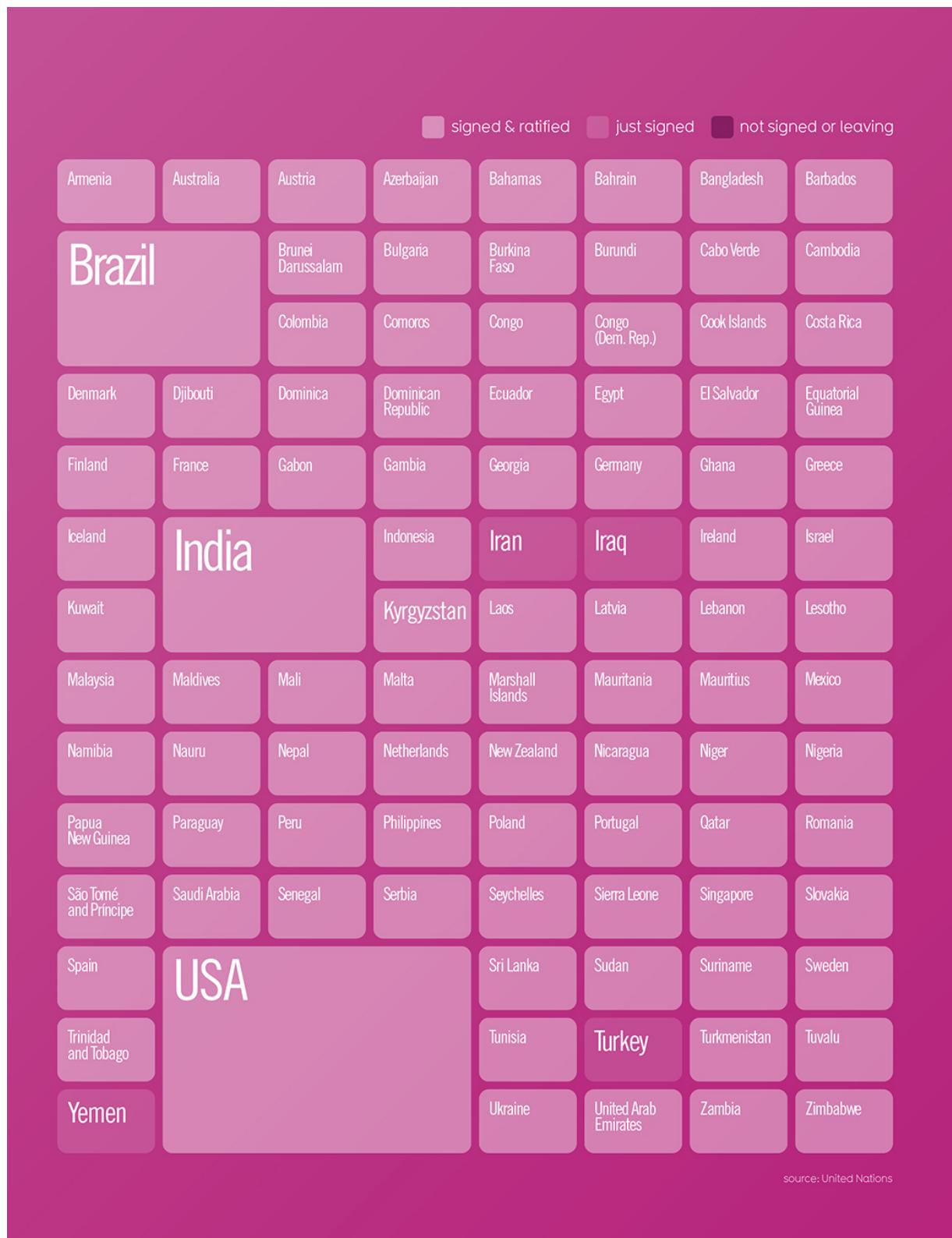
Sources: Guardian, Independent, Harper's Bazaar

112 | 113

# 190 Nations Have Signed the Paris Climate Agreement

With only a few holdouts





WORLD HEALTH ORGANIZATION UNIVERSAL HEALTHCARE COVERAGE (UHC)

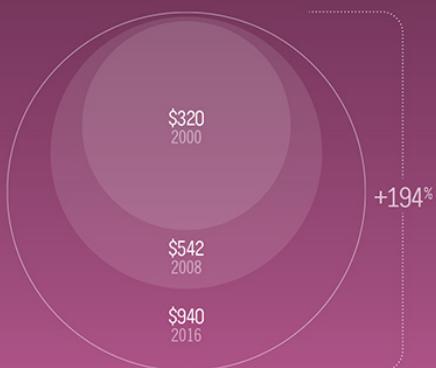
LEVEL 4

13%

LEVEL 3

45%

Global Health Expenditure per Person  
Has Never Been Higher



LEVEL 2

38%

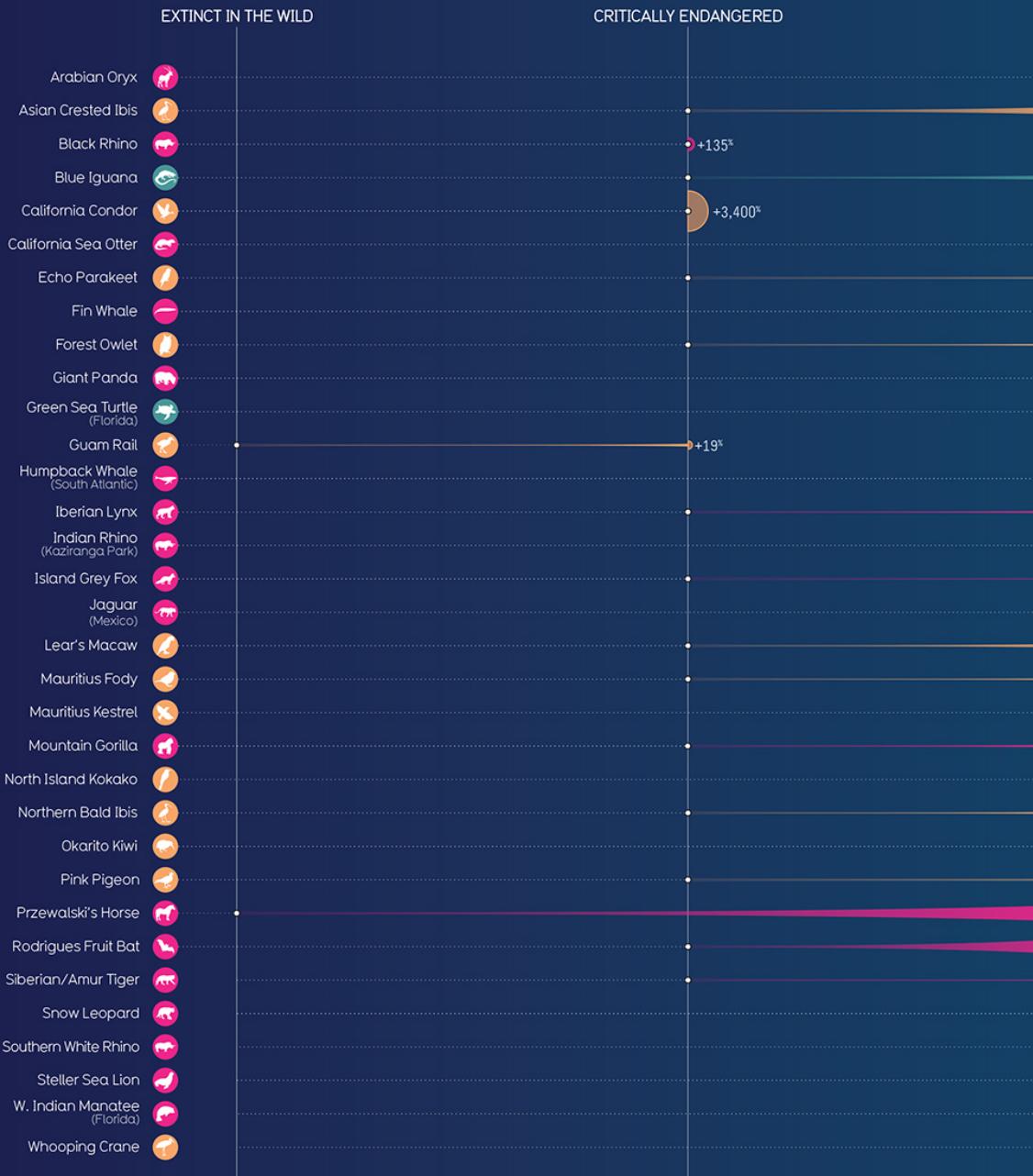
The % of Global Population Covered by  
Essential Health Services Is Growing

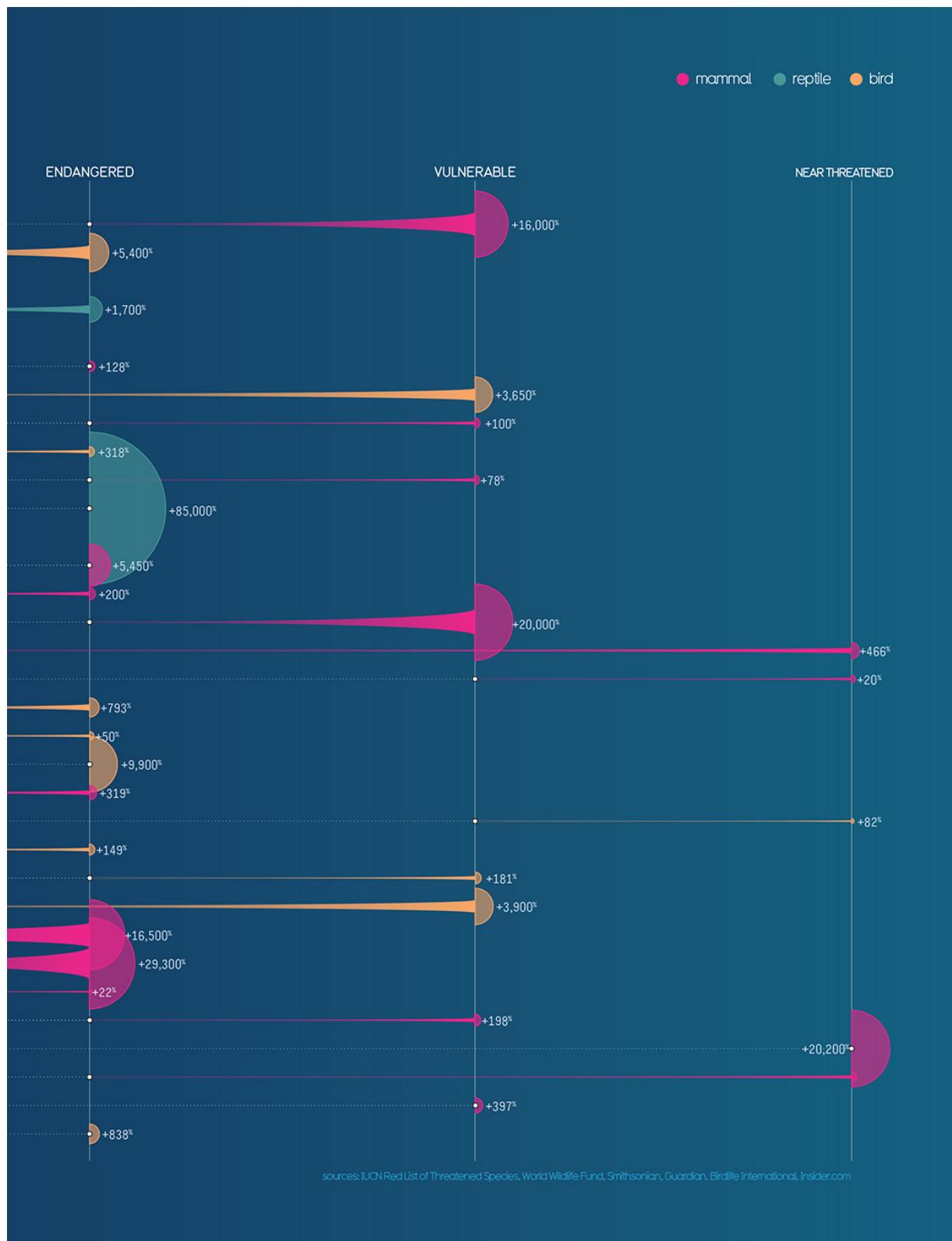
LEVEL 1 4%

Australia	Iceland	New Zealand	Switzerland
Belgium	Israel	Norway	Thailand
Brunei	Italy	Portugal	UK
<b>Canada</b>	Japan	Singapore	Uruguay
Cuba	Luxembourg	<b>South Korea</b>	USA
Denmark	Malta	Spain	
Germany	Netherlands	Sweden	
Algeria	<b>Cze. Republic</b>	Latvia	Romania
Argentina	Dom. Republic	Lebanon	Russia
Armenia	<b>Ecuador</b>	Libya	Saudi Arabia
<b>Austria</b>	Egypt	<b>Lithuania</b>	Serbia
Azerbaijan	El Salvador	<b>Malaysia</b>	Seychelles
Bahamas	Estonia	<b>Maldives</b>	Slovakia
Bahrain	Eswatini	<b>Mauritius</b>	Slovenia
<b>Barbados</b>	Fiji	<b>Mexico</b>	South Africa
Belarus	Finland	Moldova	<b>Sri Lanka</b>
Belize	<b>France</b>	<b>Mongolia</b>	St Lucia
Bhutan	<b>Georgia</b>	Montenegro	Suriname
Bolivia	Greece	Morocco	Syria
Bosnia	Grenada	Myanmar	Tajikistan
Botswana	<b>Guyana</b>	N. Macedonia	Tunisia
Brazil	Honduras	N. Korea	<b>Turkey</b>
Bulgaria	<b>Hungary</b>	Namibia	Turkmenistan
Cabo Verde	Iran	<b>Nicaragua</b>	UAE
Cambodia	Iraq	Oman	Ukraine
<b>Chile</b>	Ireland	<b>Panama</b>	Uzbekistan
China	Jamaica	Paraguay	Venezuela
Colombia	Jordan	Peru	Vietnam
<b>Costa Rica</b>	Kazakhstan	<b>Philippines</b>	
Croatia	Kuwait	Poland	
Cyprus	Kyrgyzstan	Qatar	
Albania	Gambia	Mauritania	Timor-Leste
Angola	Ghana	Micronesia	Togo
Bangladesh	Guatemala	Mozambique	Tonga
Benin	Guinea-Bissau	Nepal	Uganda
Burkina Faso	Haiti	Nigeria	Vanuatu
Burundi	India	Pakistan	Yemen
Cameroon	<b>Indonesia</b>	Papua NG	Zambia
Côte d'Ivoire	Kenya	Rwanda	Zimbabwe
Djibouti	Kiribati	<b>Samoa</b>	
DR Congo	Laos	Senegal	
Equ. Guinea	<b>Lesotho</b>	Sudan	
Gabon	Malawi	Tanzania	
based on indicators like level of antenatal care, immunisation, TB & HIV treatments, cancer screening, hospital access, access to essential medicines			
<b>bold countries</b> = free healthcare			
source: World Health Organization			

# Unendangered Animals

 = % change in population





## The Potential of Solar Is Amazing



63,300,000  
daily megawatt hours  
humanity's entire  
electricity use

401,850,000  
global solar energy potential

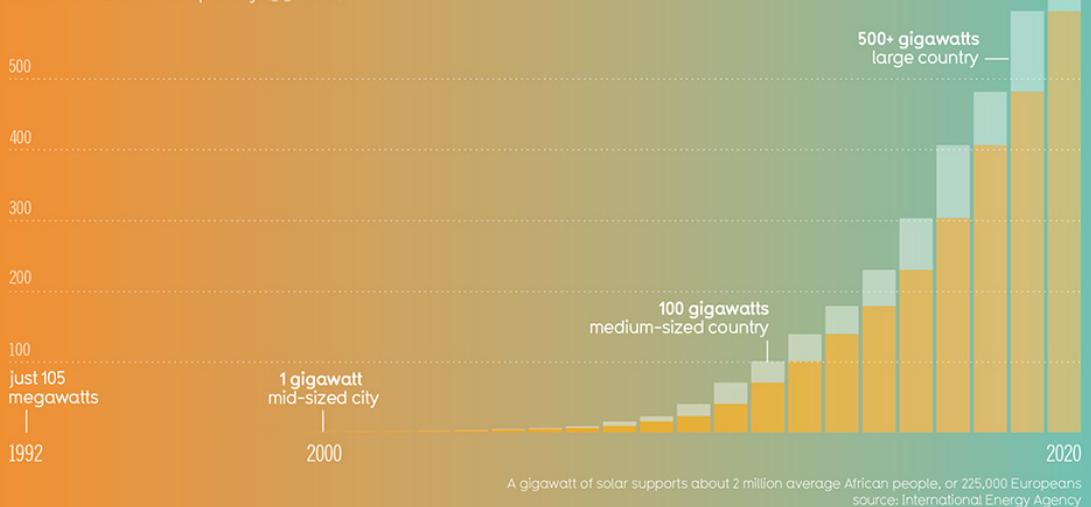
amount we're  
currently using

0.5%

source: Sandia National Laboratories

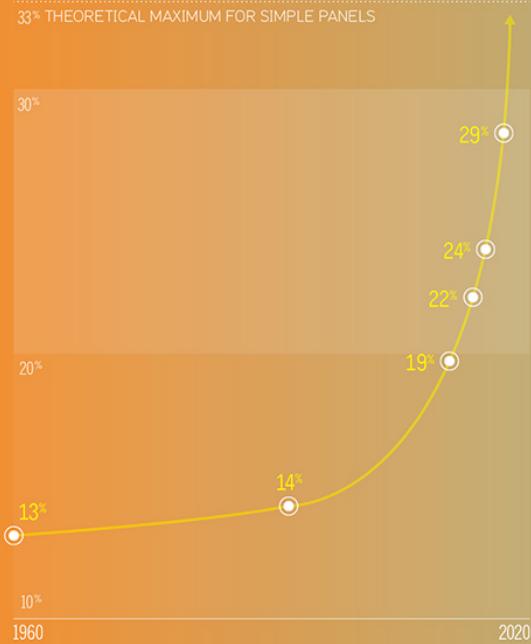
## Every Single Year We're Adding More and More

Worldwide solar capacity (gigawatts)



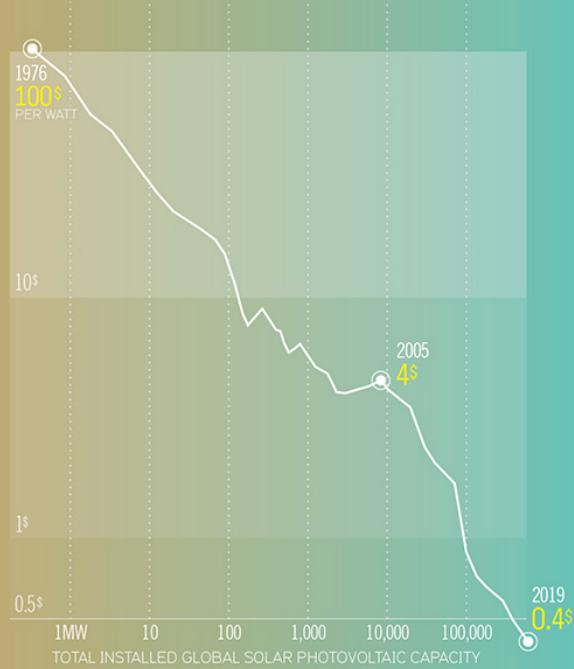
## Efficiency of Solar Panels Is Increasing

Major leaps



## The Price Has Crashed

It's never been more competitive



Ukraine's first solar power plant has opened at the site of the Chernobyl nuclear disaster

Oil Fields Make Great Solar Farms  
Just sayin'



the world's largest oil field is in Saudi Arabia

8,400 square kilometres

it's the size of Tokyo, the world's largest city



petawatt hours of energy per year  
(1.4% of global use)



petawatt hours as a solar farm  
(2.4% of global use)



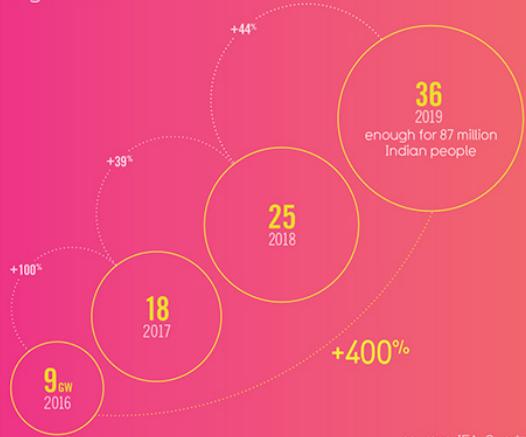
source: Independent

source: Carbon Brief

### Types of Solar Power



India's PV Capacity Has Quadrupled  
Gigawatts



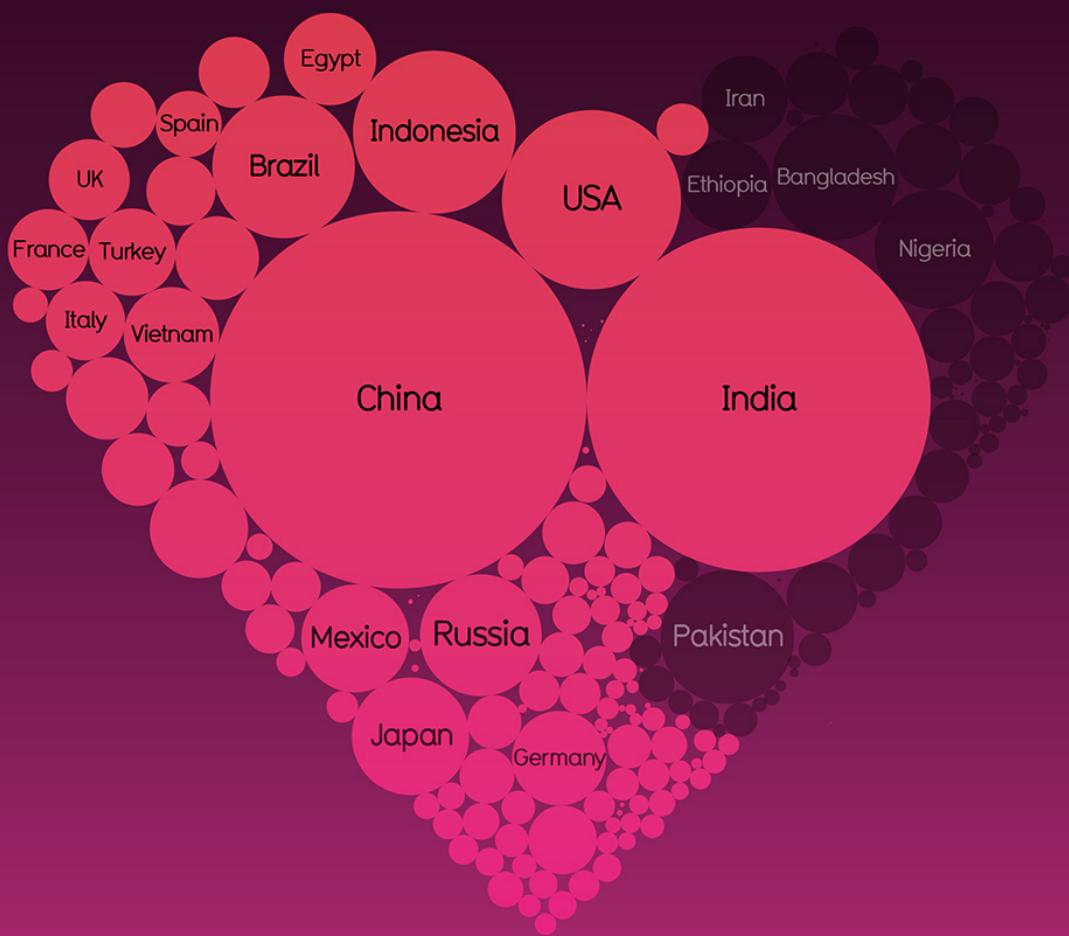
sources: IEA, Quartz

Spain Leads the World in CSP  
Megawatts per km<sup>2</sup>



source: Statista.com

# It's Legal to Be Homosexual in the Majority of the World's Countries



source: International Lesbian, Gay, Bisexual, Trans and Intersex Association

## 300+ US Hospitals Created Their Own Non-Profit Drug Company

Providing generic drugs to hospitals at affordable prices to counter **big pharma price hikes**

Major price hikes in common drugs  
since 2012

Nitropress  
Blood pressure

Isuprel  
Heart

Niacin ER  
Cholesterol

Captopril  
ACE inhibitor

310%

585%

1,300%

3,850%

20,875%  
increase

Clomipramine  
Obsessive-compulsive disorder

Doxycycline  
Antibiotic

Daraprim  
Anti-parasitic

Tetracycline  
Antibiotic

sources: TrutinRx, New York Times, LA Times

186 countries  
agreed on a law  
to reduce  
plastic waste

Consent will be required before  
sending contaminated & unrecyclable  
plastics to other countries

86 nations  
agreed to curb  
aviation  
emissions

sources: International Civil Aviation Organization

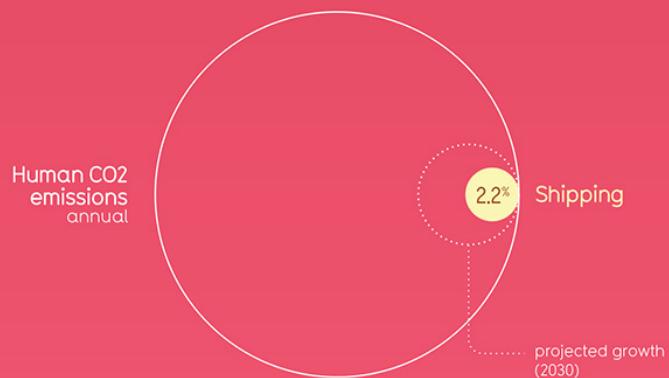
29 US States, Australia, the UK, Japan,  
South Korea, & the EU have all adopted a  
renewable portfolio standard  
It requires electrical utilities to get a certain  
% of their electricity from renewables -  
in a flexible, market-driven way

## Amazing Agreements

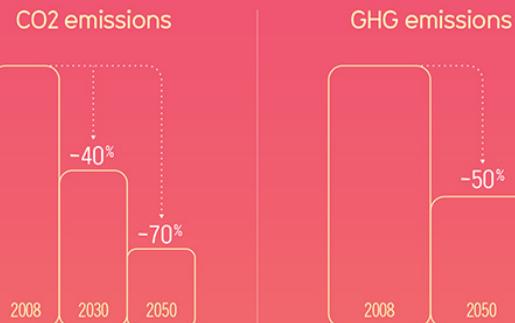
124 | 125

## A New Global Plan Aims to Cut Emissions from International Shipping

Ships are a major contributor to global greenhouse gas emissions



The United Nations International Maritime Organization adopted a new plan to help solve the problem



energy efficiency  
compulsory standards  
for all international ships



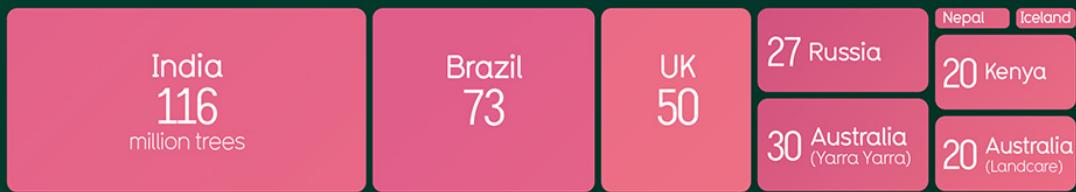
sharing tech  
to assist low-income  
nations to transition



data collection  
on fuel consumption  
will be mandatory

source: United Nations International Maritime Organization

## World's Biggest Tree-Planting Campaigns



### Australia **1 BILLION**

Forestry plan to meet the goal of the  
Paris Climate Change Agreement by 2030

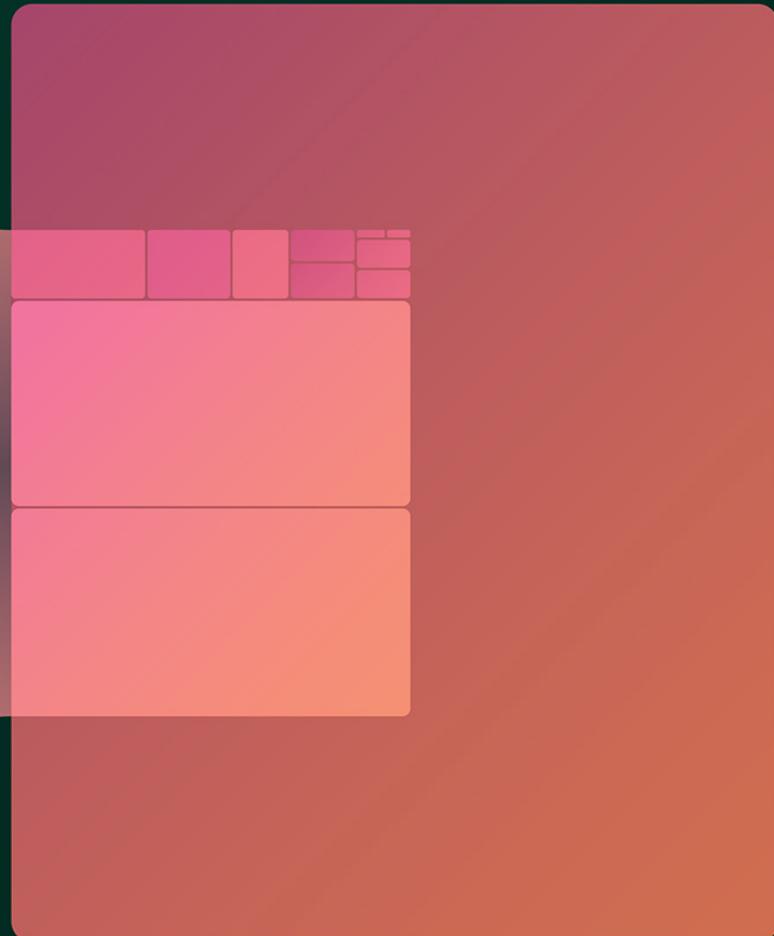
### Pakistan **1 BILLION**

Billion Tree Tsunami project spearheaded by  
cricket-star-turned-politician Imran Khan

China  
**9.9 BILLION**

largest in the world

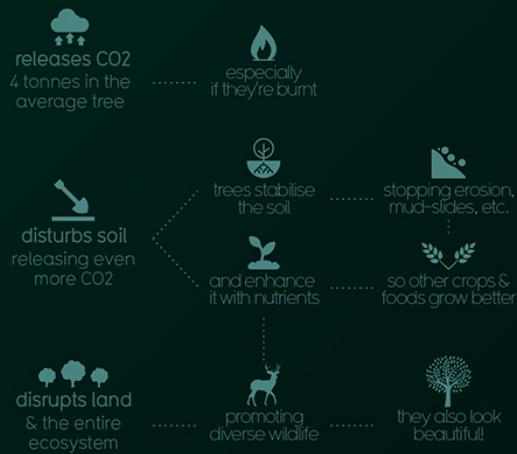
Northeast Hebei & Qinghai provinces; Hunshandake Desert





## Why Deforestation Is a Bad Idea

Because it...



## Why Deforestation Happens

Different places, different reasons



## The World Is Ripe for Reforestation

Ideal regions for replanting



### RULES FOR REFORESTATION

- protect existing forests
- plant on degraded land
- engage local people first

**'People cut down trees not because they are evil: they do it when the incentives to cut down trees are stronger than the incentives to leave them alone.'**

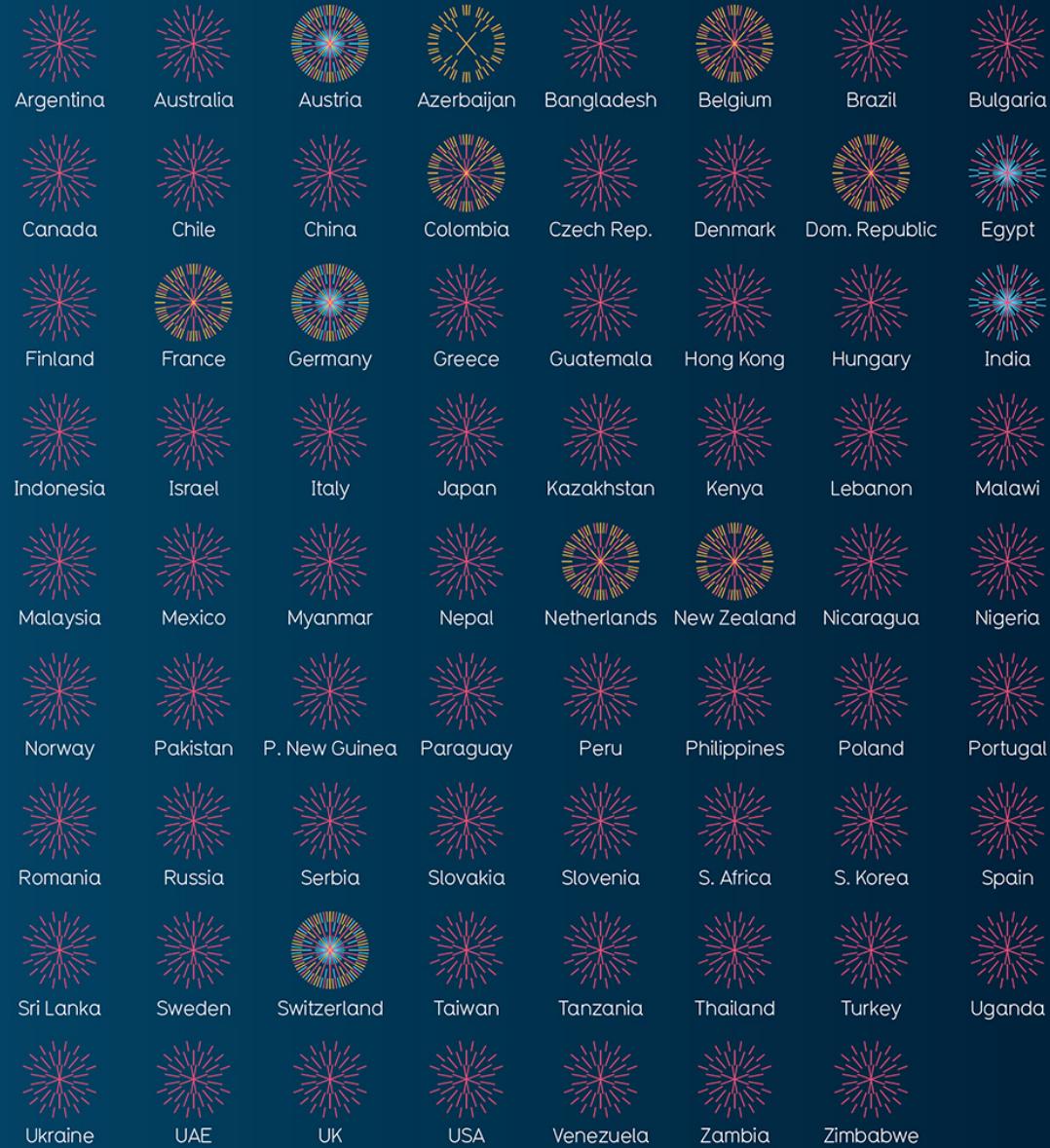
BILL GATES

Sources: World Economic Forum, EcoWatch, New York Times, BBC, Wikipedia, Bill Gates 'How to Avoid a Climate Disaster', Carbon Dioxide Removal Primer

# More Places Are Protecting Animals

## More Laws Are Coming into Effect

 basic law against cruelty  civil code recognising sentient nature  constitutional duty to protect animal dignity



sources: national Geographic, Global Animal Laws, Washington Post

130 | 131

## Laws to Protect Animals & Pets Are Becoming More Widespread



Wild Animals in Circuses



Whale & Dolphin Captivity



Animal Testing for Cosmetics



Capturing Baby African Elephants for zoo's & Circuses Is Globally

**BANNED**



Elephants are intelligent & social, and suffer when removed from their herds



They can now only be moved to African countries with native elephants

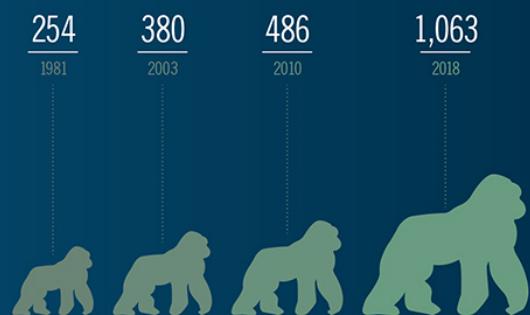


Export overseas is banned - except for genuine conservation

## And Some Animals Are Bouncing Back

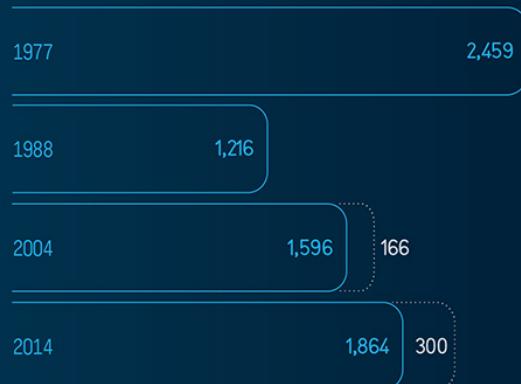
### Mountain Gorilla Numbers Rising

One of the most endangered species in the world



### Giant Pandas Rebounding

Numbers in the [wild](#) and captivity

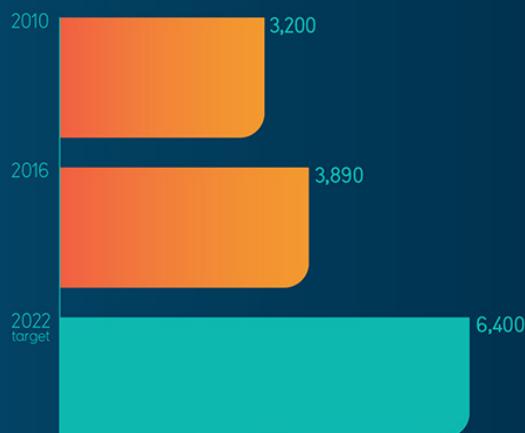


sources: Oryx, WWF, African Journal of Ecology

sources: World Wildlife Fund, IUCN Red List

### Wild Tigers Increasing

Target: nearly doubling the population by 2022



source: World Wildlife Fund

132 | 133

### Rhino Populations Growing

Thanks to law enforcement & population relocation

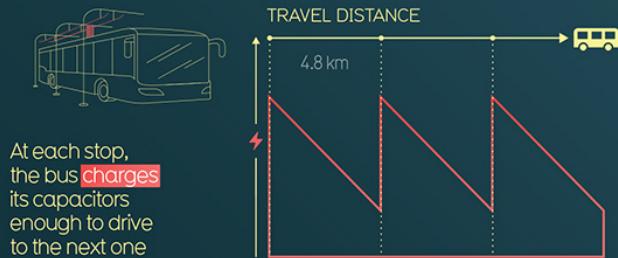


source: BBC Science Focus

# Transport

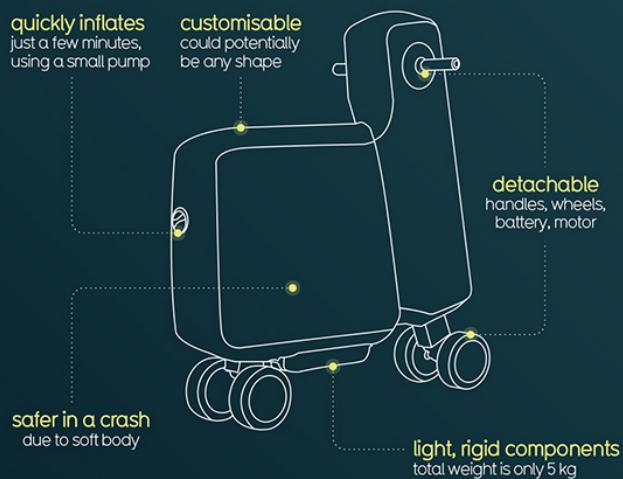
## Supercapacitor Buses Are a Thing Now

Shanghai has a network of efficient rechargeable buses



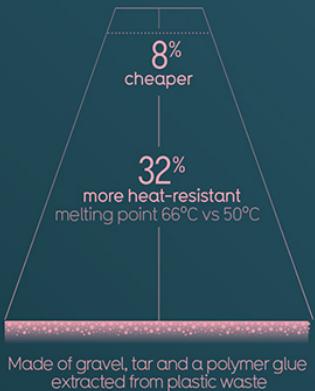
## The Inflatable Electric Scooter

The 'poimo' fits inside a backpack



## Plastic Roads

Made from recycled waste



1 km uses the equivalent of  
1,000,000 plastic bags

3X longer lasting      70% faster to build      4X lighter



fully recyclable at end of lifespan

Currently made from polypropylene plastic found in



## Japanese Wooden Cars



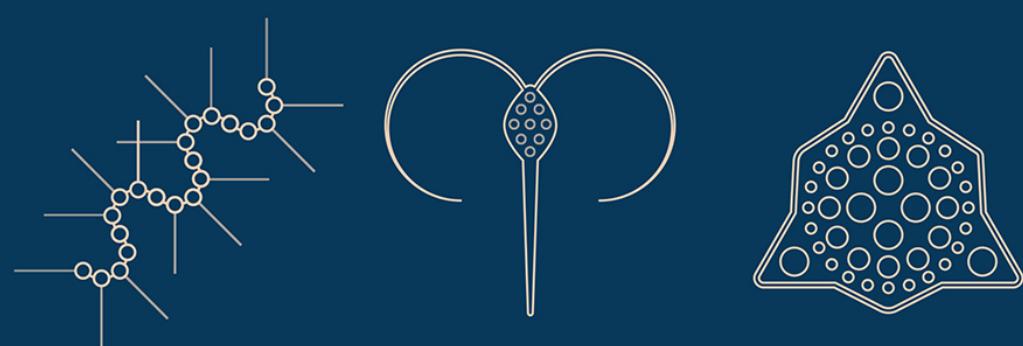
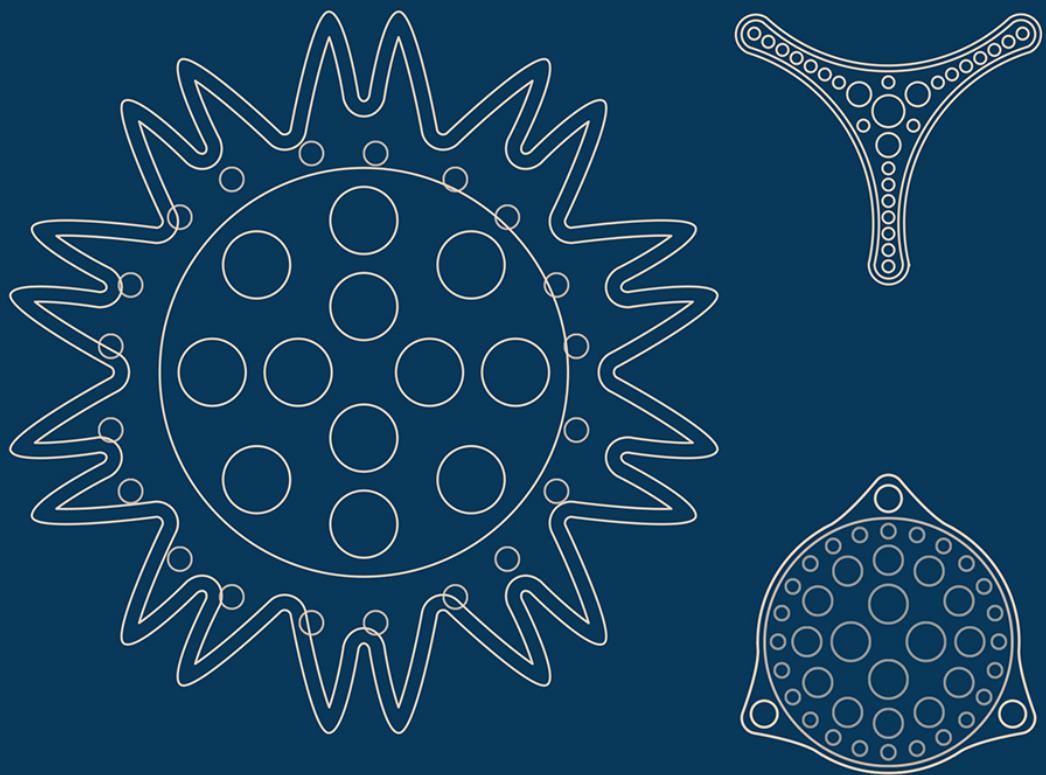
A plant-based nanofibre makes them stronger than steel, but five times lighter, removing as much as two tonnes of carbon from the car's life cycle.

