AstraZeneca

Alternative Energy

The Science of Alternative Energy and Our Systematic Approach to Achieve Ambition Zero Carbon

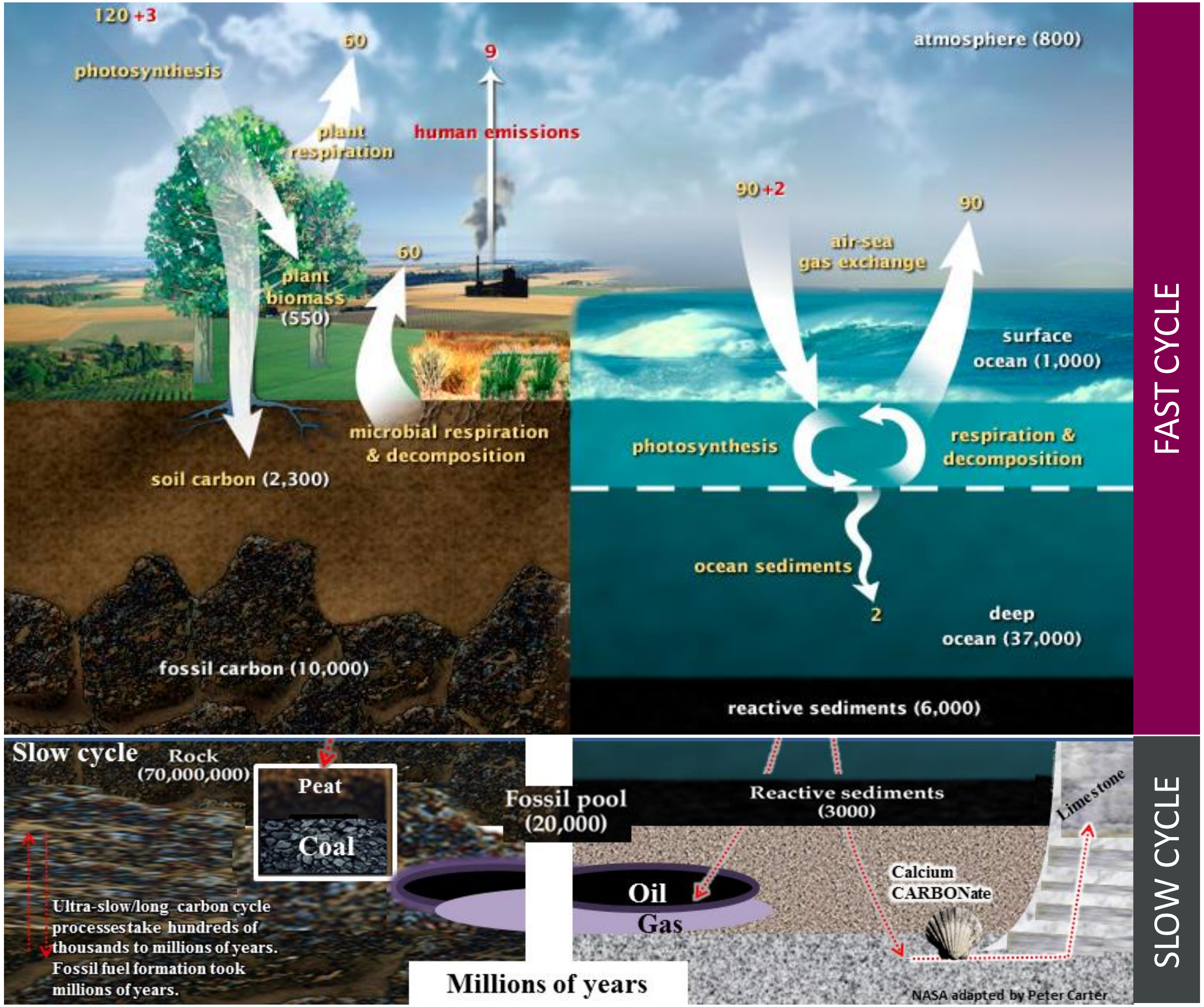
December 10, 2021

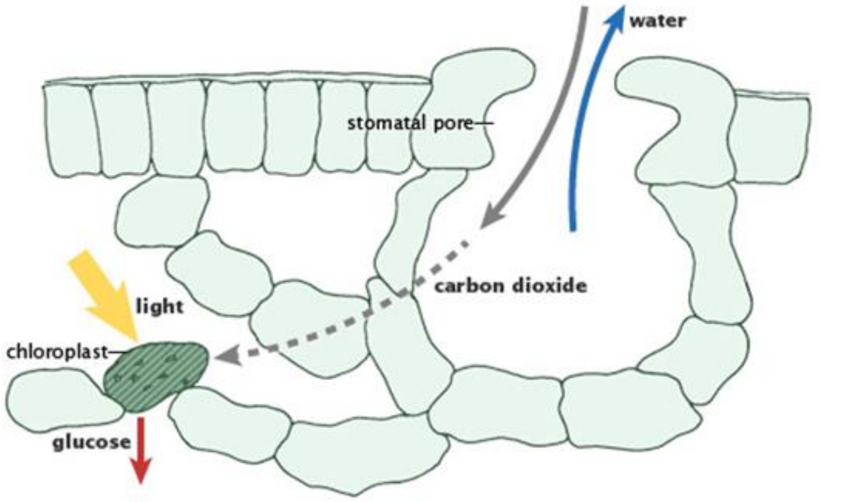
1

The Carbon Environment

A Brief Look at the Science of Carbon

A Scientific Look at the Carbon Cycle





The photosynthesis cycle, where plants absorb carbon dioxide and sunlight to create sugars. This process forms the foundation of the fast (biological) carbon cycle

(illustration adapted from PJ Sellers et al., 1992)

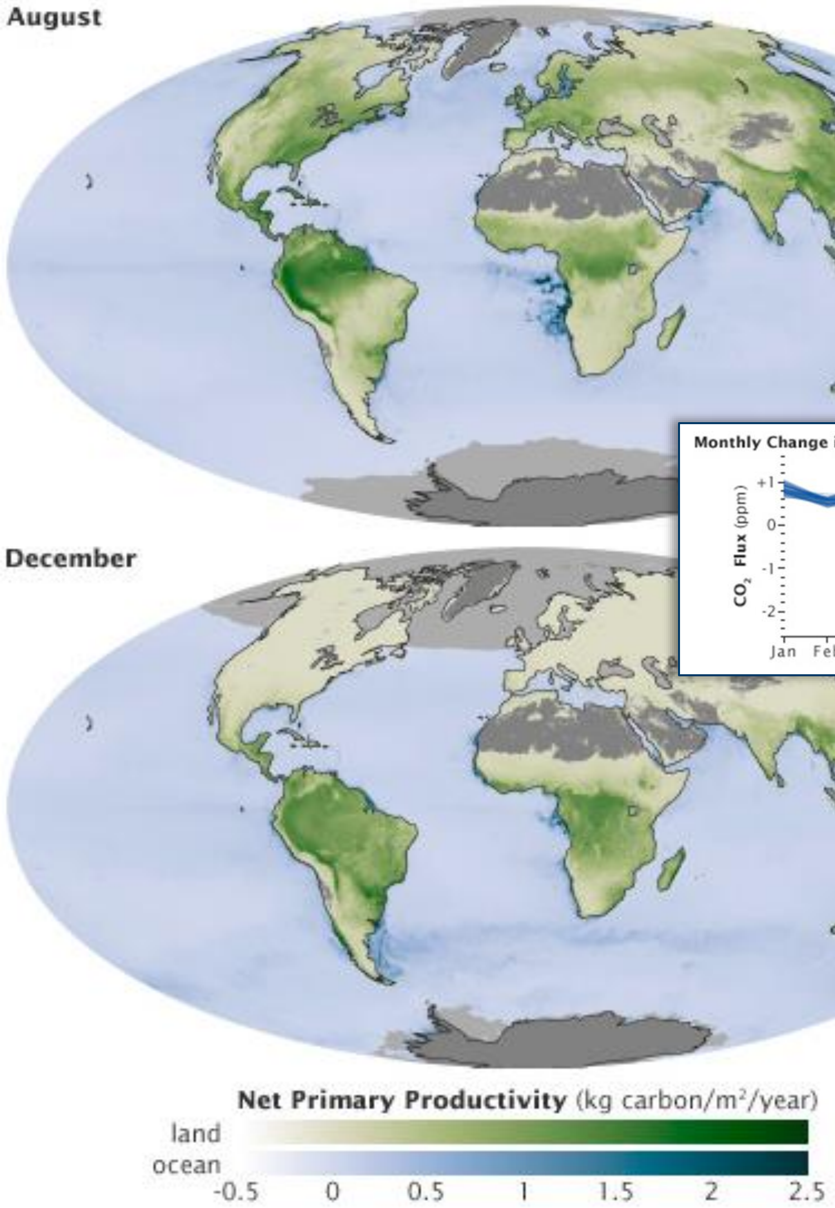
Estimated Annual Carbon Movement

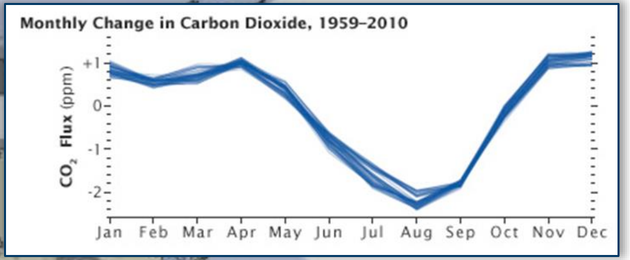
Fast Carbon Movement: 10^{16} to 10^{17} grams
Slow Carbon Movement: 10^{13} to 10^{14} grams
Human Carbon Emissions: 10^{15} grams

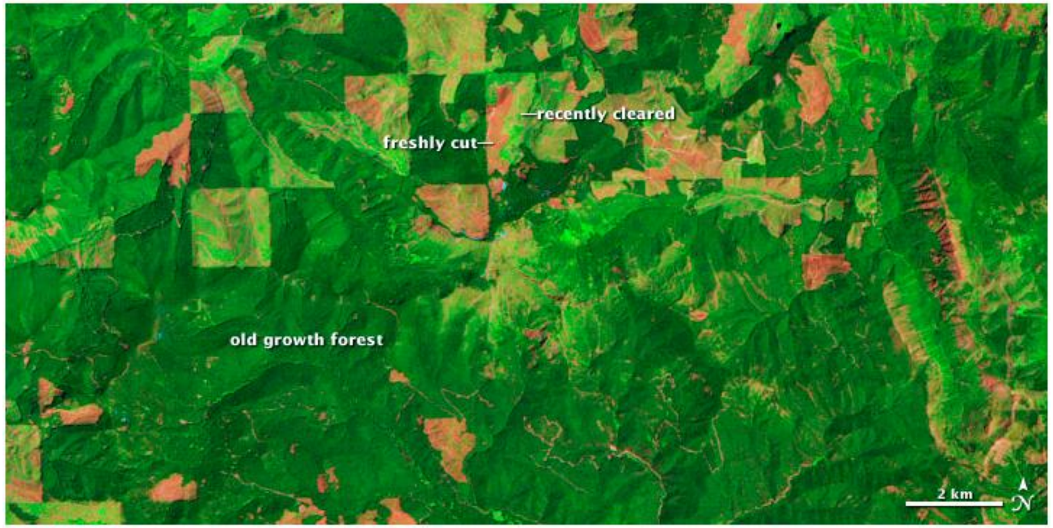
Through a series of chemical reactions and tectonic activity, carbon takes between 100-200 million years to move between rocks, soil, ocean, and atmosphere in the slow carbon cycle.

