Carbon Capture in the East Coachella Valley

EWB Innovation Weekend 2021

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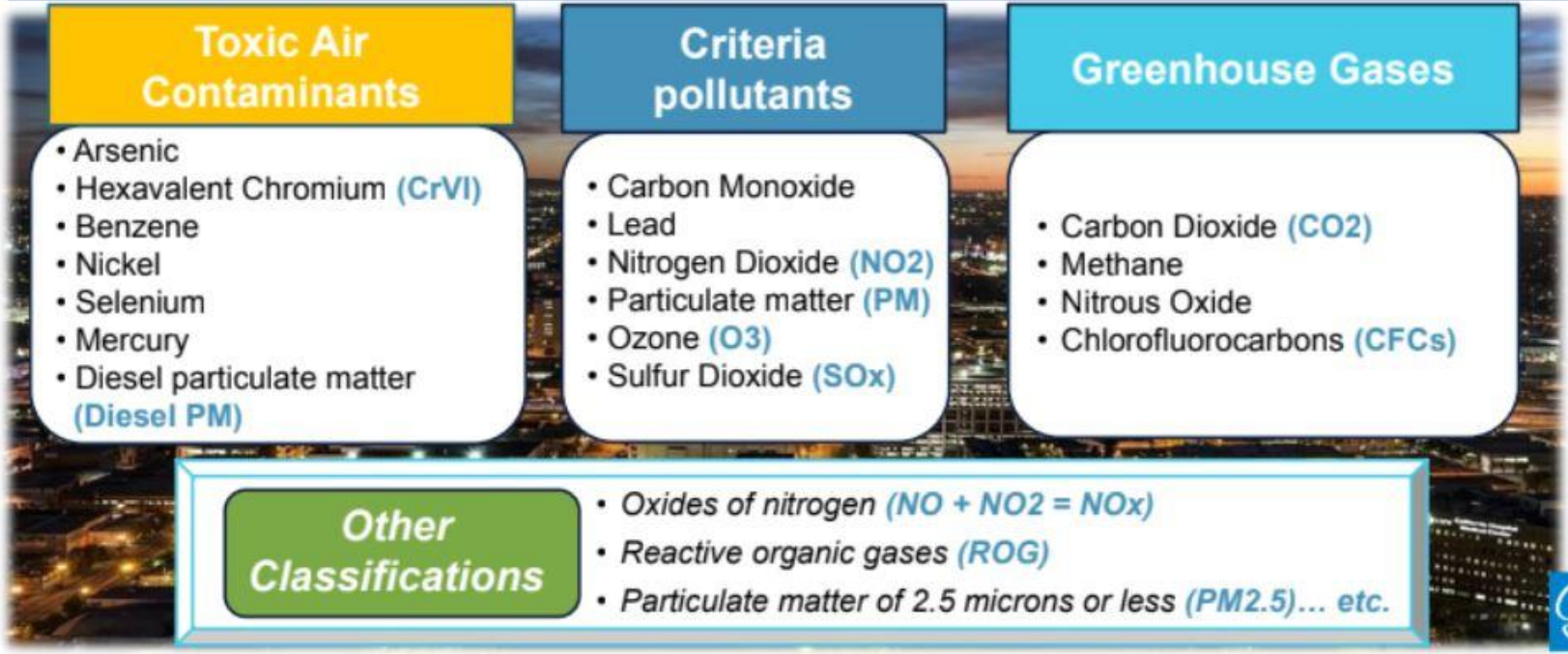
1.

Root Cause/ Problem

EXAMPLES OF AIR POLLUTION TYPES



Toxic Air Contaminants

- Arsenic
- Hexavalent Chromium (CrVI)
- Benzene
- Nickel
- Selenium
- Mercury
- Diesel particulate matter (Diesel PM)

Criteria pollutants

- Carbon Monoxide
- Lead
- Nitrogen Dioxide (NO2)
- Particulate matter (PM)
- Ozone (O3)
- Sulfur Dioxide (SOx)

Greenhouse Gases

- Carbon Dioxide (CO2)
- Methane
- Nitrous Oxide
- Chlorofluorocarbons (CFCs)

Other Classifications

- *Oxides of nitrogen (NO + NO2 = NOx)*
- *Reactive organic gases (ROG)*
- *Particulate matter of 2.5 microns or less (PM2.5)… etc.*