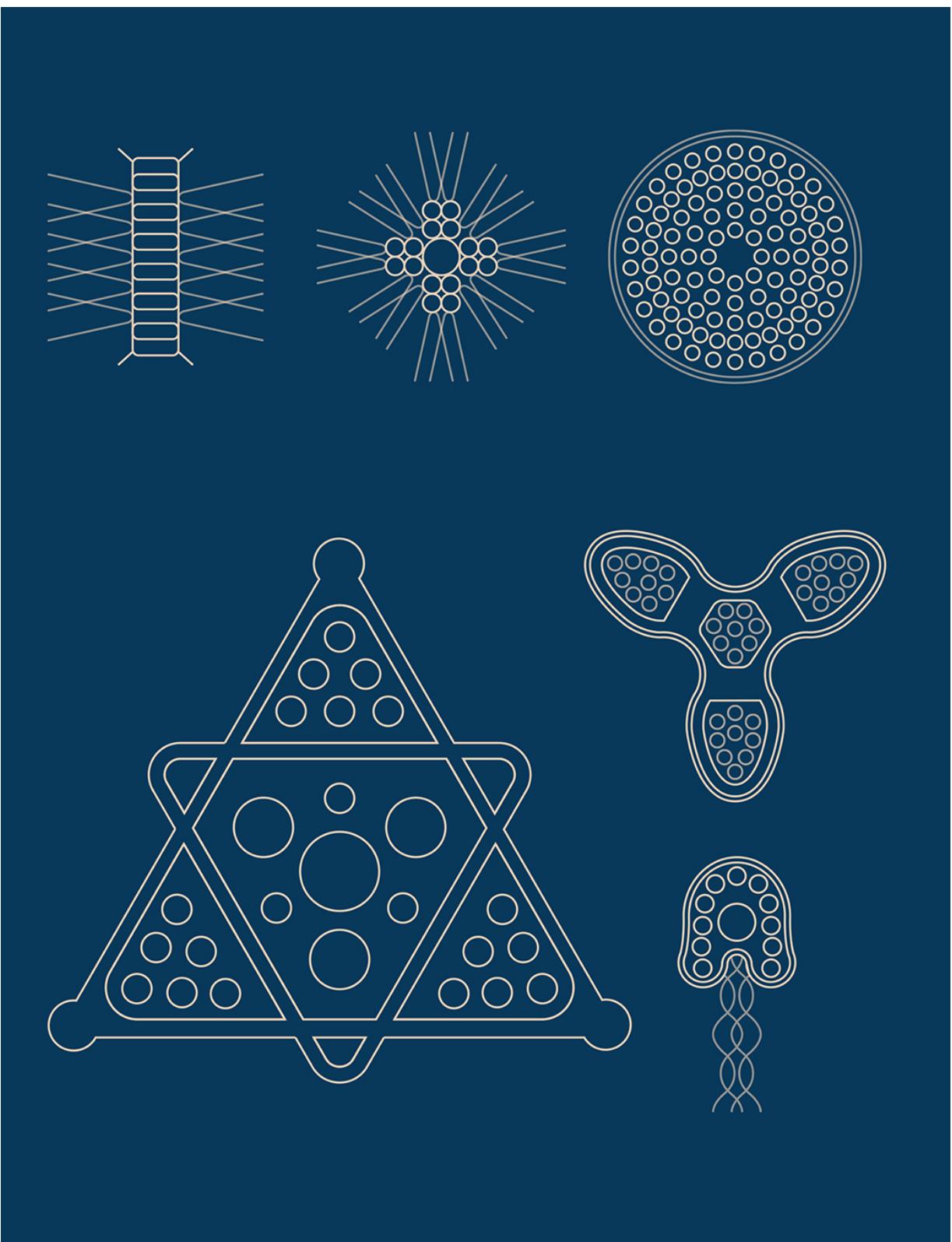
## Hydrogen Shipping



shipping emissions are high, around 2% of all greenhouse gases  
green hydrogen converted to ammonia fuel = zero emissions  
x000

sources: Shine.cn, PlasticRoad BV, Dezeen, Japanese Ministry of the Environment

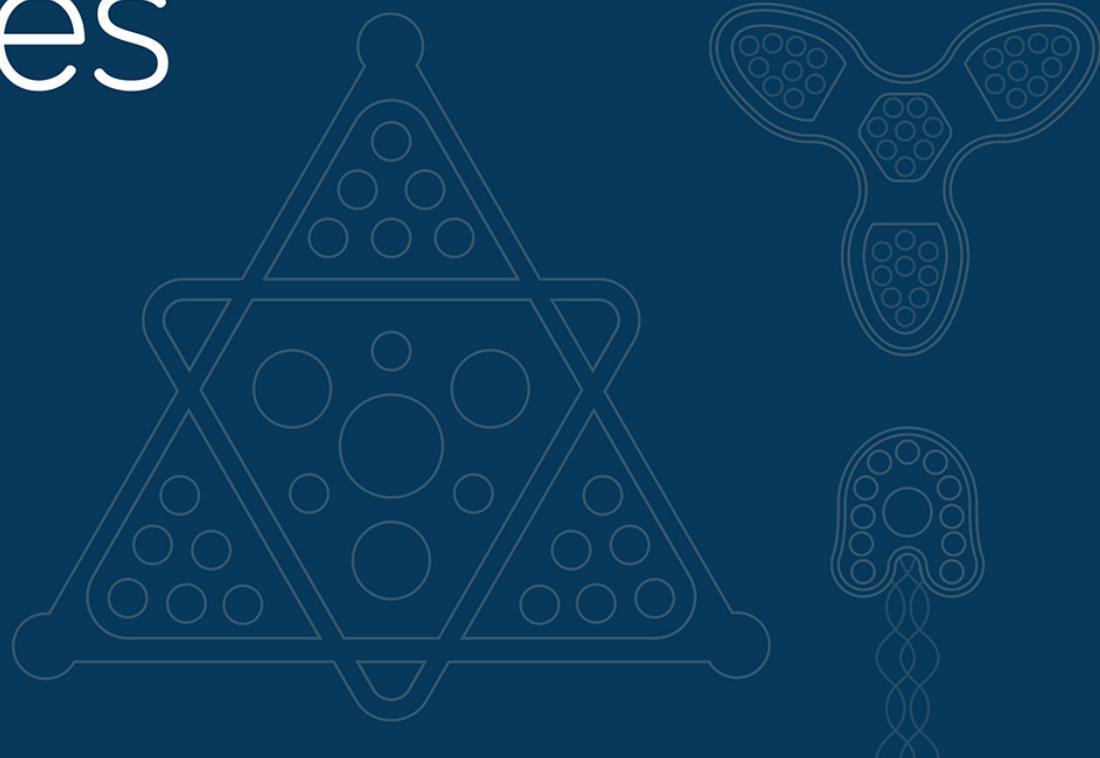




Microscopic phytoplankton and algae in the upper ocean absorb four times more CO<sub>2</sub> than the Amazon

as much as 40% of our emissions  
the equivalent of 1.7 TRILLION trees

# phytoplankton upper ocean ches



source: Buesseler et al (2020), BBC Science Focus Magazine

# The Kigali Amendment is maybe one of the best global agreements you've never heard of

It seeks to eliminate the use of hydrofluorocarbons

## HFCs are man-made gases

We use them to replace ozone-destroying CFCs



air conditioning



refrigeration



refrigeration

Unfortunately, they are also extremely potent greenhouse gases

HFCs  
up to  
12,500x  
more

warming  
potential  
of CO<sub>2</sub>

They're emitted in very small quantities...

contribution to warming  
2%

...but these quantities are rising



## Enter the Kigali Amendment

It aims to cut HFC use by 80-85% by the late 2040s starting...

- 2019 rich and developed economies e.g. Canada & EU
- 2024 large & emerging economies China & Brazil
- 2028 hot climate, lower-income nations India, Pakistan, Saudi Arabia

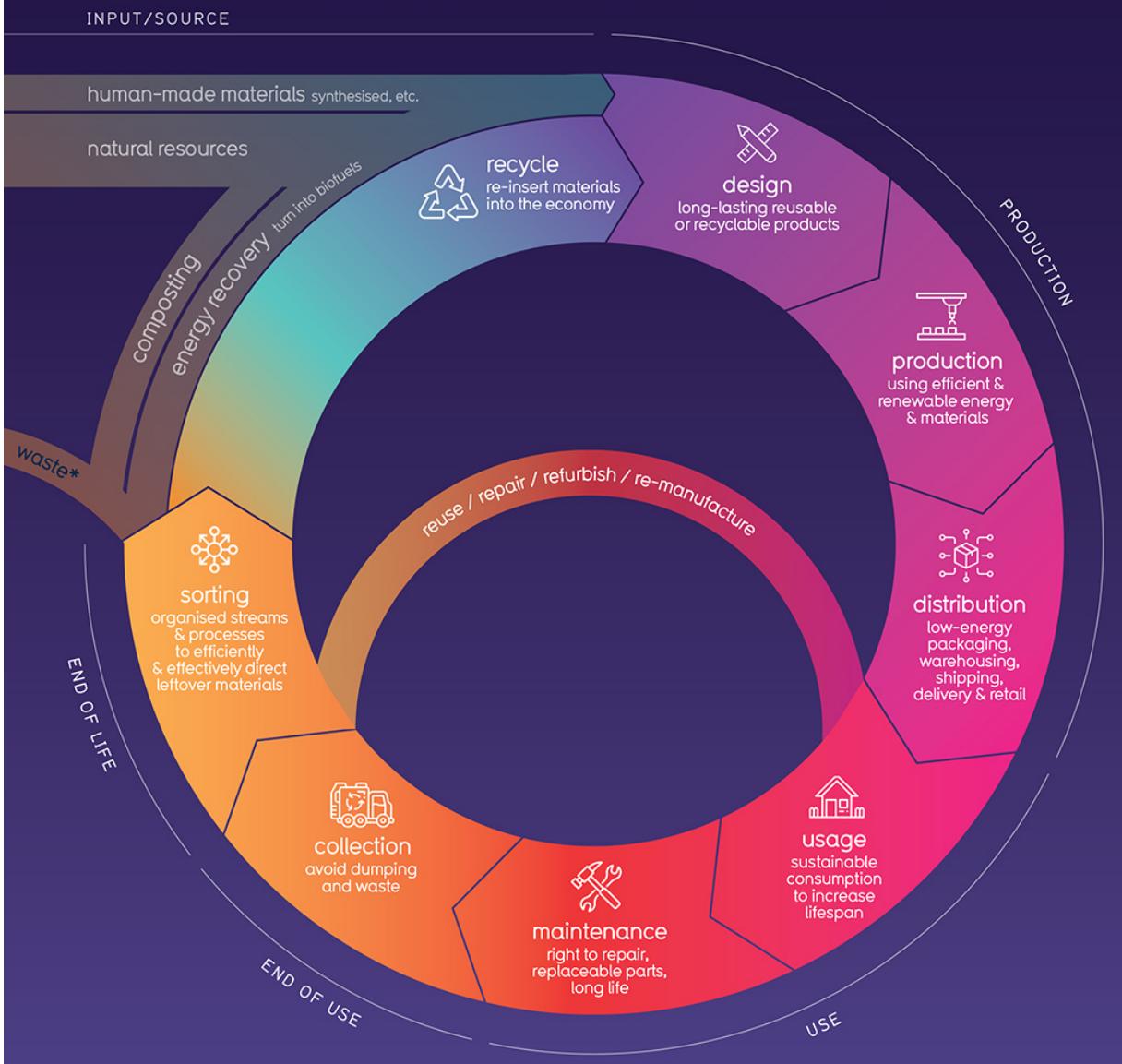
118 countries have signed up so far



If successful, the Kigali Amendment will cut warming by 0.5°C by the end of the century

Sources: United Nations, World Bank

# The Circular Economy Makes Sense



## The Linear Economy

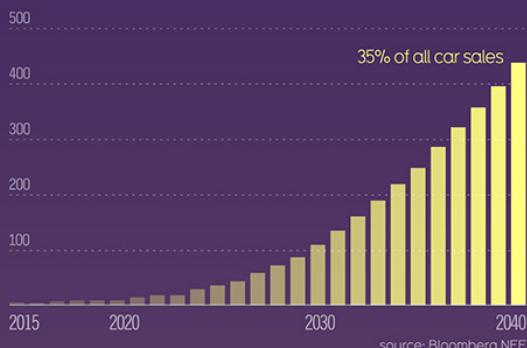


source: Ellen McArthur Foundation

# Electric Cars Are a No-Brainer

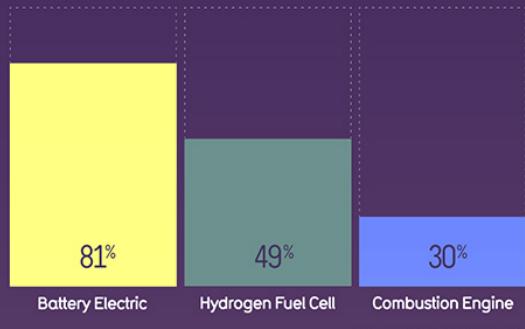
They Are Inevitable

Million electric cars on the world's roads



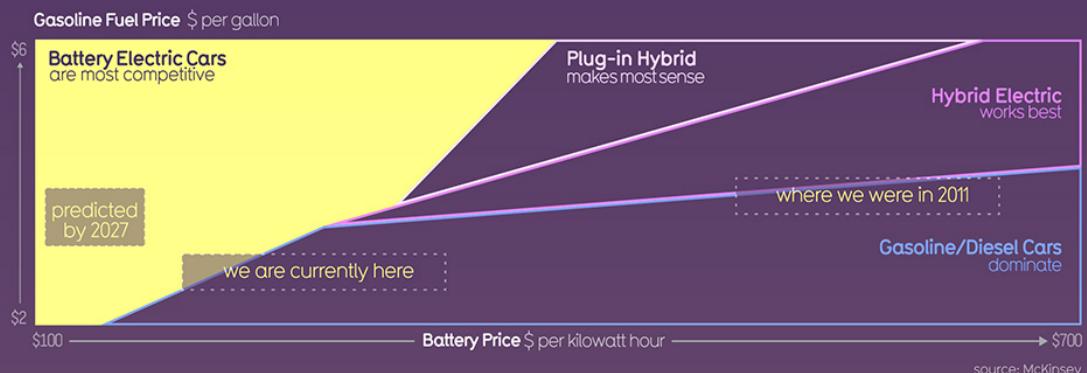
They Are Way More Efficient

% of energy delivered to wheels

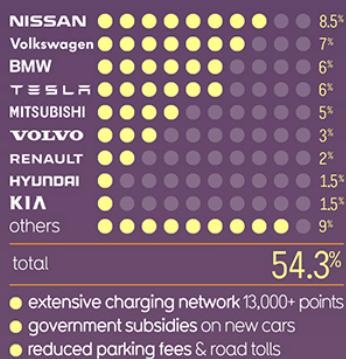


We Are So Close to the Tipping Point'

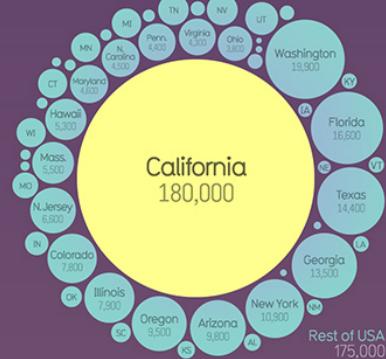
When different car types are most feasible....



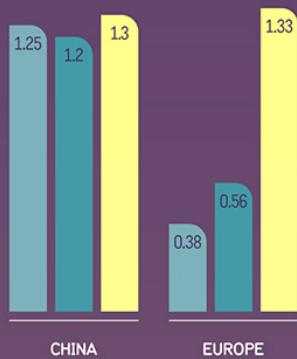
Norway Is Leading the Charge  
Over half of new car sales are electric



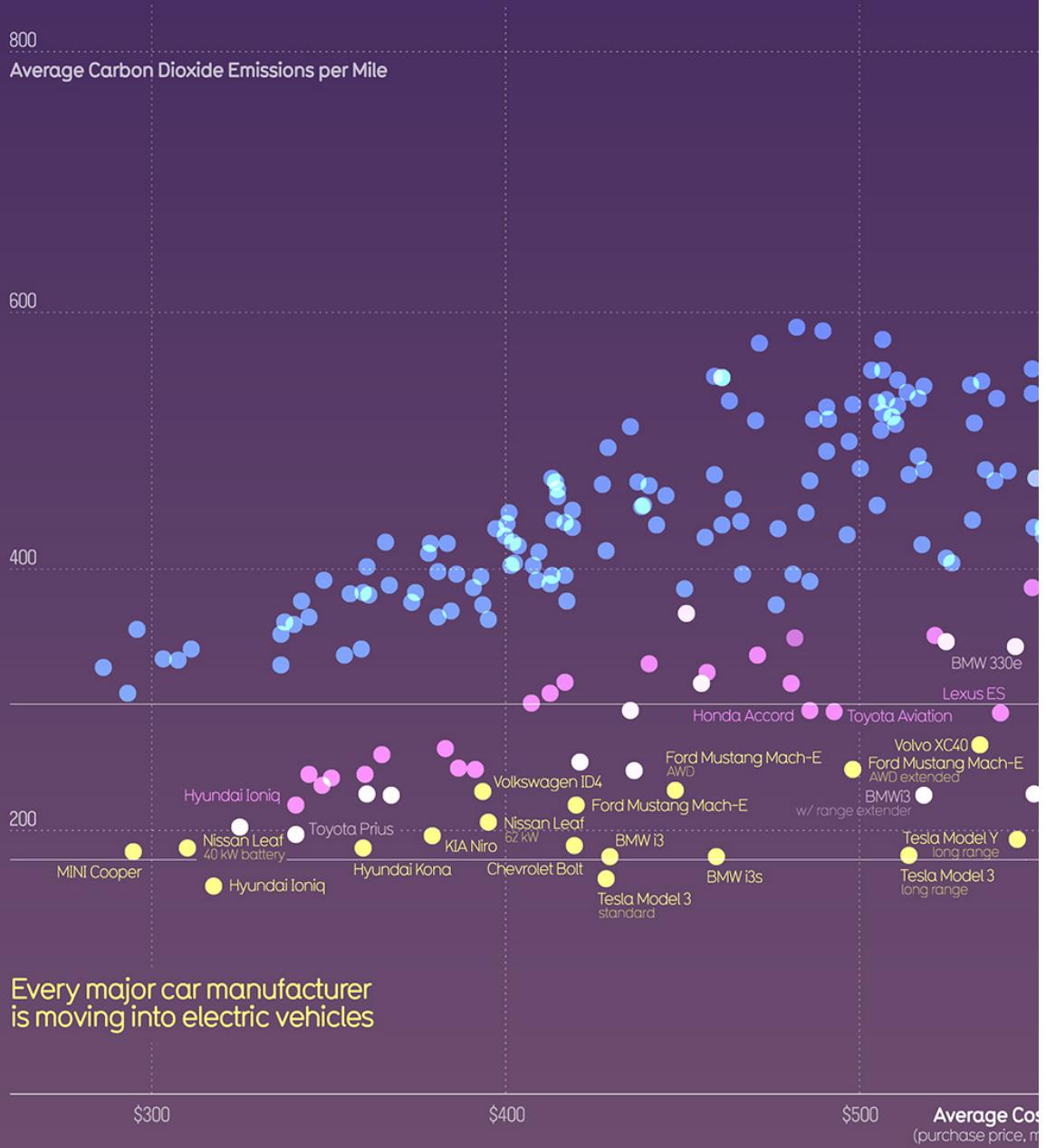
Along with California  
electric vehicles sold

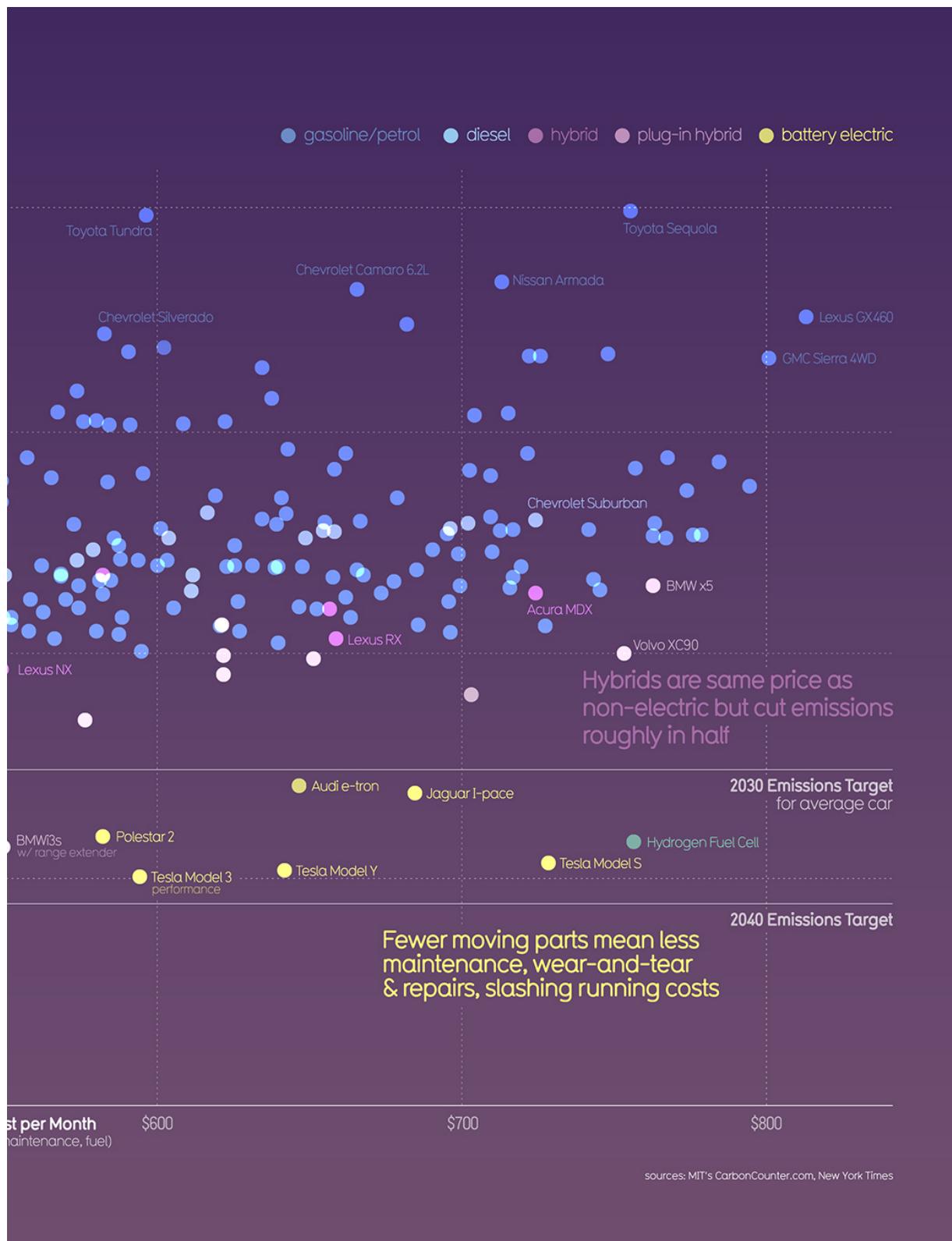


...Europe and China  
million sales 2018 2019 2020



## Electric Cars Have The Lowest Costs & Emissions Over Time





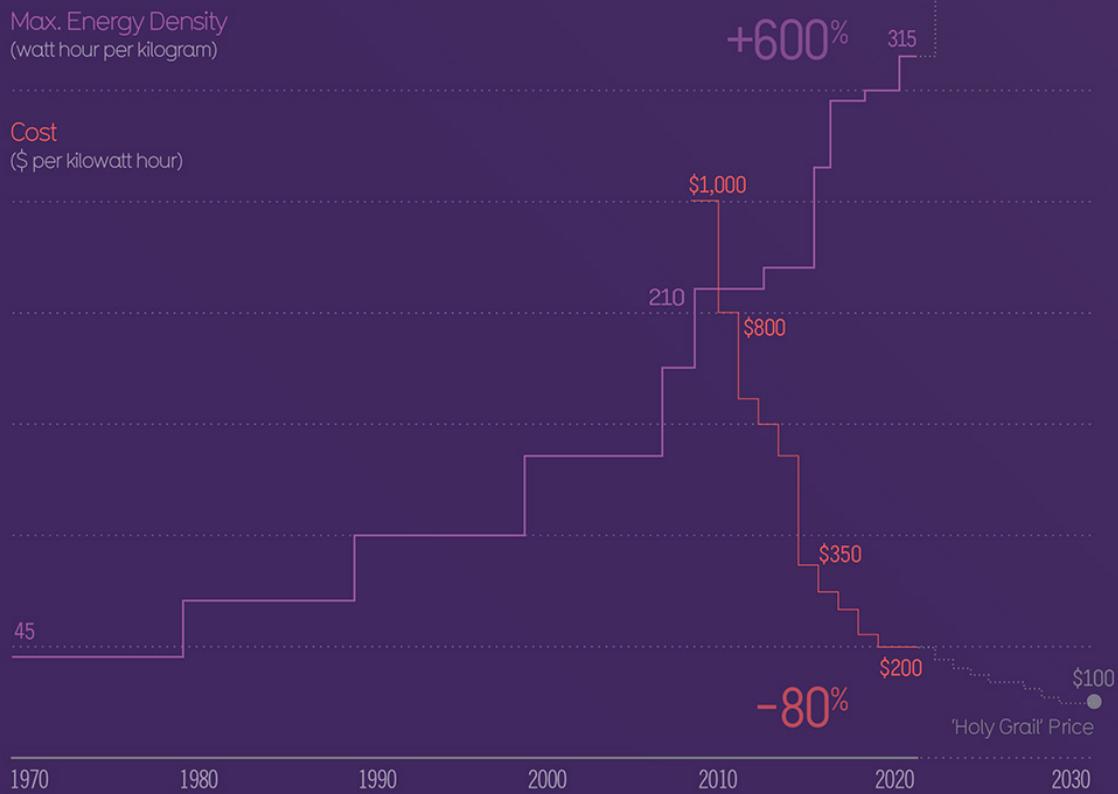
# Batteries Are Getting Better & Better

2-3x  
increase  
likely  
600\*

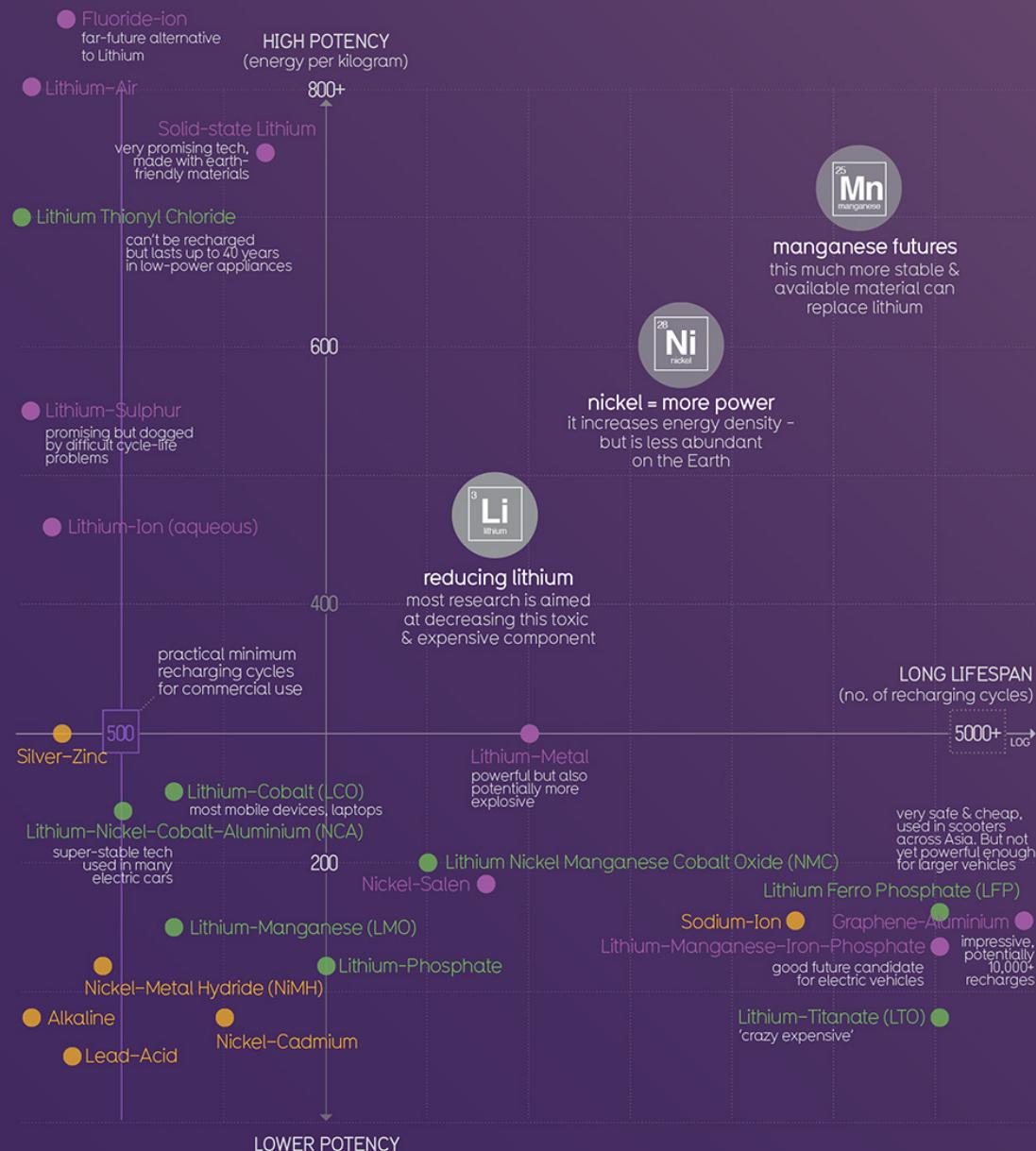
Rechargeable **Lithium-based Batteries** Are the World Leader



They Are Getting **Cheaper & More Powerful**



# Old-School, Current & Future Battery Technology



sources: Forbes, Associated Press, Battery University, Yang et al (2019), Broux (2018), Wikipedia

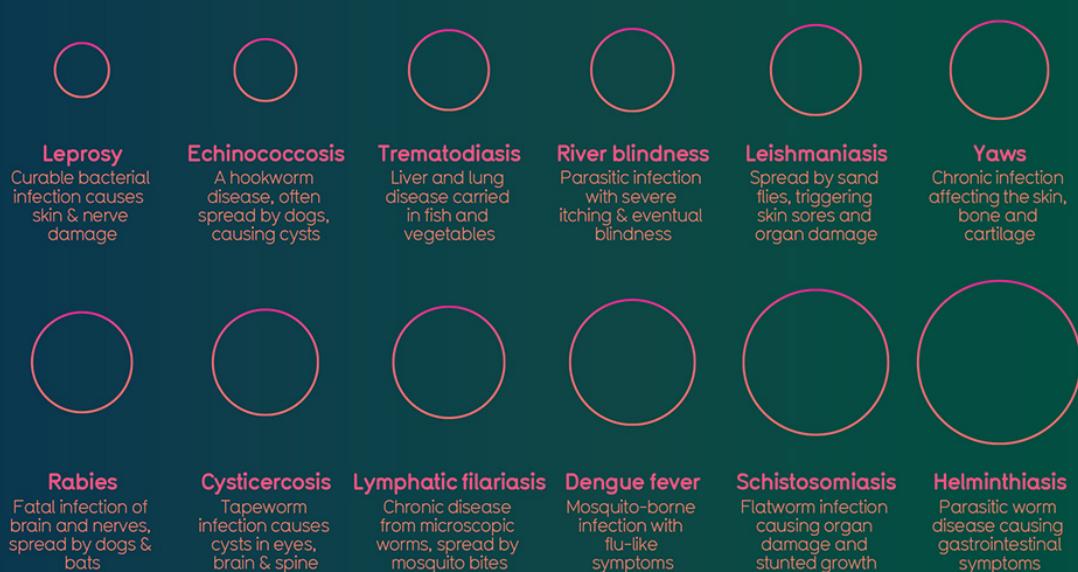
# Fewer People Are Suffering from Neglected Tropical Diseases

29% of world population affected



## Major NTDs

● = impact on lives (DALYs)



sources: United Nations, World Bank, World Health Organization

# A Wall of Fertile Land Will Cross Africa

The Great Green Wall is a mosaic of trees, cropland & ecosystems



improve food  
& water supply



restore 1m km<sup>2</sup>  
of degraded land



create 10 million  
rural jobs



sequester  
carbon dioxide



prevent  
migration out

PROGRESS  
**15%**  
completed

FINAL LENGTH  
**8,000 km**

source: GreatGreenWall.org

**carbon taxes/pricing**  
fees that must be paid when  
greenhouse gasses are released  
into the atmosphere

Current emitters don't pay for the  
climate damage caused by emissions

That's why fossil fuels stay artificially  
cheap to produce and use.  
**Their true cost is hidden.**

(usually hundreds of billion dollars a year – hurricanes, wildfires, floods, heatwaves, forest fires)

Carbon pricing reinjects these costs  
back into the economy to create a  
true price for emissions.

This coaxes businesses to pay for  
environmental pollution  
**so returning any revenue back to  
taxpayers & society**

---

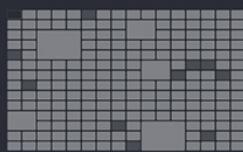
If done well, carbon pricing can...

---

- use** market forces effectively to encourage change
  - act** as a disincentive to emit greenhouse gases
  - spur** creation of carbon-free alternatives
  - reduce** consumption of carbon fuels
  - motivate** improvement of energy efficiency
  - speed up** the transition to zero-carbon fuels
  - reduce** or even eliminate the use of fossil fuels
  - raise** money to combat climate fallout & rising energy costs
- 

It's challenging to make work, but currently the best option for a fair, global framework that will actually drive down emissions

---



the Paris Agreement  
has many provisions  
for carbon pricing



models show carbon  
taxes & pricing substantially  
reducing emissions



many systems are  
already in place -  
or planned....

Sources: Carbon Tax Center, National Geographic, Carbon Brief, Clean Technica, World Bank, New York Times

# Carbon Pricing Is Catching On Around the World

57 schemes implemented or scheduled worldwide

\$230 billion carbon trading global market already established



on track to become one of the biggest commodity markets

46 national, 28 subnational regions and cities

growing fast year on year -30% in 2019



11 gigatonnes or 20% of human emissions covered

## Global Carbon Schemes IN OPERATION SCHEDULED UNDER CONSIDERATION

**BRITISH COLUMBIA** 2008  
REVENUE-NEUTRAL carbon tax on households & industries  
Money generated fed tax rebates and tax reductions  
Reduced emissions with no hurt to jobs or households  
**VERDICT SUCCESS**



**CALIFORNIA** 2017  
CAP & TRADE covers power plants, refineries & industry  
Initial price was set too high, resulting in modest results  
Emissions reduced but mostly due to other measures  
**VERDICT MIDDLING**

## What Should Carbon's Price Be?

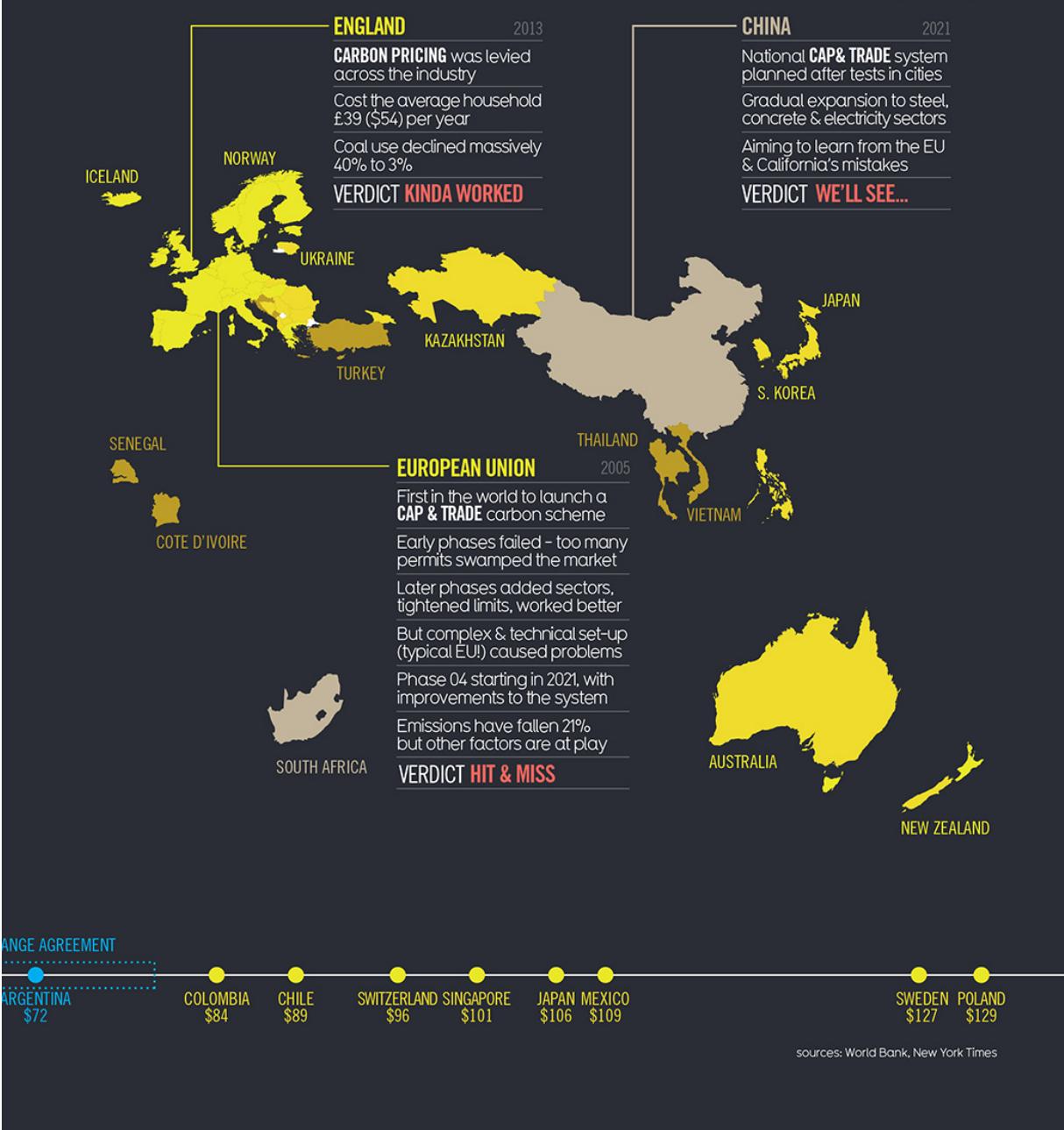
Calculating the correct price for carbon pollution is difficult as the social cost varies between countries

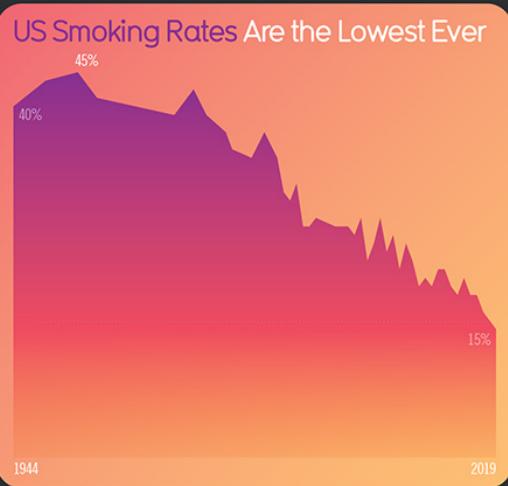
CARBON PRICE \$ PER TONNE OF CO<sub>2</sub>e



## types

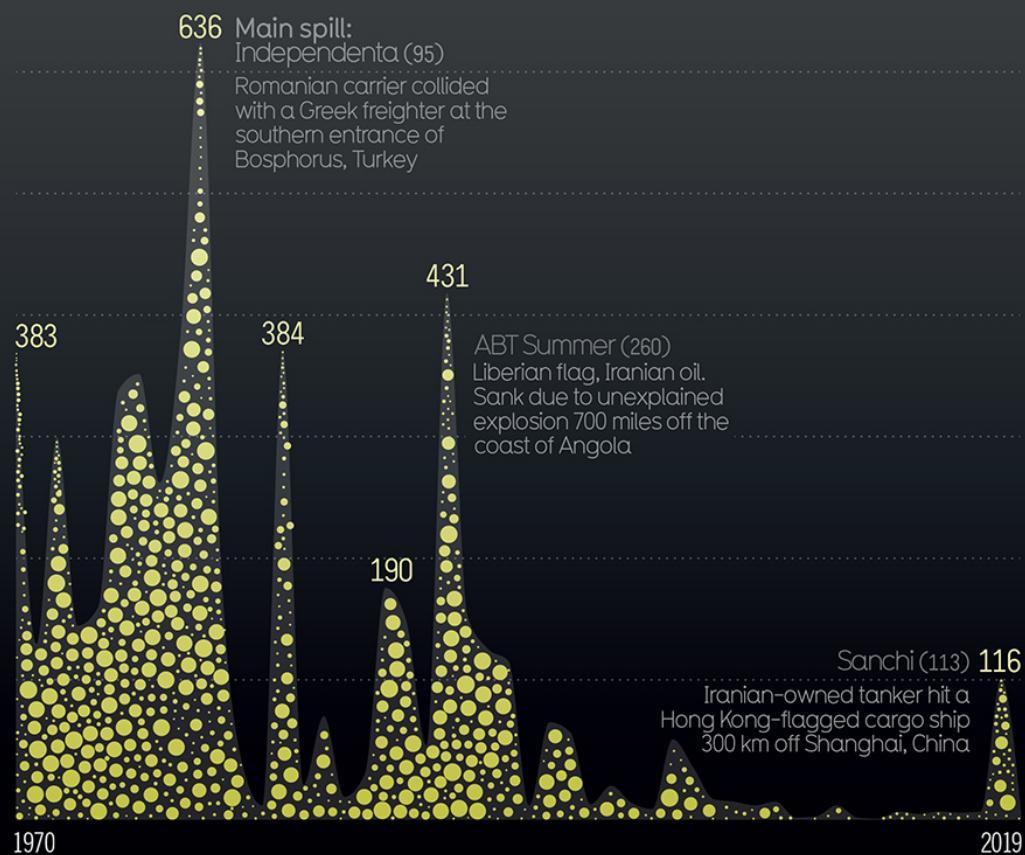
- ① WELL HEAD the company which extracts the carbon is taxed
- ② REVENUE-NEUTRAL softens impact of pricing by reducing taxes elsewhere in society
- ③ CAP & TRADE companies buy, sell & trade a fixed number of permits to emit carbon
- ④ HYBRID a mix, perhaps involving subsidies, feed-in tariffs, direct carbon taxes, etc.