Picture Source: NASA Earth Observatory, 2011

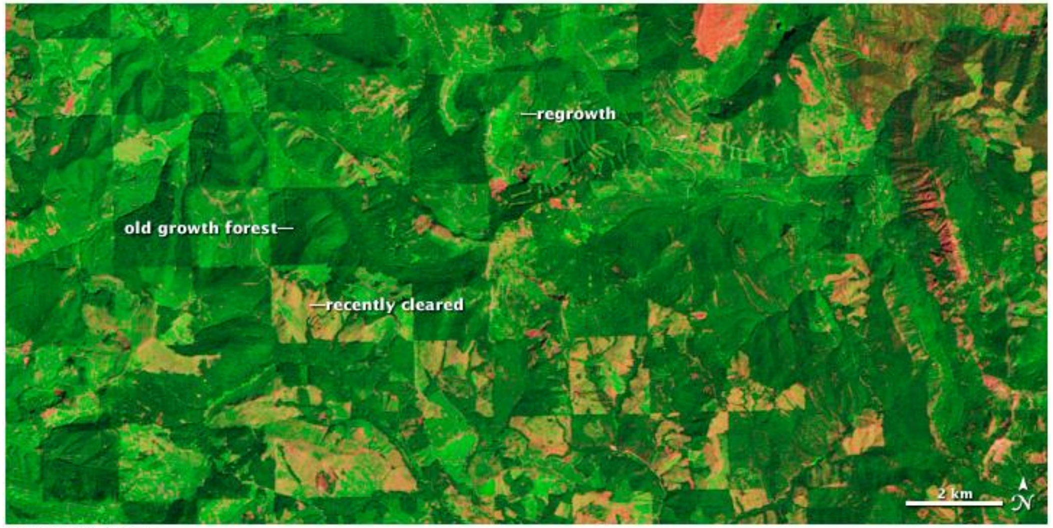
A Scientific Look at the Carbon Cycle





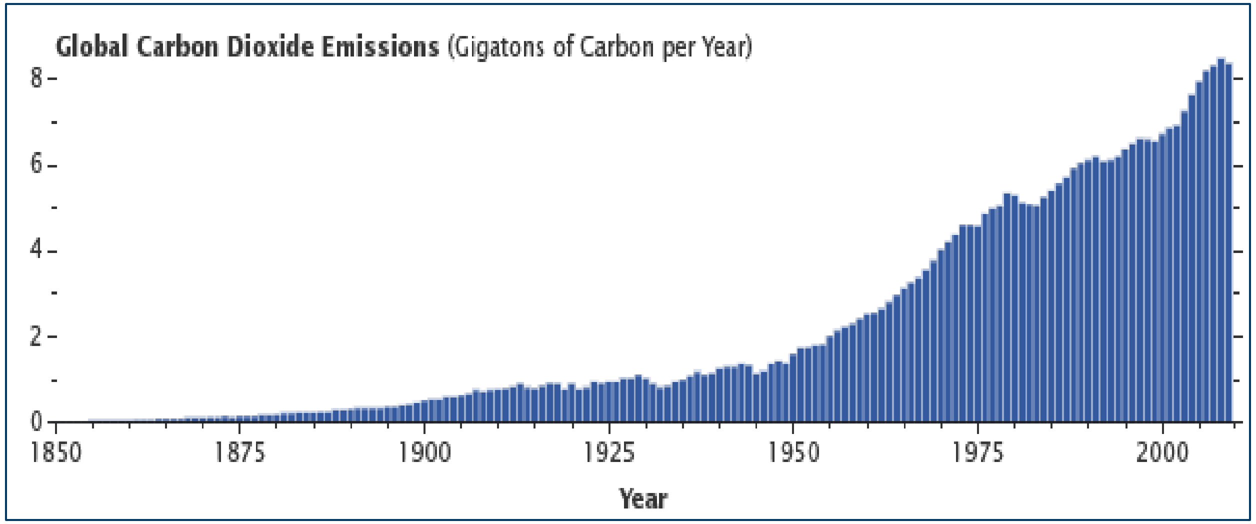


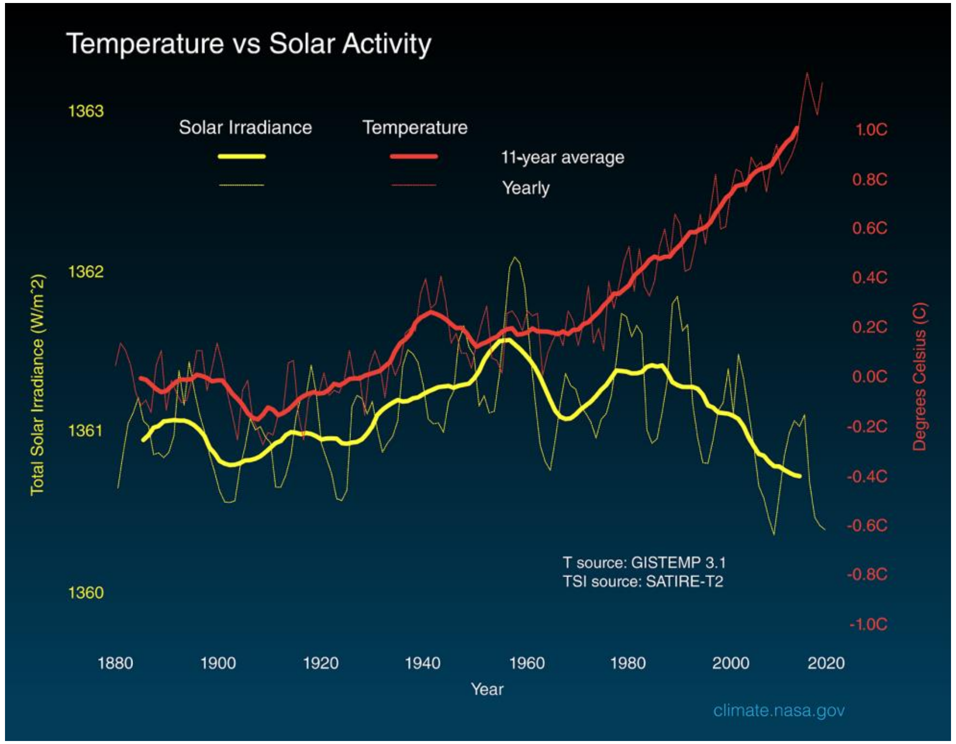
July 19, 1984

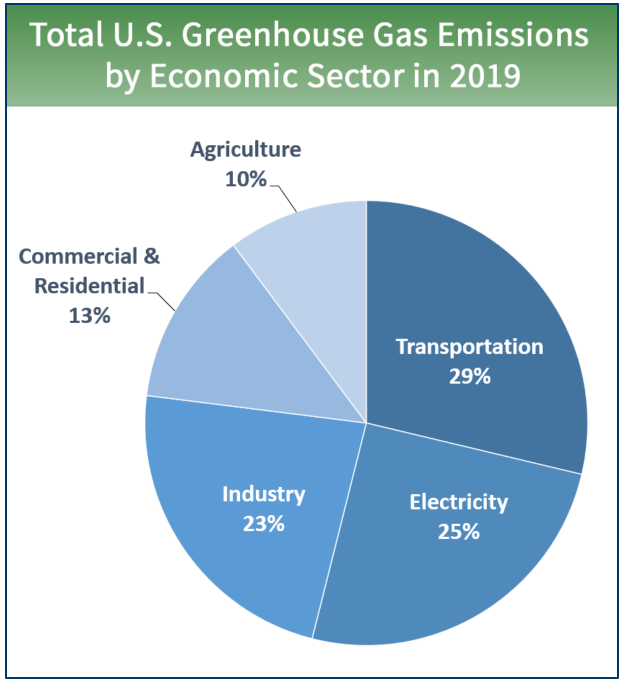


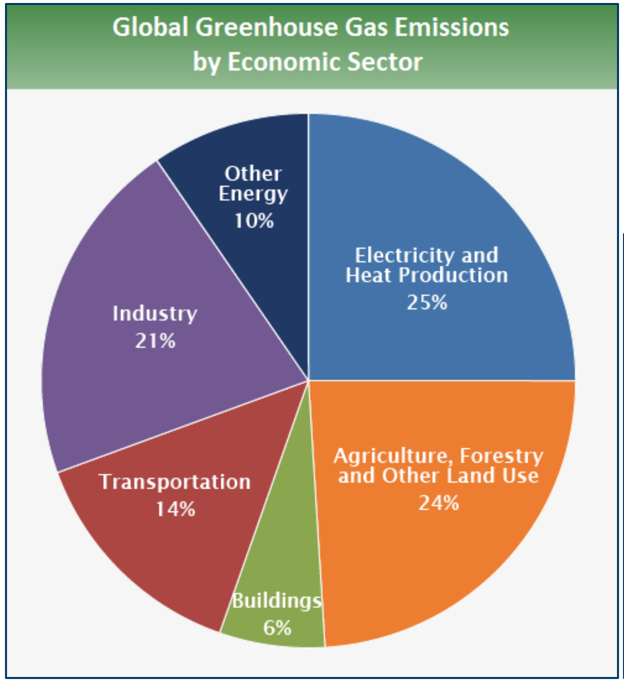
August 12, 2010

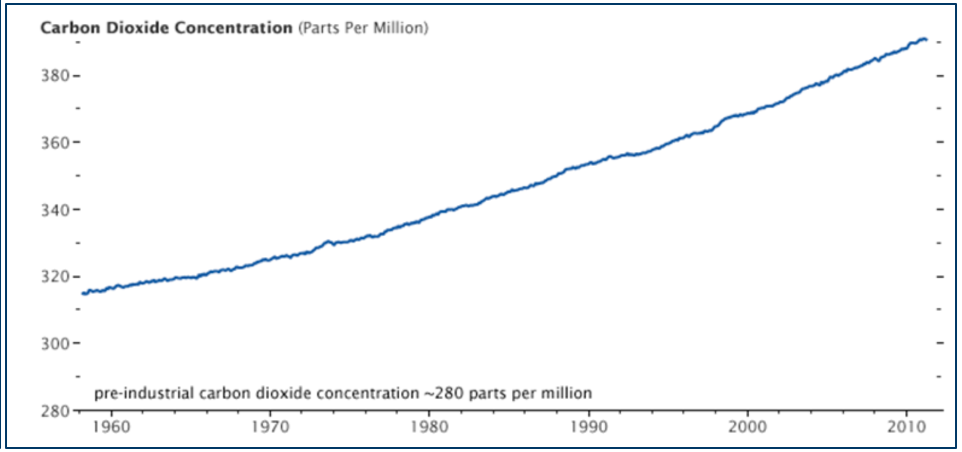
A Look at Human Carbon Emissions











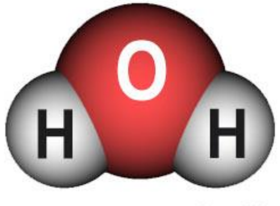
GLOBAL WARMING POTENTIAL (GWP) - Equivalencies

Comparison of other gases to the effect of Carbon Dioxide

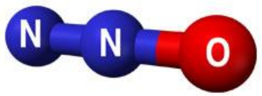
The column on the right shows how much that chemical would warm the earth over a **100-year** period as compared to carbon dioxide.