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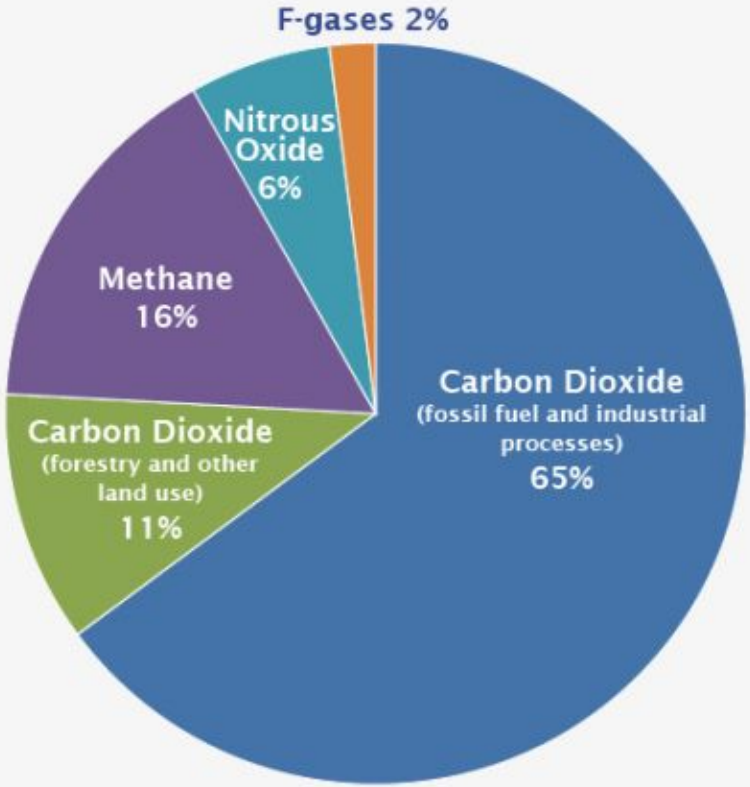
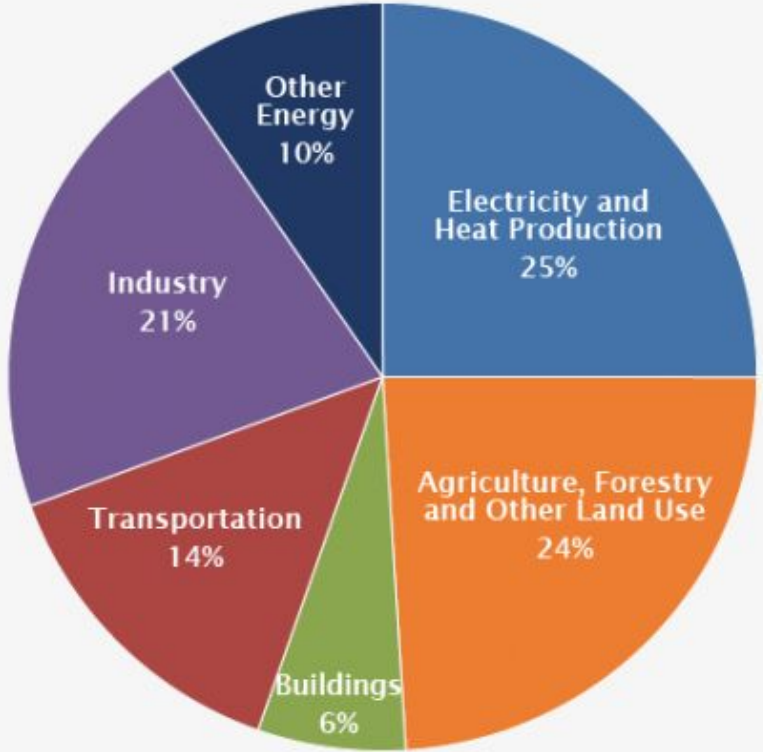
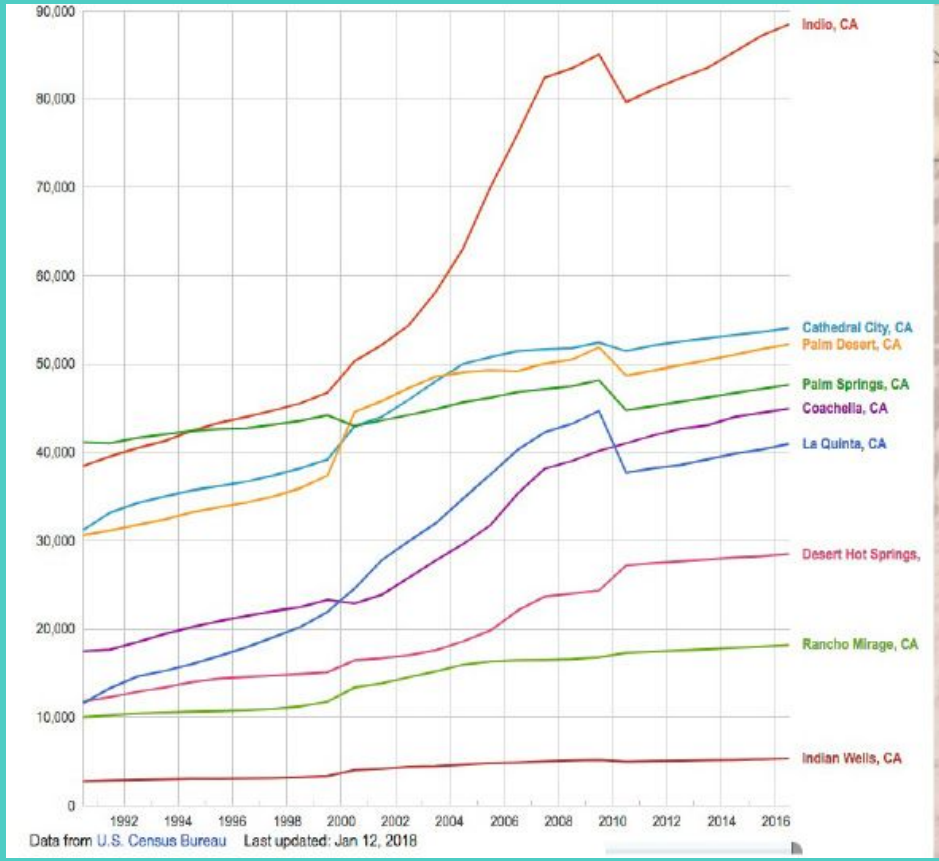
South Coast AQMD