## Oil Spills Have Decreased

thousand tonnes spilled

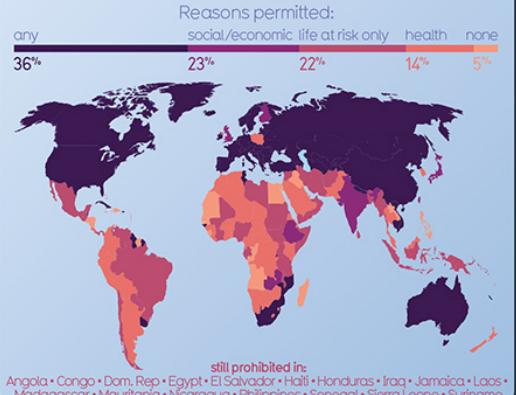


## Norway Recycles Almost All of Their Plastic Bottles



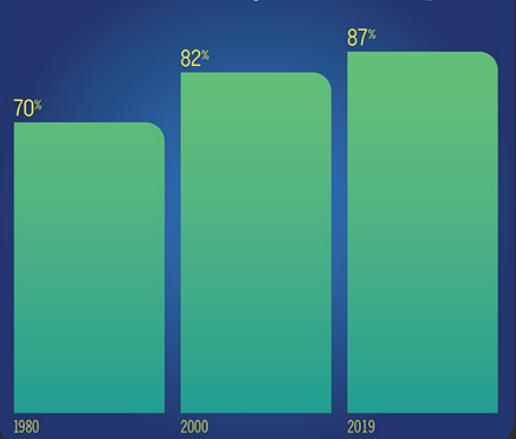
source: climateaction.org

## Most Women Have Some Legal Access to Abortion



source: Center for Reproductive Rights

## Global Literacy Is Increasing



source: World Bank

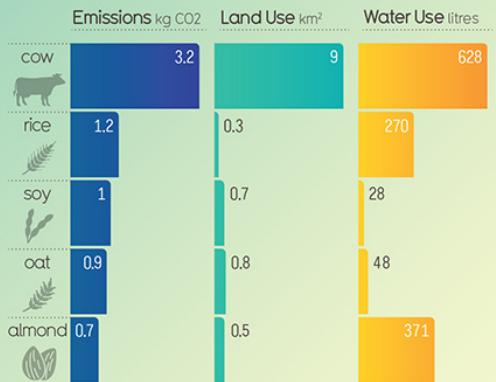
## These Cities are Ruling Bike-Sharing

rental bikes per 100,000 people



source: COYA Bike Index 2019

## Soy & Oat Milk Are the Most Sustainable



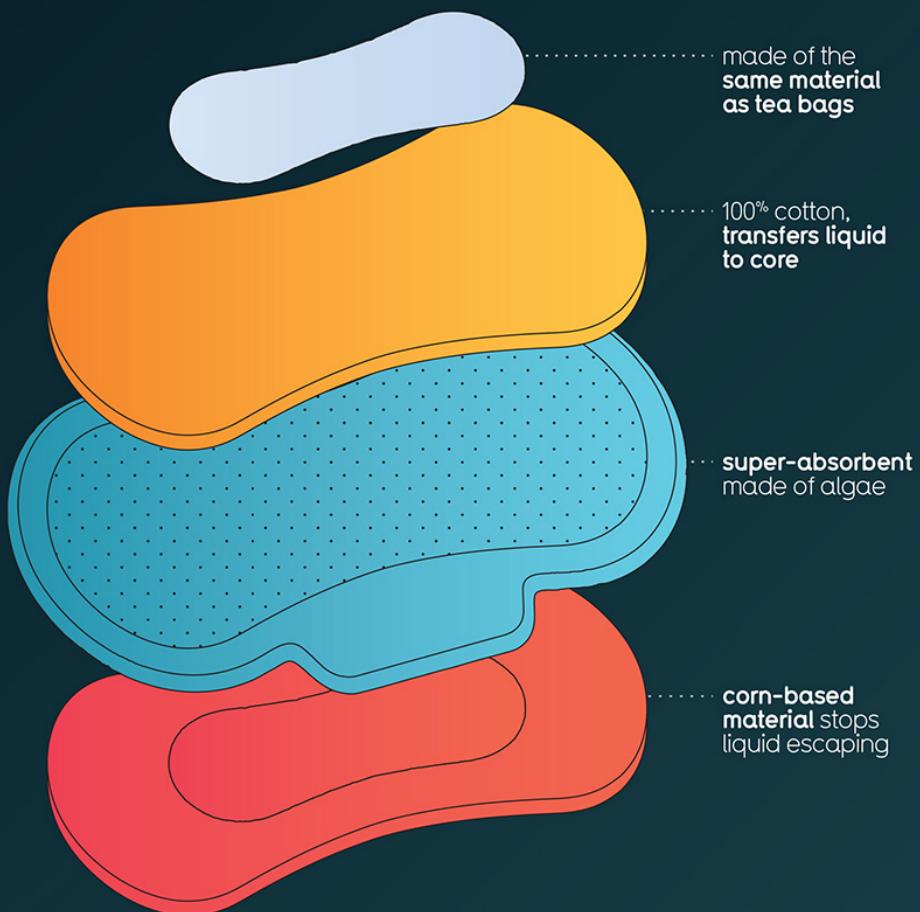
source: New York Times

Ecosia is a search engine that plants trees every time you search.

82,500,000 so far  
One every 1.3 seconds

source: Ecosia

## A 100% Biodegradable, Comfortable Sanitary Pad Has Finally Been Developed



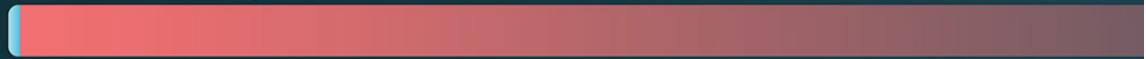
the average pad is  
90% plastic



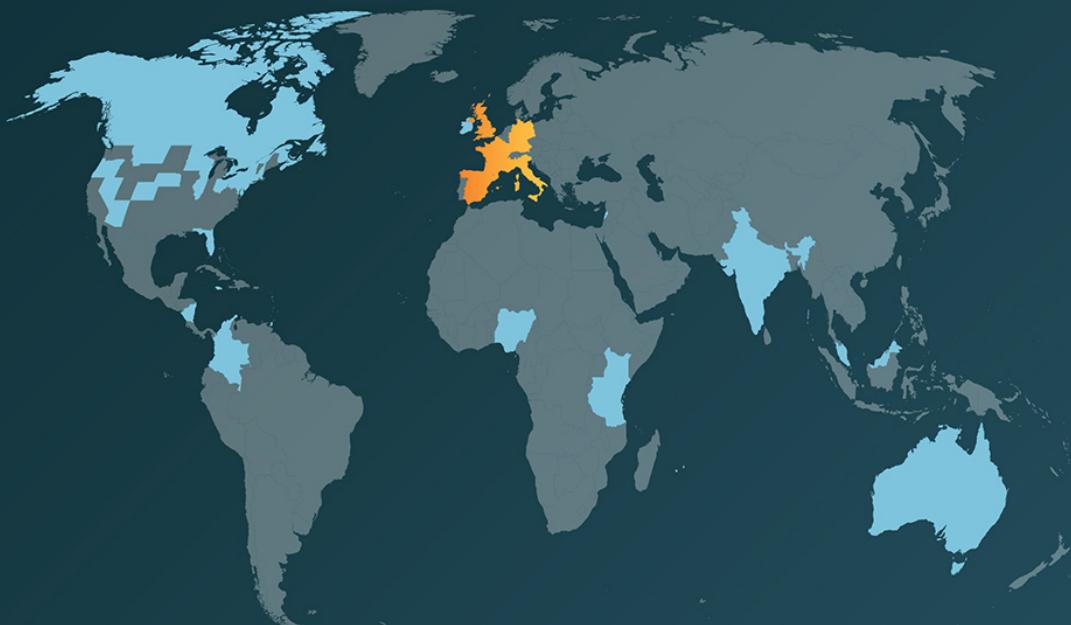
tampon applicator, string & packet are also plastic

### BIO PAD

1.5 to 6 months to degrade



## Nearly a Quarter of the World Now Supports Sales Tax-Free or Reduced-Cost Menstrual Products



Australia, Canada, Colombia, India, Ireland, Jamaica, Kenya, Lebanon  
Malaysia, Mauritius, Nicaragua, Nigeria, Tanzania, Trinidad & Tobago

Alaska, Arizona, Colorado, Connecticut, D.C., Delaware, Florida, Illinois, Maryland, Massachusetts, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Wisconsin



17 billion tampons  
are sold yearly



and at least 40%  
more sanitary pads



98% are discarded,  
ending up in landfills



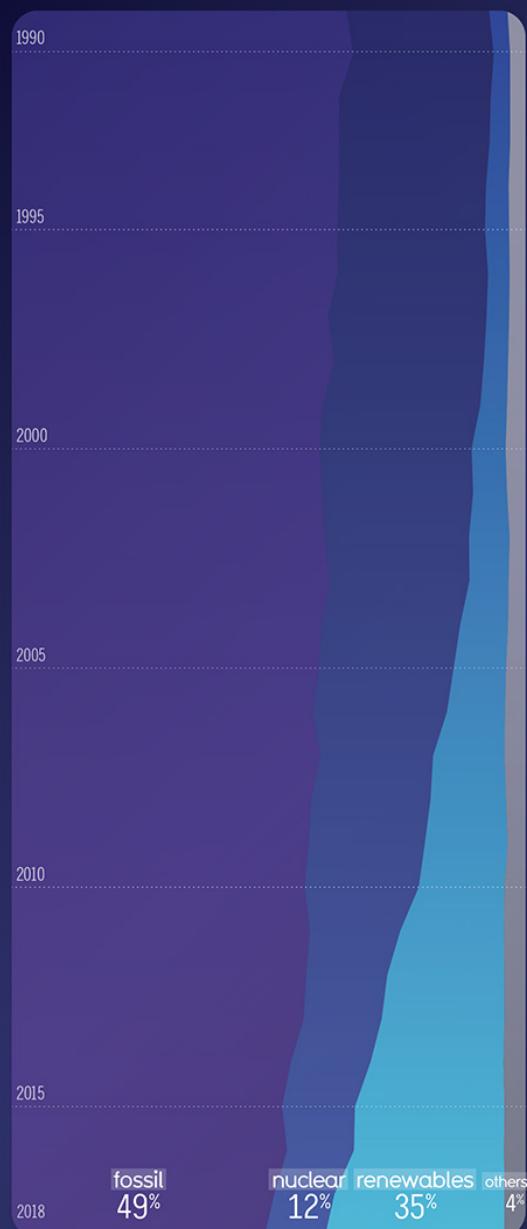
and take hundreds  
of years to degrade

**NORMAL PAD**  
centuries to degrade

Sources: University of Utah, Civiq, BBC, Tax Foundation

## Yay Germany!

Germany's Renewable Energies Are Pushing Back Fossil Fuels



source: Energie AG

Over Two-Thirds of Refugees in Germany Are in Work after Five Years



source: Deutsche Welle, Data 2013-2018

The first country in the world to ban chick-shredding

the chicken & egg industry's 'dirty secret'



all newborn male chicks are killed at birth



often by just being thrown into mechanical shredders



because they can't lay eggs so are not profitable

45 MILLION CHICKS KILLED A YEAR IN GERMANY ALONE  
123,000 per day    5,100 per hour    85 per minute

☒ verboten from 1st Jan 2022 ☒

farmers will use tech to determine a chick's sex before birth

source: DW.com

## More and More People Are Gaining Access to Electricity

100% of world population

89.6%

71.5%  
plugged in

340,000  
people per day

1990

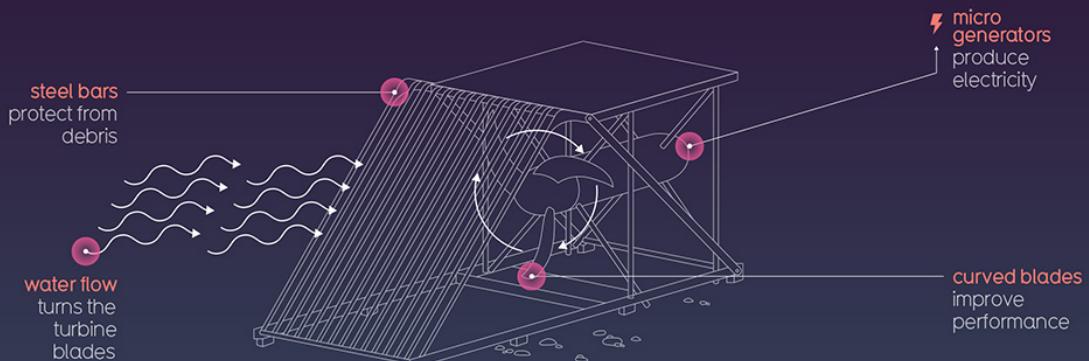
2018

source: World Bank

# New Ways to Create & Store Energy

## In-Stream Hydro Generates Zero-Carbon Power Without Environmental Damage

Small hydropower units can be placed in rivers or even inside city water pipes



From Alaska to Nepal, schemes are being proposed in remote communities to replace old, dirty and expensive diesel generators

### PROS



predictable power output



easy to install and maintain



very little space required



low power in summer months



low costs (no dams)



low ecological impact



minimal noise disturbance



care to avoid hurting fish

source: Smart Hydro Power

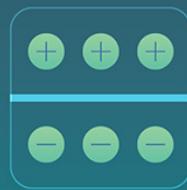
Rivers Could Generate Thousands of Power Plants' Worth of Energy



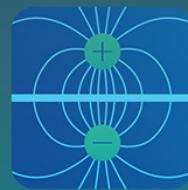
Salt is made of charged particles, positive & negative



When salt water meets fresh water, the particles detach



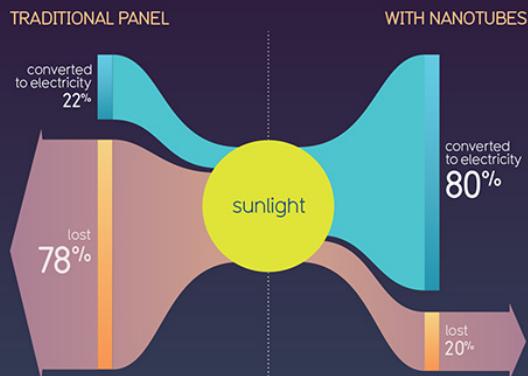
Newly invented blue membrane separates them



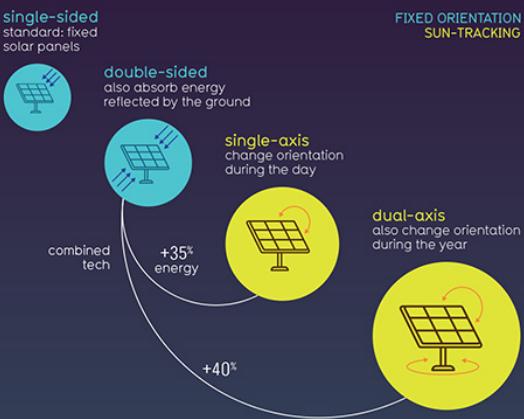
Separate areas are then connected by wire to generate electricity

source: Science Magazine

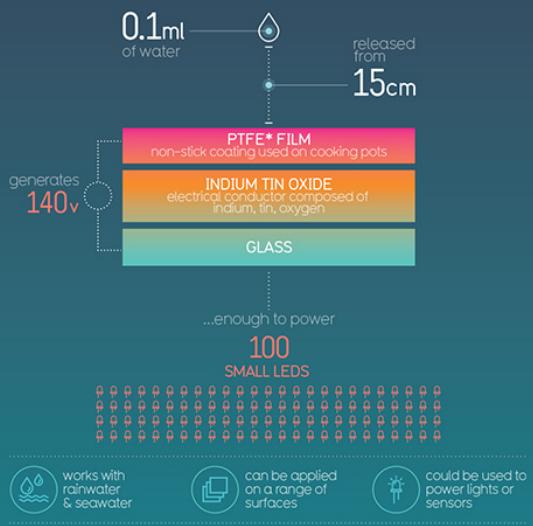
## Coating Solar Panels with Carbon Nanotubes\* Can Triple Efficiency



## Combining Solar Panel Technologies Could Boost Energy Production by a Third

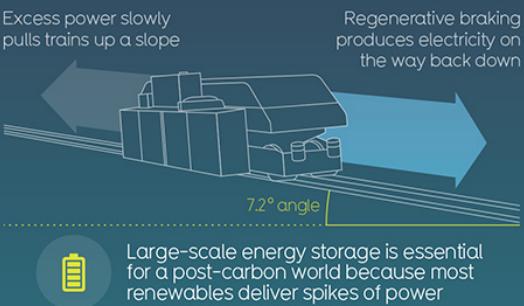


## A New Device Can Harness Electricity from Raindrops



source: Wanghuai Xu et al (2020)

## Ingenious Concrete-Filled Trains Act as Giant Batteries



% of energy retrievable:

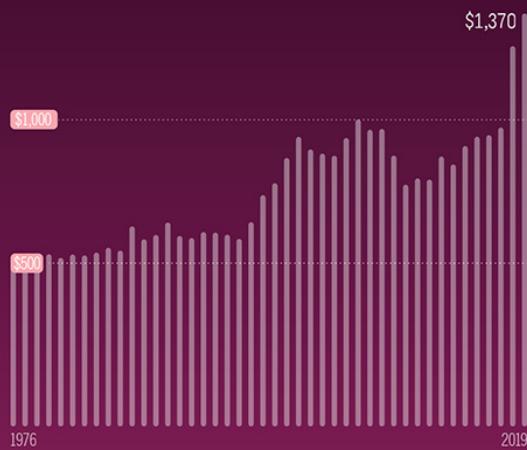


\*e.g. water wheels, steam engines, etc

sources: OVO Energy, Energymag

# Yay USA!

American People Are Very Generous...  
Average \$ donated per person per year



...Donating Billions per Year



source: Giving USA 2019

sources: Giving USA 2019, OECD

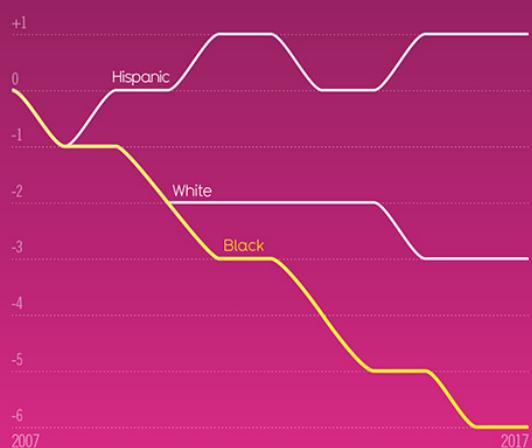
US Prisoner Numbers Are Finally Declining  
Yearly increase/decrease



source: US Bureau of Justice statistics

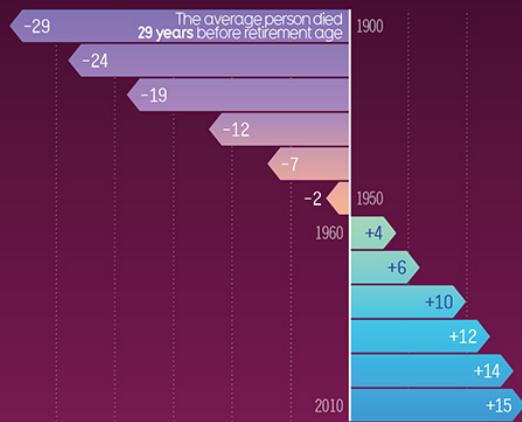
160 | 161

Along with Black Incarceration Rates  
Variation in % of total prisoners



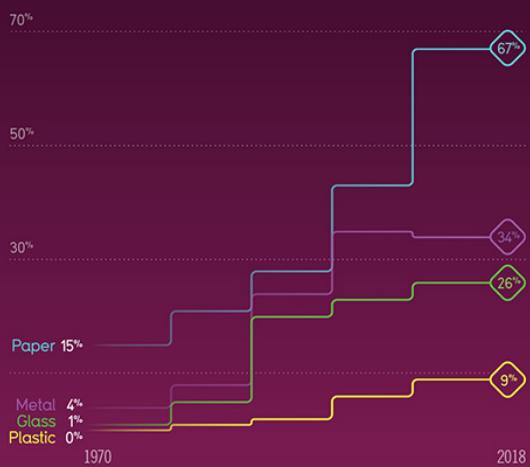
source: US Bureau of Justice statistics

## The Average US Citizen Now Lives Much Longer After Retirement



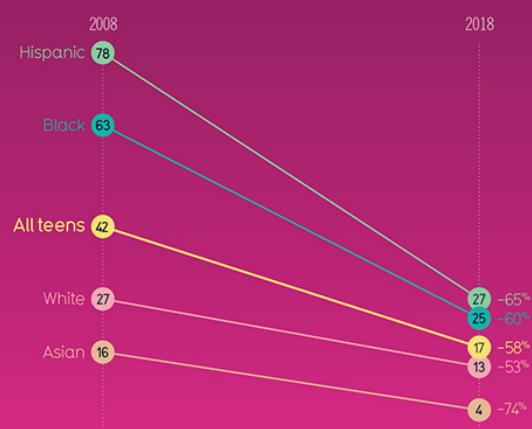
source: Statista

## US Recycling Is Finally Picking Up



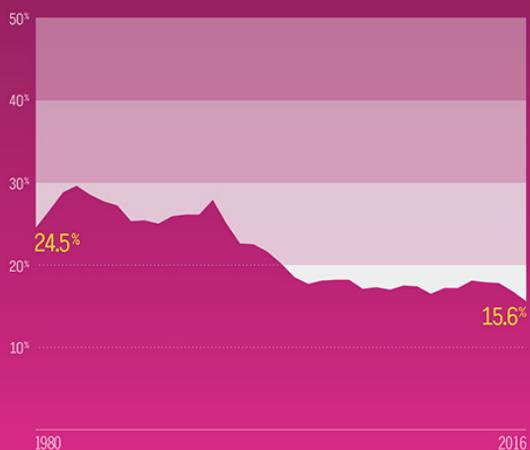
source: US Environmental Protection Agency

## US Teen Pregnancies Have Halved Births per 1,000 females aged 15-19



sources: Centers for Disease Control, Pew Research Center

## US Child Poverty Has Reached an All-Time Low



source: US Department of Agriculture

# The US Aims to Halve Food Waste by 2030

A joint effort by institutions, restaurants & grocery stores

America throws out  
30-40%  
of its food 

creating  
5-11%  
of CO2 emissions 

over \$162 bn worth



## Why is this Happening?



spoilage  
insects, rodents,  
moulds & bacteria



poor management  
bad conservation,  
over-ordering



customers  
buy or cook more  
than needed



attitude  
42% don't have time  
to consider waste

## How will it be fixed?

 reduce surplus food 

 feed hungry people 

 feed animals 

 convert to fuel 

 composting 

landfill

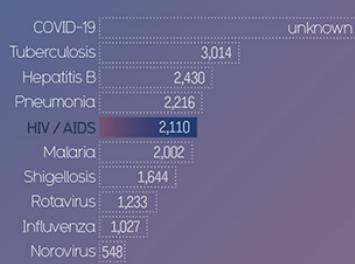
 last resort

sources: USDA, Rescuing Leftover Cuisine, UNEP, OI (2016)

# HIV / AIDS

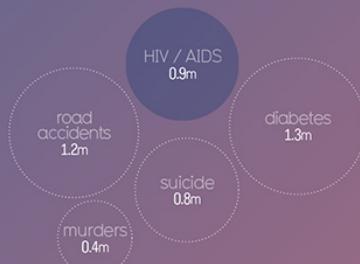
## The World's No.5 Killer Infection

Infectious disease deaths per day



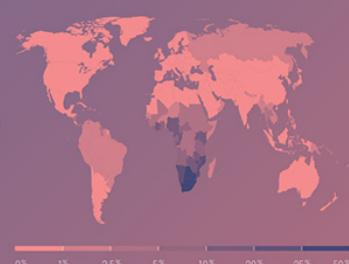
## Claims Nearly 1m Lives Per Year

Million global deaths per year



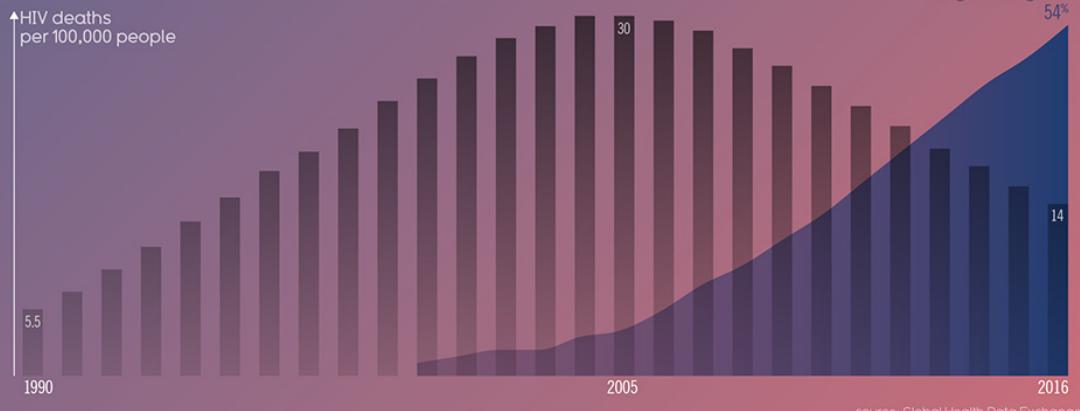
## Mostly in Southern Africa

Highest deaths

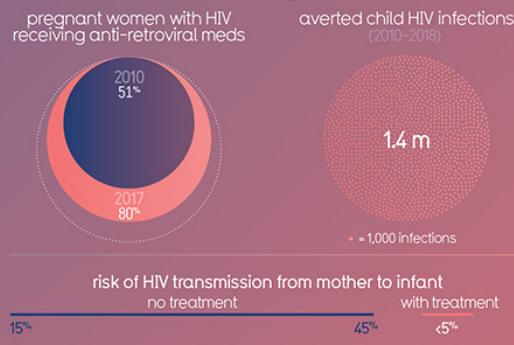


## But HIV/AIDS Is in Remission Globally

Thanks mainly to widespread anti-viral-drug treatment

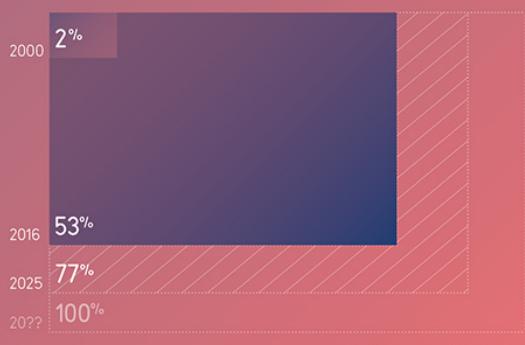


## Prevention of Mother-to-Child HIV Transmission Is Saving Kids



## Even More Sufferers Are Being Treated

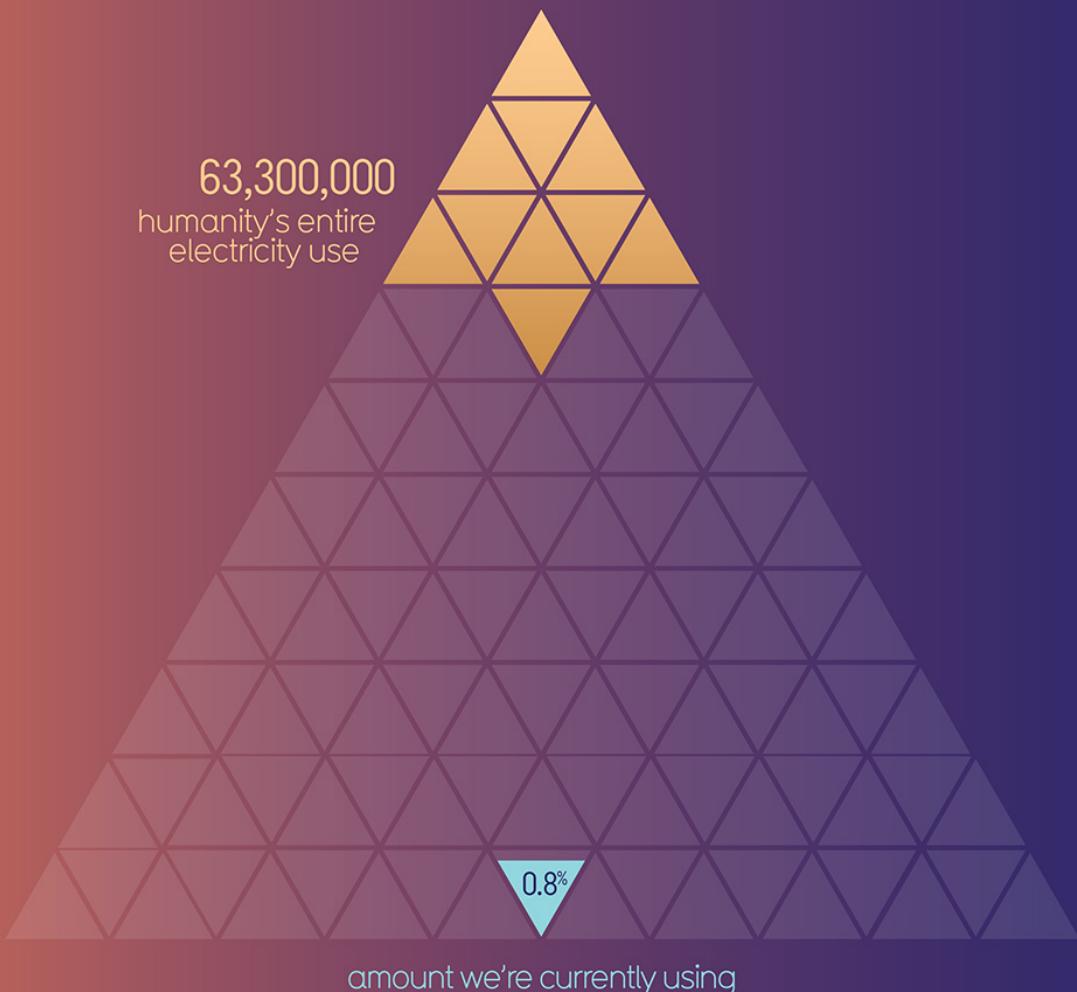
% treated (past & projected)



sources: The Lancet, The Guardian

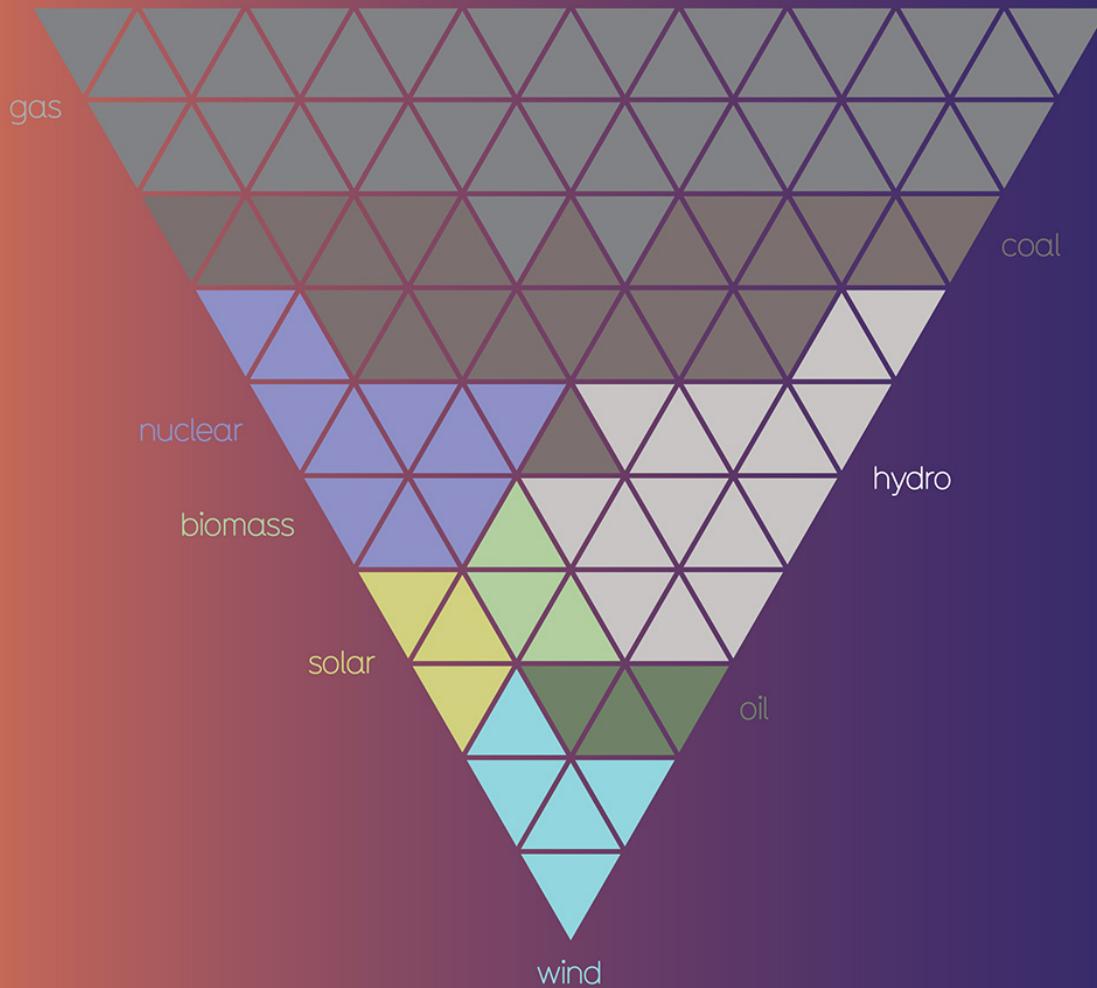
## The Potential of Wind Power Is Amazing

480,000,000  
daily megawatt hours  
global wind-energy potential



source: Global Wind Energy Council

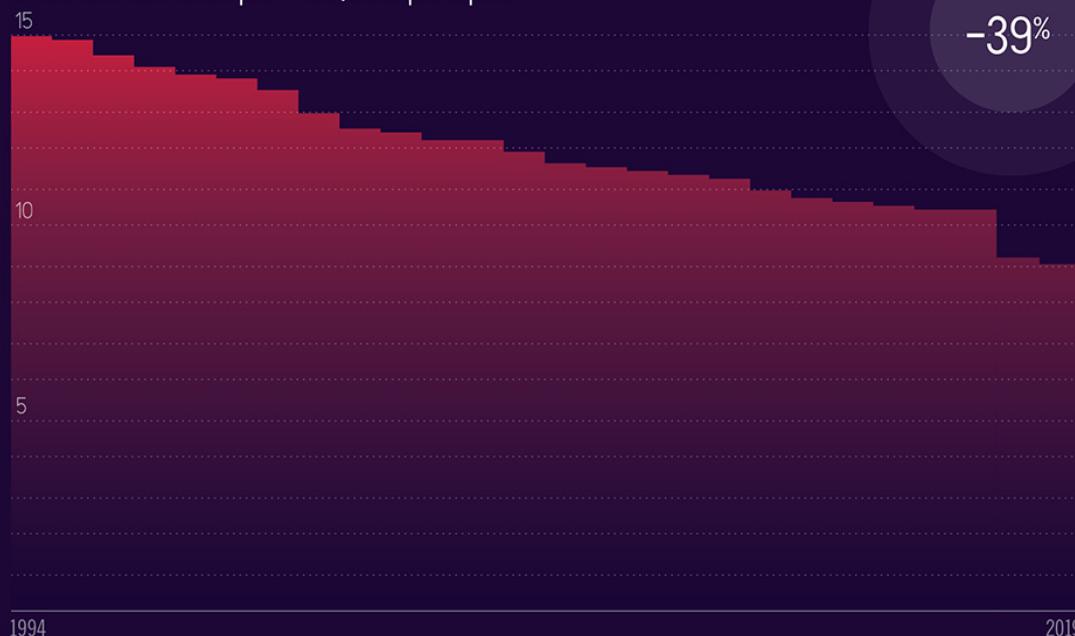
**It Now Supplies 5% of the World's Energy**  
and it's growing



source: International Energy Agency

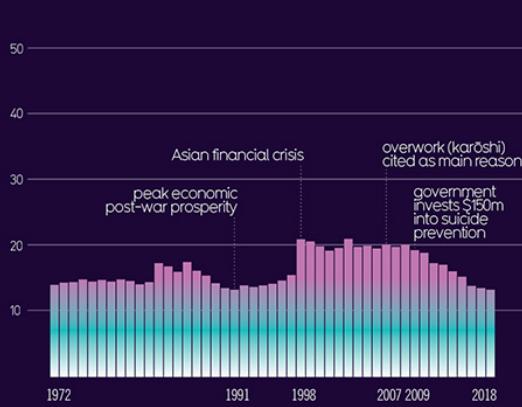
# Suicide

Global number per 100,000 people



Declines in some of the worst-suffering countries

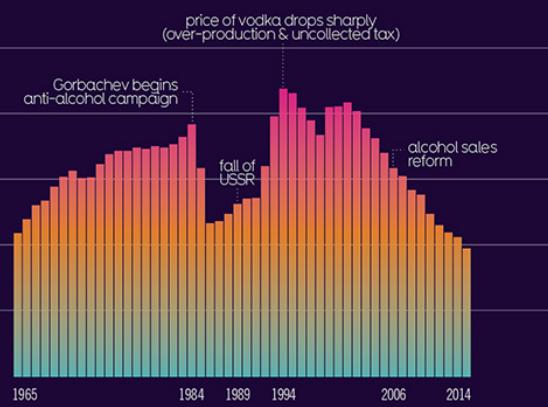
**Japanese Rate Is the Lowest for 46 Years**  
Suicides per 100,000 people



sources: Japanese government statistics, New York Times

166 | 167

**Russia Is also At a 50-Year Low**



sources: Human Cause of Death Database, RossSTAT, Moscow Times

## What reduces suicides?

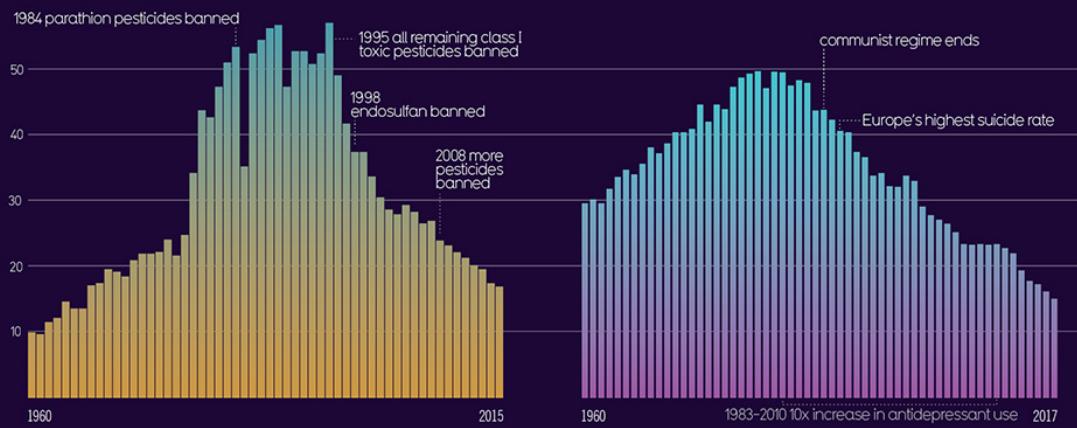
medical policy social cultural



source: Global Health Data Exchange, New York Times

### Heartening Declines in Sri Lanka

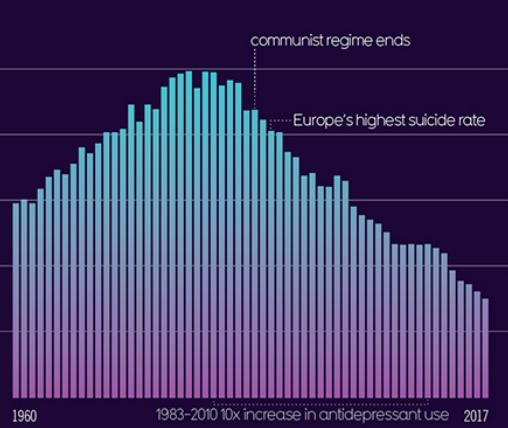
Had the world's highest suicide rate in 1990



sources: Worldbank, The Lancet

### Hungary Is also Showing a Steady Decline

Had the world's highest suicide rate in 1990

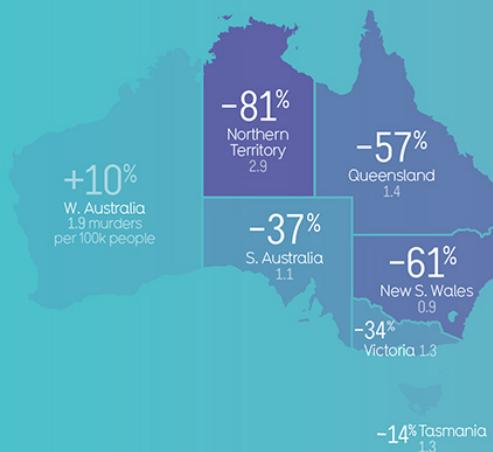


source: OECD

## Yay Australia!

### Australia's Homicide Rate Has Never Been Lower

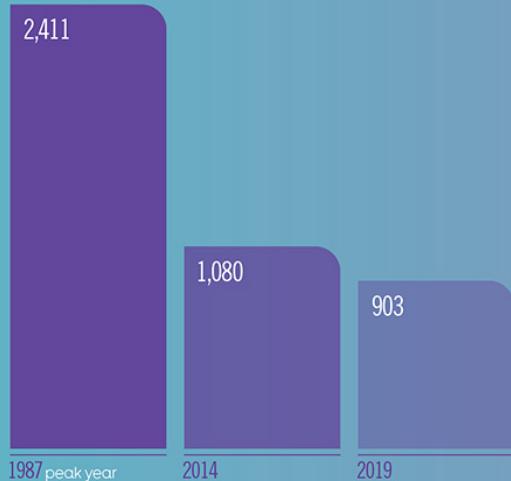
% variation 1990–2016



source: World Bank

### On Track to Eradicate Transmission of HIV among Gay Men by End of Decade

Free condoms, clean needles & anti-viral therapy



sources: Kirby Institute, Guardian

### One in Four Australian Homes Now Has Solar Panels



sources: Energy Matters, Australian PV Institute

168 | 169

Government buildings & infrastructure in three major Australian cities are now powered by 100% renewable energy

SYDNEY

MELBOURNE

ADELAIDE



street lights, government buildings, swimming pools, sports fields



75% wind, 25% solar

source: PV Magazine

## Aboriginal Australians Are Now Empowered to Reduce Wildfires using ancient indigenous techniques



Defensive burning is a fire-prevention strategy



Strategic small fires reduce undergrowth that can fuel bigger blazes



Given to organisations that practise defensive burning



Fewer fires, fewer emissions thanks to these techniques

## Australia Has a Mobile Shower and Laundry Service for the Homeless

It focuses on empathetic, positive connections



source: New York Times

source: OrangeSky.org.au, per year

## Building the most ambitious renewable energy project ever

The Australian-Singapore power link

### WORLD'S LARGEST SOLAR FARM



9 million solar panels

### WORLD'S LARGEST BATTERY



30 GWh

Buzen Substation Battery (Japan) 300MWh

O

Hornsdale (Australia) 193MWh

10 GW

enough for a small country or 10 mid-sized cities

### transporting energy to Singapore via...



### ...WORLD'S LONGEST UNDERSEA CABLE

Australia to Singapore 3,700 km

730 km Norway to UK cable

### TOTAL INVESTMENT



\$16 billion



1,500 jobs

\$750 million export revenue per year

sources: SunCable.sg, US Dollars

# Magic Materials



PLANT ANIMAL MINERAL



## Shrilk

Leftover shrimp shells & silk proteins.  
As strong as aluminium, but half the weight.