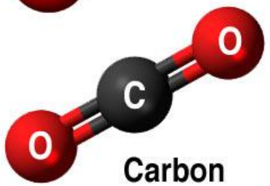
For example, **sulphur hexafluoride is used to fill tennis balls**. The table shows that a release on **1 kg** of this gas is equivalent to 22,800 kg or **22.8 tonnes** of CO_2. Therefore, **releasing ONE KILOGRAM** of sulphur hexafluoride is about **equivalent to driving 5 cars for a year!** (2)

Greenhouse Gas	Formula	100-year GWP (AR4)
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Sulphur hexafluoride	SF_6	22,800
Hydrofluorocarbon-23	CHF_3	14,800
Hydrofluorocarbon-32	CH_2F_2	675
Perfluoromethane	CF_4	7,390
Perfluoroethane	C_2F_6	12,200
Perfluoropropane	C_3F_8	8,830
Perfluorobutane	C_4F_{10}	8,860
Perfluorocyclobutane	c-C_4F_8	10,300
Perfluoropentane	C_5F_{12}	13,300
Perfluorohexane	C_6F_{14}	9,300

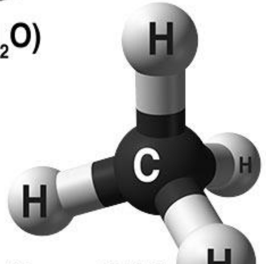


Water vapor (H_2O)

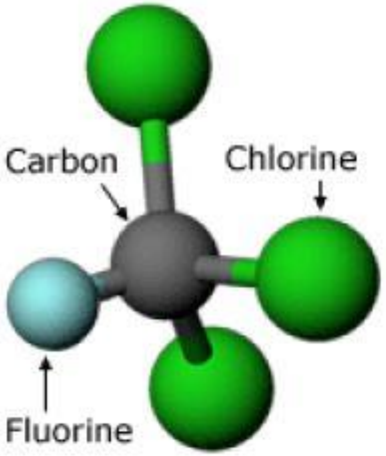
Nitrous oxide (N_2O)




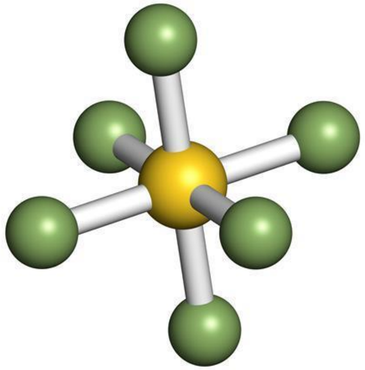
Carbon dioxide (CO_2)



Methane (CH_4)



Chlorofluorocarbon (CFC)


Sulfur hexafluoride (SF_6)

2

Governance

Current Policies of International Countries and United States

International Conference on Climate Change

UN CLIMATE CHANGE CONFERENCE UK 2021

IN PARTNERSHIP WITH ITALY

COP 26 GOALS

1. Secure global net zero by mid-century and keep 1.5 degrees within reach

Countries are being asked to come forward with ambitious 2030 emissions reductions targets that align with reaching net zero by the middle of the century. To deliver on these stretching targets, countries will need to:

- accelerate the phase-out of coal
- curtail deforestation
- speed up the switch to electric vehicles
- encourage investment in renewables.

2. Adapt to protect communities and natural habitats

The climate is already changing and it will continue to change even as we reduce emissions, with devastating effects. At COP26 we need to work together to enable and encourage countries affected by climate change to:

- protect and restore ecosystems
- build defenses, warning systems and resilient infrastructure and agriculture to avoid loss of homes, livelihoods and even lives

3. Mobilize finance

To deliver on our first two goals, developed countries must make good on their promise to mobilize at least $100bn in climate finance per year by 2020. International financial institutions must play their part and we need work towards unleashing the trillions in private and public sector finance required to secure global net zero.

4. Work together to deliver

We can only rise to the challenges of the climate crisis by working together. At COP26 we must:

- finalize the Paris Rulebook (the detailed rules that make the Paris Agreement operational)
- accelerate action to tackle the climate crisis through collaboration between governments, businesses and civil society.

Reported Outcome From Conference 2021: (COP26)

- An agreement to **re-visit emission reduction plans** in 2022 in order to try to keep the **1.5 °C Paris Agreement target achievable**.
- The first ever inclusion of a commitment **to limit ("phase down") the use of unabated coal**. More than 40 countries pledged to move away from coal.
- A commitment to **climate finance for developing countries**.
- The number of **countries pledged to reach net-zero emissions passed 140**. This target includes 90% of current global greenhouse gas emissions.
- More than 100 countries, including Brazil, pledged to **reverse deforestation by 2030**.
- **India promised to draw half of its energy requirement from renewable sources by 2030**.
- The governments of 24 developed **countries and a group of major car manufacturers** including GM, Ford, Volvo, BYD Auto, Jaguar Land Rover and Mercedes-Benz committed to **"work towards all sales of new cars and vans being zero emission globally by 2040, and by no later than 2035 in leading markets."**

The White House Policy Statement

THE WHITE HOUSE
WASHINGTON

2030 GREENHOUSE GAS REDUCTION TARGET

April 22, 2021

- The United States has set a goal to reach 100 percent carbon pollution-free electricity by 2035, which can be achieved through multiple cost-effective pathways each resulting in meaningful emissions reductions in this decade.
- The United States can create good-paying jobs and cut emissions and energy costs for families by supporting efficiency upgrades and electrification in buildings through support for job-creating retrofit programs and sustainable affordable housing, wider use of heat pumps and induction stoves, and adoption of modern energy codes for new buildings. The United States will also invest in new technologies to reduce emissions associated with construction, including for high-performance electrified buildings.
- The United States can reduce carbon pollution from the transportation sector by reducing tailpipe emissions and boosting the efficiency of cars and trucks; providing funding for charging infrastructure; and spurring research, development, demonstration, and deployment efforts that drive forward very low carbon new-generation renewable fuels for applications like aviation, and other cutting-edge transportation technologies across modes.
- The United States can reduce emissions from forests and agriculture and enhance carbon sinks through a range of programs and measures including nature-based solutions for ecosystems ranging from our forests and agricultural soils to our rivers and coasts. Ocean-based solutions can also contribute towards reducing U.S. emissions.
- The United States can address carbon pollution from industrial processes by supporting carbon capture as well as new sources of hydrogen—produced from renewable energy, nuclear energy, or waste—to power industrial facilities. The government can use its procurement power to support early markets for these very low- and zero-carbon industrial goods.
- The United States will also reduce non-CO2 greenhouse gases, including methane, hydrofluorocarbons and other potent short-lived climate pollutants. Reducing these pollutants delivers fast climate benefits.
- In addition, the United States will invest in innovation to improve and broaden the set of solutions as a critical complement to deploying the affordable, reliable, and resilient clean technologies and infrastructure available today.

3

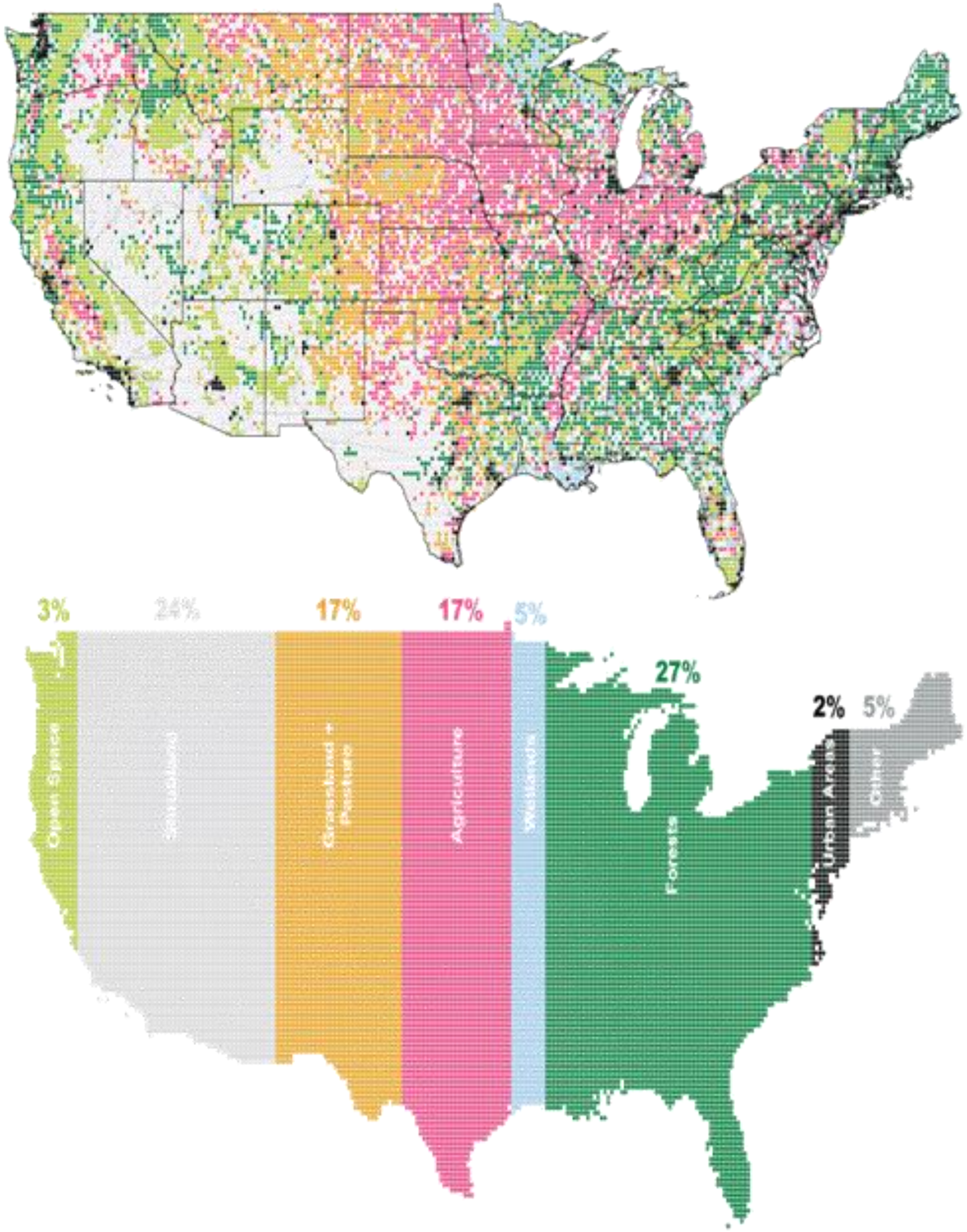
The Status of Alternative Energy

Challenges and Horizons for Sustainable Technologies

The Status of Energy in United States

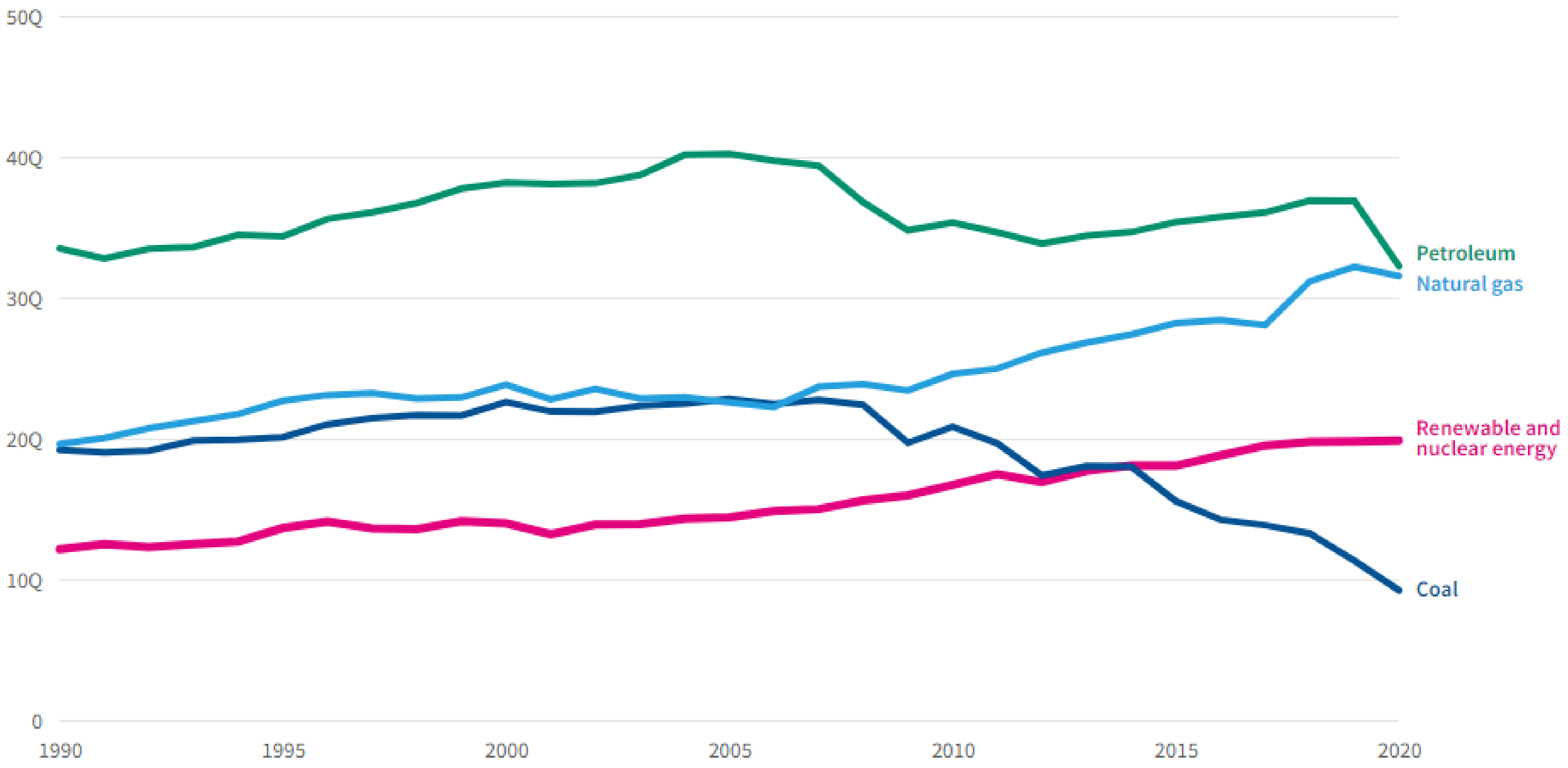
How do energy and emissions in the United States compare to the rest of the world?

- **Fossil fuels account for 79%** of US energy consumption. The share of energy consumption from nuclear and **renewable sources** has doubled since 1980 to **21% in 2020**.
- **Forty-two percent of US renewable and nuclear energy consumption is from nuclear sources**, followed by **23% from biomass like wood and biofuels**.
- In 2018, the US ranked fifth among the world's 10 largest economies for its proportion of energy consumption coming from renewable and nuclear energy.
- In 2018, **51.6% of Washington's energy consumption was from renewable and nuclear, the highest nationwide**. New Hampshire was second, with 51.5%.
- The **US emitted 5.3 billion metric tons of carbon dioxide in 2018, making up 15% of the world's emissions**.
- **Transportation is the largest source of US emissions, surpassing electricity generation in 2017**.
- **Energy-related carbon dioxide emissions were 11% lower in 2020 than 2019, partly due to pandemic travel restrictions**.



Picture Source: visualcapitalist.com/America-land-use

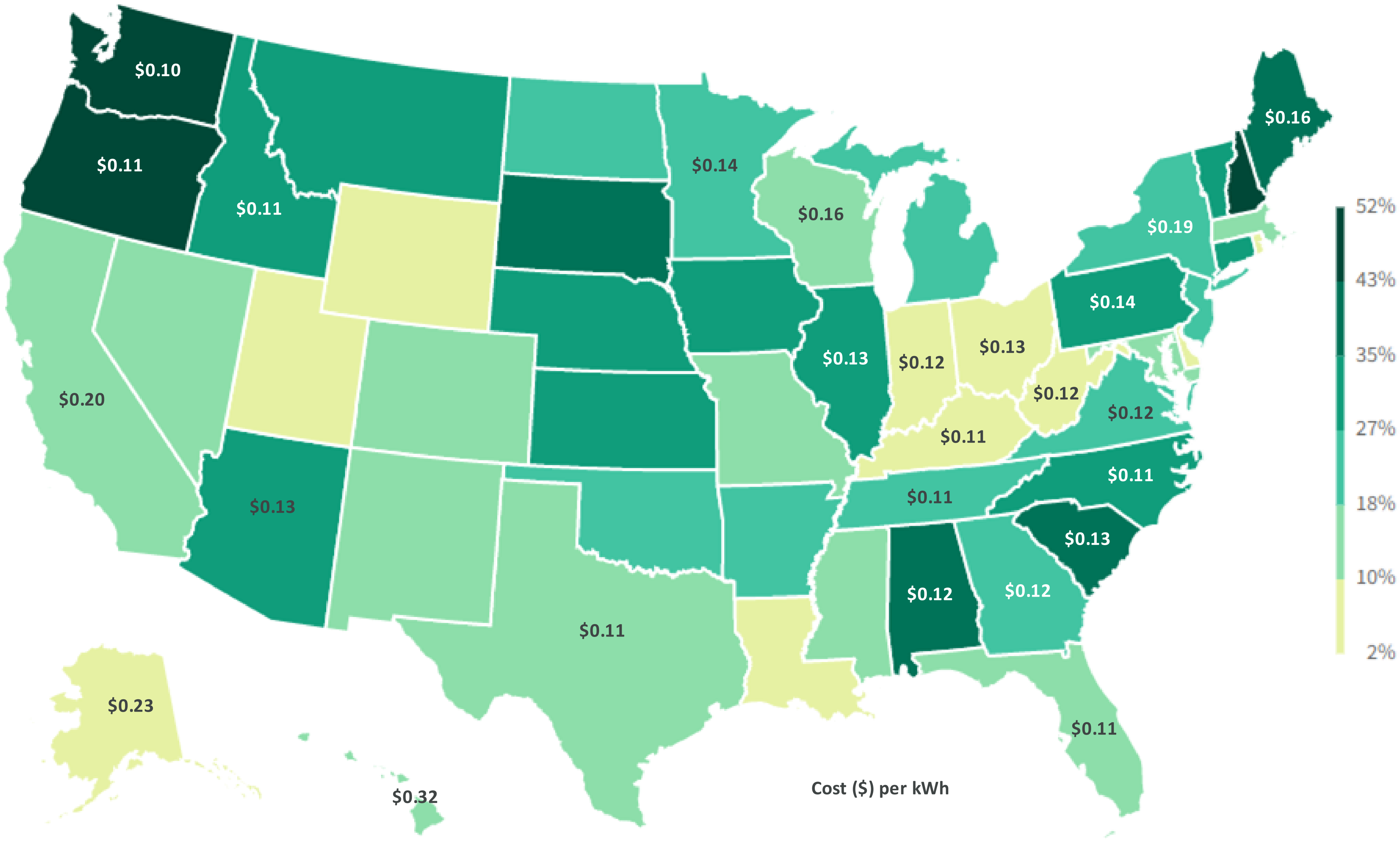
The Status of Energy Consumption in United States



ENERGY CONSUMPTION BY SOURCE (BTU)

The Status of Energy Consumption in United States

Costs shown are average price to consumer per kWh.



RENEWABLE AND NUCLEAR ENERGY AS A PERCENT OF ENERGY CONSUMPTION 2018

Indiana - Mammoth Solar Farm

- The Mammoth Solar farm will be built across Starke and Pulaski's county lines, and the initial construction site will be in a rural area about 50 miles (80 kilometers) southwest of South Bend. Doral Renewables is building the solar farm as part of an agreement with American Electric Power

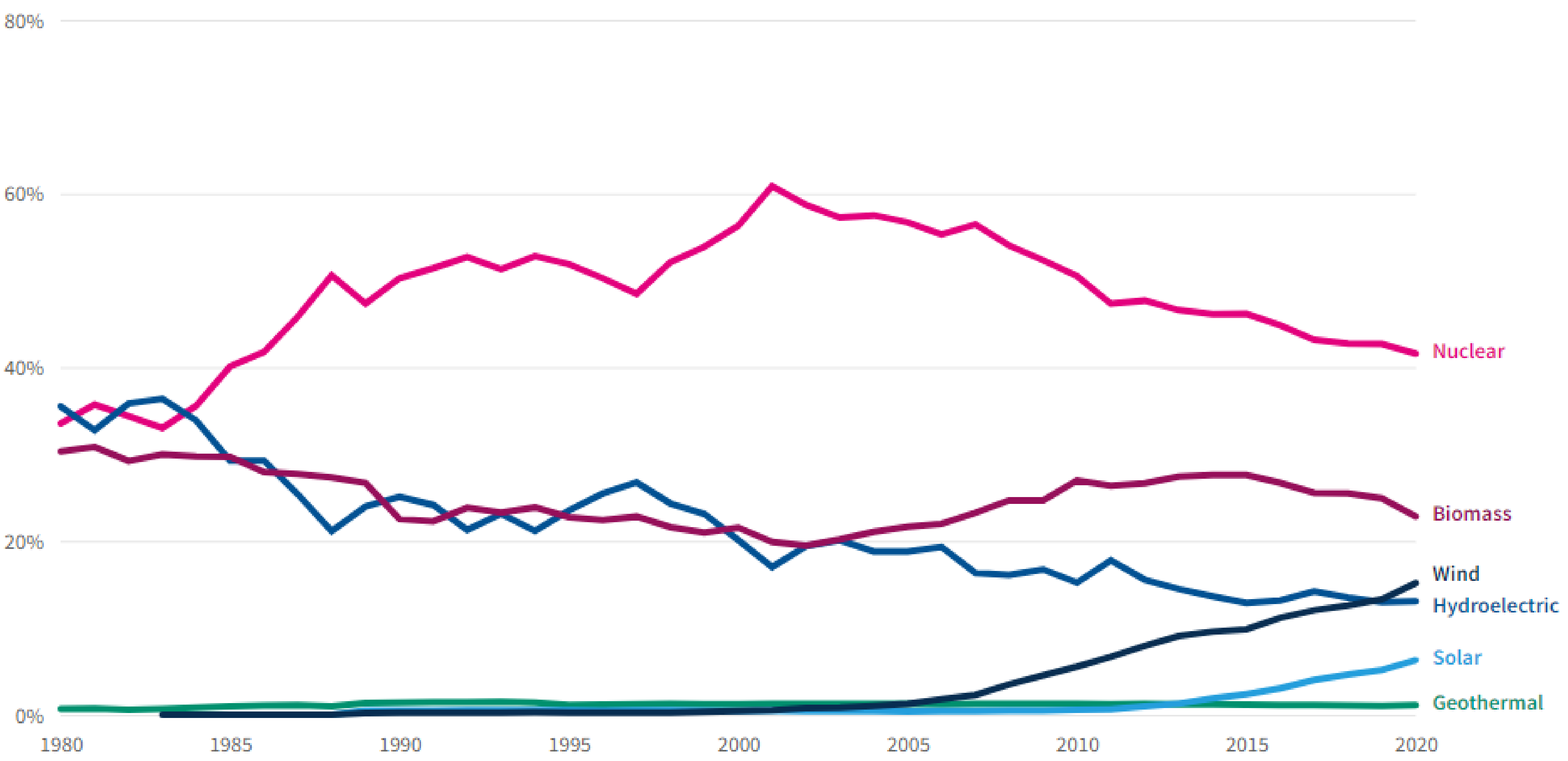
- The 13,000-acre Mammoth Solar farm will become partially operational by mid-2023 and it will start off producing 400 megawatts of electricity, enough to power 75,000 households.