+

Totally biodegradable  
Limited supply of raw materials

-



## Gulam

Short for 'glued laminated timber'.  
One of the highest available strength-to-weight ratios.



+

Totally renewable & recyclable  
Strength can vary, also expensive

-



## Hemp

Ancient, very fast-growing woven-fibre material derived from cannabis.  
Huge variety of uses.



+

Lightweight & breathable  
Illegal in some nations due to cannabis laws

-



## Nanocellulose

Tiny non-toxic fibres from ground-up wood pulp are 10 times stronger than steel.



+

extremely versatile, totally biodegradable  
requires a lot of energy to produce

-



## Mycelium

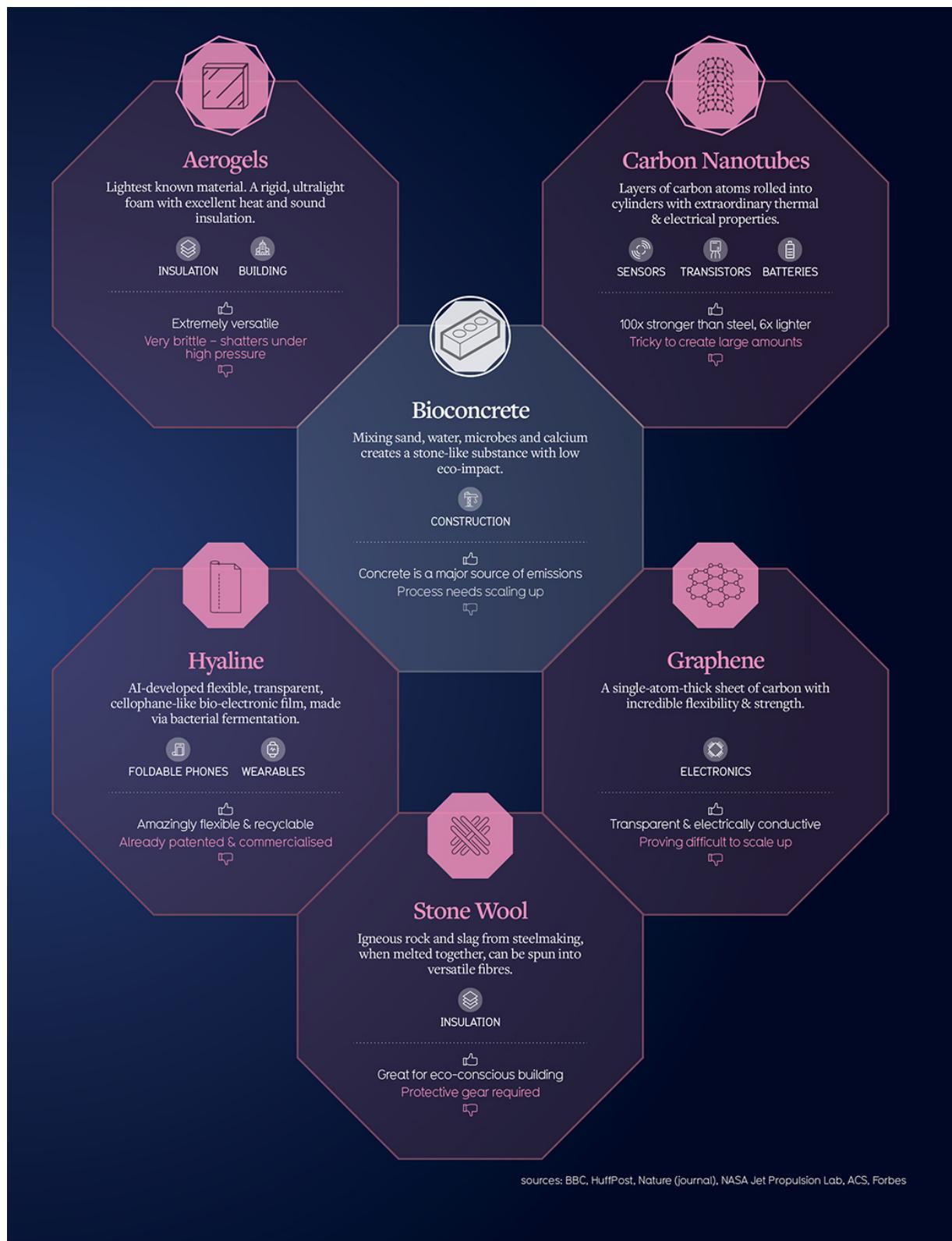
Webbed branching filaments from fungi. Growable almost anywhere, in any kind of shape.



+

Extremely versatile, already in production  
None!

-



The world has  
fourth type of  
beyond  
**DARK  
WHITE  
MILK**

there's now **RUBY**

# s gained a f chocolate...

Ruby chocolate, invented in 2017 by Belgian-Swiss confectioner Barry Callebaut, is made from unfermented cocoa beans. The exact process is a trade secret, but the result is a "sweet yet sour" taste: milkier than dark, fruitier than milk, and even sweeter than white chocolate.

# Renewable Energy

## Costs Are Falling Fast

Decrease in price 2017 to 2018

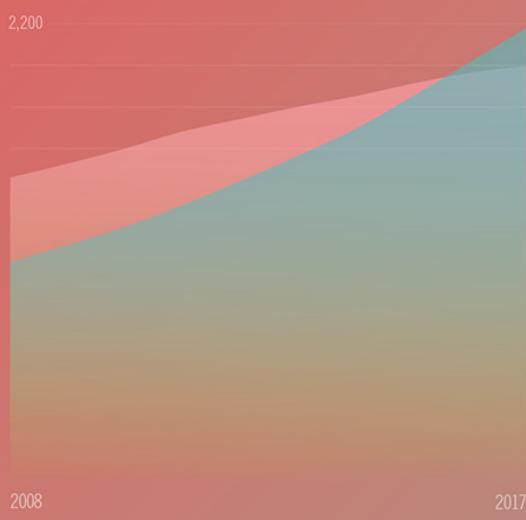


\* uses mirrors to focus sunlight to power a generator

source: IRENA.org

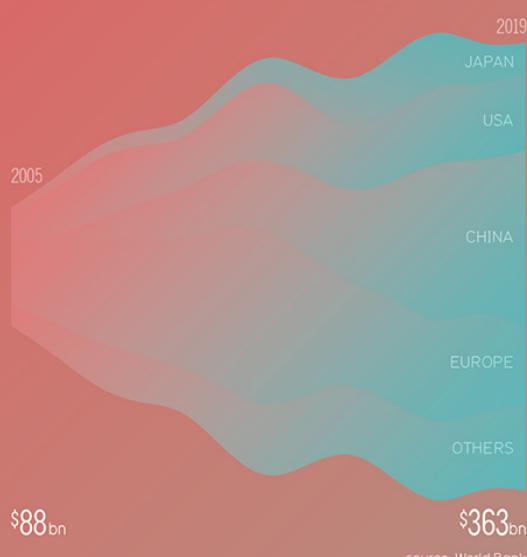
## Renewables Are Rapidly Outpacing Coal

Global energy production  
(gigawatts)



sources: International Renewable Energy Agency, Carbon Brief

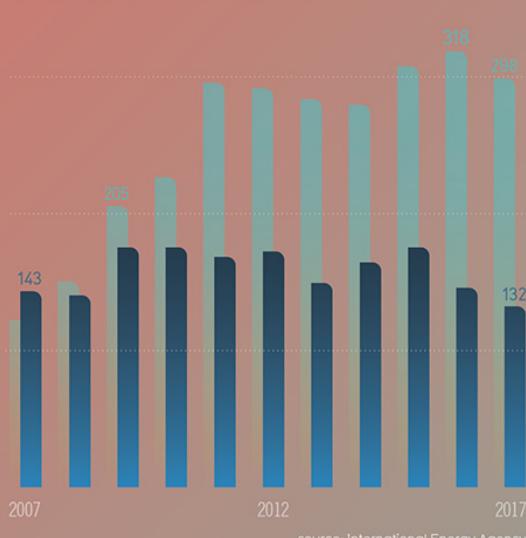
## Global Investment Is Rising...



source: World Bank

## ...To Twice as Much as Fossil Fuels

\$billion power sector investment

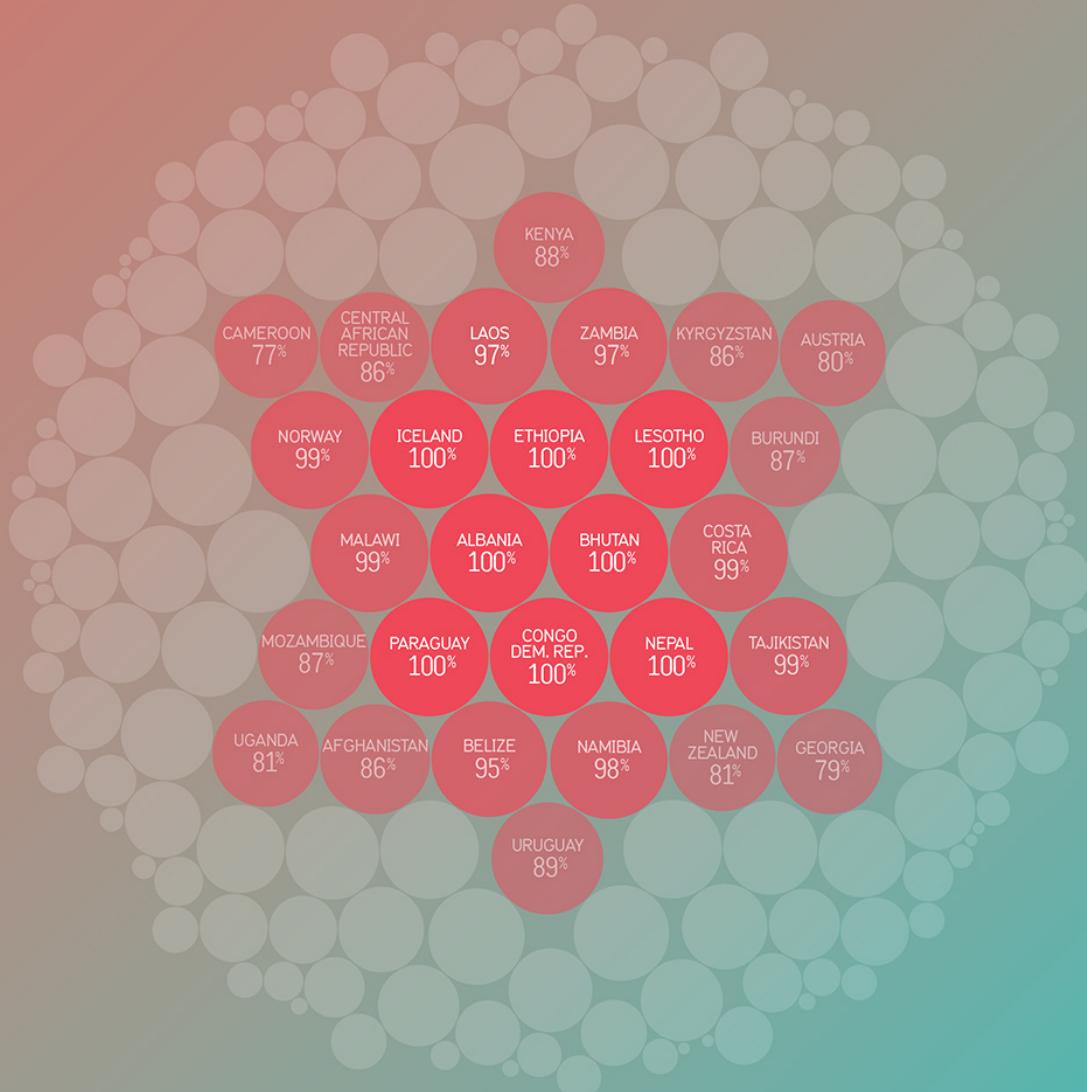


source: International Energy Agency

174 | 175

## Renewable Energy Superstars

% of electricity from renewables



source: International Energy Agency

# Fairphone 3 Is a Sustainable Alternative to Polluting Smartphones

Reducing electronic waste & improving workers' conditions

## Smartphones Are a Major Contributor to Electronic Waste



rare materials  
extraction process is  
energy-intensive;  
recycling is hard



obsolescence  
impossible to  
replace components,  
only entire phone



strong glue  
makes it difficult  
to disassemble,  
fix or recycle

## E-Waste Produced per Person per year



2021  
6.8 kg  
11% increase

the fate of most  
e-waste is unknown

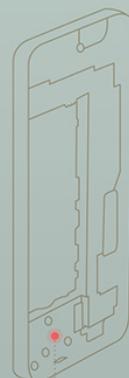
## Fairphone 3



replaceable battery  
no need for assistance



fair materials  
recycled plastics  
& copper; Fairtrade gold



screws, not glue  
for quick replacement  
of components



modular design  
fixing & upgrading  
is simpler & cheaper

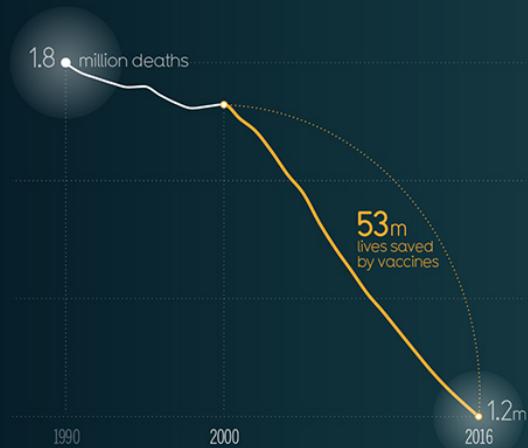


ethical production  
manufacturer guarantees  
workers' rights

sources: Dezeen.com, United Nations University

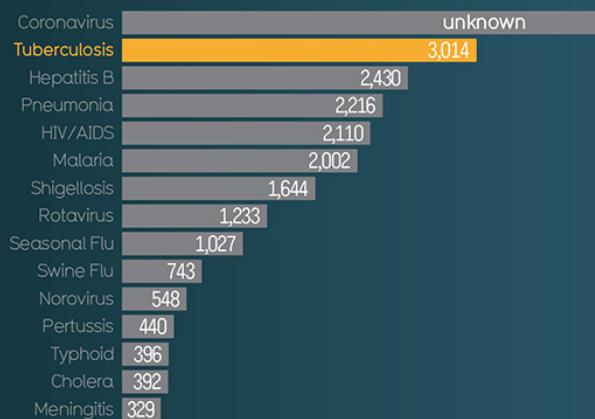
# We Are Winning the Fight Against Tuberculosis (TB)

## TB Deaths Are Falling Worldwide



## It's One of the World's Biggest Killer Diseases

Average global disease deaths per day



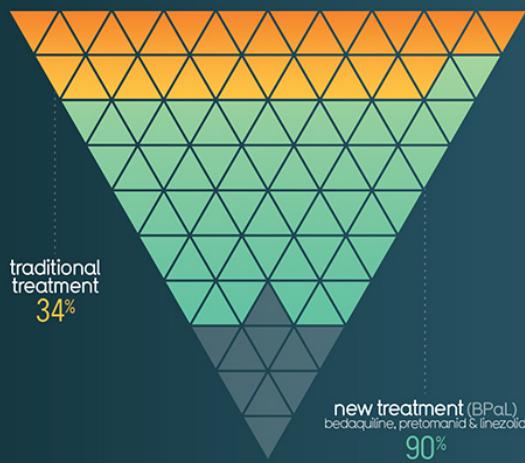
## 90%+ of Children Are Now Vaccinated

In over 100 vulnerable countries



## The Deadliest Form of TB Is Now Curable

Cure rate of extensively drug-resistant strain (XDR)



Sources: New York Times, Centers for Disease Control, Global Burden of Disease Collaborative Network, World Health Organisation

# South Korea Is Solving Its Massive Food Waste Problem

## the problem

S. Koreans generate a huge volume of food waste

130  
kg/year  
per person

It's even bigger than Europe and North America

average  
105  
kg/year



## the solution

ban on dumping food in landfill



compulsory food recycling



using special biodegradable bags



average monthly bag cost per family

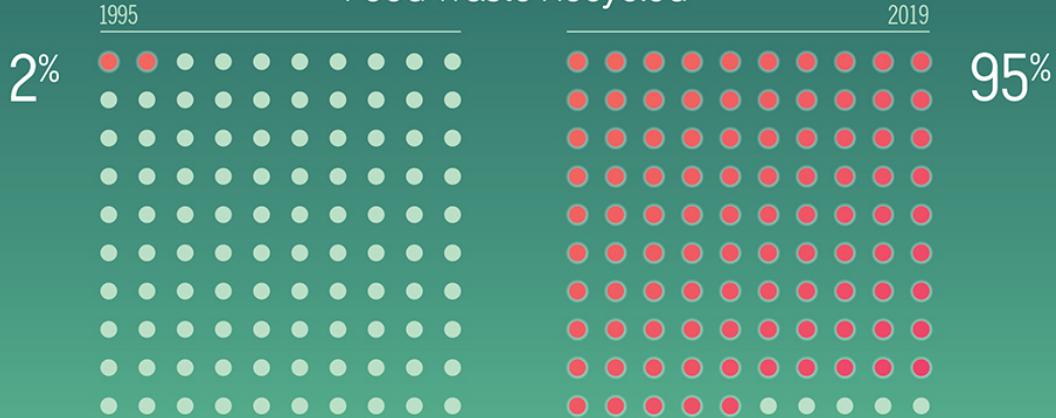


bags fund most of the scheme



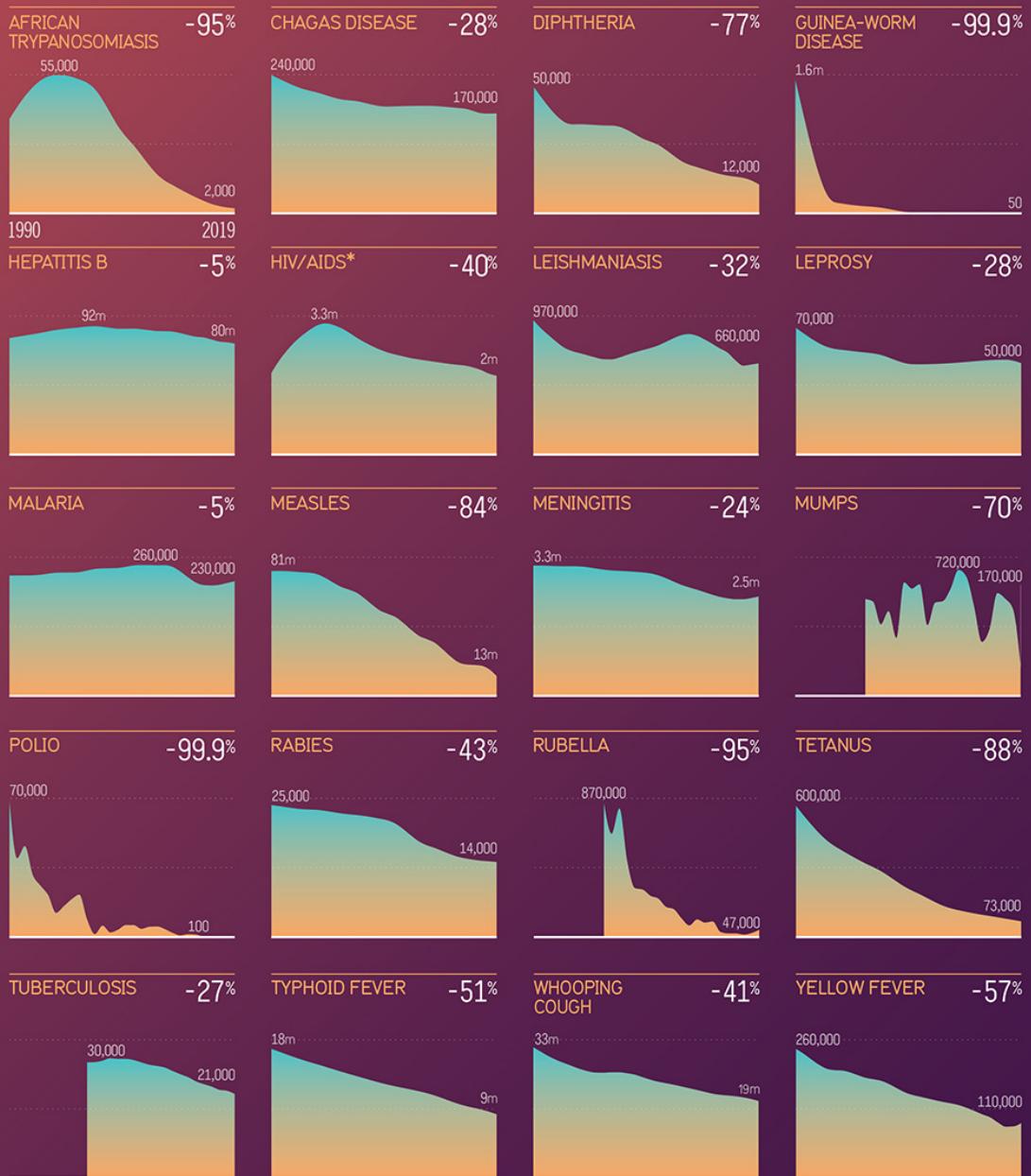
## the results

### Food Waste Recycled



source: World Economic Forum

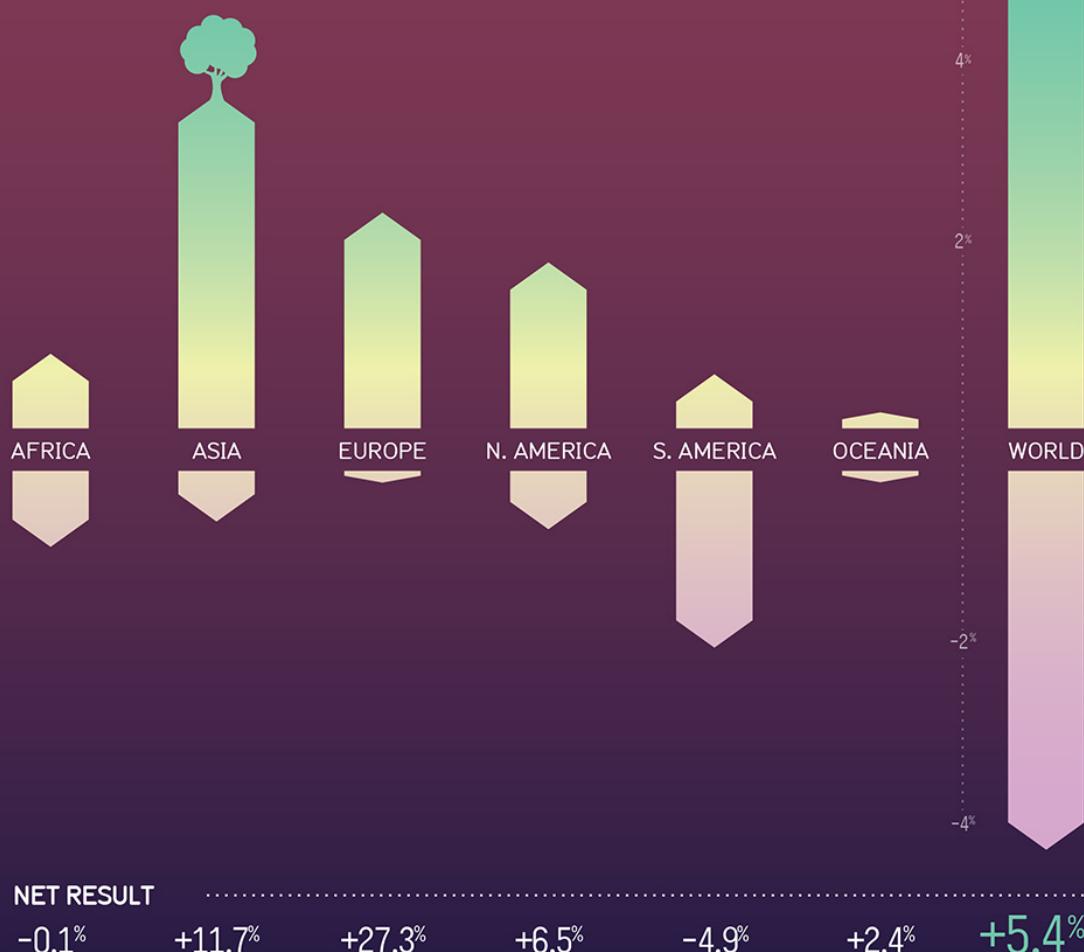
## Numbers of Infections



Source: World Health Organisation, IHME, World Bank \* = decline from peak

# Global Tree Cover Is Expanding

Gain and loss of tree canopy cover 1982–2016



## NET RESULT

-0.1%      +11.7%      +27.3%      +6.5%      -4.9%      +2.4%      +5.4%

# Life Expectancy in Africa Is Soaring

● = population



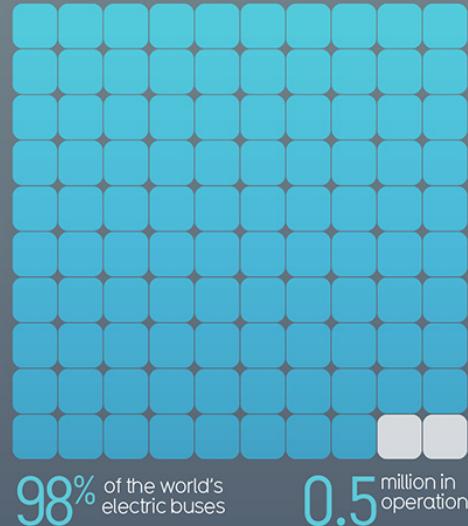
# China is...

## Eradicating Extreme Poverty

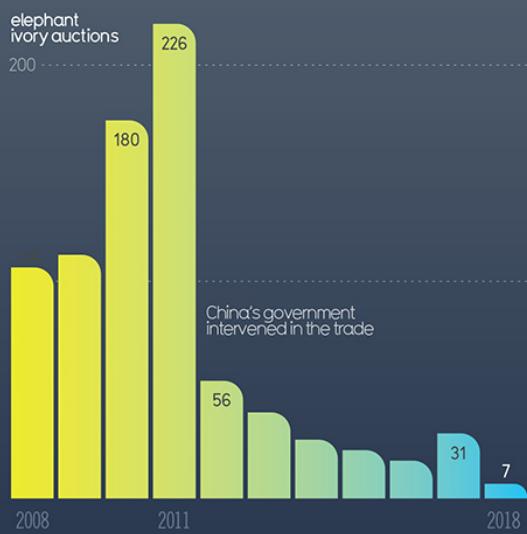
People living on less than \$1.90 per day



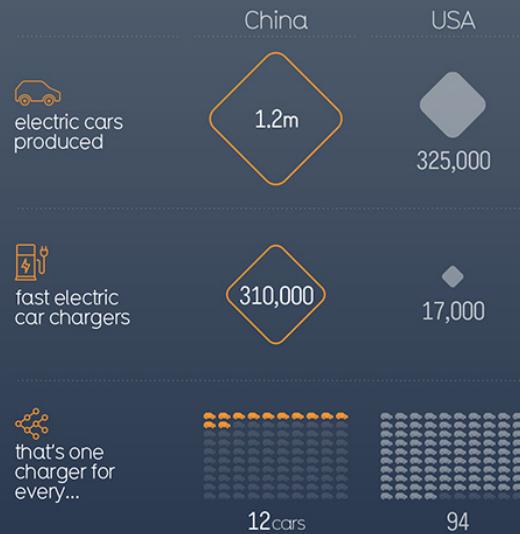
## Pioneering the Electric Bus



## Crushing Demand for Ivory

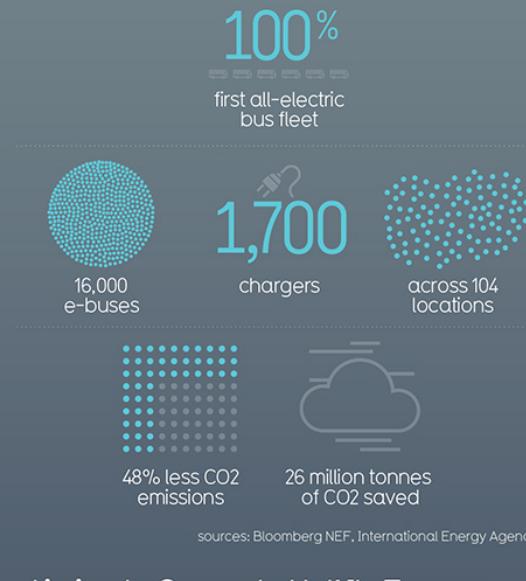


## A World Leader in Electric Cars

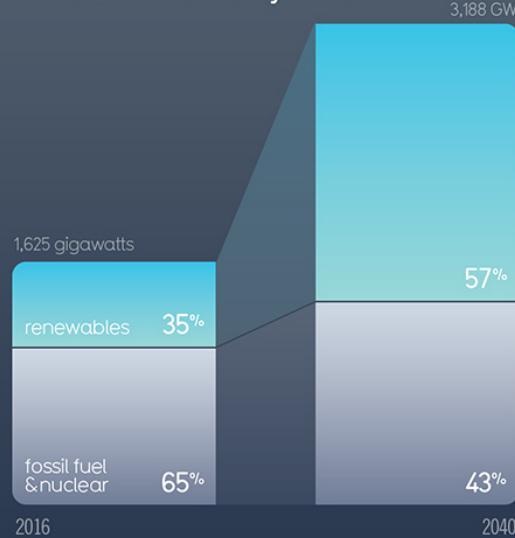


## Especially in places like Shenzhen

China's 6th biggest city (population 12 million)

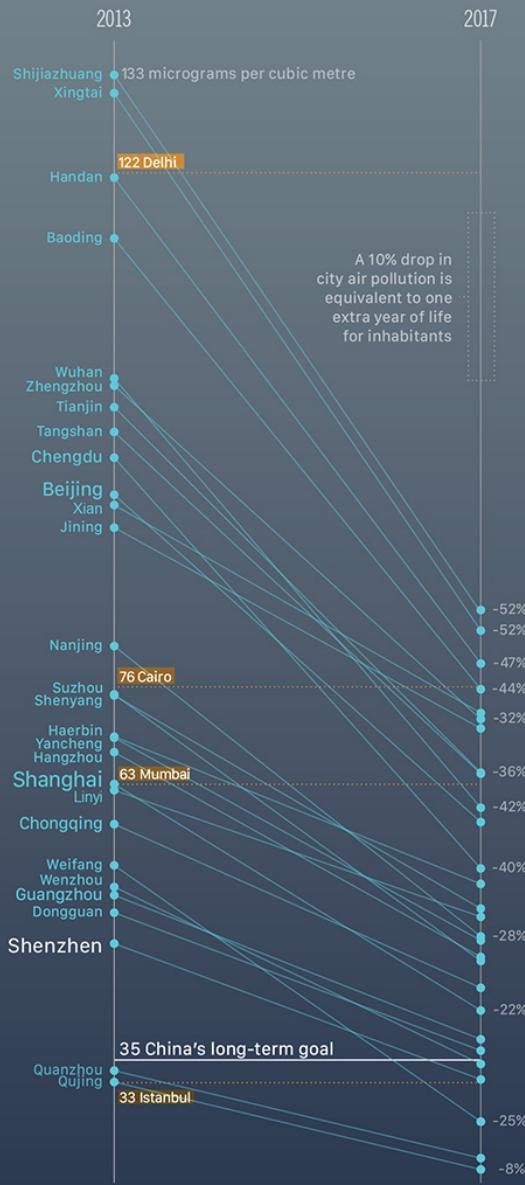


## Aiming to Generate Half Its Energy from Renewables by 2040



## Winning Its War on Air Pollution

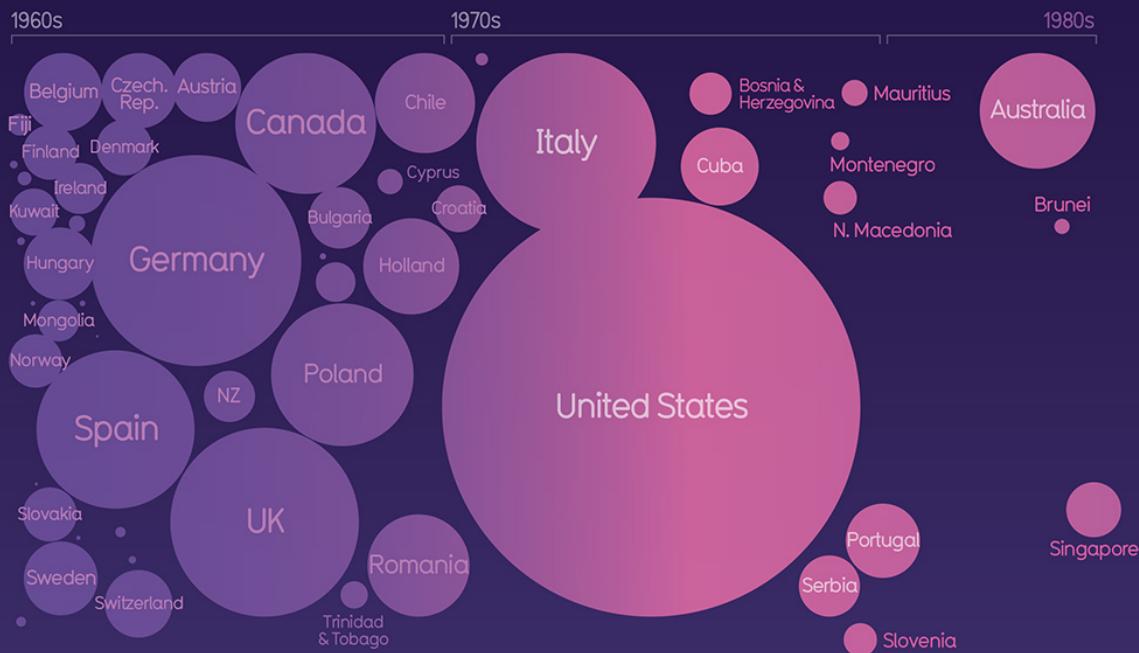
Fine particulate matter (PM 2.5) reduction (selected regions)



## We're Eliminating Malaria Worldwide

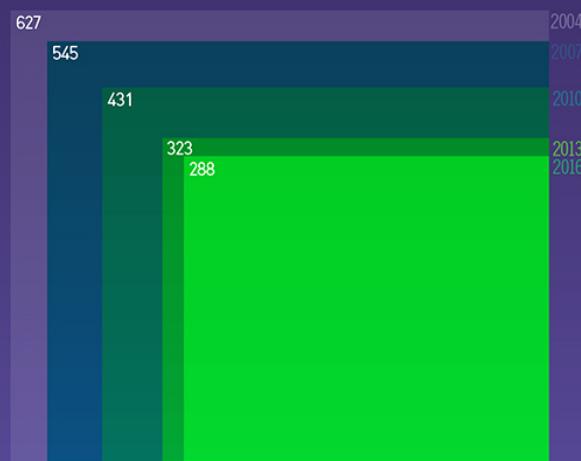
Countries certified malaria-free

(○) = population



## Fewer Children Are Dying

Thousands of deaths per year



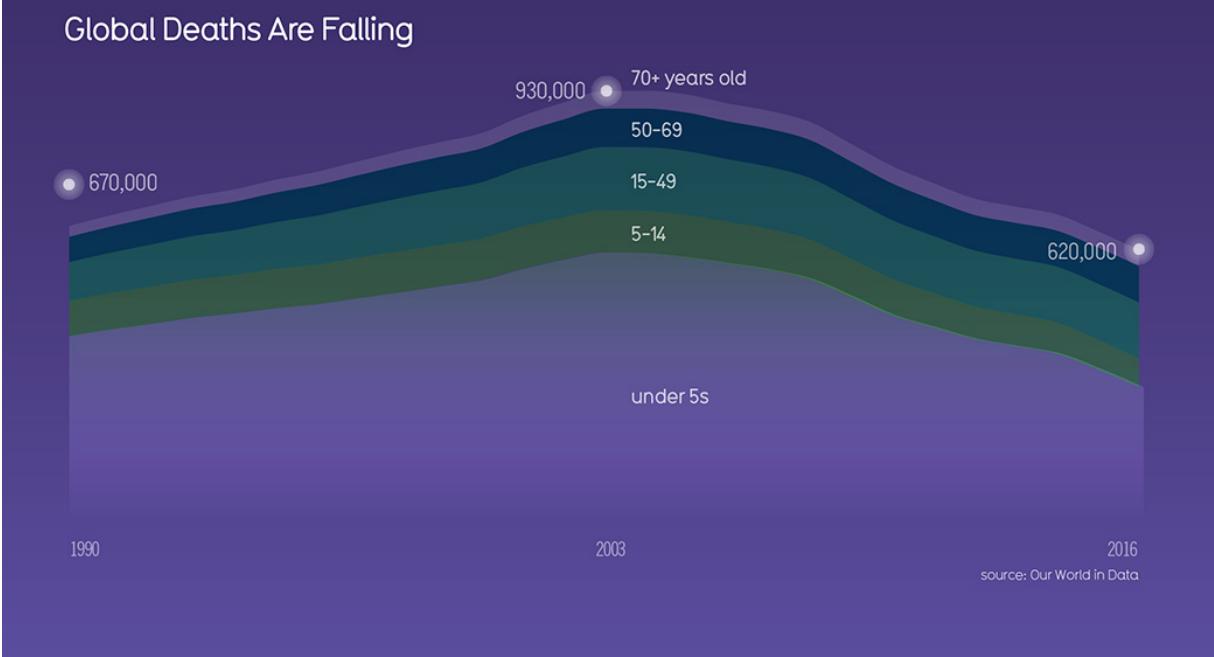
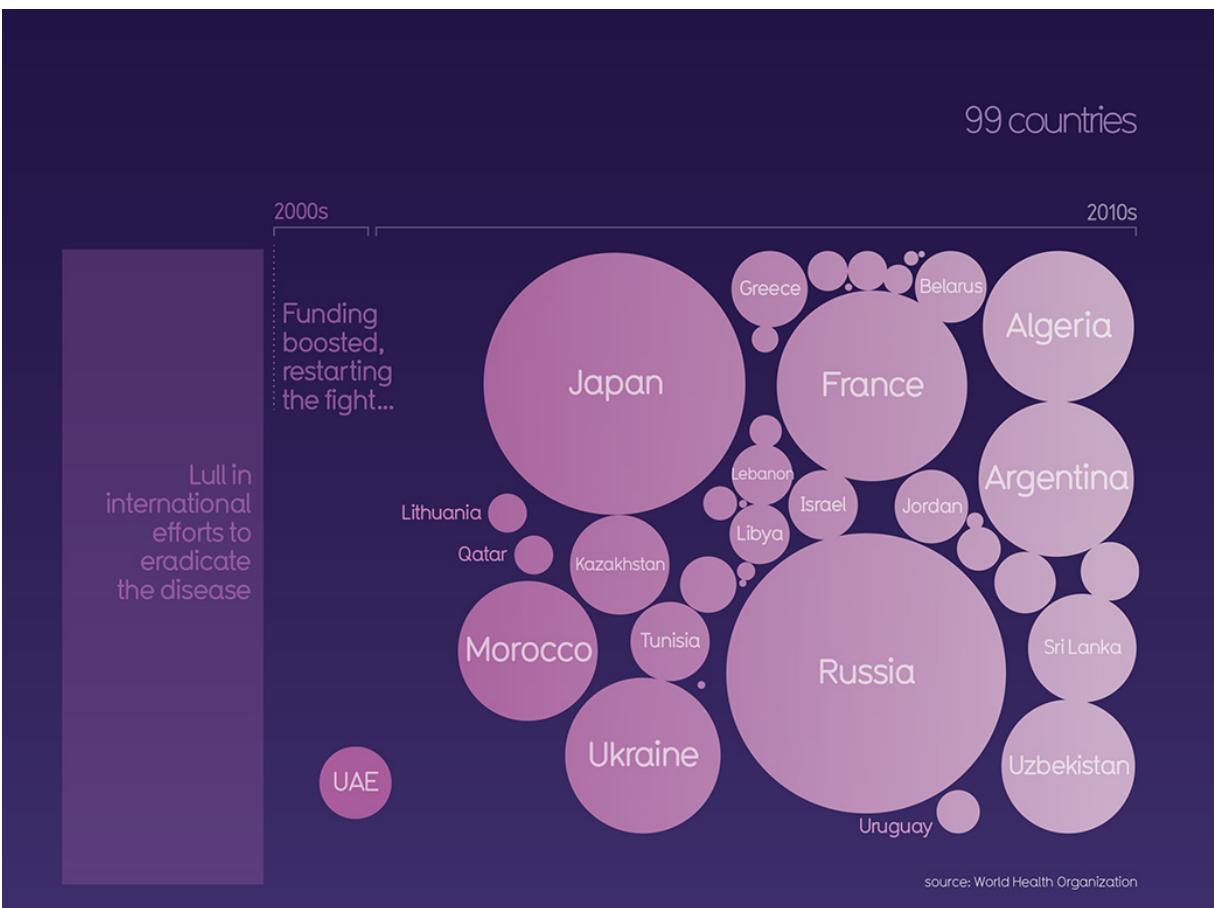
source: United Nations Children's Fund (UNICEF)