- The Mammoth Solar farm, which will have a total of 2.85 million solar panels, is expected to be fully operational by 2024, at which point it will generate a total of 1.65 gigawatts of electricity.

This is currently the largest solar farm installation in the United States

The Status of Renewable Energy Consumption in United States

(including Nuclear Power)



COMPOSITION OF RENEWABLE AND NUCLEAR ENERGY CONSUMPTION

The Challenges for Alternative Energy

1. Scalability and Timing / Commercialization Potential

For the promise of an alternative energy source to be achieved, it must be supplied in the time frame needed, in the volume needed, and at a reasonable cost with effective commercialization potential.

2. Substitutability

Best-case scenario is that an alternative energy form can be integrated directly into the current energy system as a "drop-in" substitute for an existing form without requiring further infrastructure changes.

3. Material Input Requirements

The type and volume of the resources and energy needed may in turn limit the scalability and affect the cost and feasibility of an energy alternative.

4. Water

Water ranks with energy as a potential source of conflict among peoples and nations, but some alternative energy sources, primarily biomass-based energy, are large water consumers critically dependent on a dependable water supply.

5. Energy Density

Energy density refers to the amount of energy that is contained in a unit of an energy form…The consequence of low energy density is that larger amounts of material or resources are needed to provide the same amount of energy as a denser material or fuel. Many alternative energies and storage technologies are characterized by low energy densities, and their deployment will result in higher levels of resource consumption.

Example of Challenges with Material Input Requirements

Raw Materials used in Alternative Energy Equipment

Raw Material	Fraction of Today's Total World Production	
	2006	2030
Gallium	0.28	6.09
Neodymium	0.55	3.82
Indium	0.40	3.29
Germanium	0.31	2.44
Scandium	Low	2.28
Platinum	Low	1.56
Tantalum	0.39	1.01
Silver	0.26	0.78
Tin	0.62	0.77
Cobalt	0.19	0.40
Palladium	0.10	0.34
Titanium	0.08	0.29
Copper	0.09	0.24
Selenium	Low	0.11
Niobium	0.01	0.03
Ruthenium	0.00	0.03
Yttrium	Low	0.01
Antimony	Low	Low
Chromium	Low	Low

How do you mine these elements in a sustainable way while keeping costs low?

Source: David Fridley, "Nine Challenges of Alternative Energy", 2010

The Challenges for Alternative Energy

6. Intermittency

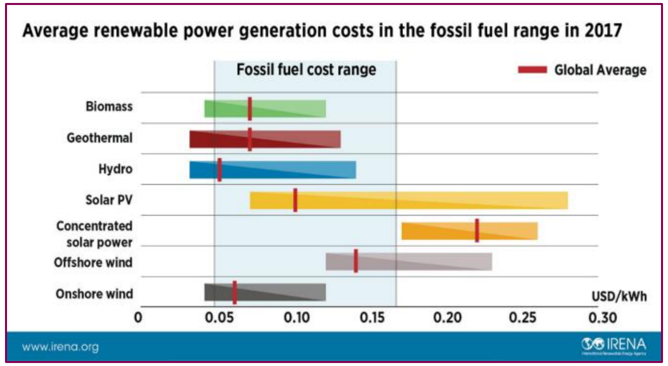
We expect energy to be there when we call for it! This system of continuous supply is possible because of our current use of a grid/network based upon large stores of fossil fuels. Alternative energies such as solar and wind power, in contrast, produce only intermittently as the wind blows, the sun shines, and seasonal harvests of crops for biomass-based fuels.

GENERATION TYPE	CAPACITY FACTOR
Photovoltaics	12–19%
Thermal solar	~15%
Thermal solar with storage	70–75%
Wind	20–40%
Hydropower	30–80%
Geothermal	70–90%
Nuclear power	60–100%
Natural gas combined cycle (non-peaker)	~60%
Coal thermal	70–90%

** The amount of time typically available to produce energy*

7. The Law of Receding Horizons

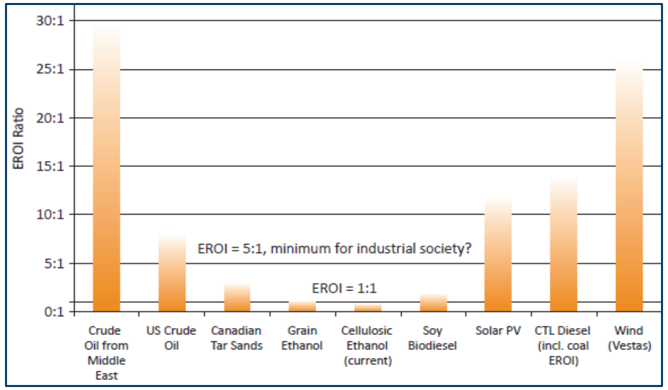
An often-cited metric of the viability of alternatives is the expected break-even cost of the alternative with oil, or the price that crude oil would have to be to make the alternative cost competitive. Underlying this calculation, however, is an assumption that the input costs to alternative energy production would remain static as oil prices rise, thereby providing the economic incentive to development.



** Alternative energy costs continue to decrease in overall costs as technology continues to improve.*

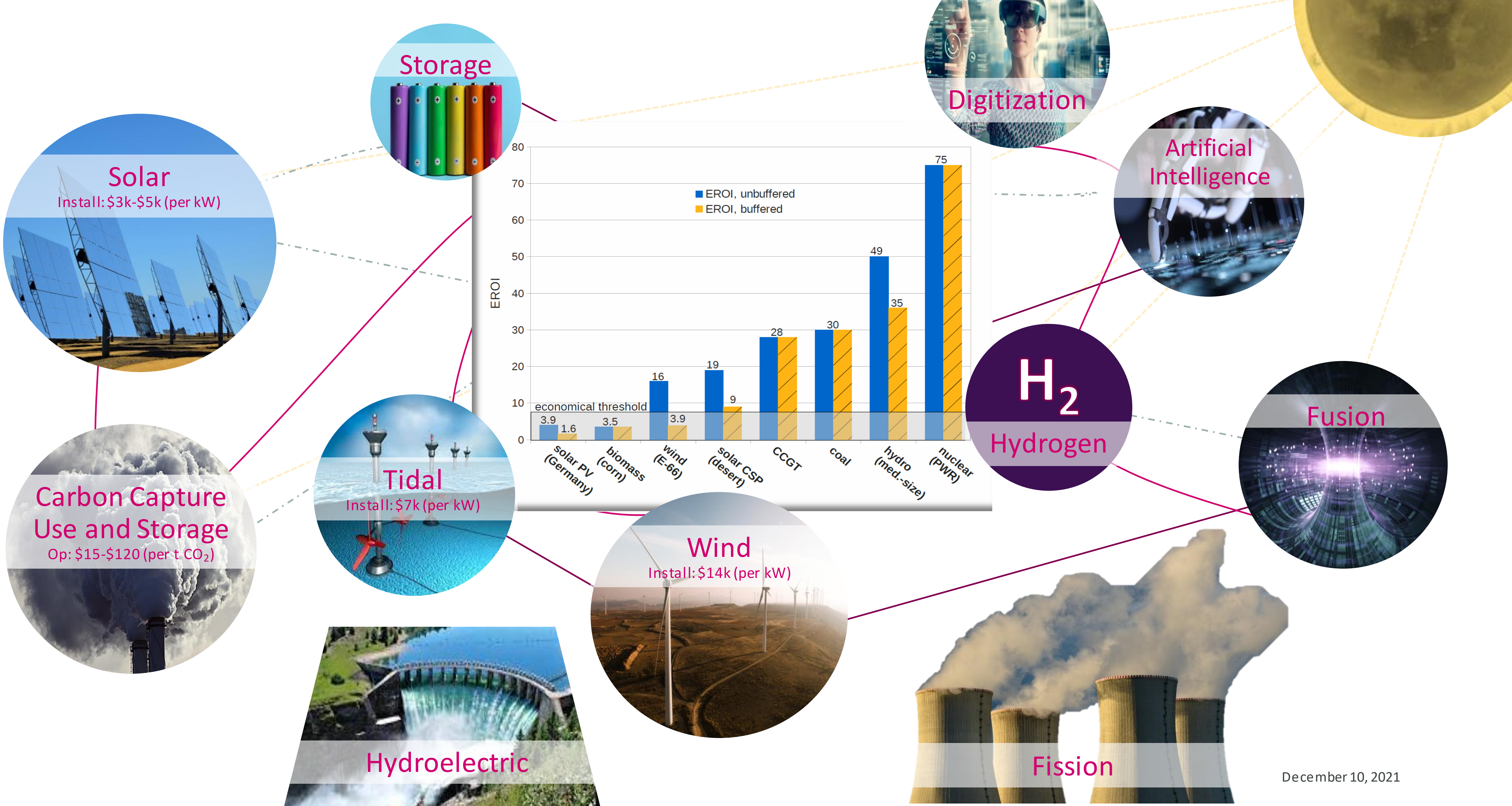
8. Energy Return on Investment

Our economy and society functions on the amount of net energy we have available. “Net energy” is, simply, the amount of energy remaining after we consume energy to produce energy. Consuming energy to produce energy is unavoidable, but only that which is not consumed to produce energy is available to sustain our civil activities. The ratio of the amount of energy we put into energy production and the amount of energy we produce is called “energy return on investment” (EROI).



Excerpt from David Fridley, “Nine Challenges of Alternative Energy”, 2010

Alternative Energy – Current & Future

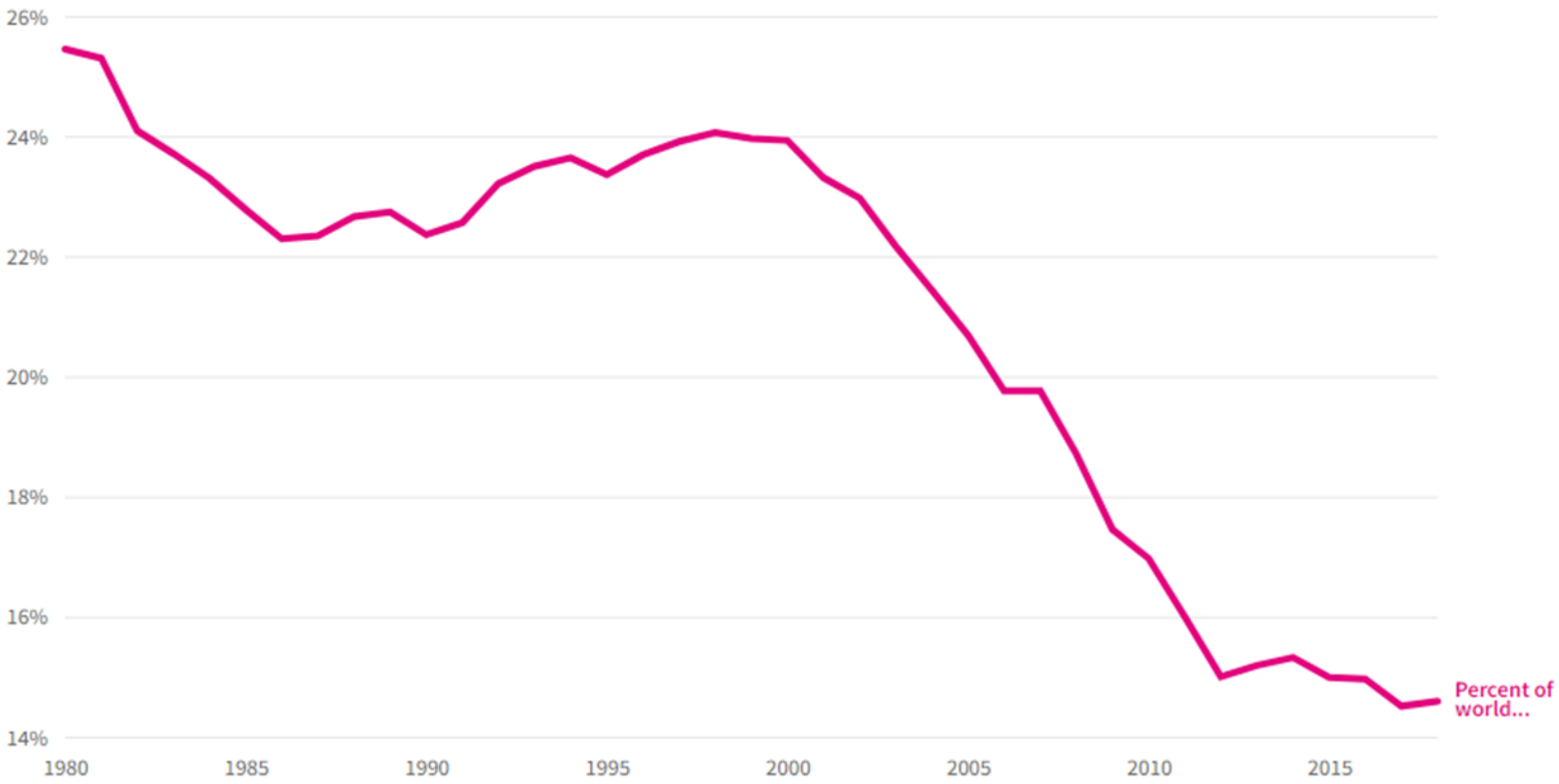


So, Where are we with Carbon Dioxide Emissions?

ENERGY & EMISSIONS

The US emitted 5.3 billion metric tons of carbon dioxide in 2018, making up 15% of the world's emissions.

In 1980, the US emitted 25% of global carbon dioxide emissions. It's produced 20% of the world's total emissions since 1980.



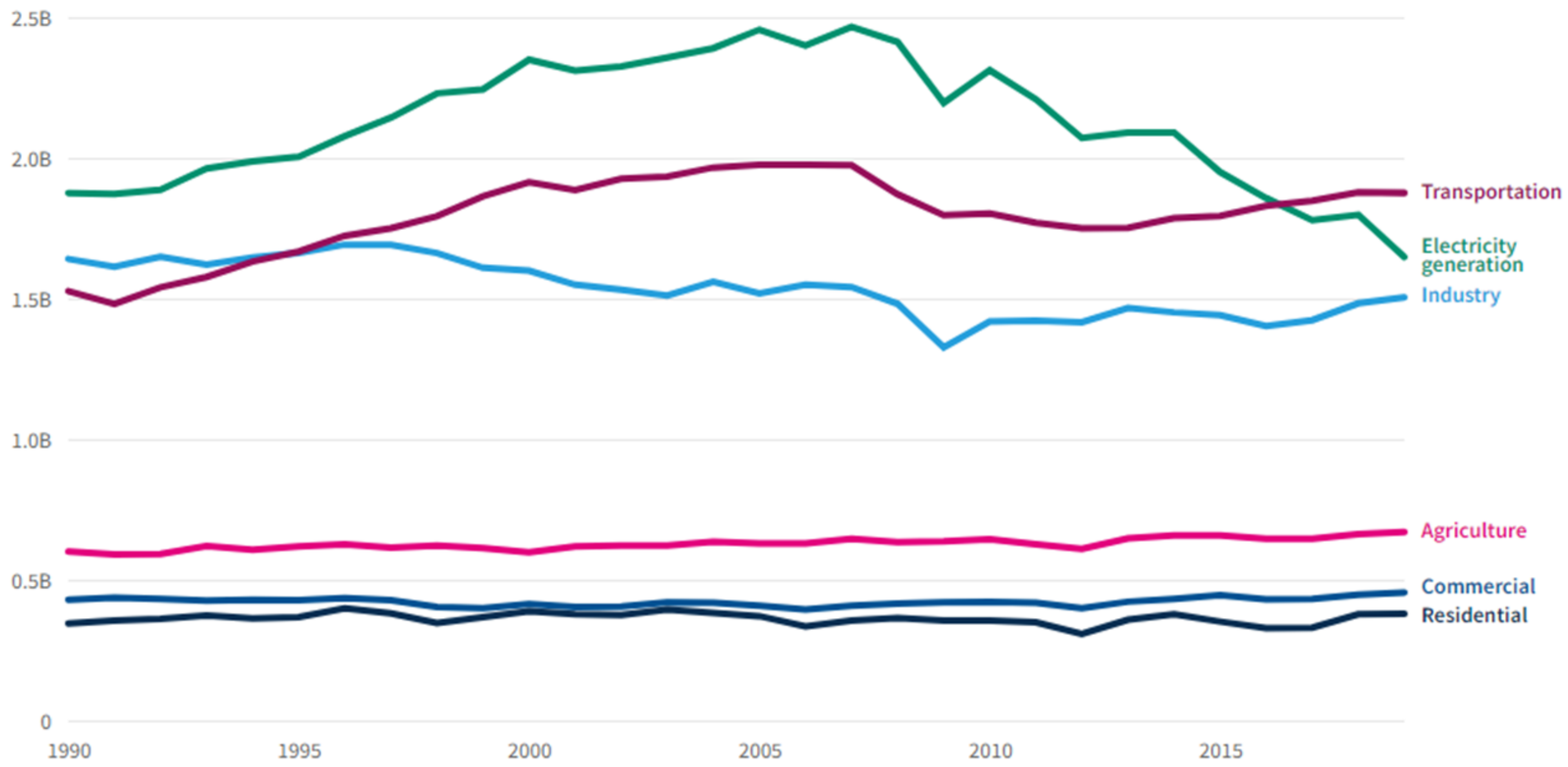
US AS PERCENT OF WORLD CARBON DIOXIDE EMISSIONS

So, Where are we with Carbon Dioxide Emissions?

ENERGY & EMISSIONS

Transportation is the largest source of US emissions, surpassing electricity generation in 2017.

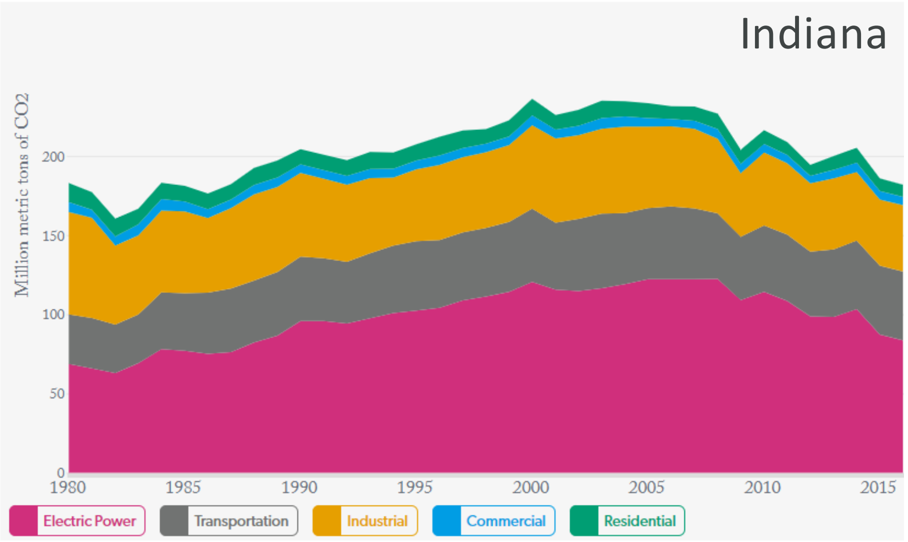
Transportation and electricity generation almost entirely contribute to emissions through fossil fuel combustion that produces carbon dioxide. Industrial activity contributes to emissions in various ways including fossil fuel combustion, natural gas, chemical production, fluorinated gases.



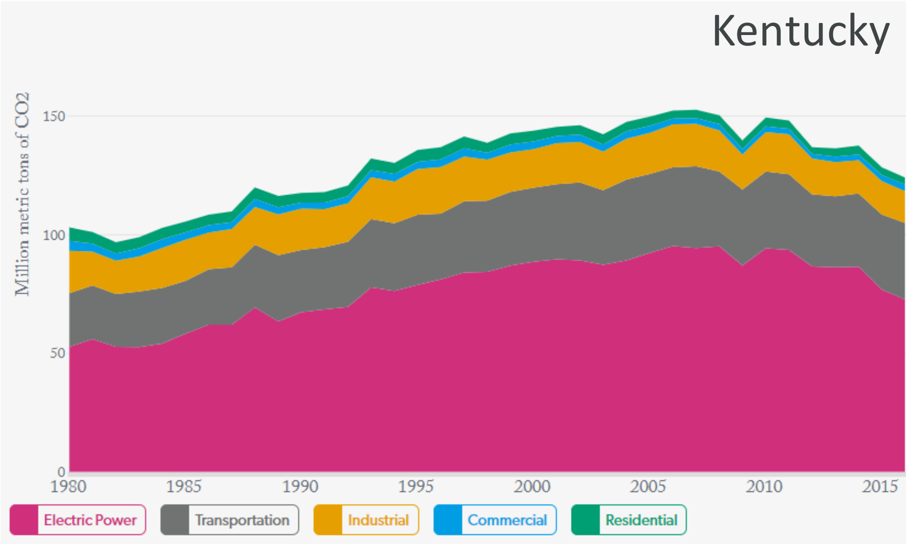
GREENHOUSE GAS EMISSIONS BY SECTOR (MILLION TONS OF CO2 EQUIVALENTS)

How does Indiana compare with surrounding States on Carbon Dioxide Emissions?