184 | 185

Simple bed nets  
have prevented  
half a billion  
malaria  
infections



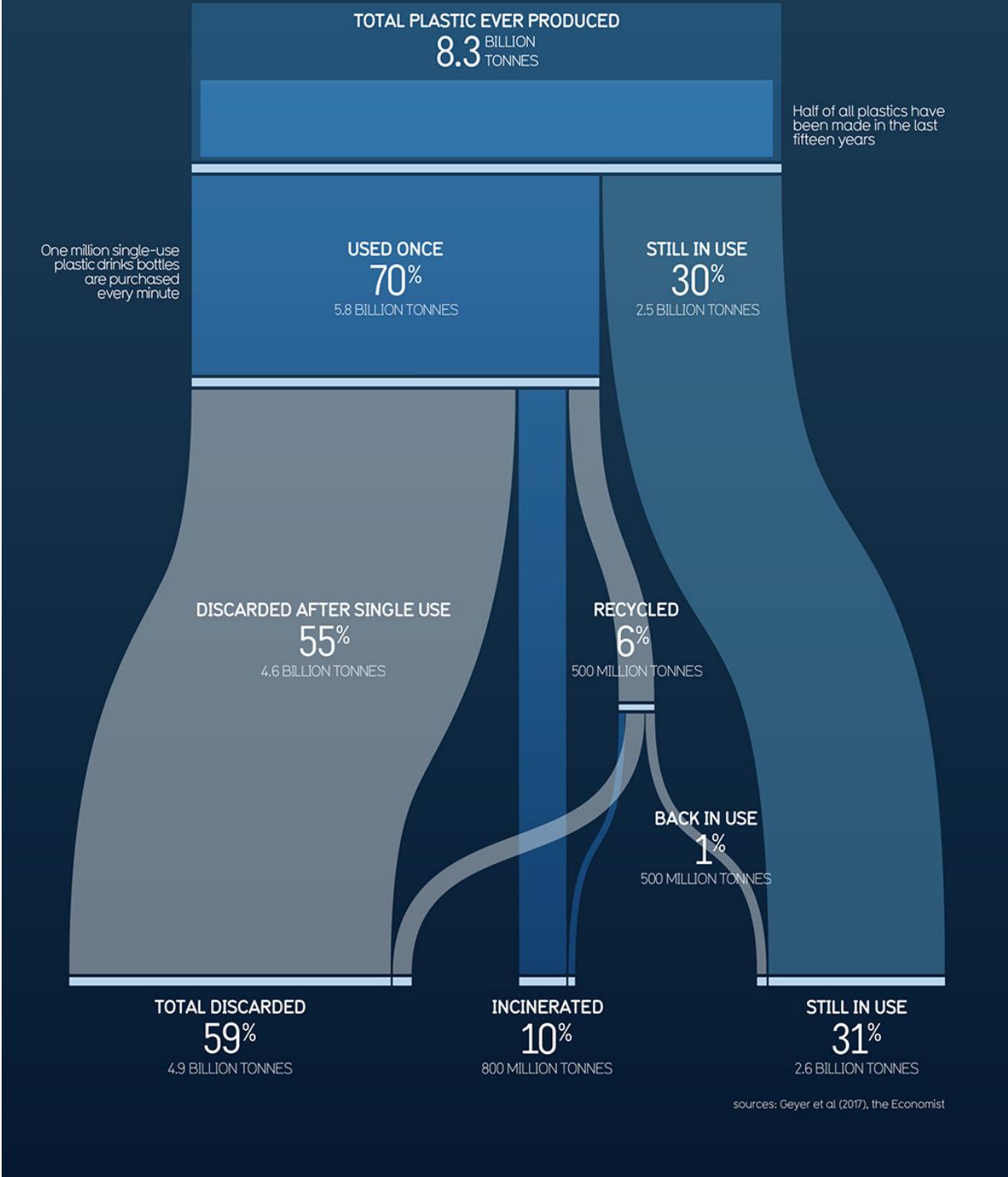
source: Our World in Data



# How do we solve our **PLASTICS** problem?

-  pollution
-  microplastics
-  carbon emissions
-  poor biodegradability

# the problem



# Main Types of Plastic

PLASTIC	PET	HDPE	PVC	LDPE	PP	PS	other
NAME	Polyethylene Terephthalate	High-Density Polyethylene	Polyvinyl Chloride	Low-Density Polyethylene	Polypropylene	Polystyrene	many different plastics
AKA	polyester, PETE	polythene	vinyl			Styrofoam	
USES	 	 	 	 	 	 	 
PROPERTIES	clear, very tough	crinkles to touch, floats	transparent, strong	soft, flexible but tough	heat-resistant	brittle, glassy, insulating	multiple
% OF PRODUCTION	9%	14%	10%	17%	18%	6%	26%
AMOUNT IN ENVIRONMENT	11.2%	14%	5.3%	20%	19.3%	6%	24.2%
RECYCLABILITY	HIGH	HIGH	NO	HIGH	MEDIUM	LOW	MIXED

BIODEGRADABLE?	NO	NO	NO	NO	NO	NO	NO	some
HEALTH & SAFETY	mixed odours; flavours leak in; do not reuse	safe	no no contact with food or drink, leaks chemicals	safe	safe	affected by fats, never use as food storage, extremely toxic	no	no usually not healthy, do not use store food
COMMON WASTE	most single-use plastic waste			food wrappers, grocery bags	bottle tops, straws	majority of ocean waste		
PYROLYSIS see page 100	NO	YES	NO	YES	YES	MAYBE	MAYBE	

NAME	AKA	USES
PUR Polyurethane	spandex, lycra	clothing
PC Polycarbonate	perspex, acrylic	compact discs, eye-glass lenses, riot shields
PMMA Polymethylmethacrylate	nylon	contact lenses, glazing, paints
PA Polyamides	teflon	clothing, tyres, ropes, toothbrush bristles
PTFE Polytetrafluoroethylene	bio-polyester	non-stick frying pans, plumber's tape
PCL Polycaprolactone		clothing, glues
ABS Acrylonitrile butadiene styrene	saran, clingfilm	lego, computer keyboards, printers
PVDC Polyvinylidene chloride		packaging
XPS Extruded polystyrene		insulation
PF Phenol formaldehyde	bakelite	foam, mouldings, billiard balls
POM Polyoxymethylene		gears, industrial uses
MF Melamine formaldehyde	acetal	children's cups & plates
SAN Styrene acrylonitrile		food containers, kitchenware, packaging
APET Amorphous PET		water bottles
PBA Polybutyrate		paper cups
PBS Polybutylene succinate		agriculture
CPET Crystalline PET		microwave containers

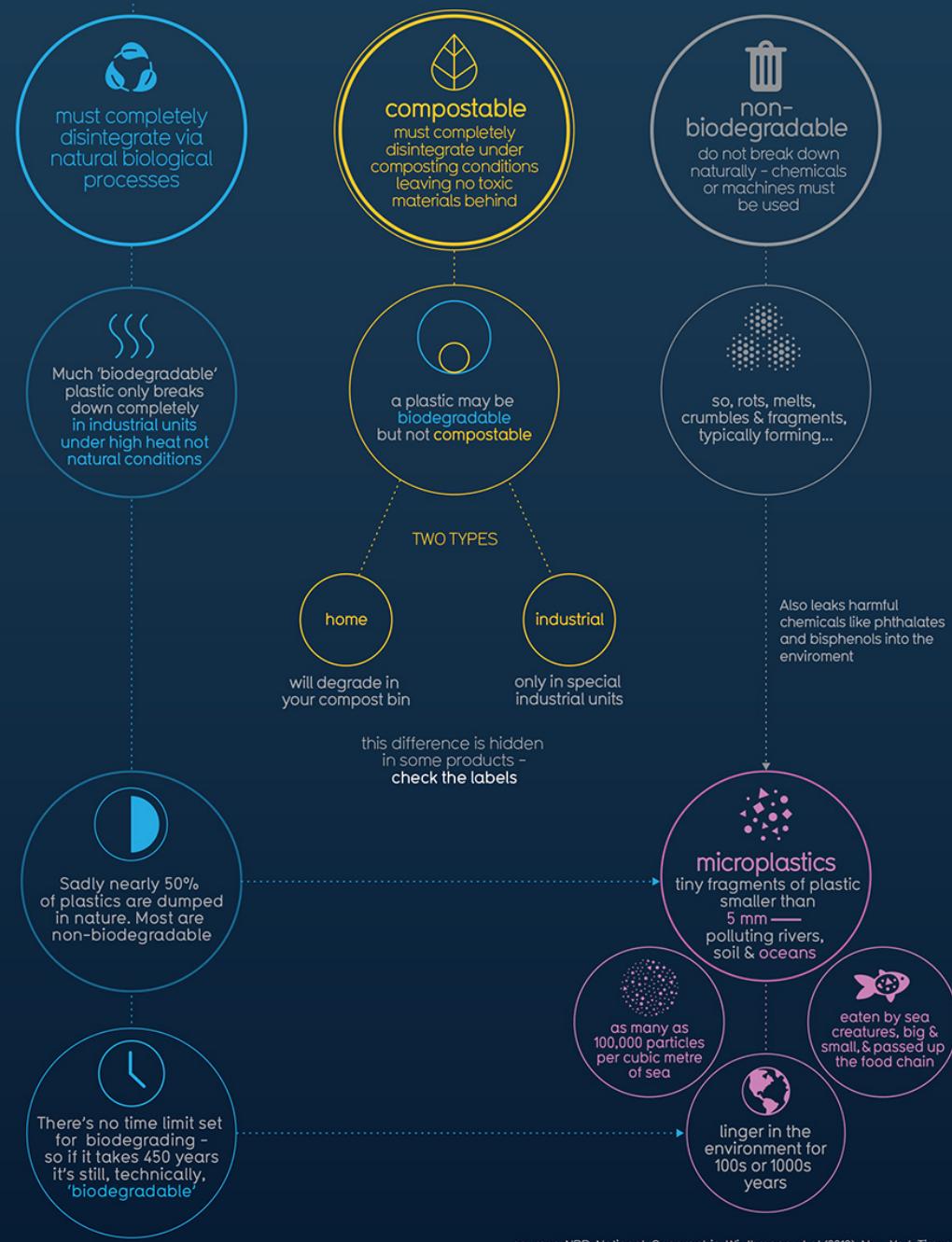
POPULARITY

The properties that make plastics so versatile & useful also make them difficult or impossible for nature to fully assimilate

168 | 189

Sources: Guardian, Our World in Data

## 'Biodegradable' Plastics



Sources: NPR, National Geographic, Wiethmann et al (2018), New York Times

# Can't we just use bioplastics instead?

plastics not made from fossil fuels like oil  
instead come from 'bio', potentially renewable sources like:



starch



wood pulp



proteins



sugars



crop residues



Watch out for marketing terms like  
'plant-based', 'bio-based' or  
'compostable'



Any plastic derived from these  
sources can be called a  
'bioplastic'



But those sources aren't necessarily  
**biodegradable, compostable** or even  
ecofriendly

## ⊕ PROS

- usually more sustainable
- 80% less energy usage
- 80% less emissions
- fewer toxins released in production
- several are biodegradable
- a few are compostable

## ⊖ CONS

- extra land, water to grow materials
- more fertiliser used
- not as strong or versatile as normal plastics
- chemical additives still used (dyes, fillers, coatings)
- broadly no more biodegradable than normal plastics
- not always recyclable in usual recycling streams

## What \*are\* they good for?



## Current usage

1% of all plastics

## Popular & emerging bio-plastics

POPULARITY ↑	PRIMARY SOURCE	USES	♻️	⚡	⼯	🏠	🔥	NOTE
TPS	maize starch	films, bags, cutlery, packaging	●	●	●	●	●	starch is abundant & renewable
PLA	corn starch	3D printing, cups, nappies, teabags	●	●	●	●	●	can replace PS(6), PP(5), ABS
PHB	glucose	transparent films	●	●	●	●	?	may replace PVC(3) & LDPE (4)
PHA	sugars	packaging, films, straws, bottles	?	●	●	●	●	very promising, replaces PP, tricky to scale
bioPE	ethanol	water bottles	●	●	●	●	●	identical to PE just not fossil-fuel
PEF	sugars	bottles, films, food trays	●	●	●	●	?	shows promise
plantic	corn starch	food packaging	●	●	●	●	●	great food packaging, home compostable

good

♻️ recyclable ⚡ separate stream req. ⚡ biodegradable ⚡ industrially compost 🏠 home compost 🔥 heat resistant (good for packaging)

sources: Wikipedia, Forbes, US Environmental Protection Agency, Broeren (2017), Yale School of the Environment

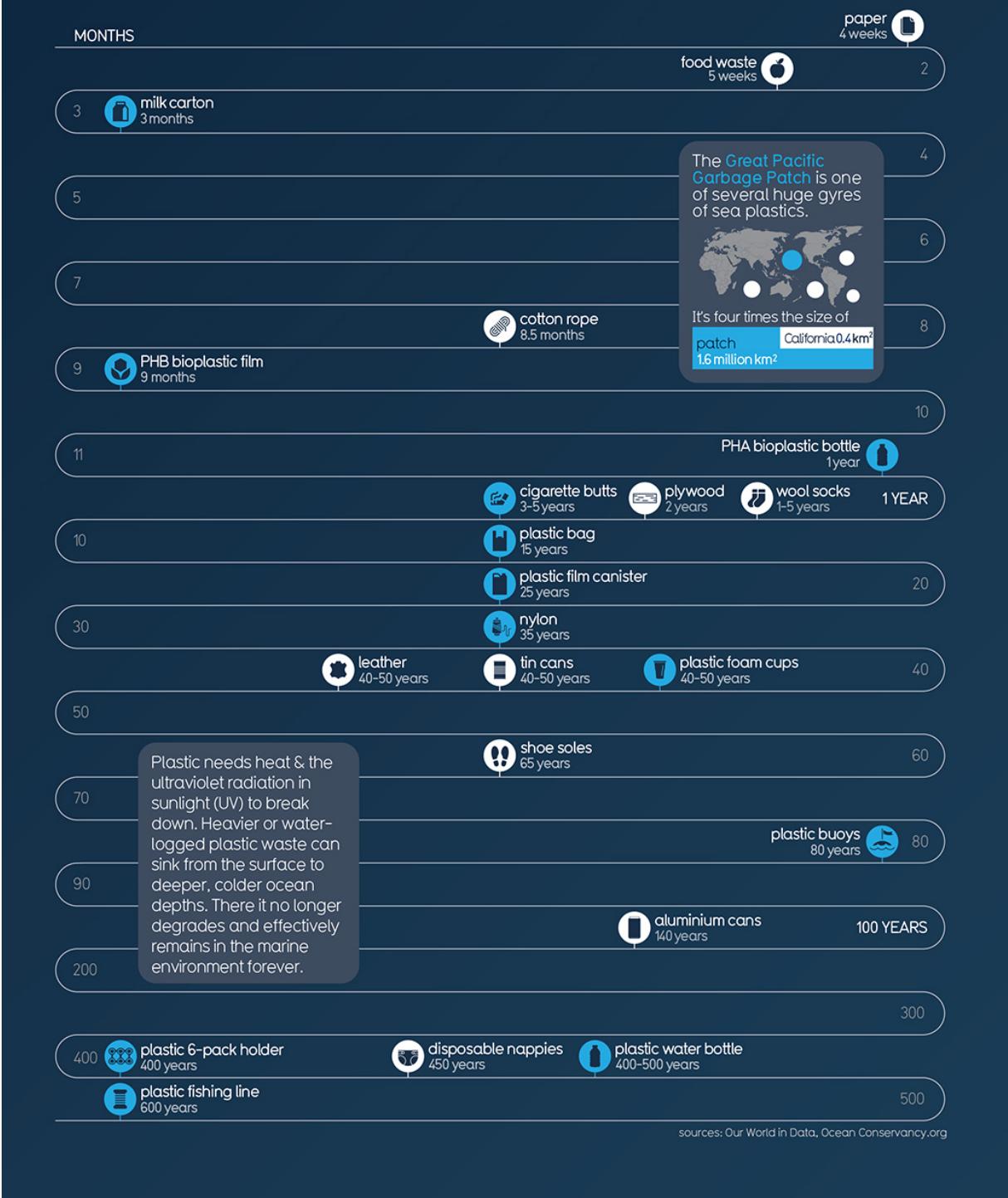
## Most Plastic Waste



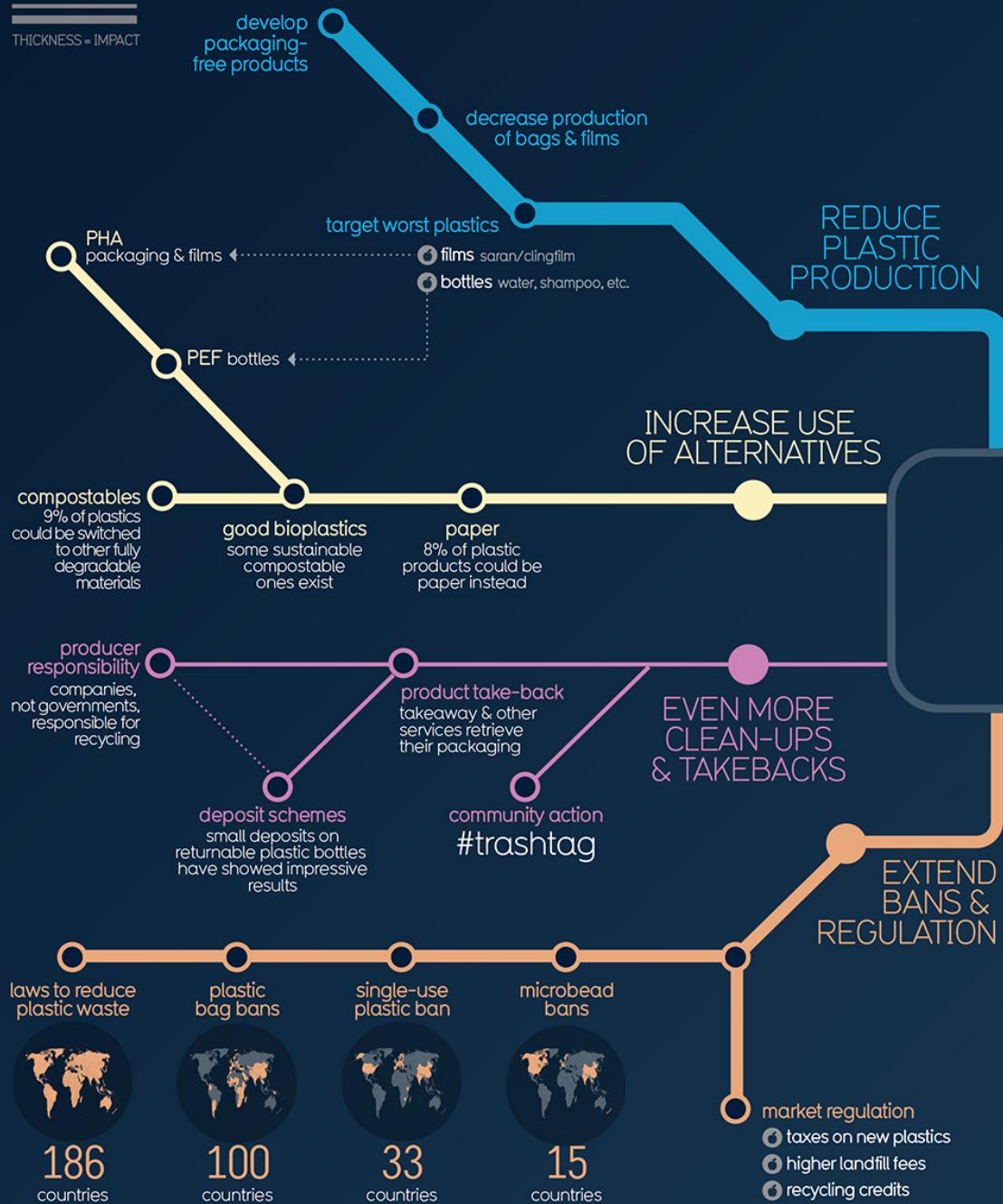
## Most Dumped on Beaches



# Marine Debris Decomposition Time



# Our Routes for Solving Plastics





# Creative Solutions

Pyrolysis converts used, unrecyclable waste back into plastic & energy



**what is it?**  
a chemical process that  
breaks plastic back  
down into its molecular  
building blocks



**major impact**  
chemical conversion  
could recycle 26 million  
tonnes per year  
(up from 1.4m today)



**double recycling**  
plastics that are too  
contaminated or can't be  
mechanically recycled  
can undergo pyrolysis

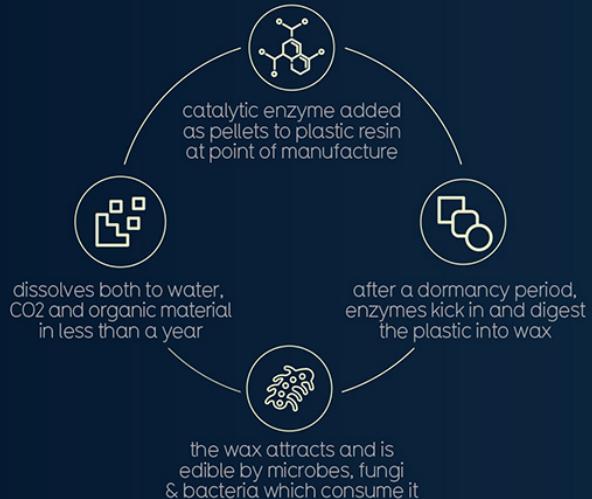


**infinite recycling**  
potentially a plastic  
can go through pyrolysis  
over and over  
again, ad infinitum

Pyrolysis is an early-stage technology, so accurate data on its impact & contributions is still emerging

source: PEW

## Bespoke Enzymes Can Turn Major Plastics into Biodegradables



works on world's leading  
non-biodegradable plastics  
polyethylene (PET) and  
polypropylene (PP)



Doesn't work on landfill.  
Only works on dumped plastic.  
On land & not in the ocean.

source: Polymateria.com

## Six Organic, Biodegradable Alternatives to Single-Use Plastics



**seaweed extract**  
a jelly (agar) made from the fast-growing sea plant  
(replaces bags)



**fish scales**  
waste from food factories bound with algae  
(packaging)



**cellulose nanofibres**  
tiny, crystalline molecules extracted from wood pulp  
(styrofoam)



**hemp**  
tough, super-versatile material from cannabis plants  
(bottles)



**elephant grass**  
a low-cost, hardy, fibrous African plant  
(packaging)



**mycelium**  
thread-like roots of mushrooms bound into plant material  
(styrofoam)

sources: Wired, CNN, Washington State University

## We're Developing & Harnessing Natural Organisms & Substances That Can Eat & Digest Plastic Waste



**bacteria**  
breaks the plastic down & uses it as energy as fuel for further digestion



**fungi**  
promising & already in use but much harder to harness on an industrial scale



**enzymes**  
mutant bacterial enzyme (PET hydrolase) can easily metabolise plastic in hours



**mealworms**  
microorganisms in the guts of the darkling beetle larvae break down plastic



**PUR**  
Polyurethane e.g. sneakers, nappies, sponges



**PET**  
Polyethylene bottles, food containers



**PS**  
Polystyrene disposable cups & glasses, packaging

sources: European Commission, Nature (journal), Stanford University

# What can you do?

## Simple actions to take in your everyday life





Blood donors  
Canada and  
receive a text  
when their  
is used

in Sweden,  
the UK

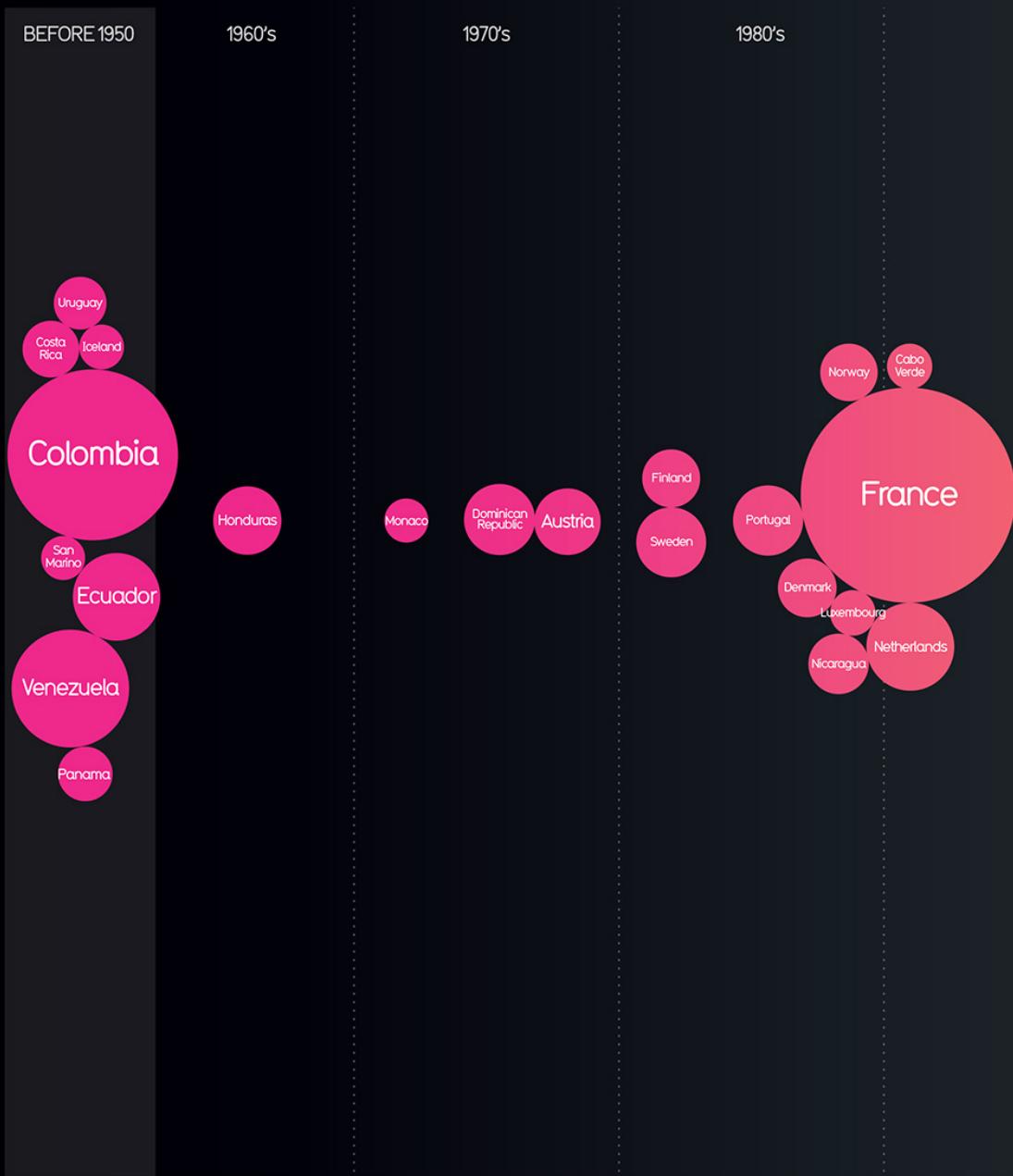
blood

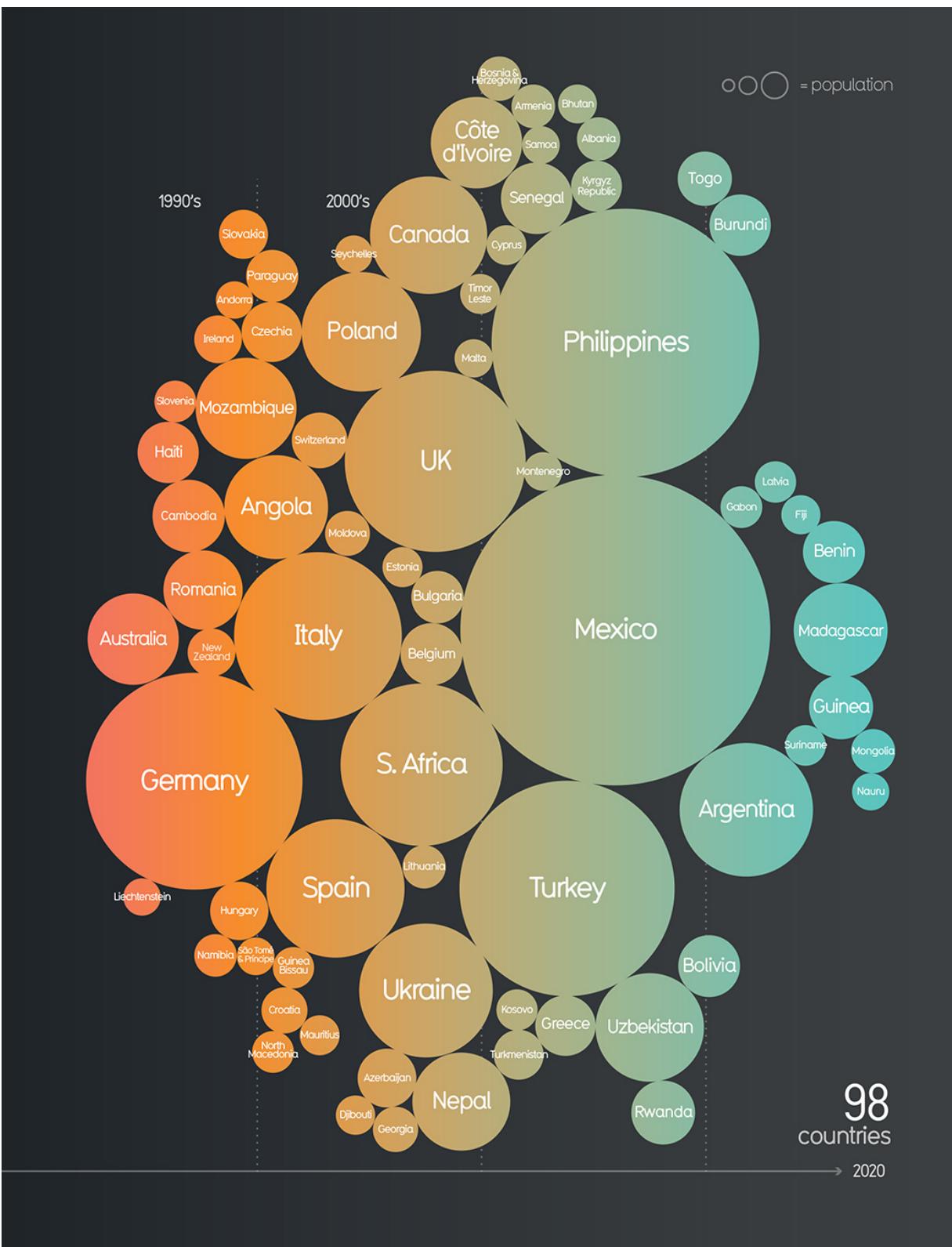
The blood you donated has  
now helped a patient! Thanks!

sources: Global News Canada, Independent, NHS

# The Death Penalty is Disappearing

Nations who have banned





# Unexpectedly Positive Things to Arise out of the Tragedy of the Coronavirus Pandemic

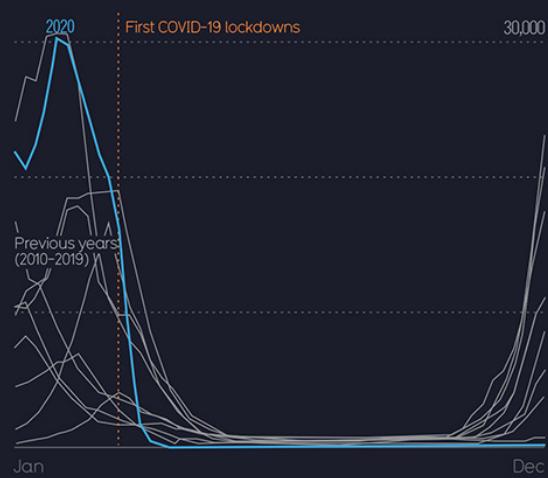
Millions **Volunteered...**  
to help fight the coronavirus on all fronts



sources: Guardian, Scientific American, New York Times, NBC

## Cases of Flu Crashed

Number of positive influenza tests per week, N. America

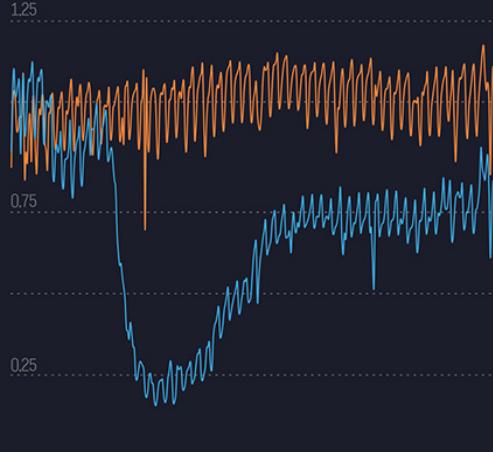


source: Scientific American

204 | 205

## Emissions from Aviation Dropped

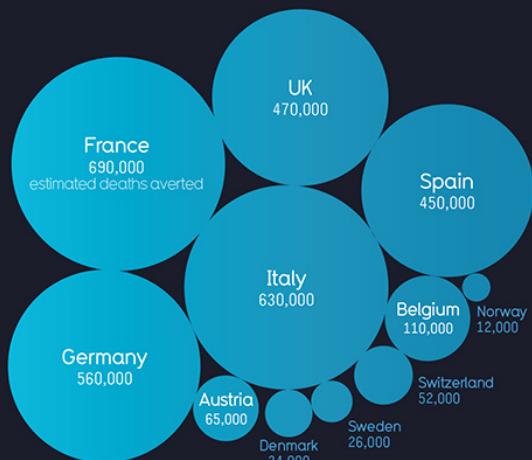
Megatonnes of CO<sub>2</sub> in 2020 vs 2019



source: US Bureau of Justice Statistics

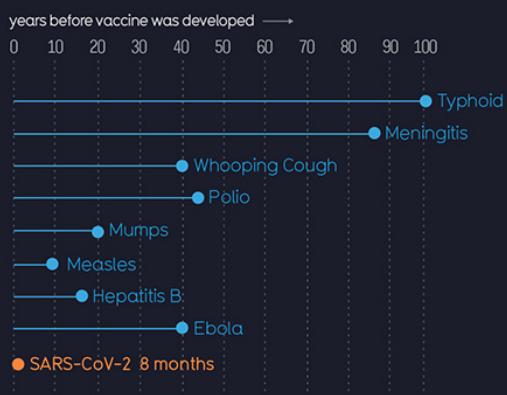
## Lockdown Measures Saved Millions

Minimum lives saved....



source: Nature (journal)

## We've Never Developed Such Powerful & Effective Vaccines So Quickly...

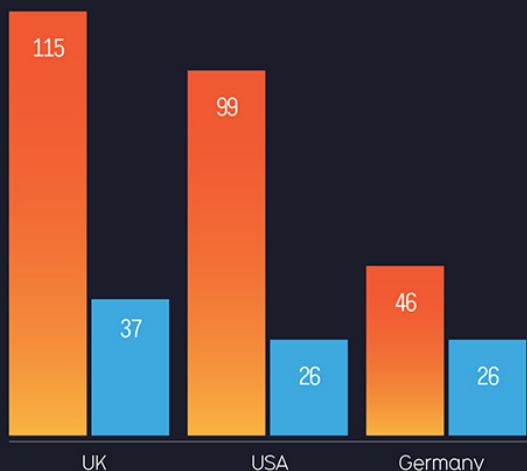


Thanks to unprecedented international funding, resources, collaboration and sharing of research

source: Nature (journal)

## Traffic Congestion Plummeted

Hours stuck in traffic per average driver per year



sources: Centers for Disease Control, Pew Research Center

We can recycle our plastic disposable face masks into roads to reduce waste

1 km of road would use up 3 million masks, preventing 93 tonnes of waste going to landfill.

6.8 billion masks are used worldwide daily. That's 2,268 km of potential road surface.