Emissions by state across sectors, 1980-2016



Emissions by state across sectors, 1980-2016



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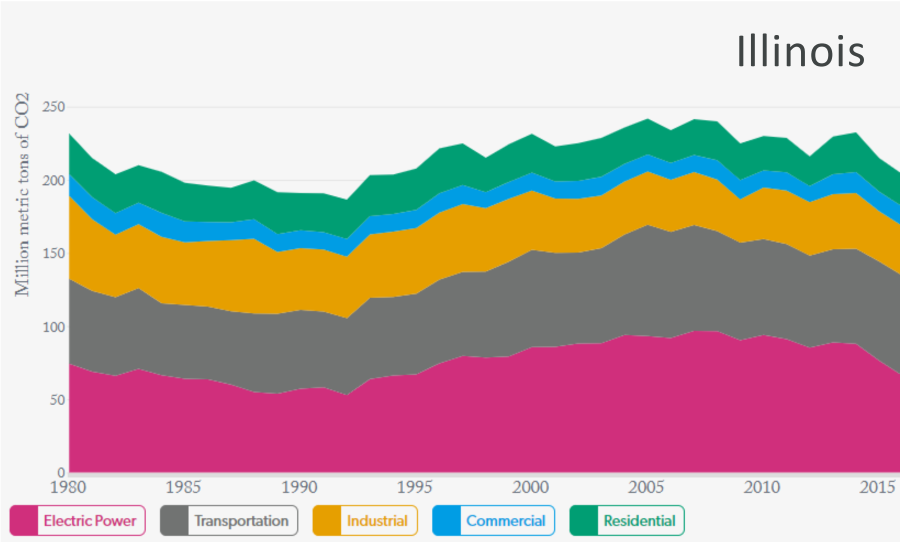
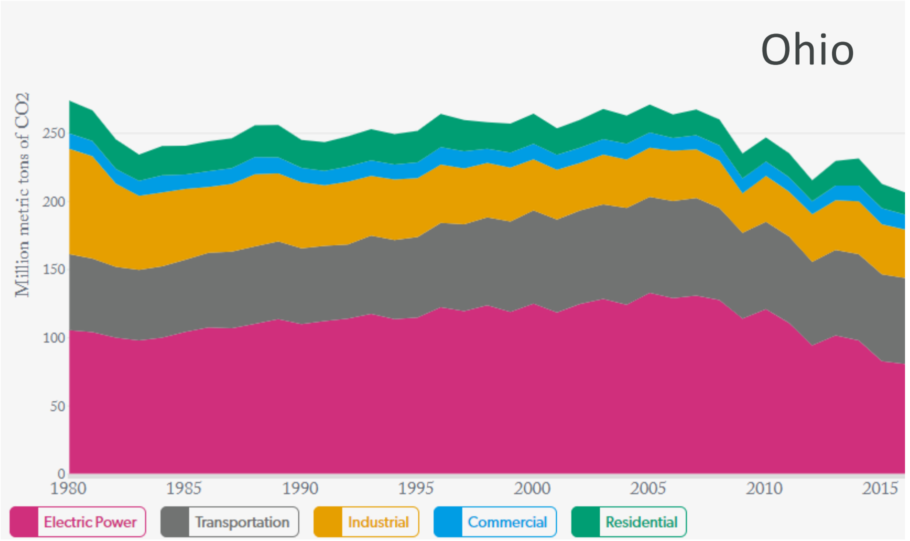
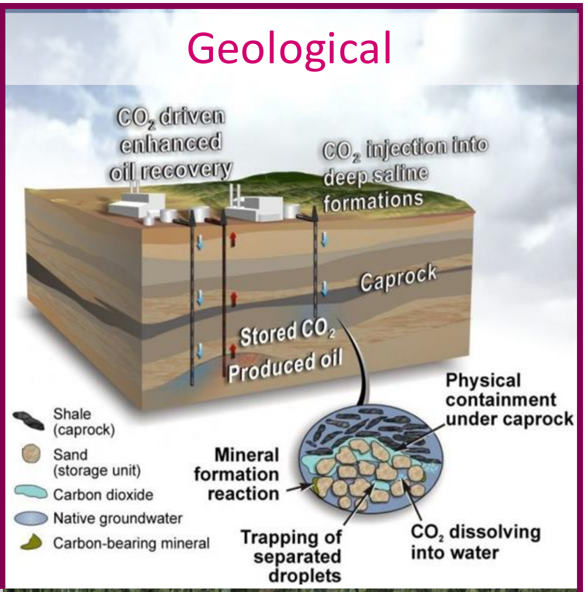


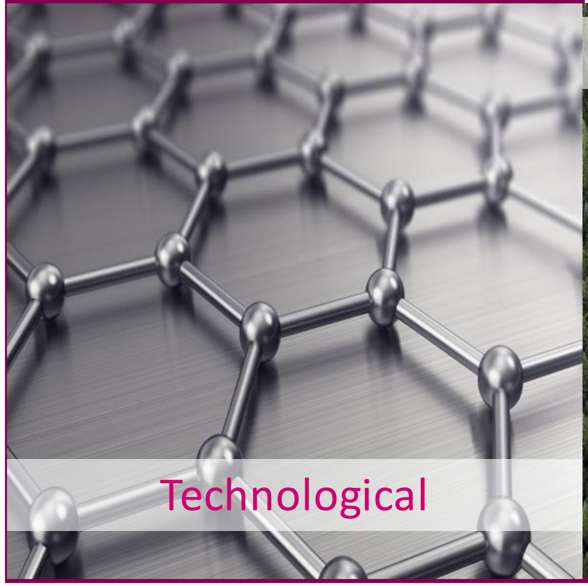
Emissions by state across sectors, 1980-2016



What can we do with Current Carbon Emissions?

Carbon Capture, Use,
And Sequestration/Storage

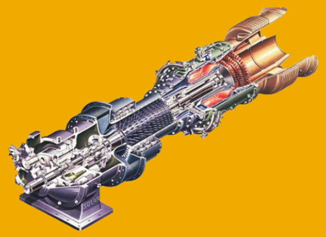




- Carbon capture, use, and sequestration/storage technologies can capture more than 90 percent of carbon dioxide (CO2) emissions from power plants and industrial facilities.
- Captured carbon dioxide can be put to productive use in enhanced oil recovery and the manufacture of fuels, building materials, and more, or be stored in underground geologic formations.
- Twenty-six commercial-scale carbon capture projects are operating around the world with 21 more in early development and 13 in advanced development reaching front end engineering design (FEED).
- Carbon capture can achieve 14 percent of the global greenhouse gas emissions reductions needed by 2050 and is viewed as the only practical way to achieve deep decarbonization in the industrial sector.
- The use of carbon dioxide as a raw material to produce graphene, a technological material. Graphene is used to create screens for smart phones and other tech devices. Graphene production is limited to specific industries but is an example of how carbon dioxide can be used as a resource and a solution in reducing emissions from the atmosphere.

Other Technology to Consider

Electric Boilers



Turbine (CHP)

Geothermal

4

AstraZeneca's Approach

Ambition Zero Carbon 2025 (Alternative Energy)

Who are We?

We are a global, science-led biopharmaceutical business and our innovative medicines are used by millions of patients worldwide.

Oral Solid Dosage (OSD)

● Oncology ● Cardiovascular ● Diabetes

We follow the science ● We put patients first ● We play to win ● We do the right thing ● We are entrepreneurial

TAGRISSO® osimertinib

CALQUENCE® (acalabrutinib) 100 mg capsules

kombiglyze XR (saxagliptin and metformin HCl extended-release) tablets

Qtern® (dapagliflozin/saxagliptin) 5 mg/5 mg tablets

farxiga® (dapagliflozin) 5mg & 10mg tablets

xigduo® XR ONCE-DAILY (dapagliflozin/metformin HCl extended-release) 5/1000 mg tablets

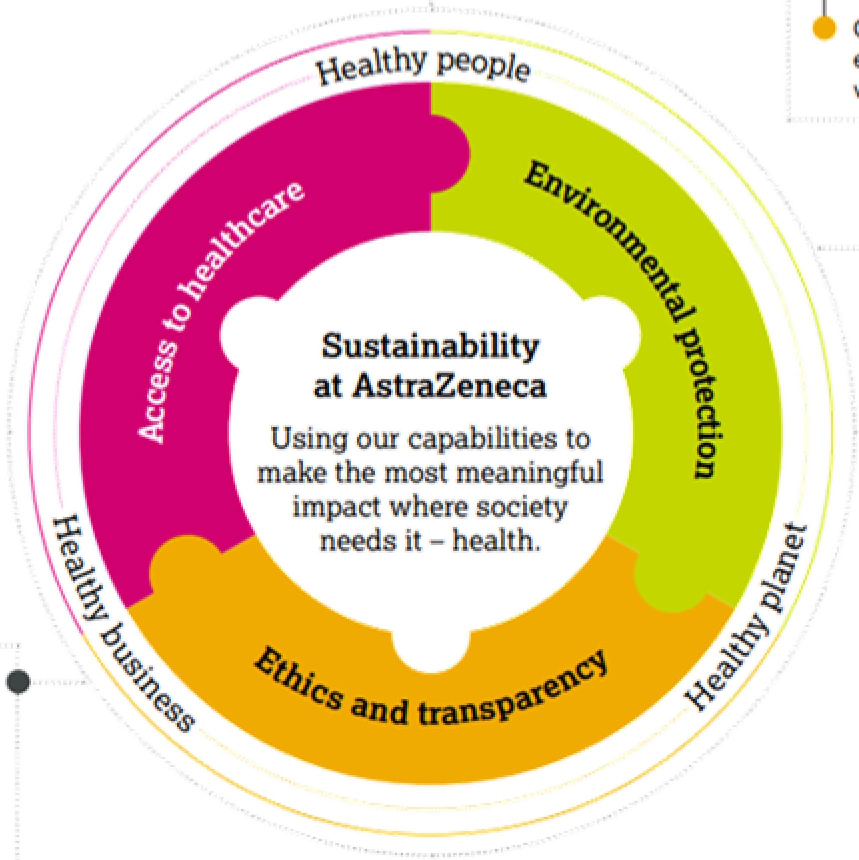
onglyza® (saxagliptin) 5 mg tablets

AstraZeneca

What Sustainability means to AstraZeneca

Sustainability at AstraZeneca is about using our capabilities to make the most meaningful impact where society needs it — health. We know the health of people, the planet and our business are interconnected, each impacting the others.

Our goal is to always be moving our organisation towards greater sustainability. Our efforts in sustainability go beyond meeting our annual and longer-term targets. We must continually evolve our mindset and our practices to meet changing times. This is both a responsibility and a business opportunity.



Our sustainability strategy

Our sustainability strategy is guided by a materiality assessment. This robust process determines the topics that are most important to AstraZeneca and our stakeholders, giving us the opportunity to achieve the most positive impact. We have 16 material focus areas, which are grouped under three interconnected priorities – Access to healthcare, Environmental protection and Ethics and transparency

Our ambitions

- Work towards a future where all people have access to sustainable healthcare solutions for life-changing treatment and prevention
- Demonstrate global leadership to proactively manage our environmental impact across all our activities and products
- Create positive societal impact and promote ethical behaviour in all markets across our value chain

Our sustainability approach

- **Systems thinking** – recognising that our globalised world binds us together in a dynamic, complex network of relationships. We know the health of people (including our workforce, patients and society at large), the planet and our business are interconnected. The scale and severity of the issues we face today require us to assess all options simultaneously. We look for opportunities that offer synergies and address systemic issues
- **Long-termism** – acknowledging there are no quick fixes; anticipating and designing out unintended impacts; observing how impacts change over time; building resilience
- **Aiming to leave things better than we found them** – we differentiate between addressing our negative environmental impacts and creating the conditions for deep, lasting sustainability

Greenhouse gas reduction

Targets

GHG sites and fleet

2025 target
Eliminate Scope 1 and 2 emissions by end of 2025.

2020 update
Reduced Scope 1 and 2 emissions by 60% since 2015.

Status: On plan

Road fleet electrification

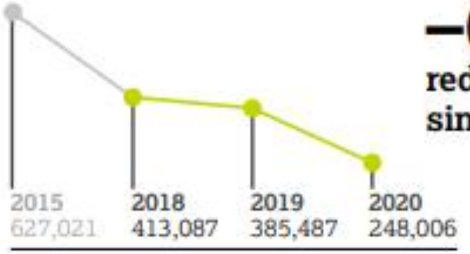
2025 target
100% zero emissions road fleet by 2025.

2020 update
Our electric vehicles fleet represents 0.3% of our total fleet.