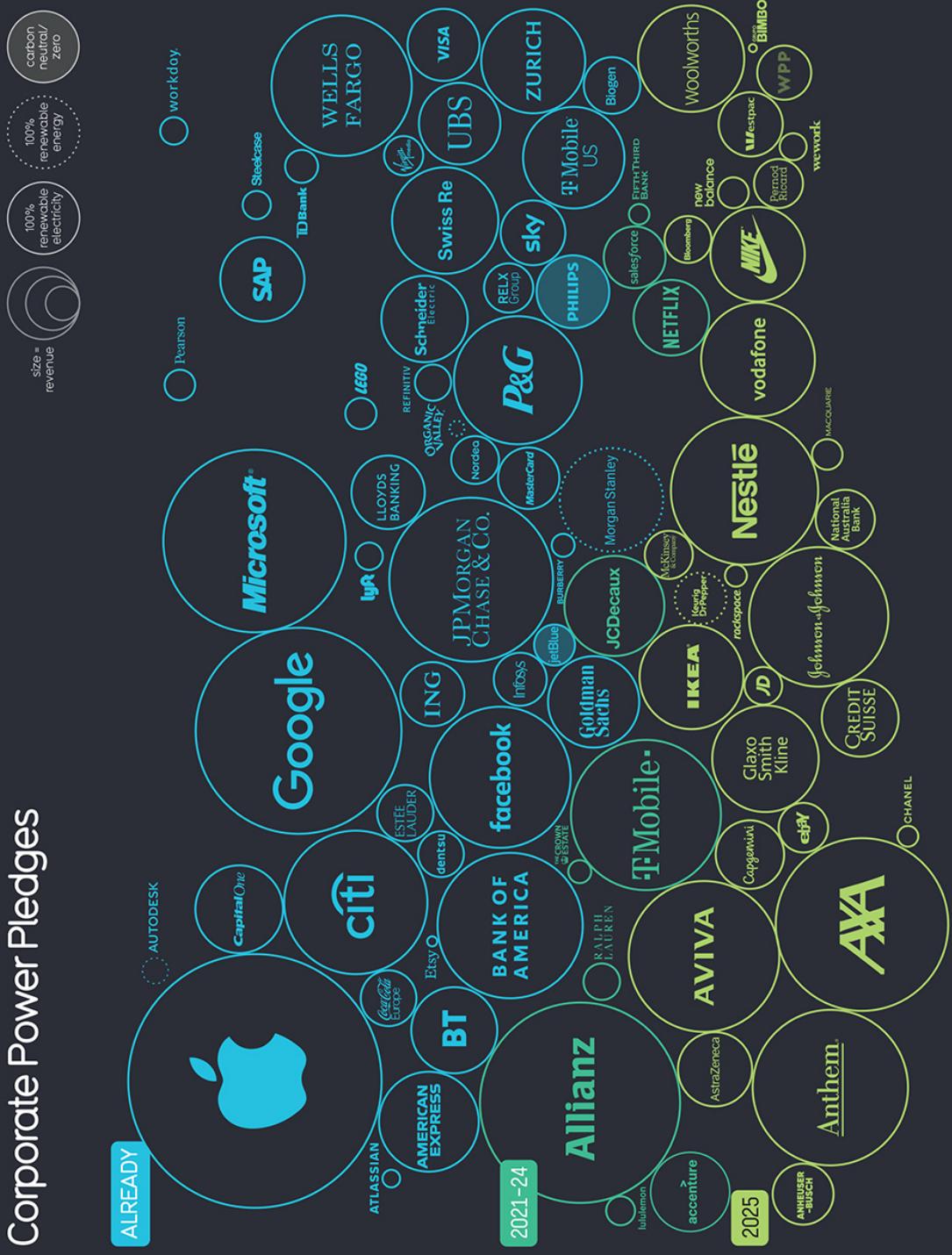
sources: Centers for Disease Control, Pew Research Center

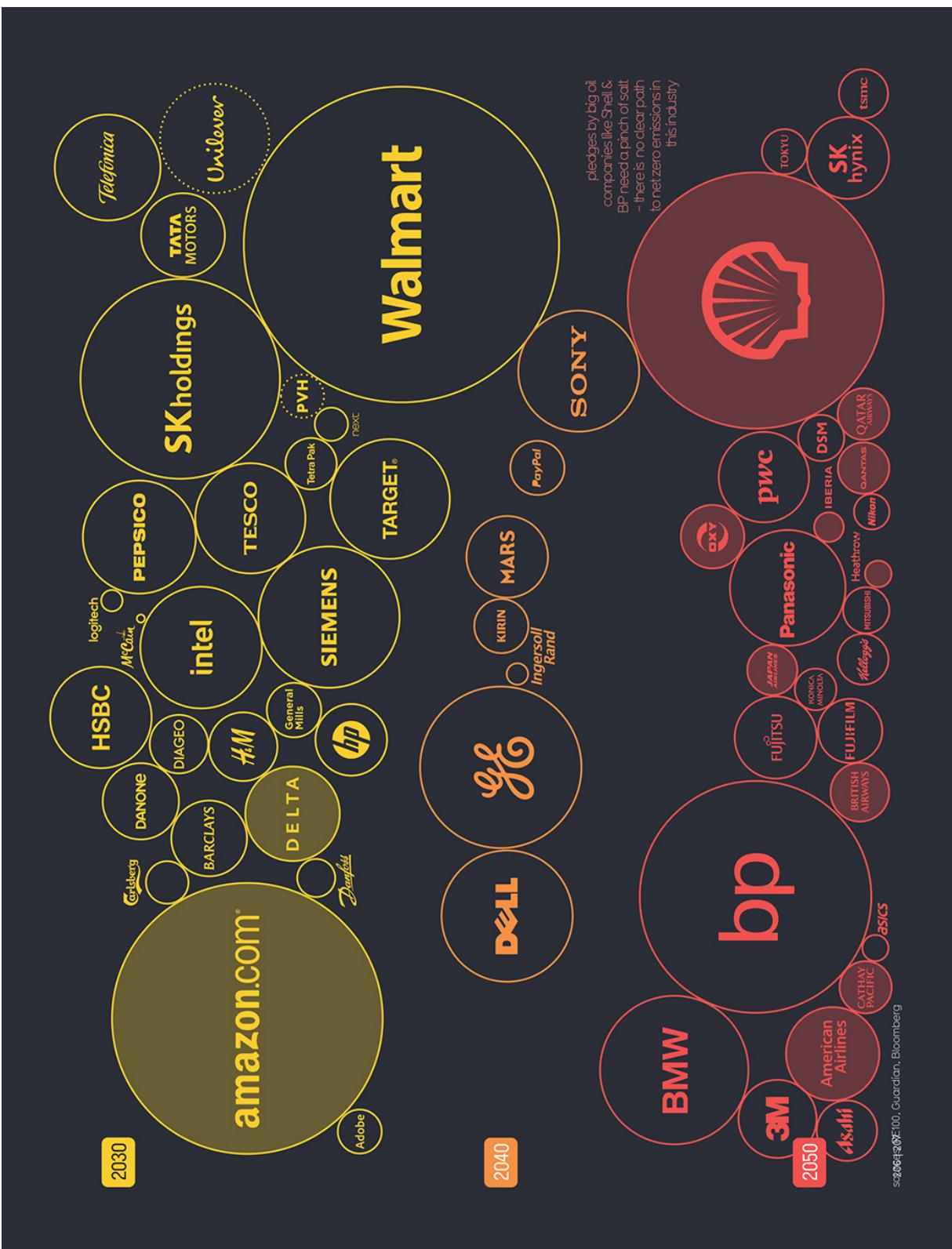
## Corporate Power Pledges

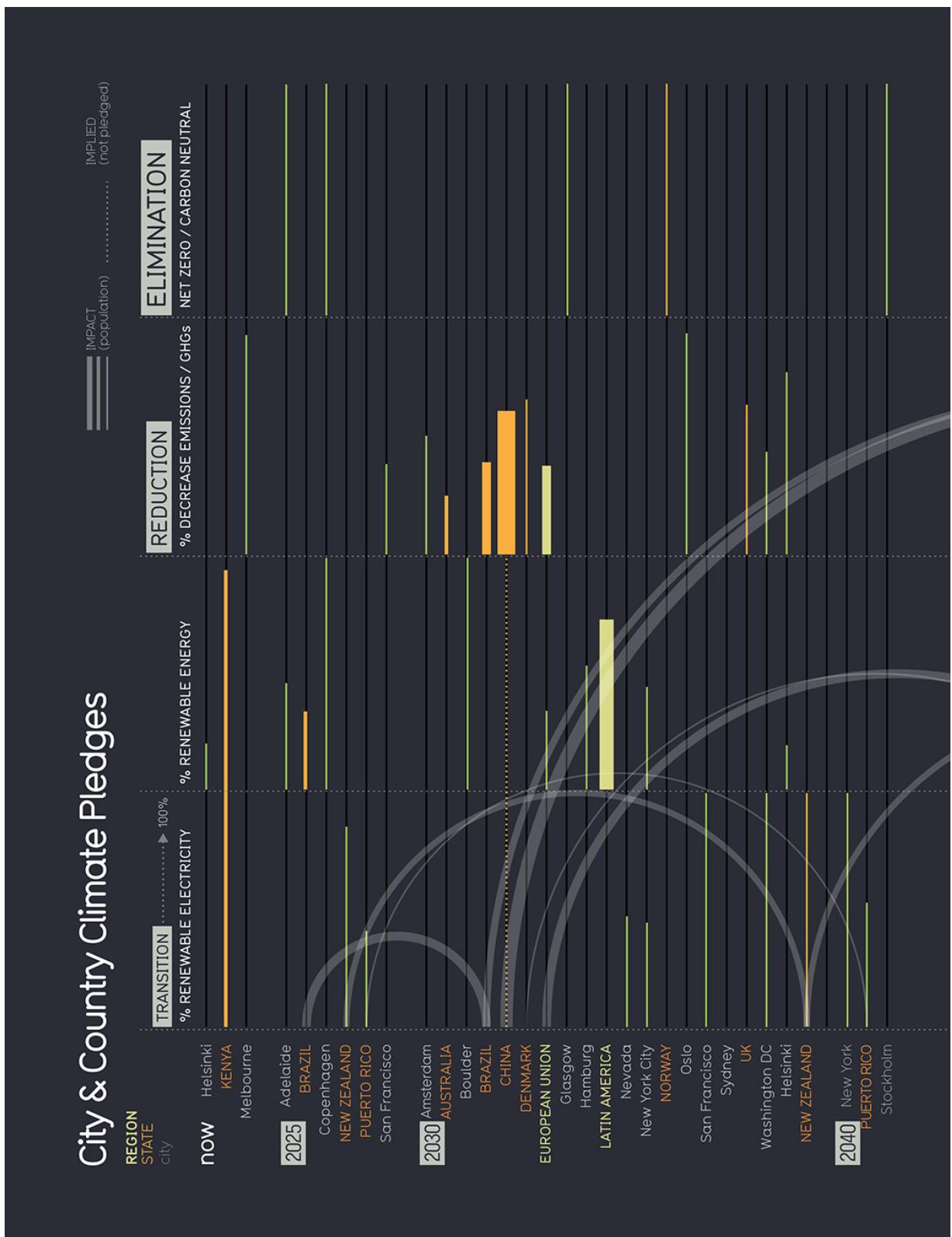
ALREADY

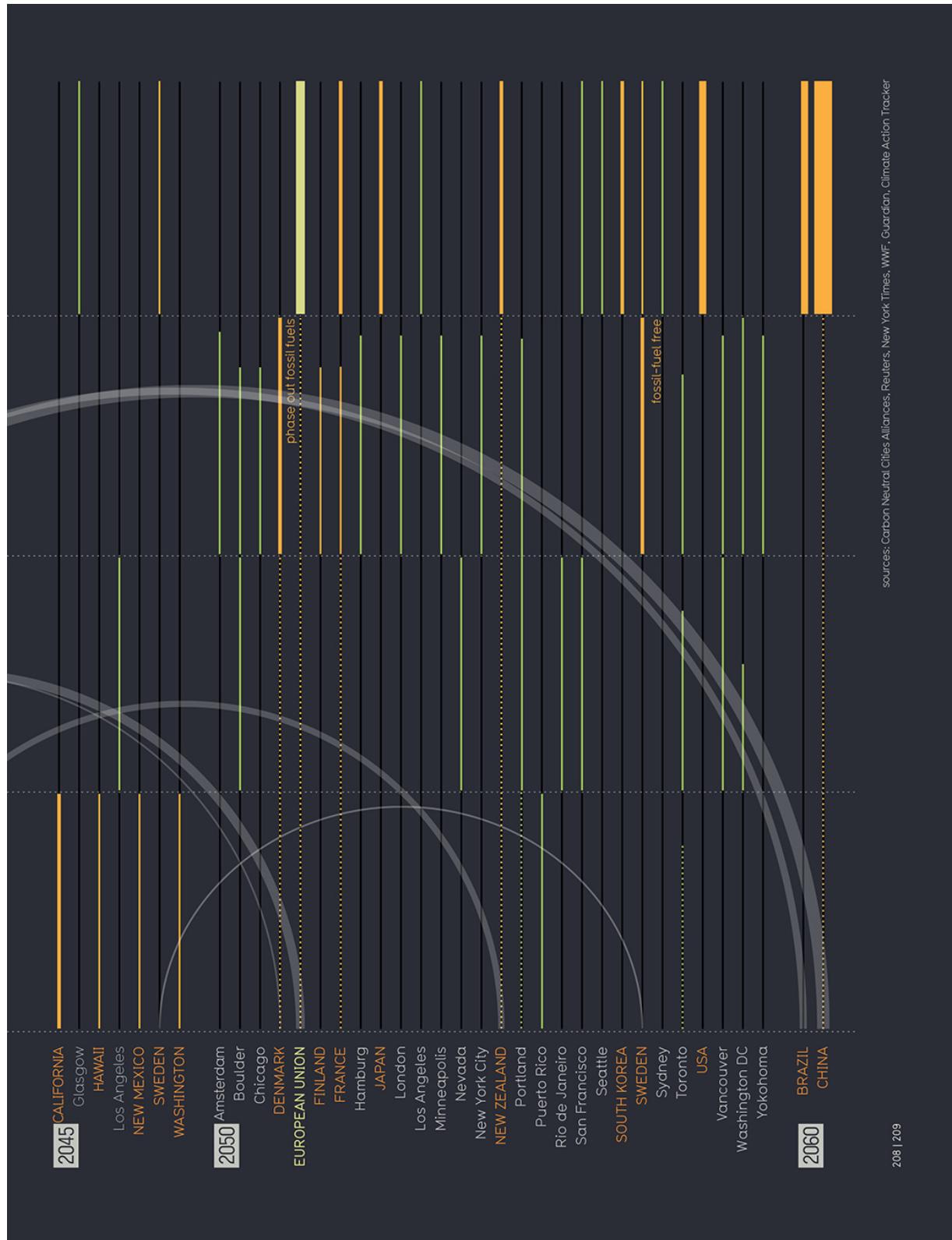
2021-24

2025





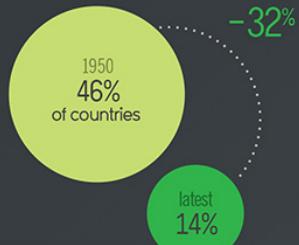




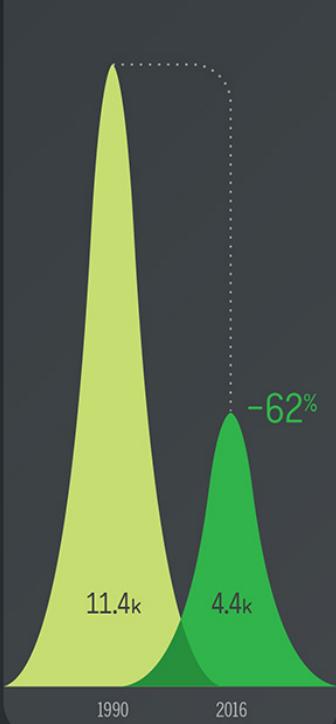
# Things Going Down! Down! Down!

in a good way

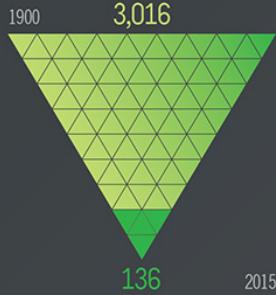
Discriminatory Policies  
against ethnic minorities



Global Death Penalty  
executions per year



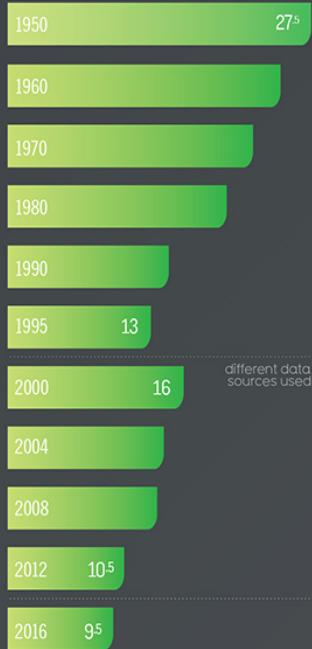
Hours of Housework  
average weekly hours



Lab-Grown Meat  
cost per pound



Child Labour  
% of children 5-17 in work



sources: World Bank, The Economist, Cato Institute, University of Maryland, Our World in Data

# Land Preservation Is Happening

**PROTECTED AREA**  
square kilometres

**972**

Northeast Greenland Park  
World's largest national park & land protection area



**924**

Nigeria

**EQUIVALENT SIZE**

A global agreement to restore the world's deforested & degraded land.  
2030 target: 3.5 million square kilometres

**1,727**  
The Bonn Challenge

54 countries have signed up



The Great Bear Rainforest  
British Columbia, Canada

**158**

Canada signed deals with First Nations people, timber companies and environmental organisations to protect its forests

Birch River Park  
Alberta, Canada

**67**

**147**  
AREA THE SIZE OF Bangladesh

**70**

Ireland

Cosmic Village of the Jaguars  
Colombia

**43**

Serranía de Chiribiquete is the biggest protected tropical rainforest park in the world

**43**

Denmark

Lake Titicaca  
Peru & Bolivia

**84**

\$500m deal to preserve the largest lake in S. America

**92**

Cyprus

Tompkins Conservation  
Chile & Argentina

**8**

American foundation has bought & donated national park land

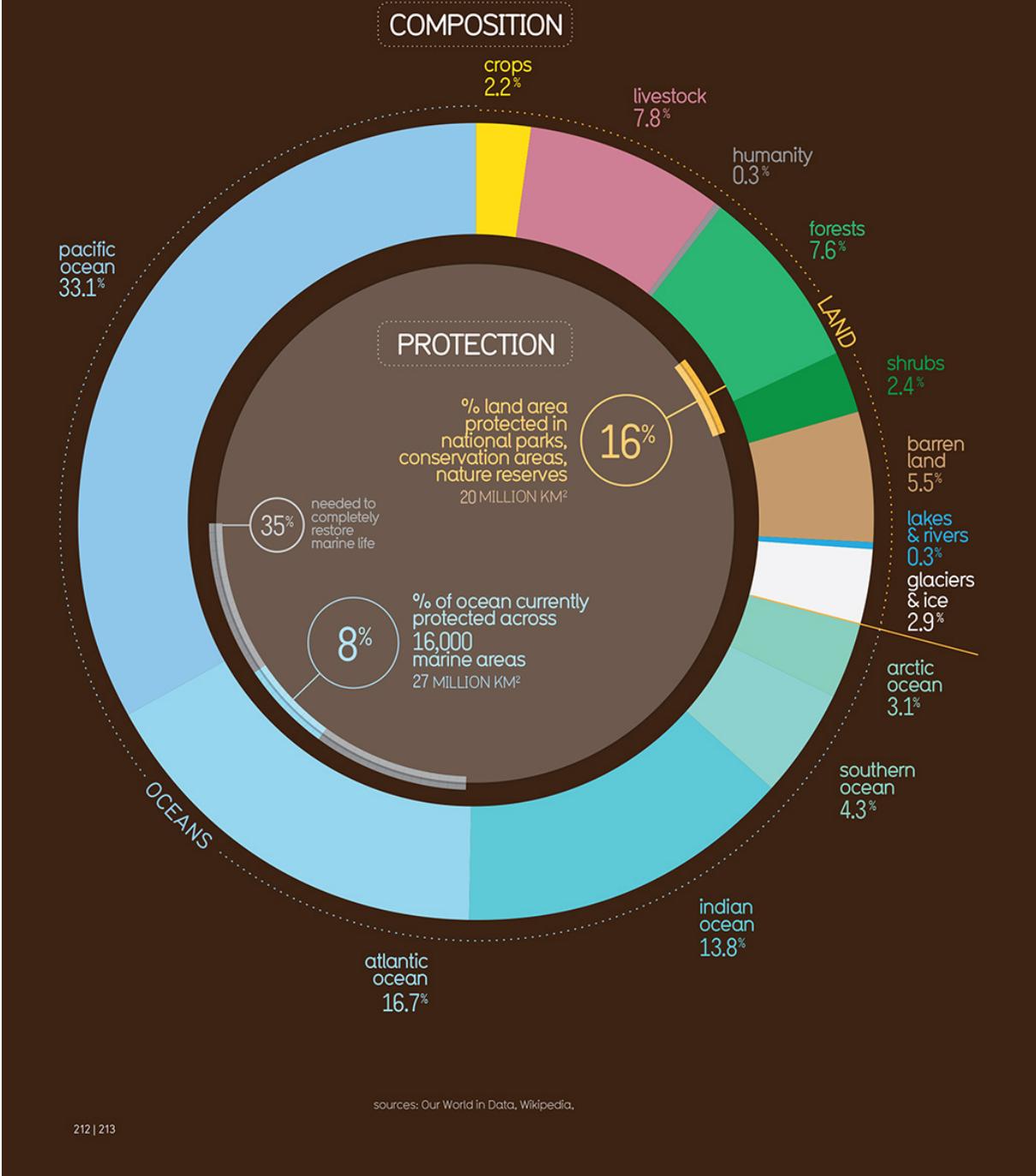
**91**

Puerto Rico

- safeguards biodiversity
- increases CO2 absorption
- ensures clean air & water
- adds resilience to natural disasters

sources: BBC, Bonn Challenge, National Geographic

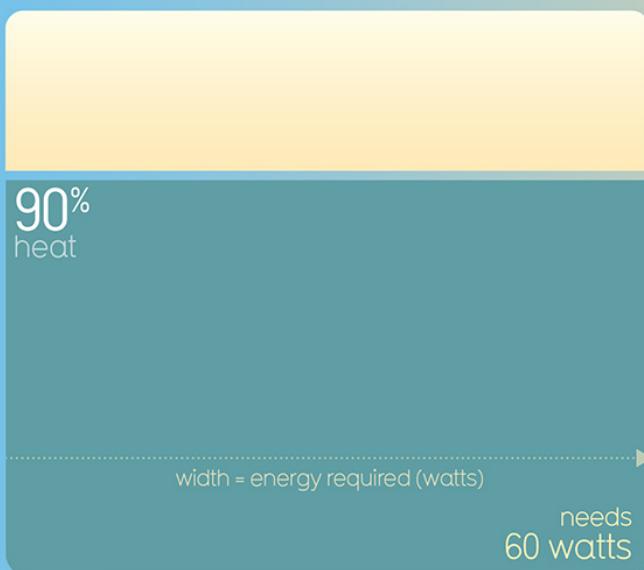
# Protecting the Surface of the Earth



## LED Bulbs

Use Far Less Energy to Generate the Same Amount of Light...

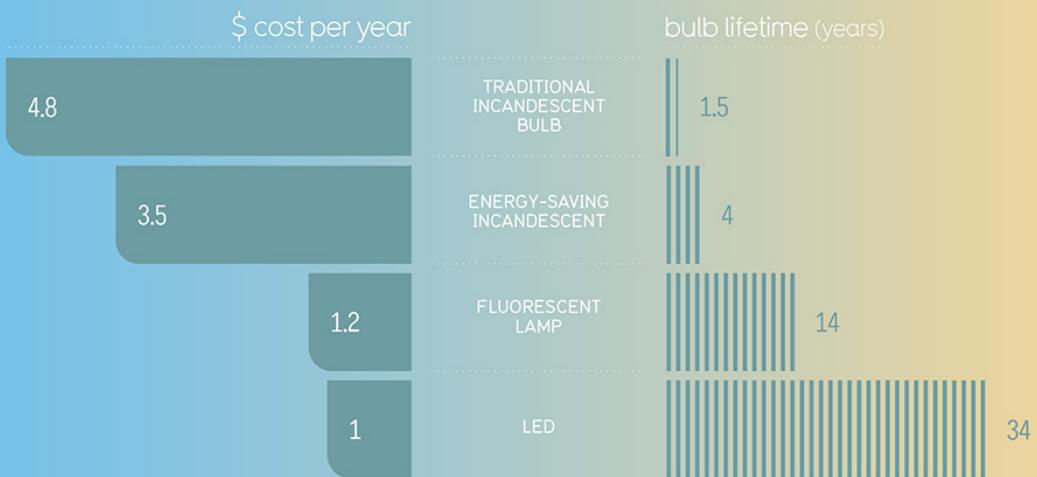
incandescent bulb



fluorescent

LED

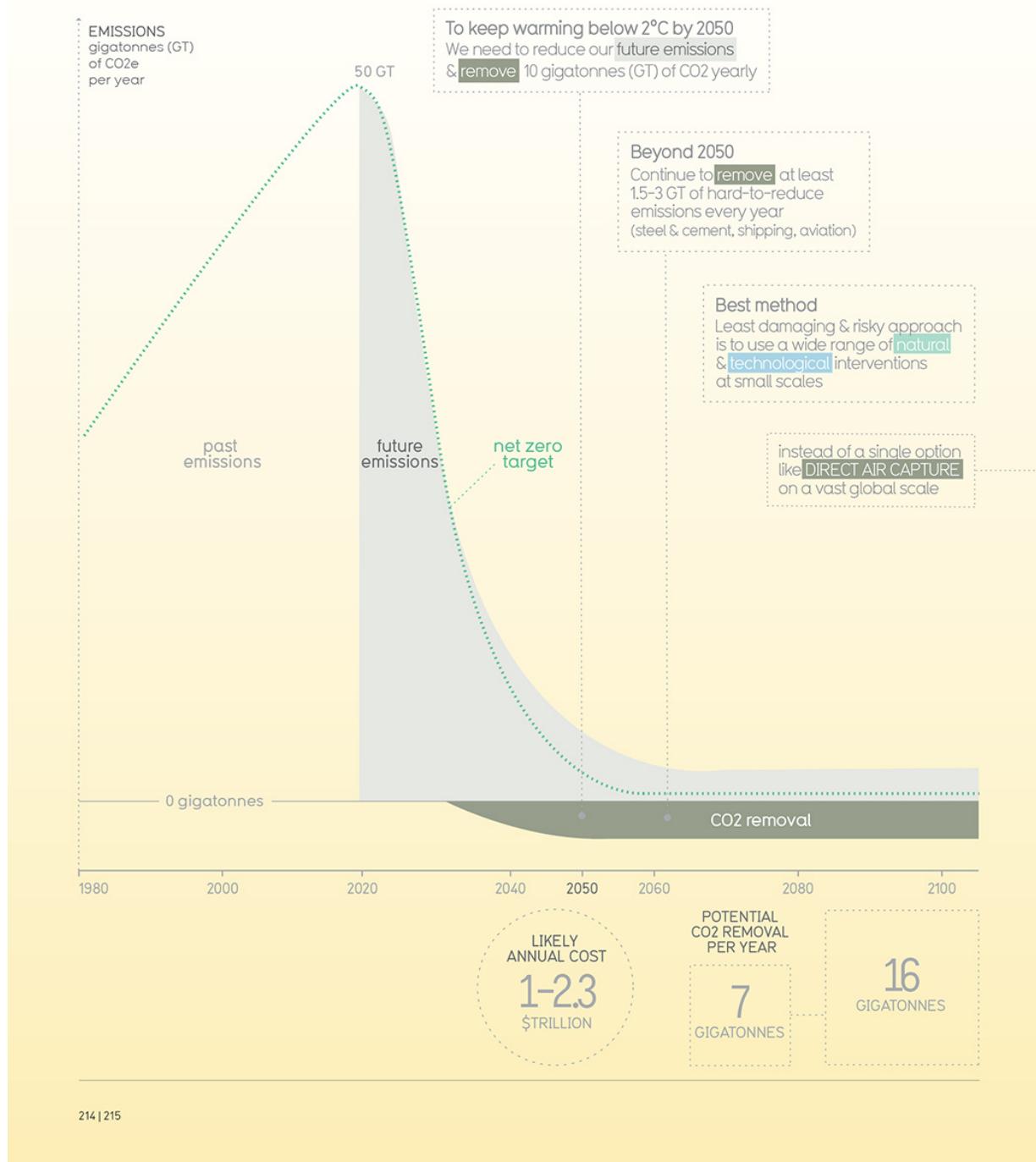
...Saving Energy & Money



sources: International Energy Agency, energy.gov

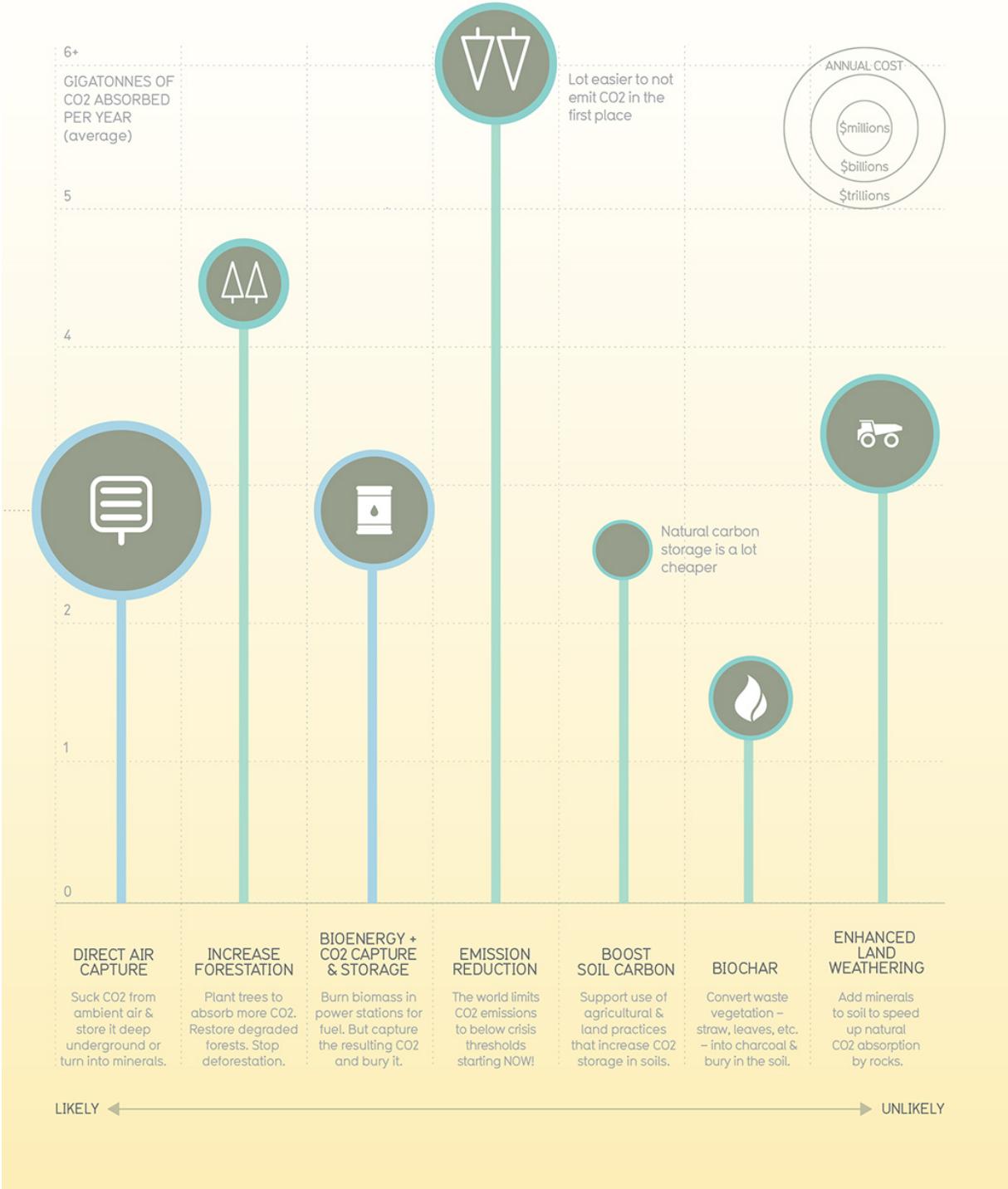
## CO<sub>2</sub> Removal Is Part of Getting to Net Zero

We probably can't limit global heating without sucking carbon from the air



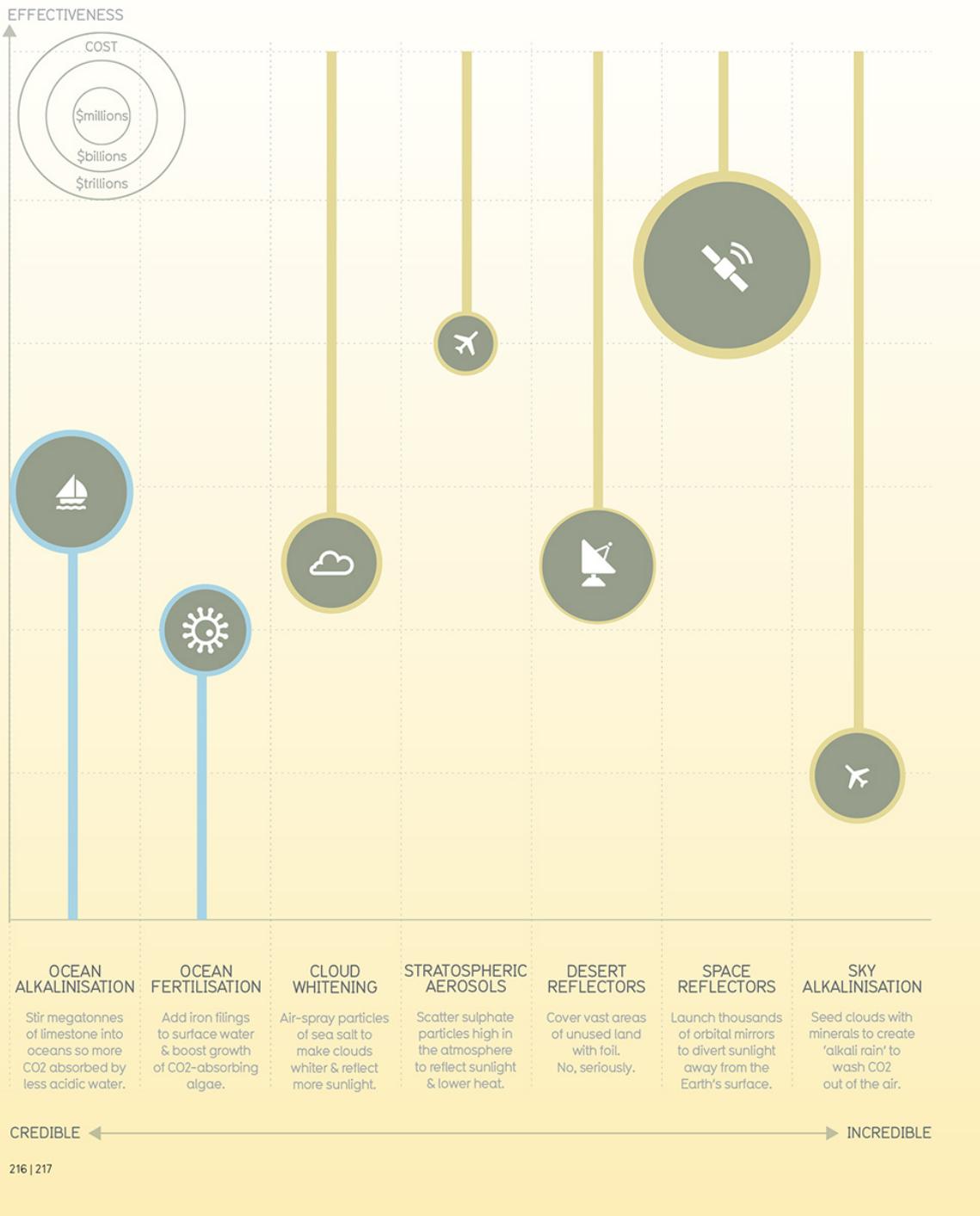
# Our Portfolio of CO<sub>2</sub> Capture Techniques

NATURAL  
TECH



# Climate Hacking: For Emergencies Only

Extreme Geoengineering & Solar Management Are Fallbacks



# Carbon Capture at Source

Suck up the CO<sub>2</sub> before it even hits the atmosphere



**INDUSTRIAL SOURCES**  
Install special capture devices at fossil-fuel plants to absorb emissions



**SUPER EFFECTIVE**  
Capture the highly concentrated greenhouse emissions before they're diluted in the air



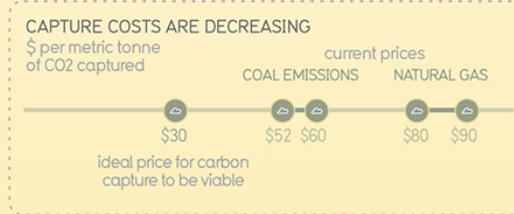
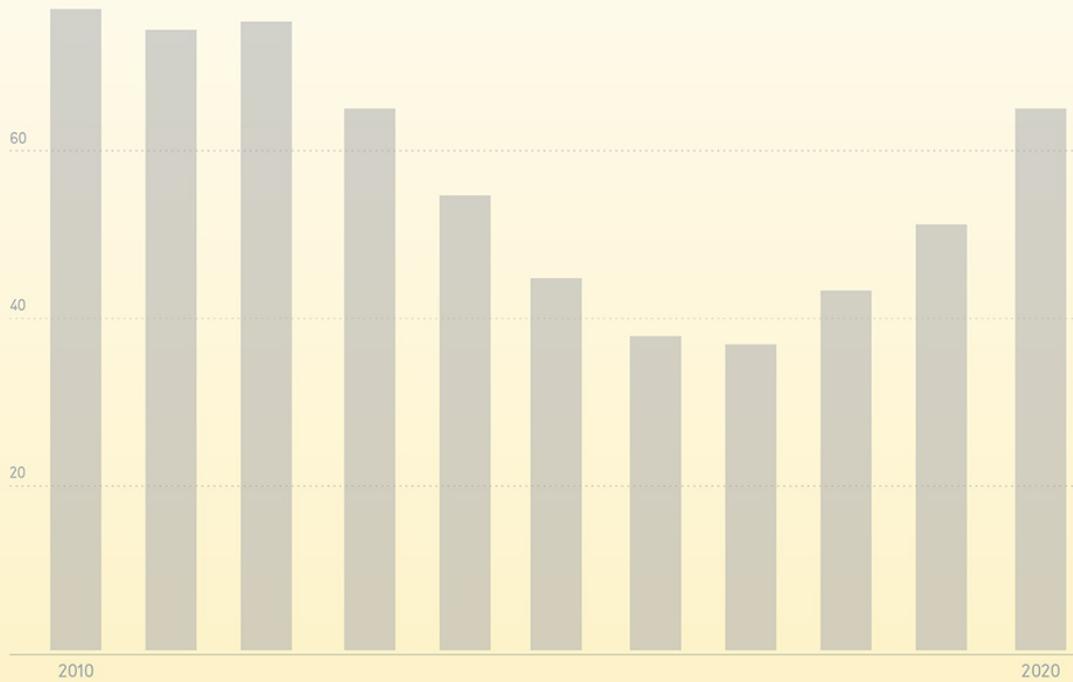
**BUT EXPENSIVE**  
Hundreds of \$ millions to install and operate. Plus heat energy is required to extract the CO<sub>2</sub>.



**ON THE RISE**  
Many projects already installed, already capturing 40 million tonnes per year (0.1% of emissions)

80

CARBON CAPTURE FACILITIES WORLDWIDE

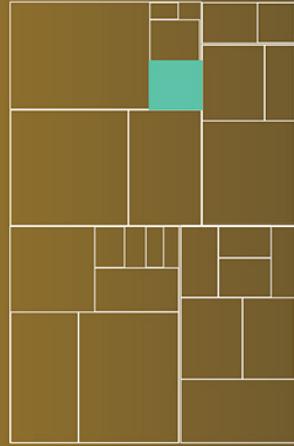


sources: New York Times, IPCC, National Academy of Sciences, Carbon Dioxide Removal Primer, Cicero, BBC, The Royal Academy

# Is it Wrong to Fly?

Air travel accounts for ~2.5% of global greenhouse gas emissions

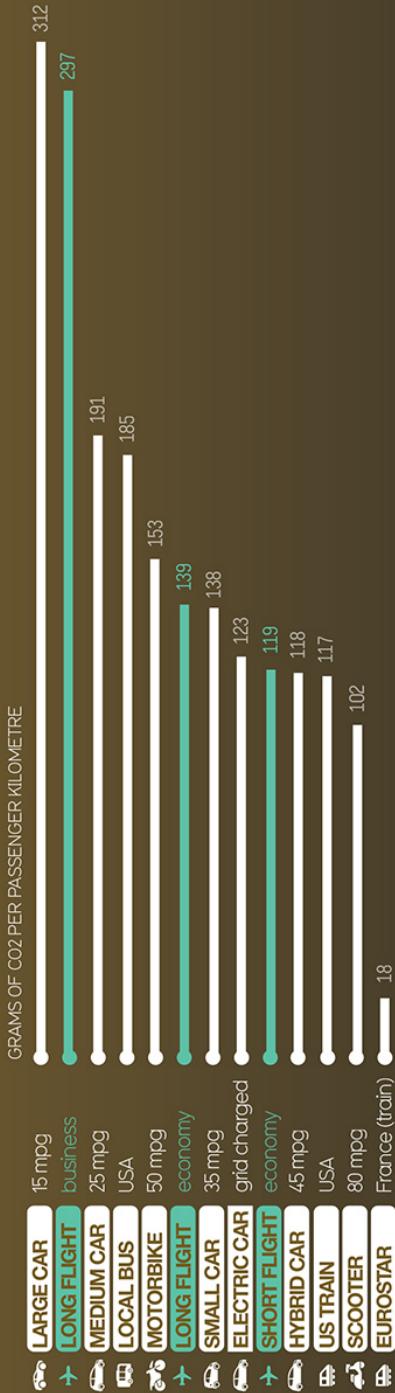
But closer to 5-8% of climate impact  
due to high-altitude release  
of gases & vapours



45,000 just  
in the USA

relative global heating effects (radiative forcing)  
of major components of aviation emissions

It's definitely one of the worst forms of transport, emissions-wise



Flying has become an essential part  
of our society, culture & economy

It's not going away

And nor are its  
emissions

PREDICTED INCREASE  
between

**240%**  
and  
**360%**



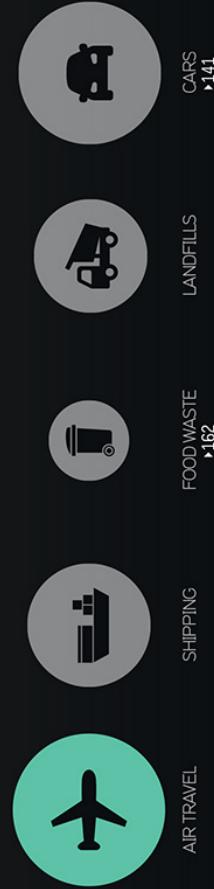
If aviation's eco-targets aren't met soon, air travel could consume **25%** of our global carbon emissions\* allowance



\*Paris Agreement carbon budget to stay under 1.5°C

But if everyone just  
stopped flying, it  
would have a minor  
impact on emissions

And many things are as bad or worse emitters & maybe easier to tackle...



Sources: New York Times, Carbon Brief, IPCC, National Geographic, NRDC, DATA

141

162

# Some Solutions Are Ready for Take-Off

## 'CORSIA' CARBON OFFSETTING & REDUCTION SCHEME FOR INTERNATIONAL TRAVEL



192 countries onboard

Global agreement where airlines commit to using sustainable aerofuels or offsets to cancel out emissions from international flights



non-mandatory until 2027



not domestic flights  
Paris Agreement covers those



private jets exempt

### Sustainable Aerofuels



Up to 80% emissions savings across entire lifecycle



Not here yet - still expensive & difficult to produce



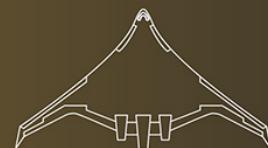
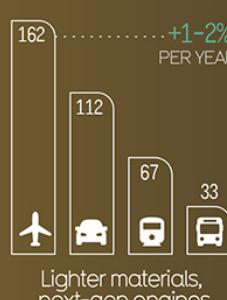
Stringent safety requirements means uptake is low



Will work best for international flights (400 miles or more)

### Boosting Aircraft Efficiency

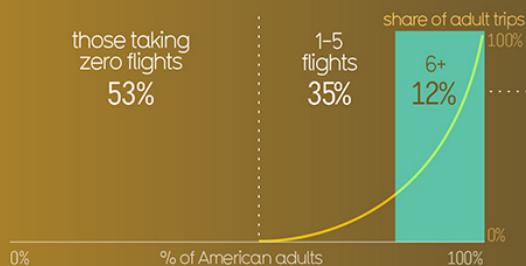
% IMPROVEMENT SINCE 1980



27% LESS FUEL BURNED  
15% WEIGHT REDUCTION  
New aerodynamic plane designs

### Better Personal Choices

THE 12% OF US ADULTS WHO TAKE 6+ FLIGHTS A YEAR ARE RESPONSIBLE FOR 70% OF ALL US AVIATION EMISSIONS



#### choose direct flights

they're better because 25% of emissions occur on take-off and landing



#### consider cabin class

first-class passengers use 5x the emissions of economy by taking up more plane space



#### reduce unnecessary flights



#### seek alternative transport

trains, especially electric trains in Europe, are most ideal - but US trains are fossil-fuel powered



#### offset your flight emissions

there are some good schemes - see our guide 220

sources: US Bureau of Transport, Nat Geo, World Bank

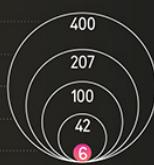
# Electric Planes?

## ALICE, THE WORLD'S FIRST COMMERCIAL, ALL-ELECTRIC PASSENGER AIRCRAFT

### Top Speed km/h



### \$Fuel Cost per 100km



### Passenger Capacity

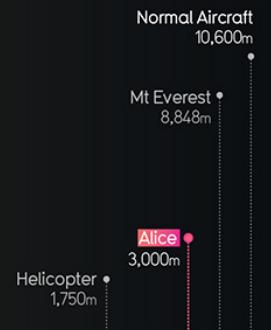


### Range



GOOD AS AN URBAN OR RURAL AIR-TAXI

### Max Cruising Altitude



\* Cessna Citation XLS, Airbus H175 Helicopter

sources: BBC, Wikipedia & others

### Challenges

OVER 200 ELECTRIC PLANE DESIGNS ARE IN DEVELOPMENT BUT THE TECHNOLOGICAL HURDLES ARE HIGH

The aviation industry is built on energy-dense fuels

An electric 747 would need a battery

Future battery tech might reduce this

Hydrogen or hybrid-electric planes are possible



Gasoline is incredibly energy dense



7x heavier than the plane itself



But by not nearly enough



But continued use of aerofuels more likely at least for international flights

sources: BBC, Wikipedia

# Does Carbon Offsetting Really Work?

when you reduce emissions in one place to compensate for emissions you caused somewhere else

✈ so to offset the 1.5 tonnes of CO<sub>2</sub> on your transatlantic return flight ✈

you might invest in programmes to support



renewable energy



clean-water access



cleaner cookstoves



tree planting

problem!

there are no global or national regulations in most countries on what a carbon offset is

so anyone can sell one



early programmes  
proved useless,  
even fraudulent



but today, some beautiful news

Gold Standard

solid independent certifications exist

Green-e

what makes a good one?

high quality schemes need to be

real



the project  
actually exists

verified



independent  
3rd-party checks

enforceable



repercussions  
if not completed

permanent



not easily  
reversible

additional



accomplishing  
something new

leak-proof



emissions stopped  
not just shifted

ultimately, do offsets work?

mathematically



If executed well,  
and are high quality,  
they can deliver  
a fair offset

socially/politically



Does voluntary offsetting  
take the pressure off  
corporate polluters &  
detract from systemic issues?

ethically

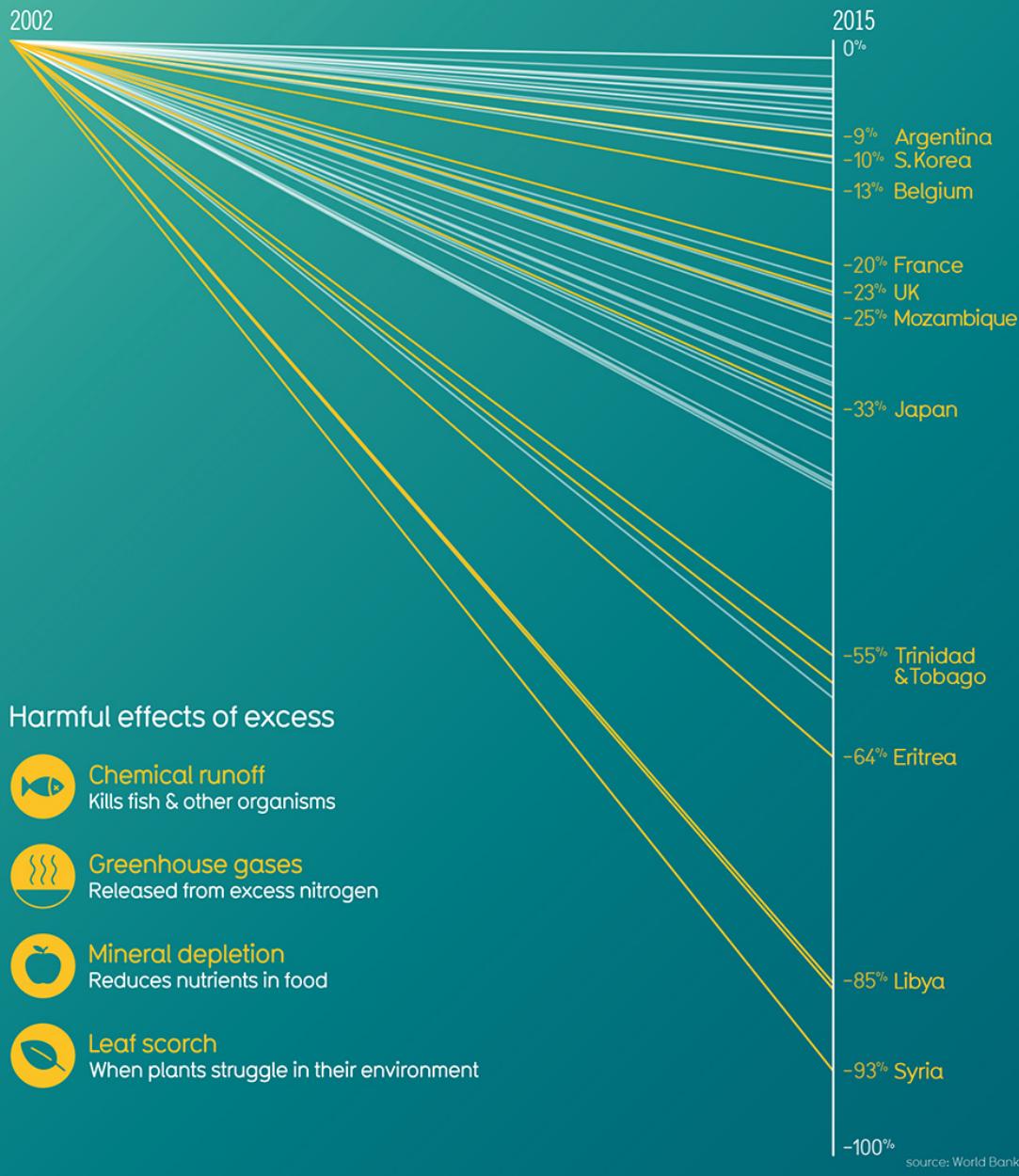


Is it okay for people  
in rich countries  
to just 'buy out' their  
climate guilt?

sources: IPCC, National Geographic, Natural Resources Defence Council

# 50 Countries Have Reduced Their Overuse of Fertilisers

Decrease in nitrogen, potash & phosphate per hectare



More than  
institutions  
have de-invested  
**\$14 TRILLION**  
from fossil-  
companies

1,200  
worldwide  
vested

N  
fuel  
S

breakdown of institutions

faith institutions 15% de-invested	philanthropy 17%
education 15%	pension funds 14%
government 15%	corporations 6%
NGOs 4%	health care 1%

source: GoFossilFree.org

# Seaweed: food, fertiliser, feed, fuel

Can it be all these things – and tackle our emissions problem?

## Sea Trees



Seaweed absorbs at least as much CO<sub>2</sub> as trees, but without taking up valuable land. A dry tonne of kelp absorbs about a tonne of CO<sub>2</sub> in its lifetime.

sources: Nature Geoscience, Science, FAO, ScienceNordic, Project Drawdown

## Ultra Fast Growing

MAX GROWTH PER DAY (cm)

Bamboo	90
Kelp	60
Kudzu	30
Algae	4.2
Acacia	2.5

Kelp seaweed grows incredibly quickly – it's one of the fastest-growing plants in nature. So fast, it could be harvested for its various uses **every 90 days**.

sources: Drawdown, PLOS One, BBC, Monterey Bay Aquarium, EarthnWorld

## Biofertiliser



Seaweeds contain powerful, growth-stimulating hormones.\* They stimulate seed germination and nutrient uptake while protecting plants from infections.

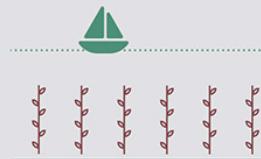
\*auxins, cytokinins, gibberellins

source: Journal of Scientific & Industrial Research

## 100% Sustainable, Low-Carbon Crop



Ocean seaweed farms have none of the major downsides of land farming: **deforestation, overuse of fertilisers, fresh water and fuel-burning machinery**.



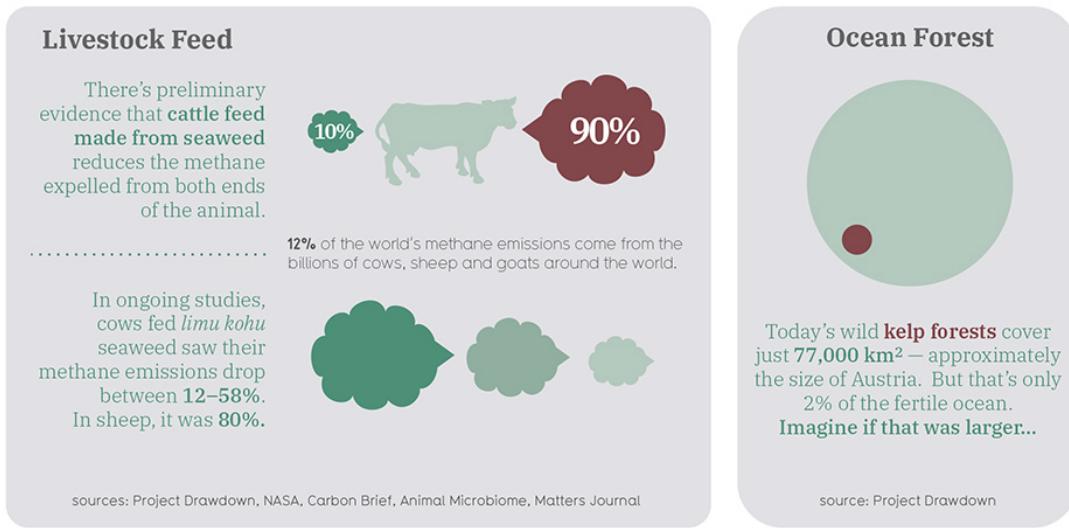
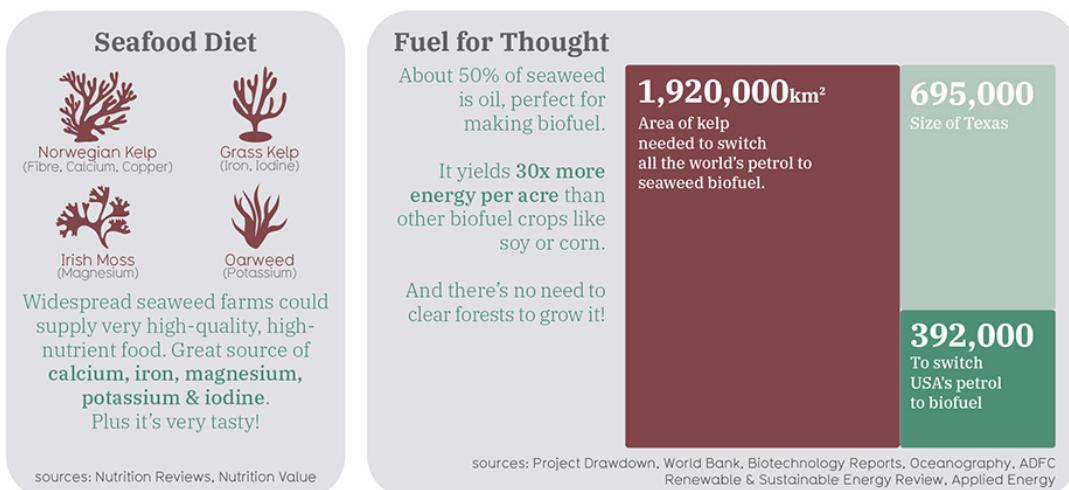
Because they grow vertically, seaweed farms **use less space**, and attract aquatic life, boosting the ecosystem. They also sit 25m underwater so boats can pass above.



Harvesting is simple and often done by hand, using very little CO<sub>2</sub> burning fuel.

The first seaweed farms are in trials off the coast of Hawaii.

sources: Project Drawdown, Matters Journal, The Atlantic, World Bank, National Geographic, BBC



# Methane

AKA 'natural gas' – the other major greenhouse gas

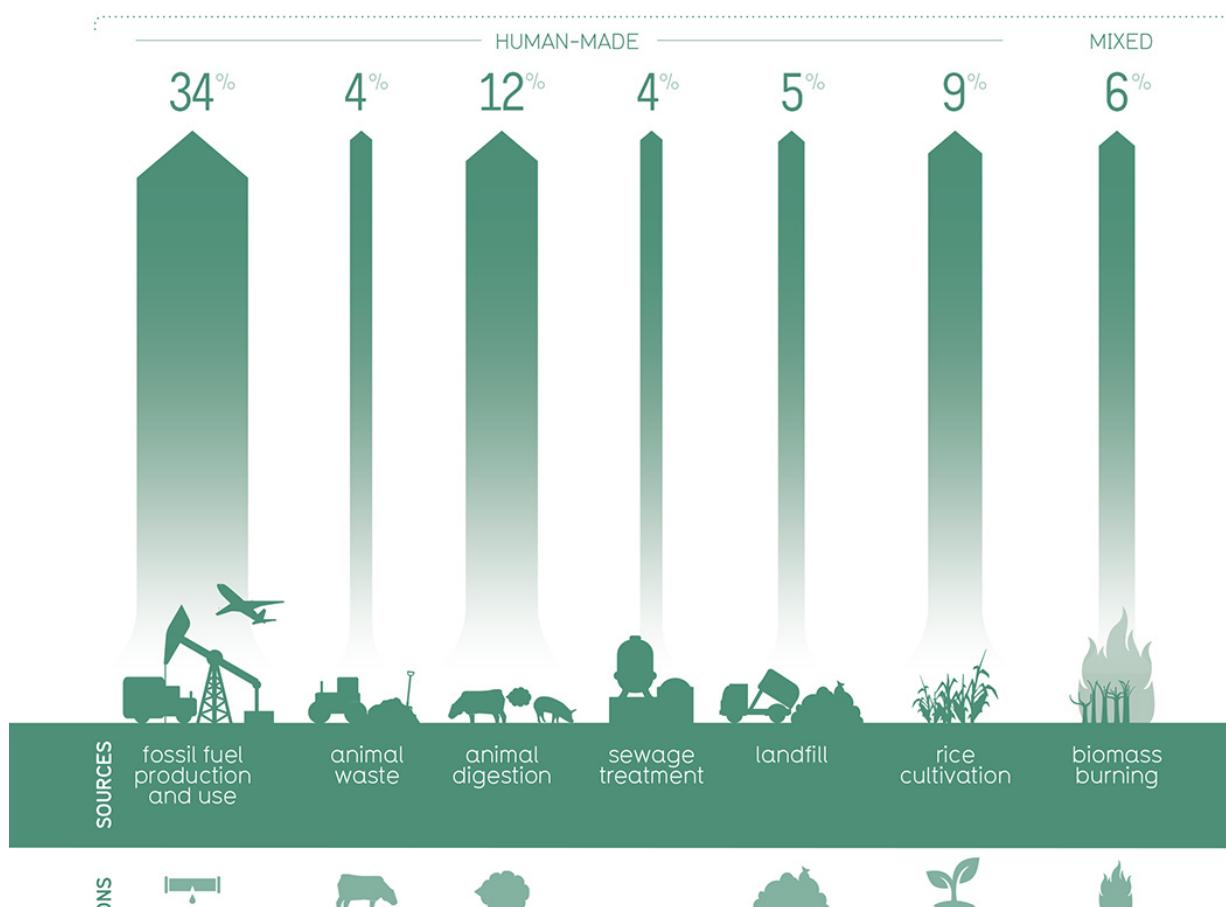


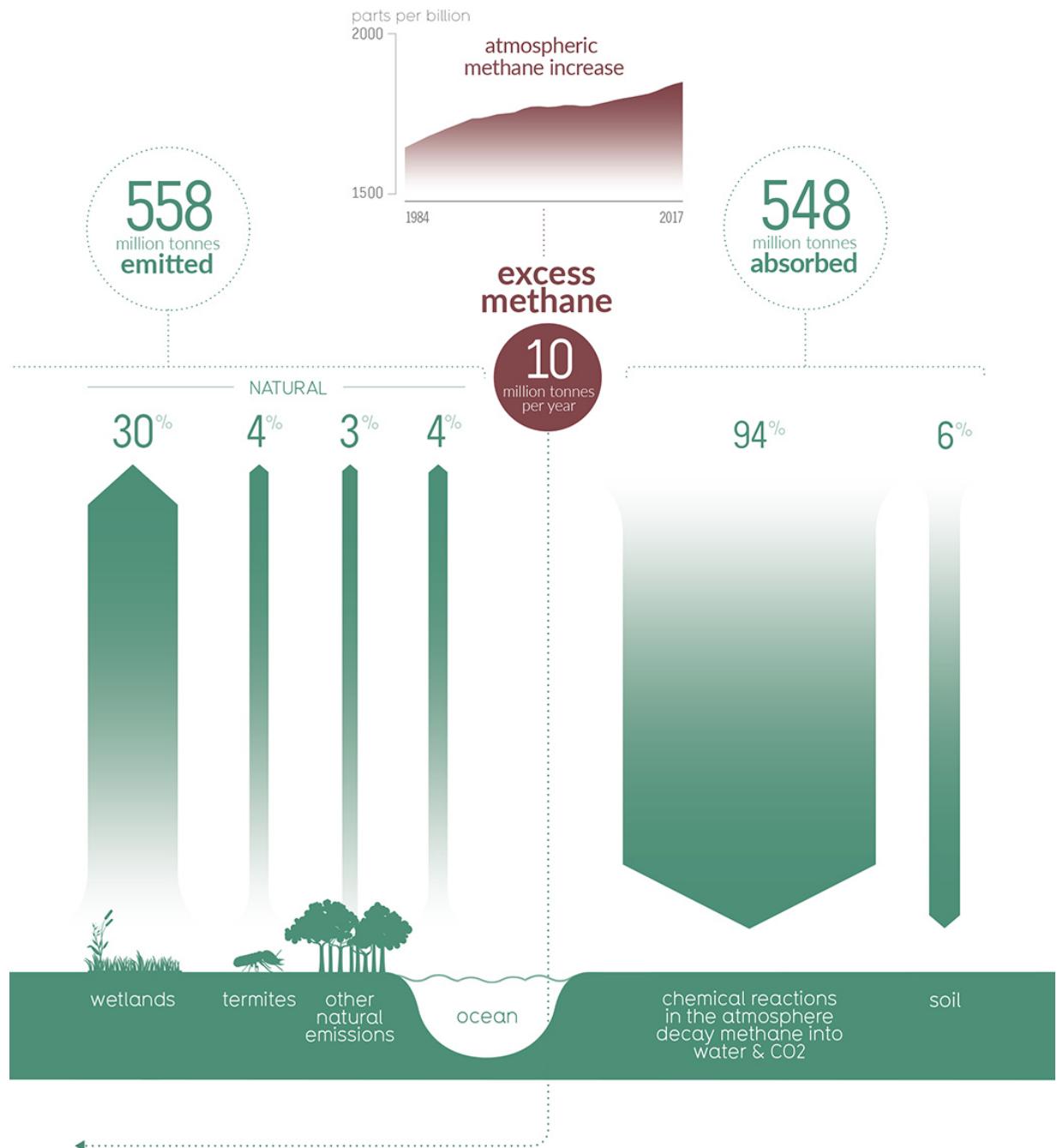
Methane (CH<sub>4</sub>) makes up **16%** of our total greenhouse gas emissions – it's used mostly to generate electricity.



A more powerful GHG gas than carbon dioxide (CO<sub>2</sub>), CH<sub>4</sub> hits the atmosphere **faster & dissipates quicker**.

So it warms the planet **rapidly in the short term**. Whereas CO<sub>2</sub> heats the planet over the long term.





## The Potential of Hydrogen Power Is Amazing!



true natural resource  
super-abundant, non-toxic  
element – will never run out



no direct emissions  
burns cleanly – releasing  
only energy & water



highly stable  
can be liquified & stored in  
fuel cells for weeks & years



easy to transport  
via pipelines, or in trucks  
and ships

**H** is already in use around the world – and its potential looks rosy  
size = potential

ALREADY  
done deal

- rocket fuel
- oil refining
- making fertiliser
- first fuel-cell cars

DEFINITELY  
makes sense

- air-taxis
- domestic heating
- steel production
- industrial heating
- energy storage

PROBABLY  
some obstacles

- trucks/lorries
- short-haul flights
- industrial transport

PROBLEMATIC  
major issues

- buses
- shipping
- long-haul flights
- widespread cars

main problem

It's currently difficult to manufacture **H** without emitting carbon

TYPE OF  
HYDROGEN



BLUE



BLACK/  
BROWN



YELLOW



GREEN

WHAT made from fossil fuels,  
mostly methane

same as grey but  
CO<sub>2</sub> is captured

made with types  
of coal

synthesised with  
nuclear energy

renewable energy to  
extract **H** from water

% OF CURRENT  
GLOBAL H

(76)

(0)

(23)

(0)

(2)

\$ PER KILO

\$1-3

\$1.5

ideal price

\$2

unknown

\$2.5-6

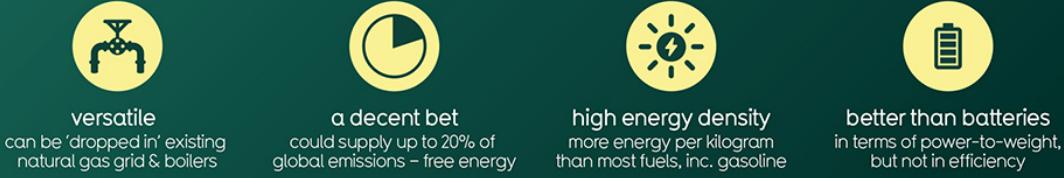
NOTE

every tonne of H  
generates 11 tonnes  
of CO<sub>2</sub>

not here yet,  
CO<sub>2</sub> capture tech  
in its infancy  
►214

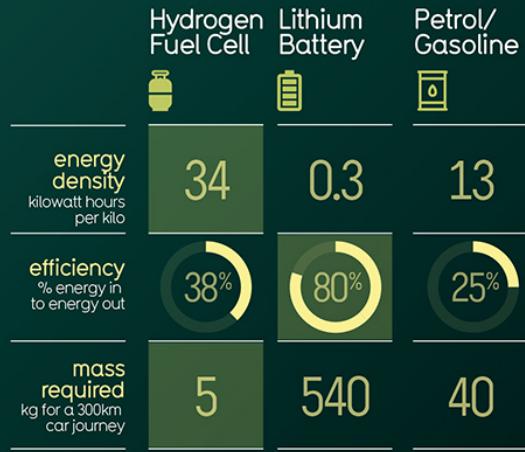
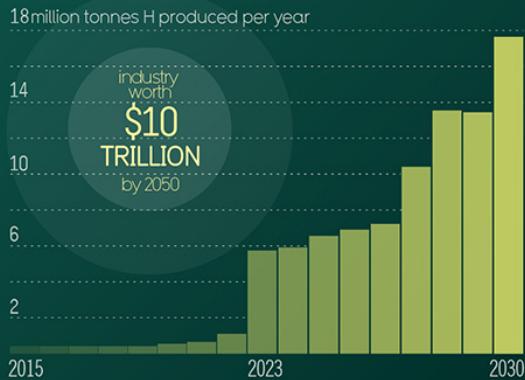
dirty tech –  
needs to be  
phased out

strong possibility  
for carbon-free  
hydrogen



## Global Production Is Ramping Up

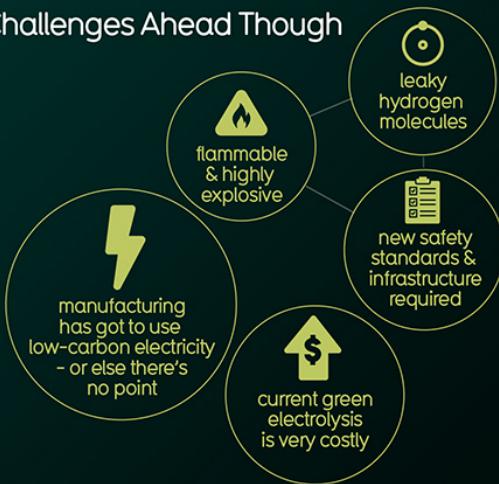
With big plans for the future



## Major Players Have Entered the Race



## Challenges Ahead Though



sources: Carbon Brief, International Energy Agency, 'How to Avoid a Climate Disaster' (Gates, 2020)

## What about H-Fuelled Passenger Cars?

Are Fuel Cell Electric Vehicles (FCEVs) a true alternative to 'battery electric'?



**fuel-celled**  
electricity generated from  
onboard supply of H tanks



**fast refuelling**  
can fill up at a traditional  
gas station in 5 mins



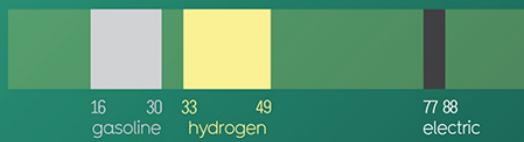
**refuelling network**  
infrastructure will  
need to be built



**industrial storage**  
expensive level of gas  
compression required

### Overall Efficiency Is Less Than Electric

% OF ENERGY DELIVERED TO WHEELS



### But Max Range Is About the Same

MILES BEFORE RECHARGE

BMW X5	H
VOLKSWAGEN ID 3	H
TESLA MODEL X	H
HYUNDAI NEXO	H
TOYOTA MIRAI	H
TESLA MODELS S	

### Big Car Makers Are Split

MANY ARE ALREADY WEDDED TO BATTERIES

OUT



**Audi**

**FIAT** DAIMLER  
Mercedes-Benz

**Volkswagen**  
**T E S L A**  
General Motors

IN



**HYUNDAI**  
**HONDA**  
**BMW**  
**TOYOTA**

*Ford*

ON THE FENCE

**NISSAN**



**H** vans & lorries  
most manufacturers are investing  
in **H**-powered fuel cell trucks  
for commercial fleets

520

402

380

360

336

200



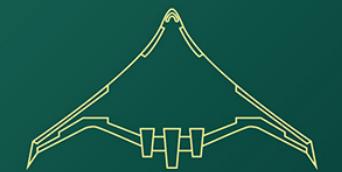
they're off!  
About 9,000 FCEVs  
on already on  
Californian roads



ultimately **H** needs to be green & carbon-free  
only **H** produced from renewable  
energy like solar & wind makes sense  
or else we're just adding more emissions

# Hydrogen Aircraft Could be Possible

But at least 10 years away



planes will have to be redesigned to accommodate fuel cells



## long haul unlikely

Compounding effect of greater storage, aircraft design, etc. makes hydrogen long haul very challenging



liquified hydrogen needs 4x the storage of kerosene airfuels



## short & medium haul is feasible

The EU is shooting for 2035-2040 for hydrogen-powered flights of less than four hours (which cause 60% of aviation's emissions)



## fuel cell air-taxis

Like a big drone, basically, but powered by lighter hydrogen fuel cells for increased lift and range - 5 people up to 600 km.



## hybrids possible

Using H in flight to power fuel cells, or combining with CO<sub>2</sub> to create new synthetic liquid fuels, may mean less change to existing infrastructure

### A Hydrogen PowerPaste for Scooters, Motorcycles & Drones

Amazing new solution for small vehicles



H is combined with magnesium to make powdered magnesium hydride



adding water activates a chemical reaction to produce H to drive a motor



10x energy density of electric battery



functional from -30 to 250 degrees C

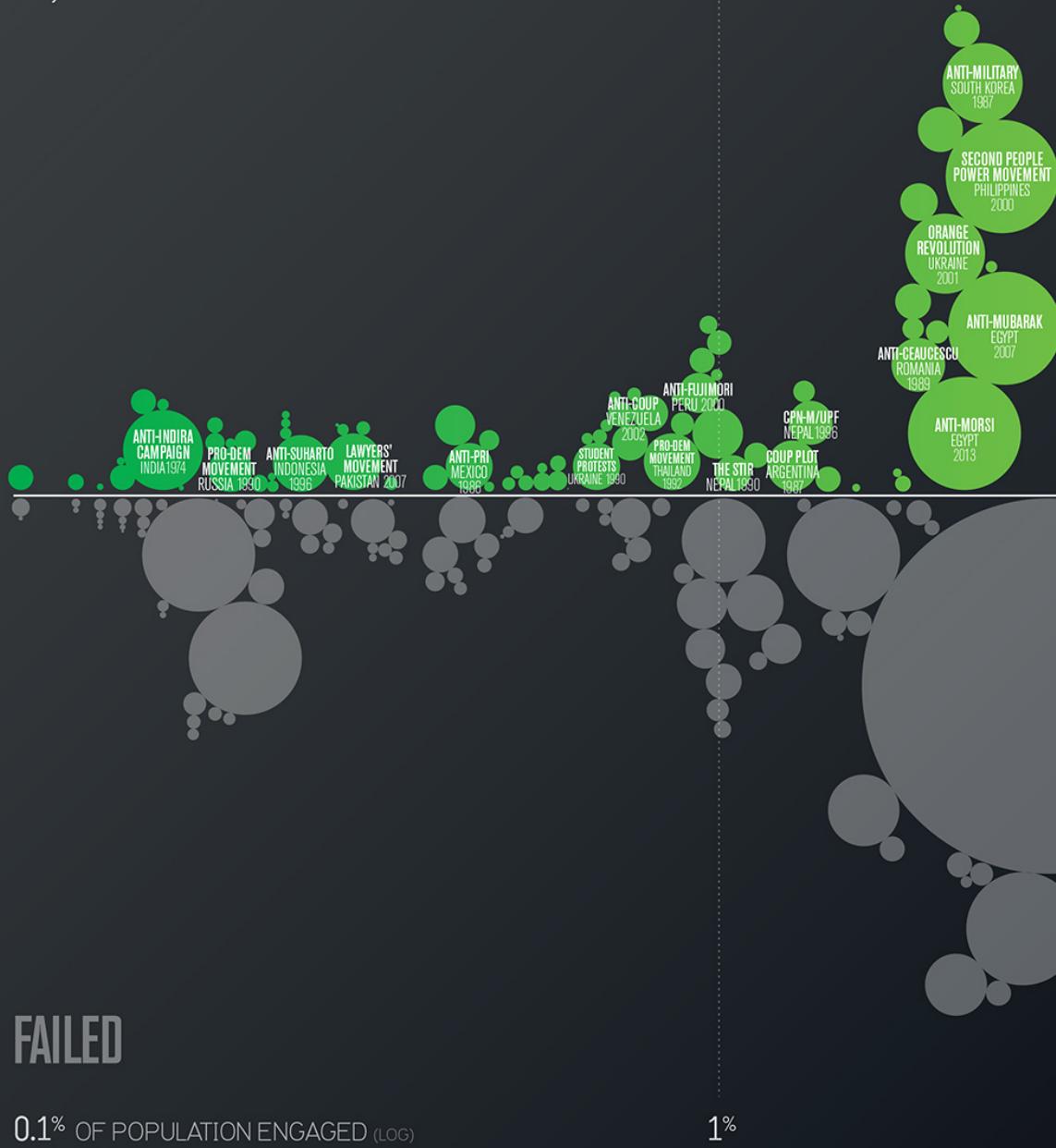


stored in swappable cartridges & cannisters

sources: Fraunhofer Institute, Airbus, Carbon Brief, The Week, 'How to Avoid a Climate Disaster' (Bill Gates, 2020)

# Protests Engaging 3.5% of a Population Very Rarely Fail

Major movements 1960 onwards



# SUCCEEDED



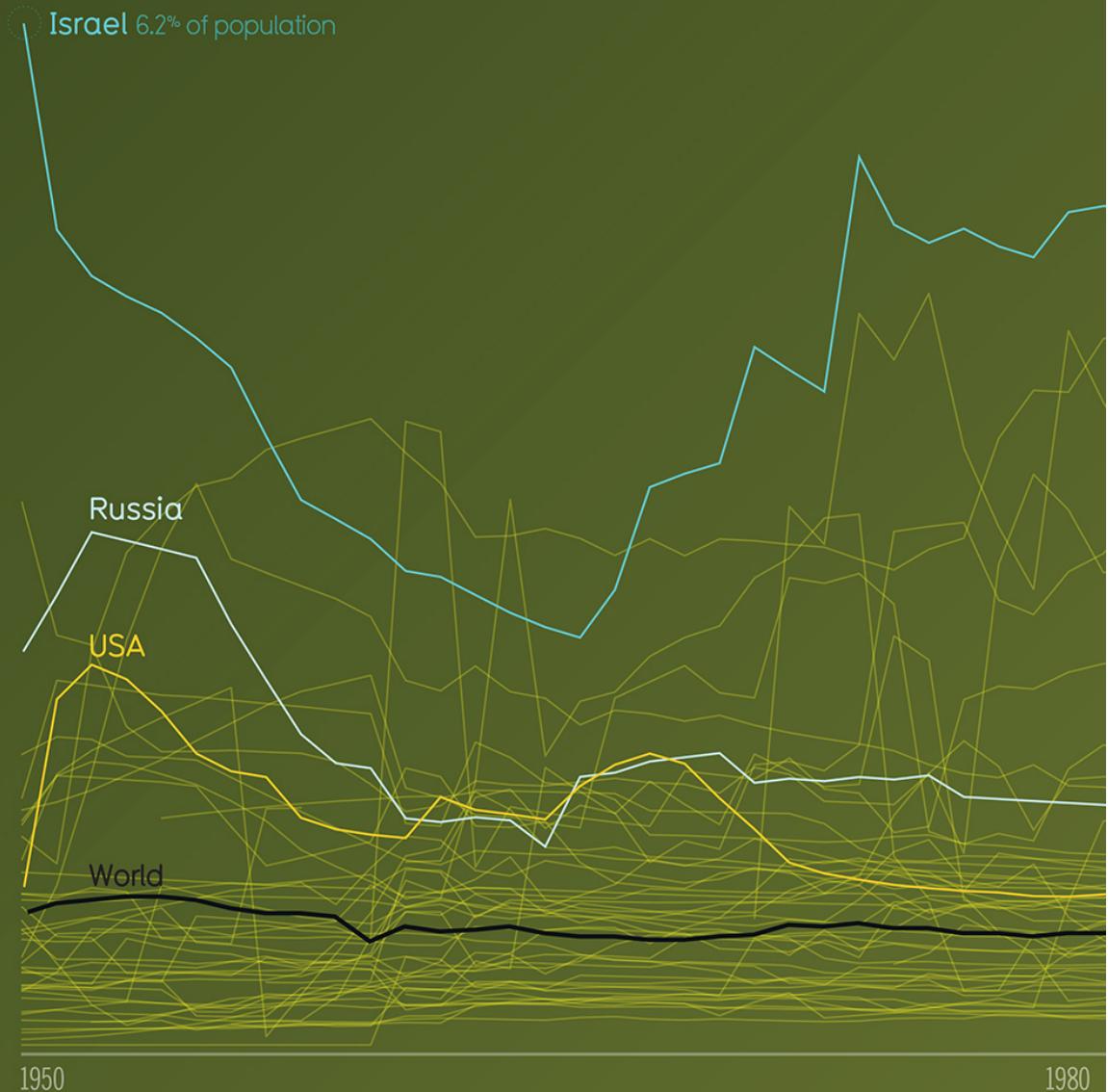
**REF**  
**REDUC**  
**REUSE**  
**REPAIR**  
**REPURPOSE**  
**RECYCLE**

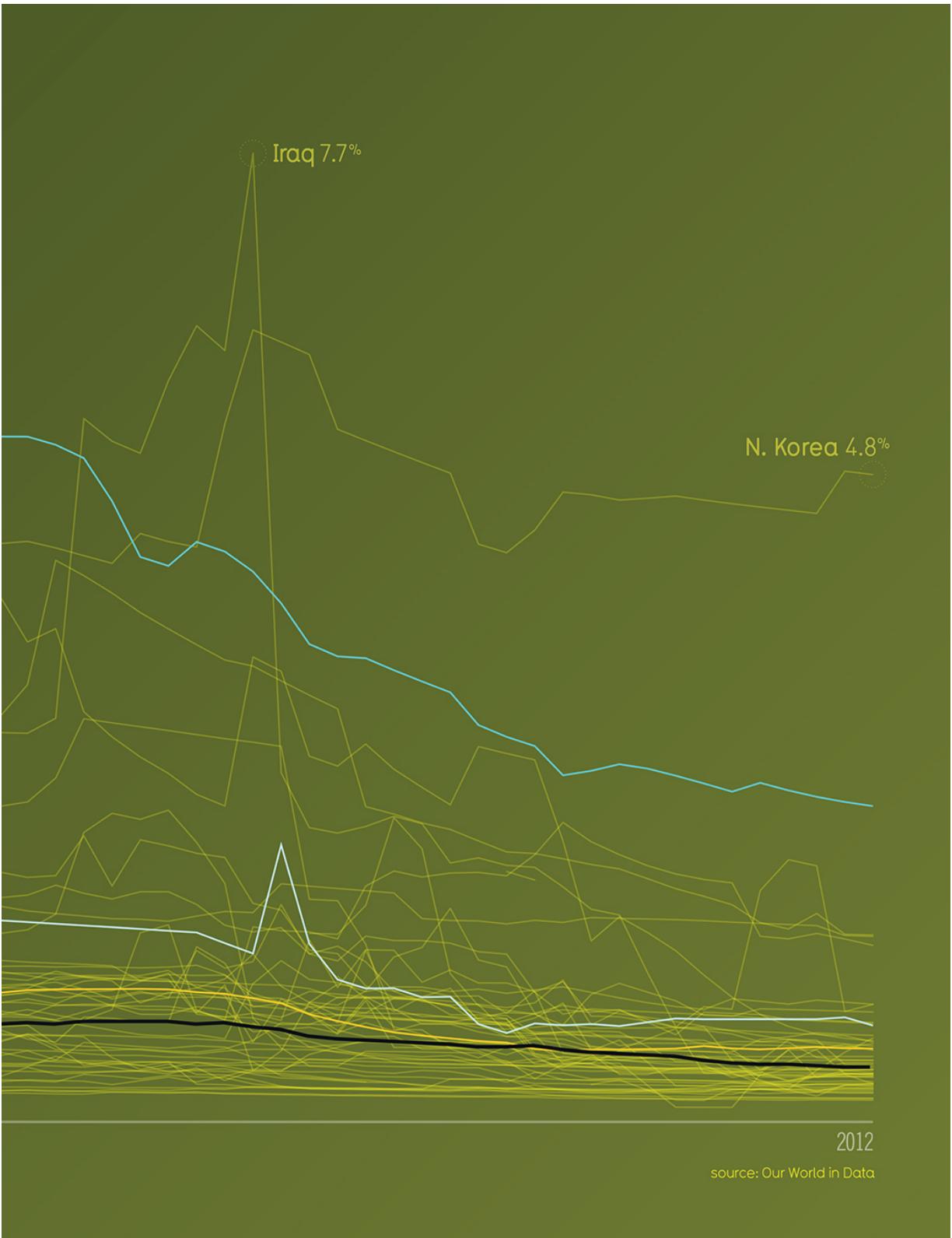
(last resort)

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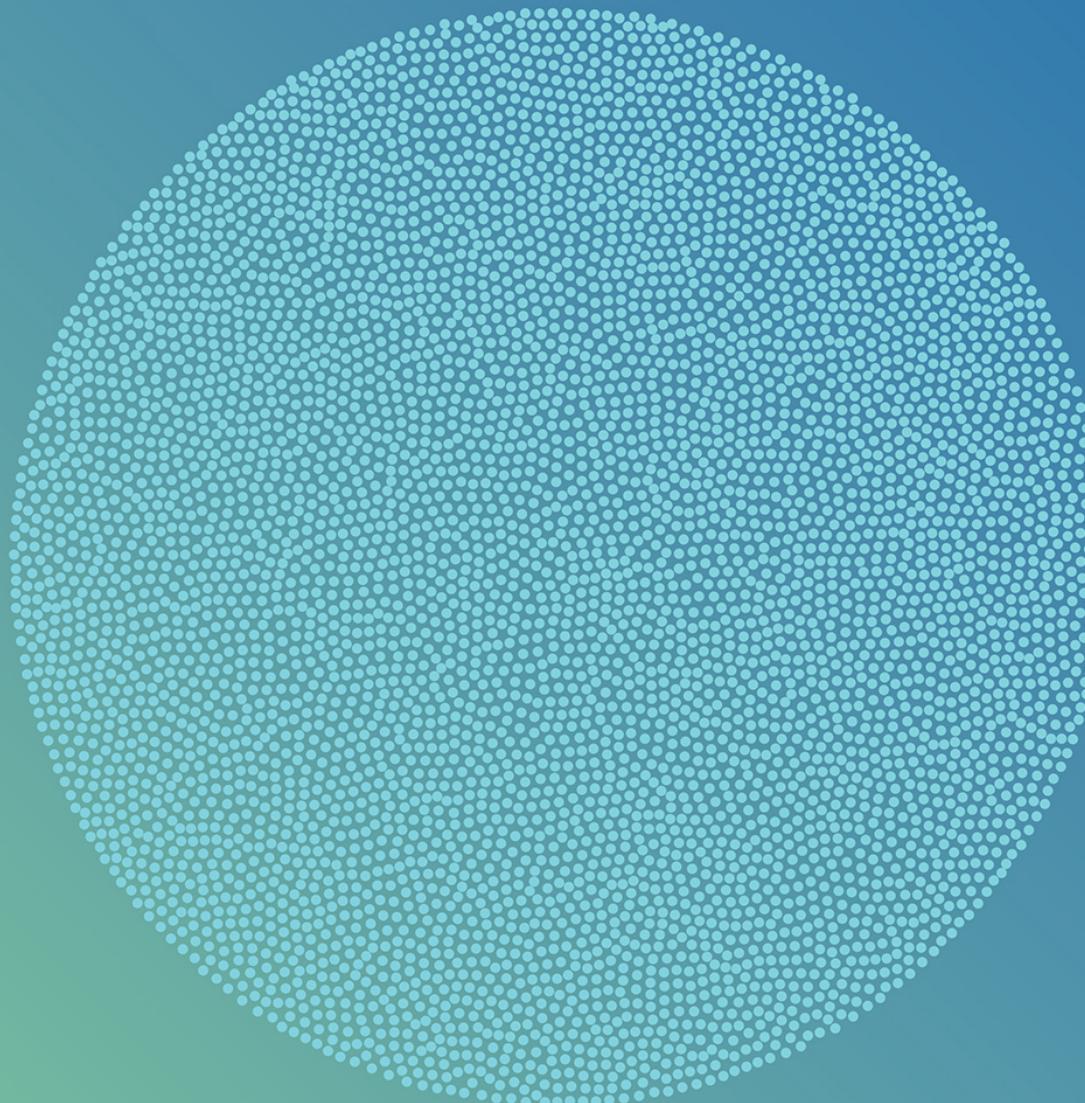
# Armies Everywhere Are Shrinking