Status: On plan

Highlights

Total Scope 1 and 2 emissions (tCO_2e)



–60% reduction since 2015

New electric vehicles target set in 2020

KPIs

Ambition Zero Carbon 2025 (tonnes (t)CO_2e)	2015 baseline	2018	2019	2020
Scope 1[2]	295,211[3]	272,737[3]	254,402[3]	224,771
Scope 2 - Market based[4]	331,811[3]	140,350[3]	131,085[3]	23,235
Total Scope 1 & 2	627,021	413,087	385,487	248,006
Scope 1 & 2 intensity (tCO_2e per million USD of revenue)	25	19	16	9
Scope 2 - Location based[4, 5]	276,663[3]	248,984[3]	233,951[3]	212,003
Outside of Scopes (CO_2 of biological origin)	2,822	7,178	6,666	5,640

Road fleet electrification	2015 Baseline	2018	2019	2020
Total vehicles - leased	17,233	16,002	16,338	16,911
Percentage of leased hybrid vehicles	0%	5%	22%	39%
Percentage of leased vehicles that are PHEV	0%	1%	3%	7%
EV100: Electric Vehicle fleet	0%	0.1%	0.2%	0.3%

Greenhouse gas reduction

Targets

Energy consumption

2025 target
Reduce total energy consumption by 10% from 2015 to 2025.

2020 update
Total energy use was 1,595,330 MWh, representing a 13% reduction from the 2015 baseline.

Status: On plan

Energy productivity

2025 target
Double energy productivity from 2015 to 2025.

2020 update
Energy productivity increased by 23% since 2015.

Status: On plan

Renewable electricity

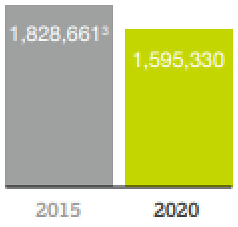
2025 target
100% renewable electricity consumption globally by 2025.

2020 update
89% of all electricity use came from renewable sources in 2020.

Status: On plan

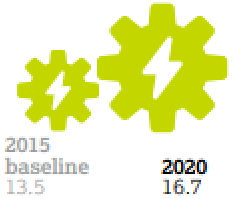
Highlights

Total energy use (MWh)



–13%
reduction since 2015

EP100: Energy productivity (million USD per GWh total energy)



Total renewable electricity consumption

KPIs

Site energy consumption and renewables	2015 baseline	2018	2019	2020
Total energy use (MWh)	1,828,661[3]	1,850,984[3]	1,741,955[3]	1,595,330
EP 100: Energy productivity (million USD per GWh total energy)	13.5	11.9	14.0	16.7
Renewable energy – electricity and heat (MWh)	113,839	557,947	544,095	699,649
RE100: Renewable electricity use[8]	13%	62%[3]	62%	89%
Renewable electricity – on-site solar PV (MWh)	N/A	3,345	5,329	5,257
Renewable electricity – imported (MWh)	104,571[3]	524,316[3]	510,029	668,762
Renewable electricity – imported	14%	70%	71%[3]	99.88%
Onsite self-generated electricity from non-renewable sources (MWh)	68,445	103,014	104,713	89,349

Greenhouse gas reduction

Targets

Scope 3 emissions

2025 target

Reduce selected Scope 3 emissions by 20% from 2015 to 2025.

2020 update

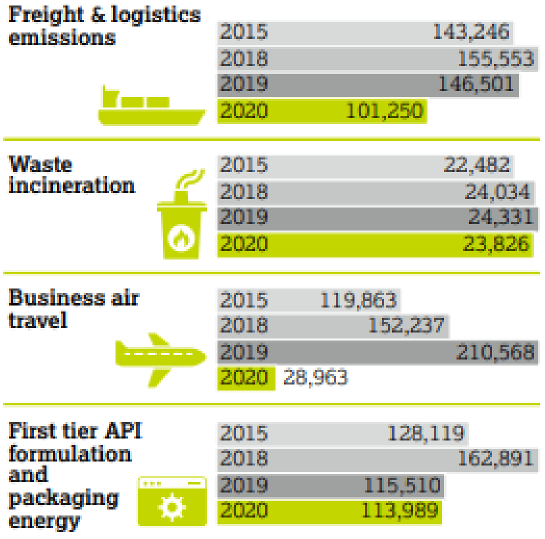
In 2020 we continued improvement in emission management from selected sources:

- 29% reduction in freight & logistics emissions since 2015.[12]
- 6% increase in waste incineration emissions since 2015.
- 76% reduction in business air travel emissions since 2015.
- 11% reduction in first tier API formulation and packaging energy emissions since 2015.

Status: On plan

Highlights

Progress on selected Scope 3 emissions (tCO_2e)



KPIs

Carbon negative value chain 2030 (Scope 3)	2015 baseline	2018	2019	2020
Freight & logistics (within Category 4) (tCO_2e)[12, 13]	143,246[3]	155,553[3]	146,501[3]	101,250
Freight & logistics Air2Sea&Rail conversion (tonne.km)	54%	63%	70%	78%
Freight & logistics Air2Sea&Rail conversion (volume)	49%	56%	62%	70%
Waste incineration (within Category 5) (tCO_2e)	22,482[3]	24,034[3]	24,331	23,826
Business air travel (within Category 6) (tCO_2e)[13]	119,863[3]	152,237[3]	210,568[3]	28,963
First tier active pharmaceutical ingredient (API), formulation and packaging (F&P) energy (one year in arrears, 90% of spend in each category) (within Category 1) (tCO_2e)[14]	128,119	162,891	115,510	113,989
pMDI use phase (within Category 11) (tCO_2e)	706,936	869,137[3]	1,012,732[3]	978,895

AZ Forest

2025 target

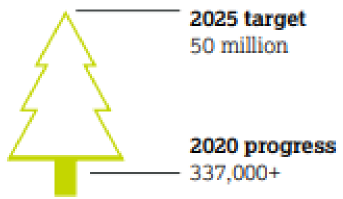
Plant and steward 50 million surviving trees.

2020 update

337,357 trees planted in Australia and Indonesia.

Status: Lagging

Number of trees planted



AZ Forest	2018	2019	2020
Trees planted	N/A	N/A	337,357

To address greenhouse gas emissions, we follow a hierarchy

Ambition Zero Carbon 2025

Aim: no residual emissions
Strategy: secure supply of credits

Avoid

Through green design and new ways of working

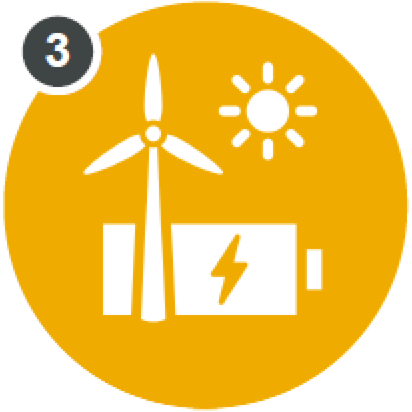
- Circularity: Assets, Products, Processes
- Asset strategy

Reduce

Improve efficiencies and change energy use behaviour

EP 100

- Continuous Improvement (ISO50001)
- Assess & Invest: NRRGG Capital Fund



Substitute

Substitute energy use with renewables and lower impact fuels/vehicles

RE 100 EV 100

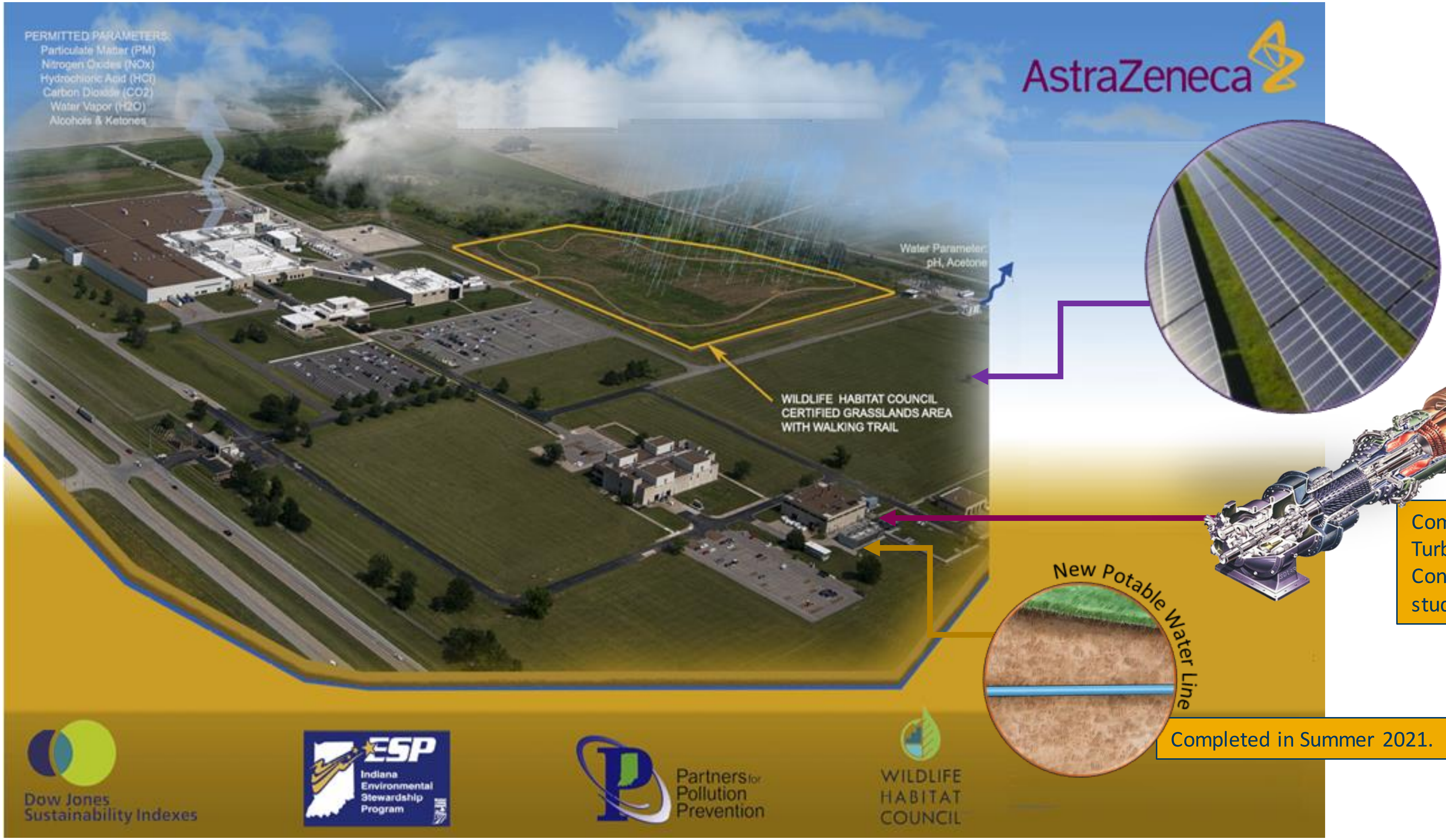
- Ren. Energy PPAs & Fuel Switch /Electrification
- Electric Vehicles
- Low/Zero GWP refrigerants

Compensate

High-quality carbon removal projects for residual/ accidental emissions

- Value Chain CO2 Removal Technology – very high unit cost

Ambition Zero Carbon – Mt. Vernon Campus



2 MW Solar Farm installation completed in October 2021, consisting of 5,760 panels on seven acres, which will substitute 10-15% of imported electricity consumed.

Combined Heating & Power (CHP) Turbine Installation Potential. Conducting Co-gen engineering study in 2021-2022.

Completed in Summer 2021.

*"Almost all **scientific** inquiry **begins** with an observation that piques curiosity or raises a **question**"*

Confidentiality Notice