Soldiers as % of population



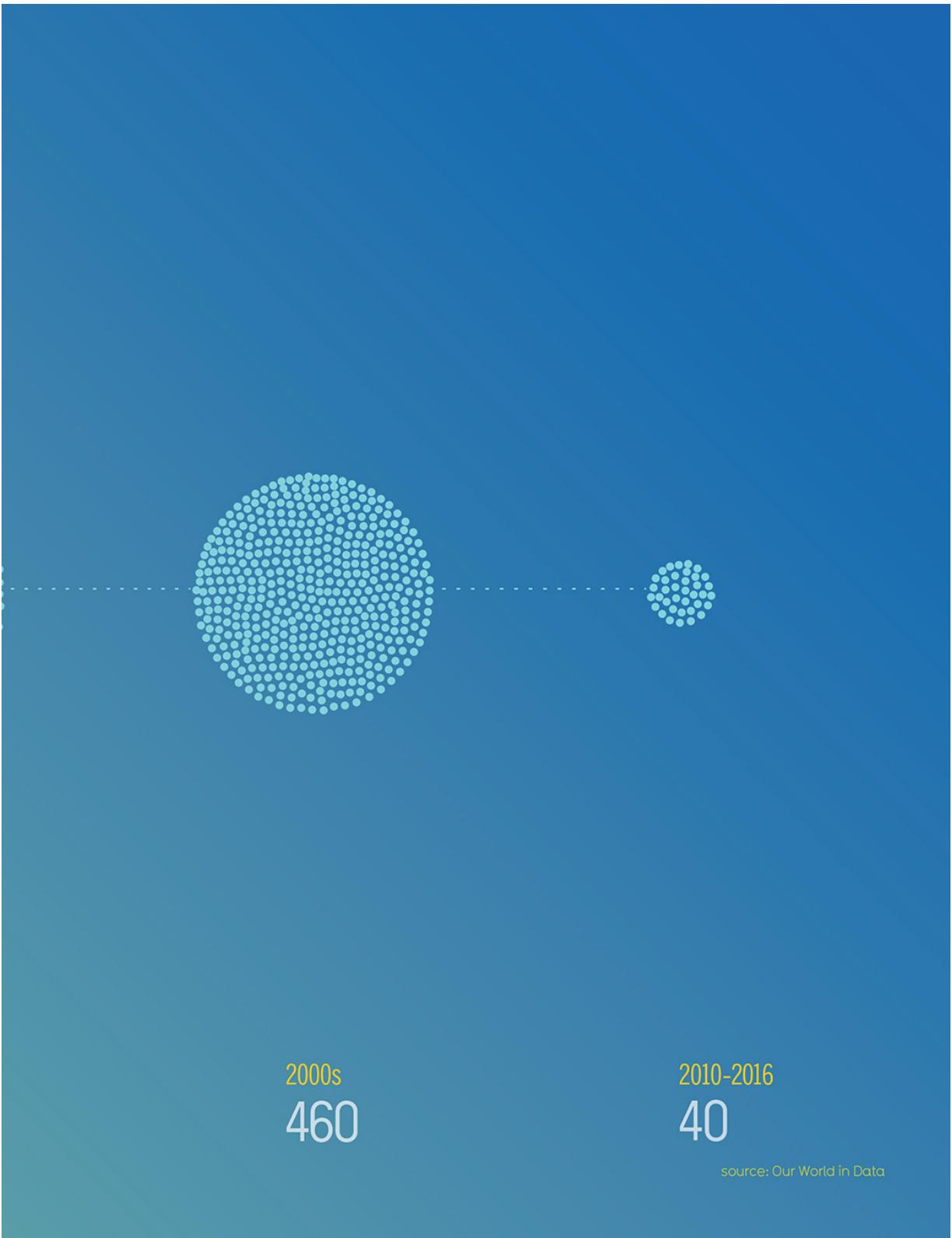


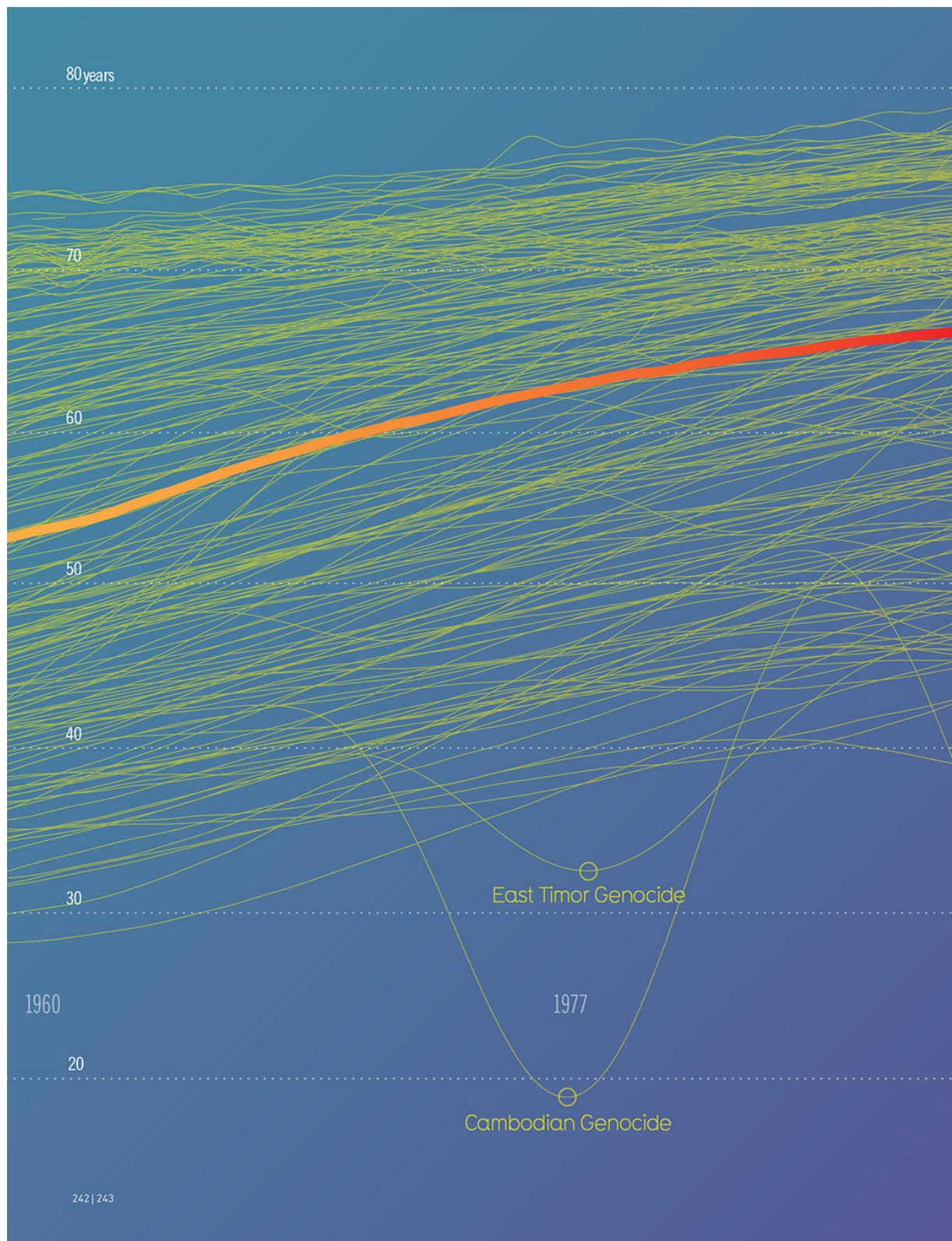
## Famine Deaths Have Plummeted Globally

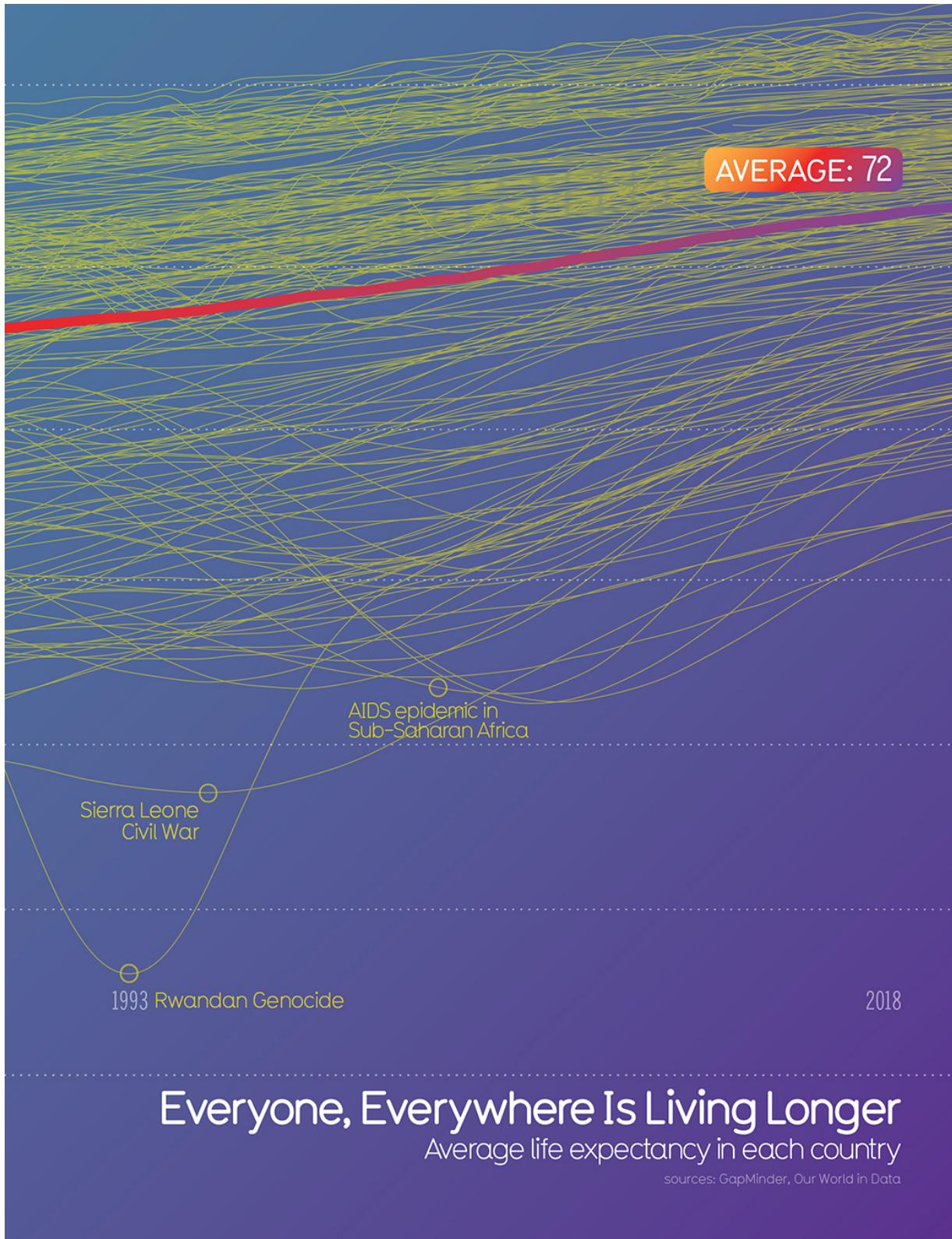


1960s

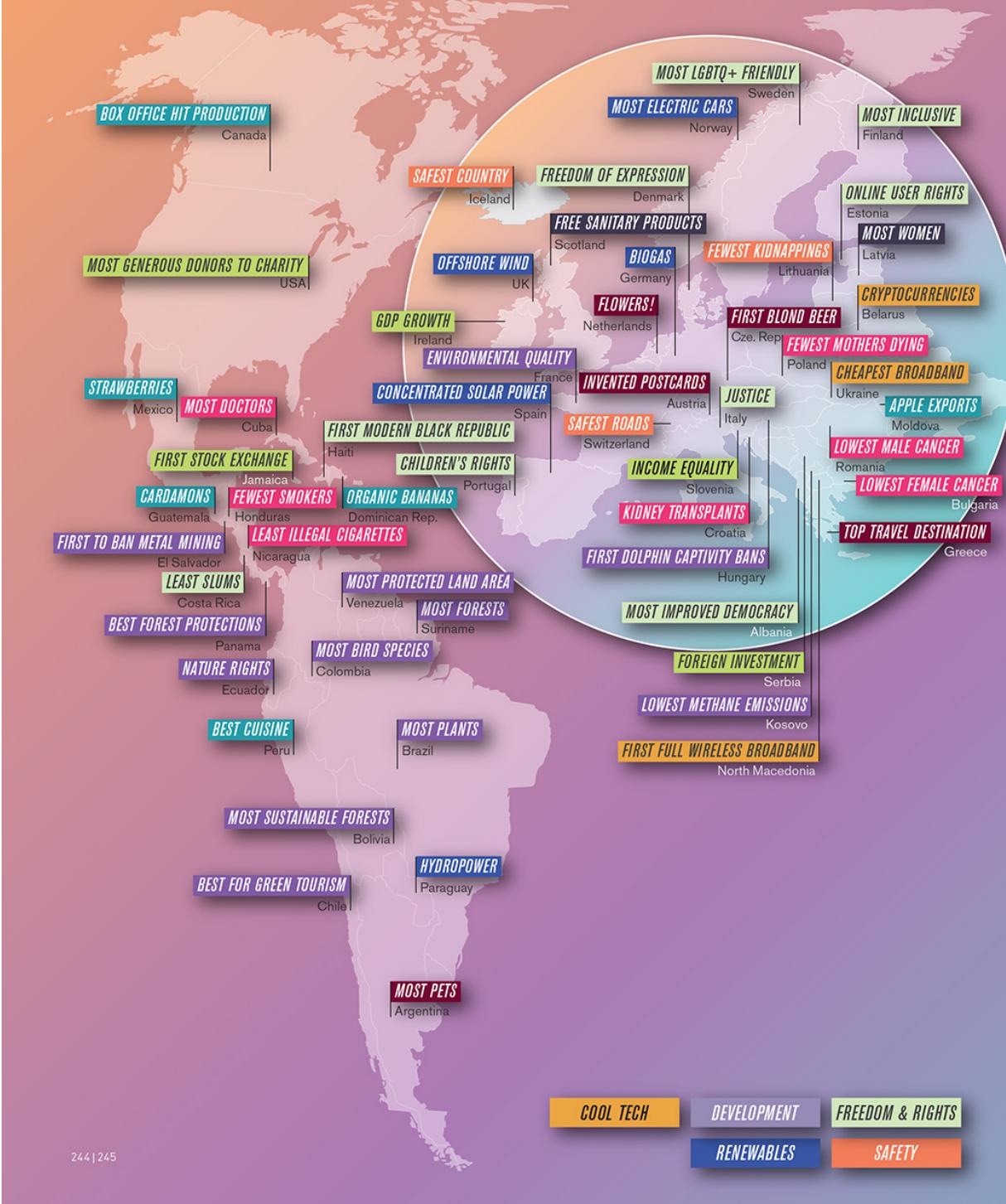
5,470 DEATHS per million people

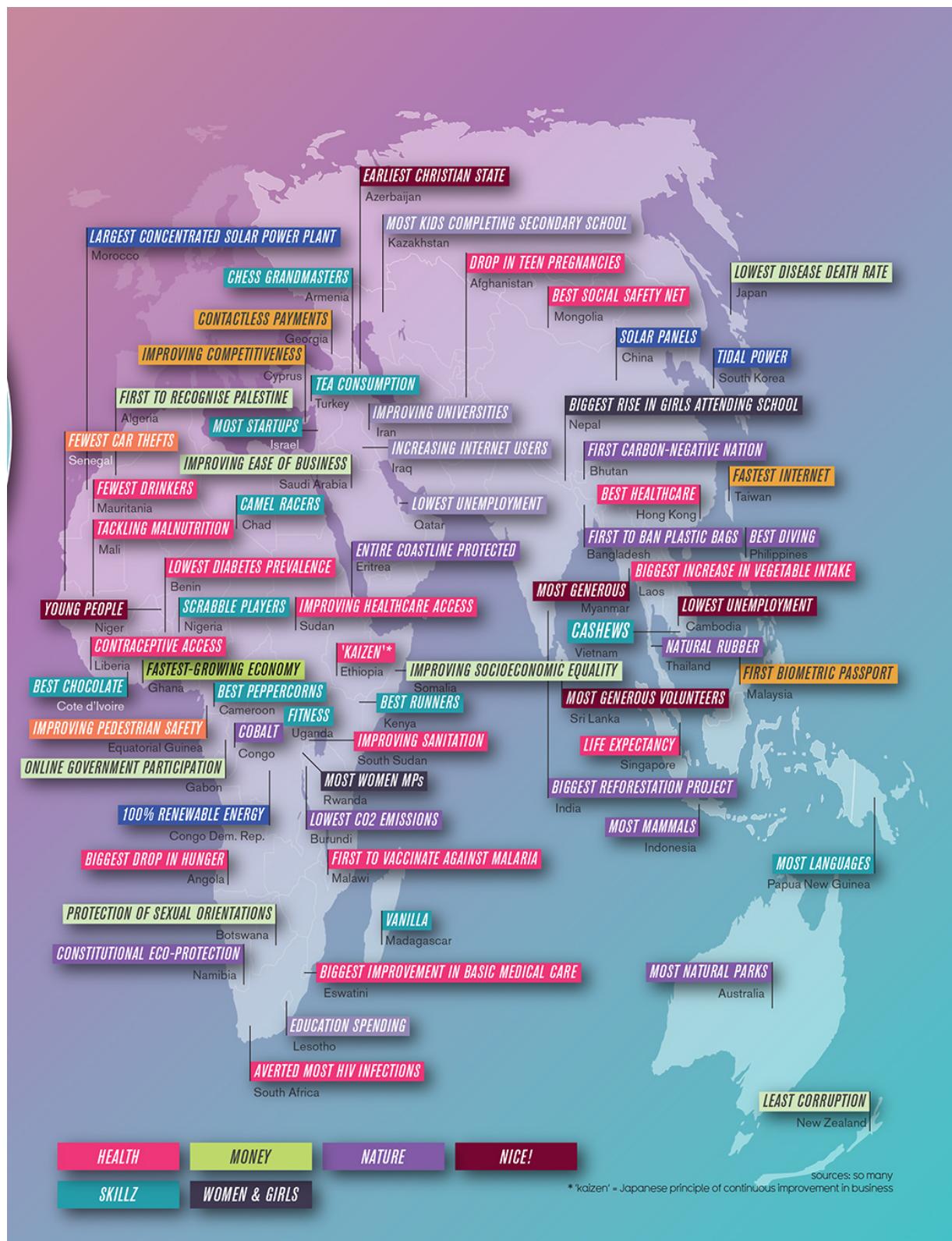


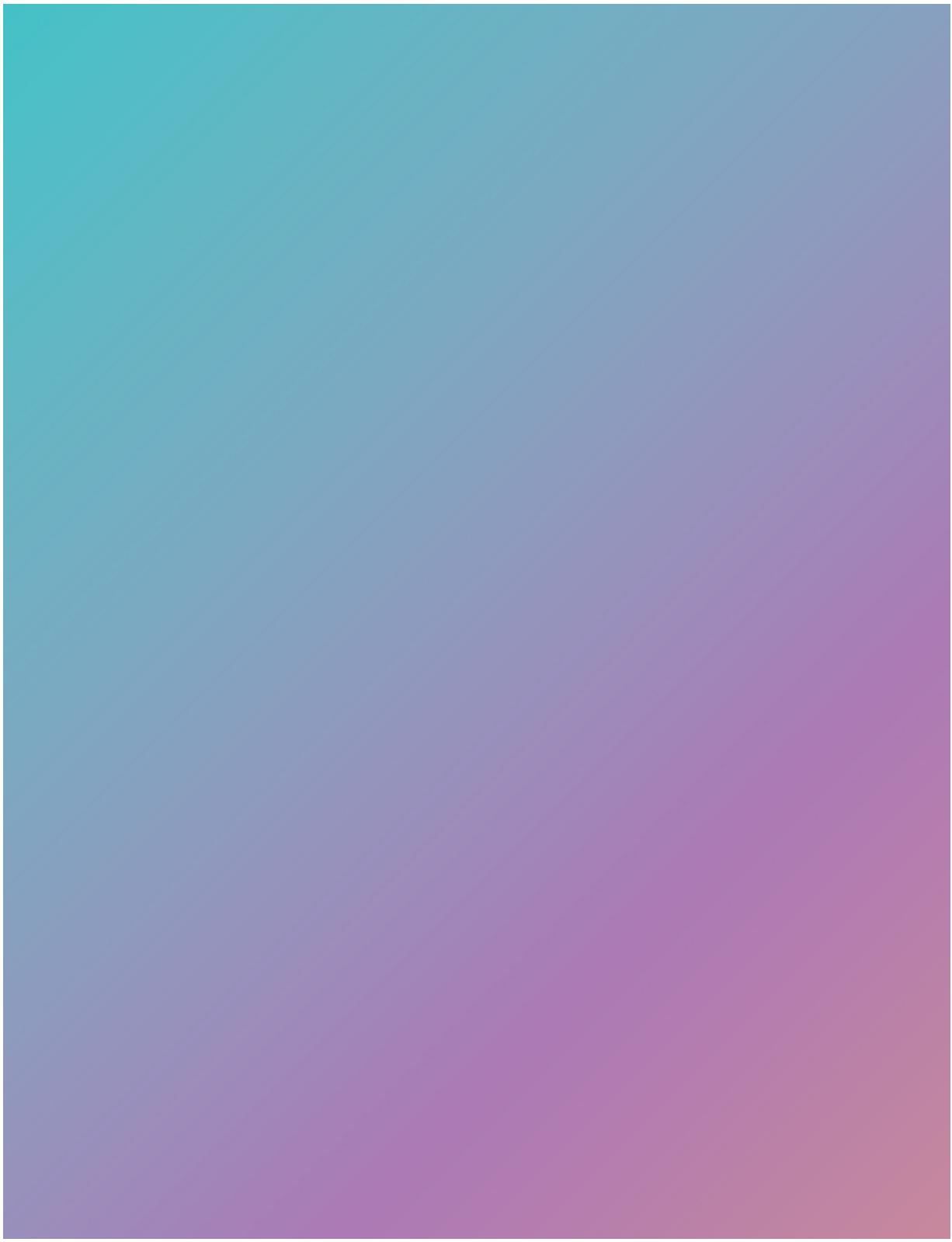


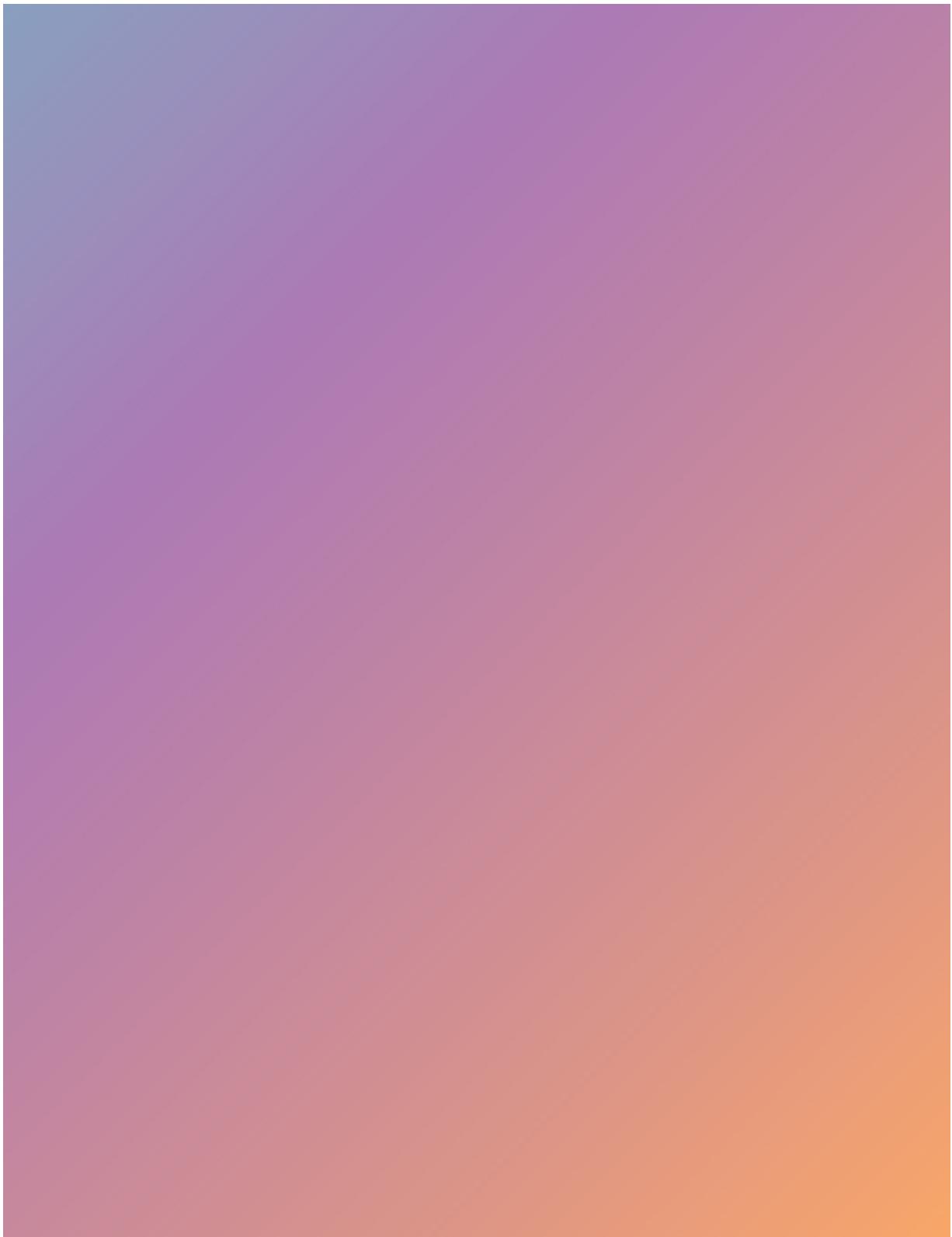


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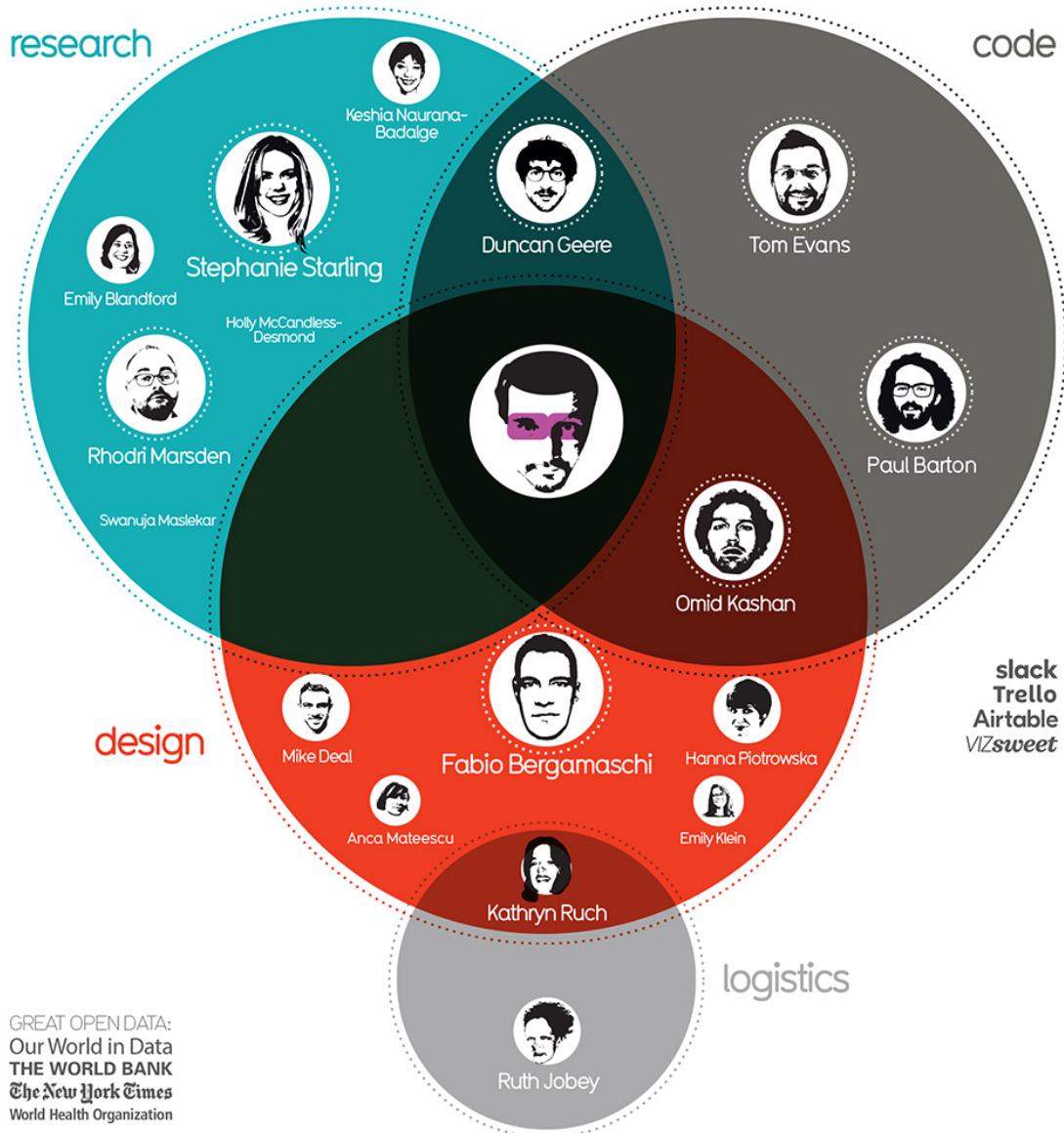








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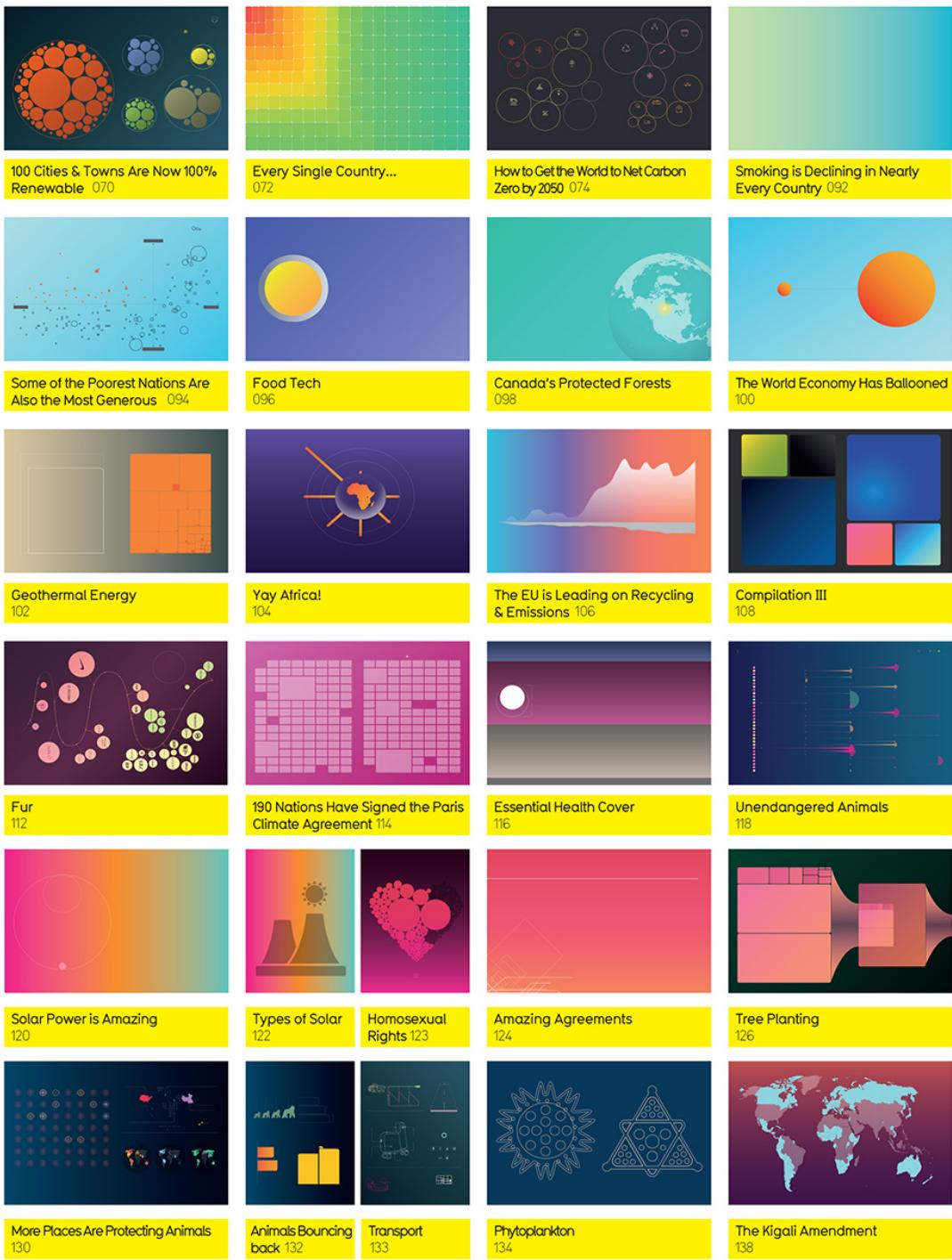
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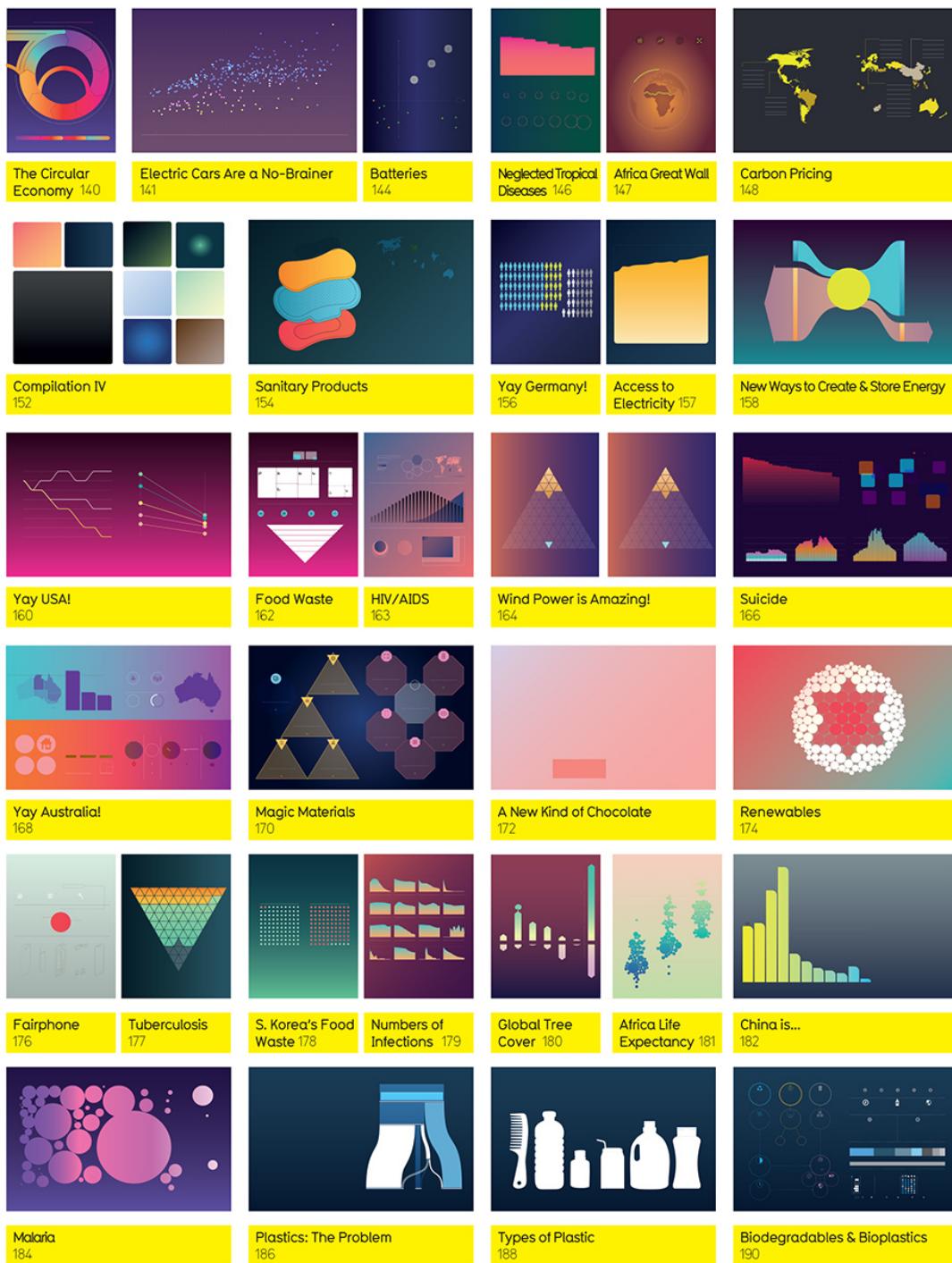
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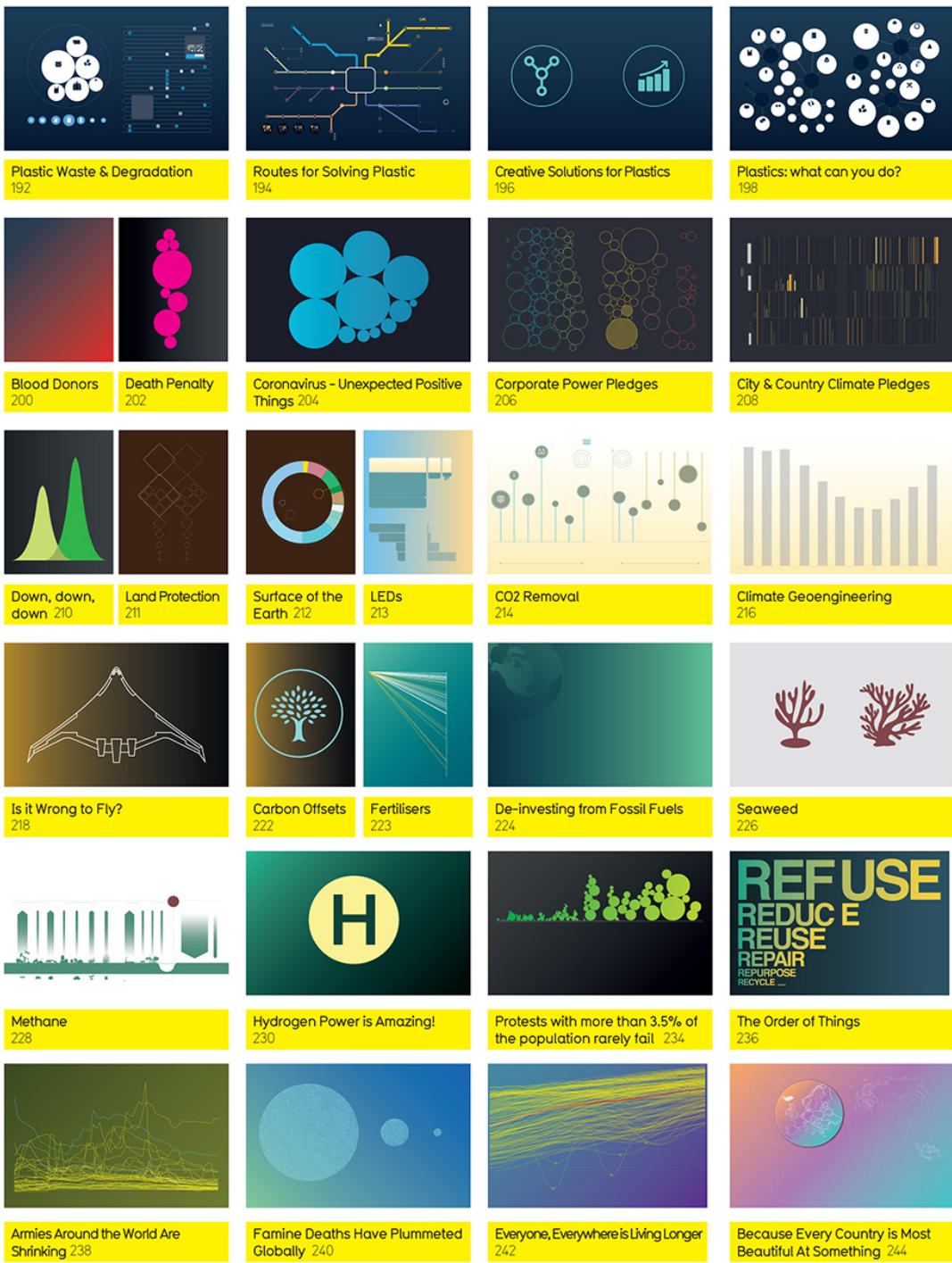
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## About David McCandless

David McCandless is a London-based author, data-journalist and information designer.

His best-selling infographic books *Information is Beautiful* and *Knowledge is Beautiful* are dedicated to visualising ideas, issues, knowledge and data.

His information design work has appeared in hundreds of publications internationally and online including The Guardian, Wired and the BBC.

He has worked on visualisation projects for Google, Microsoft and the Bill & Melinda Gates Foundation, and trained teams at Apple, Twitter, Salesforce and many others.

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