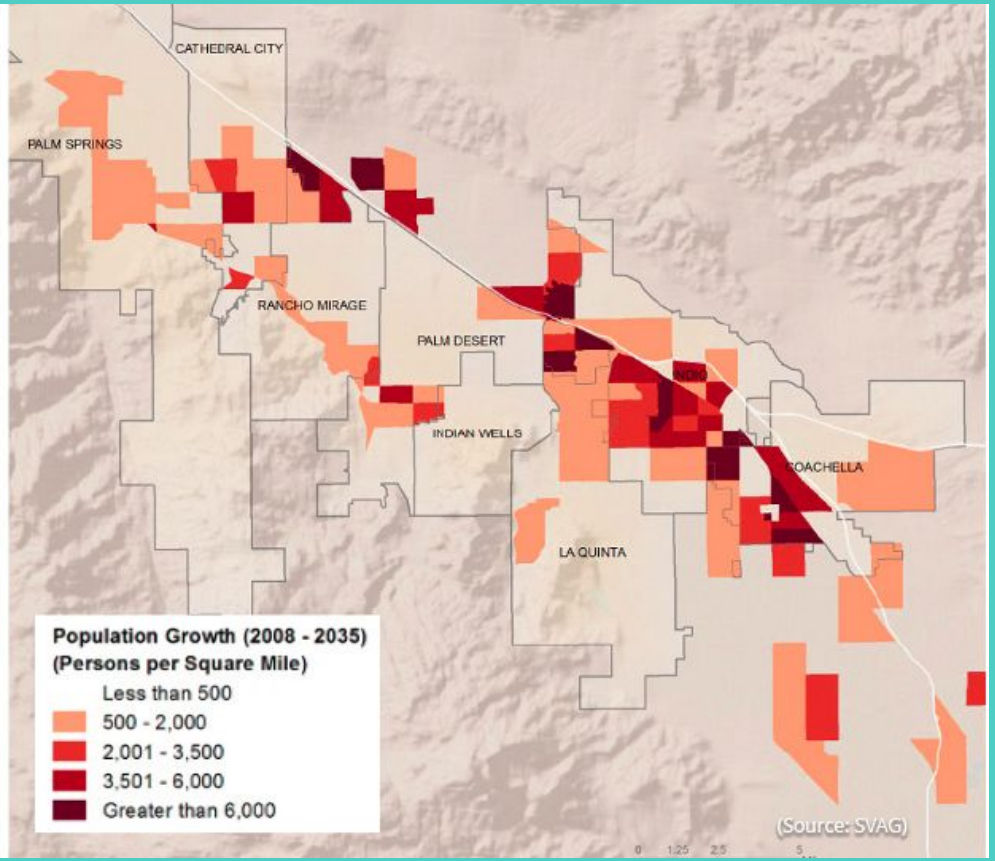
Global Greenhouse Gas Emissions by Gas



Global Greenhouse Gas Emissions by Economic Sector




90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Indio, CA
Cathedral City, CA
Palm Desert, CA
Palm Springs, CA
Coachella, CA
La Quinta, CA
Desert Hot Springs,
Rancho Mirage, CA
Indian Wells, CA
Data from U.S. Census Bureau Last updated: Jan 12, 2018


CATHEDRAL CITY
PALM SPRINGS
RANCHO MIRAGE
PALM DESERT
INDIO
INDIAN WELLS
COACHELLA
LA QUINTA
Population Growth (2008 - 2035)
(Persons per Square Mile)
Less than 500
500 - 2,000
2,001 - 3,500
3,501 - 6,000
Greater than 6,000
(Source: SVAG)

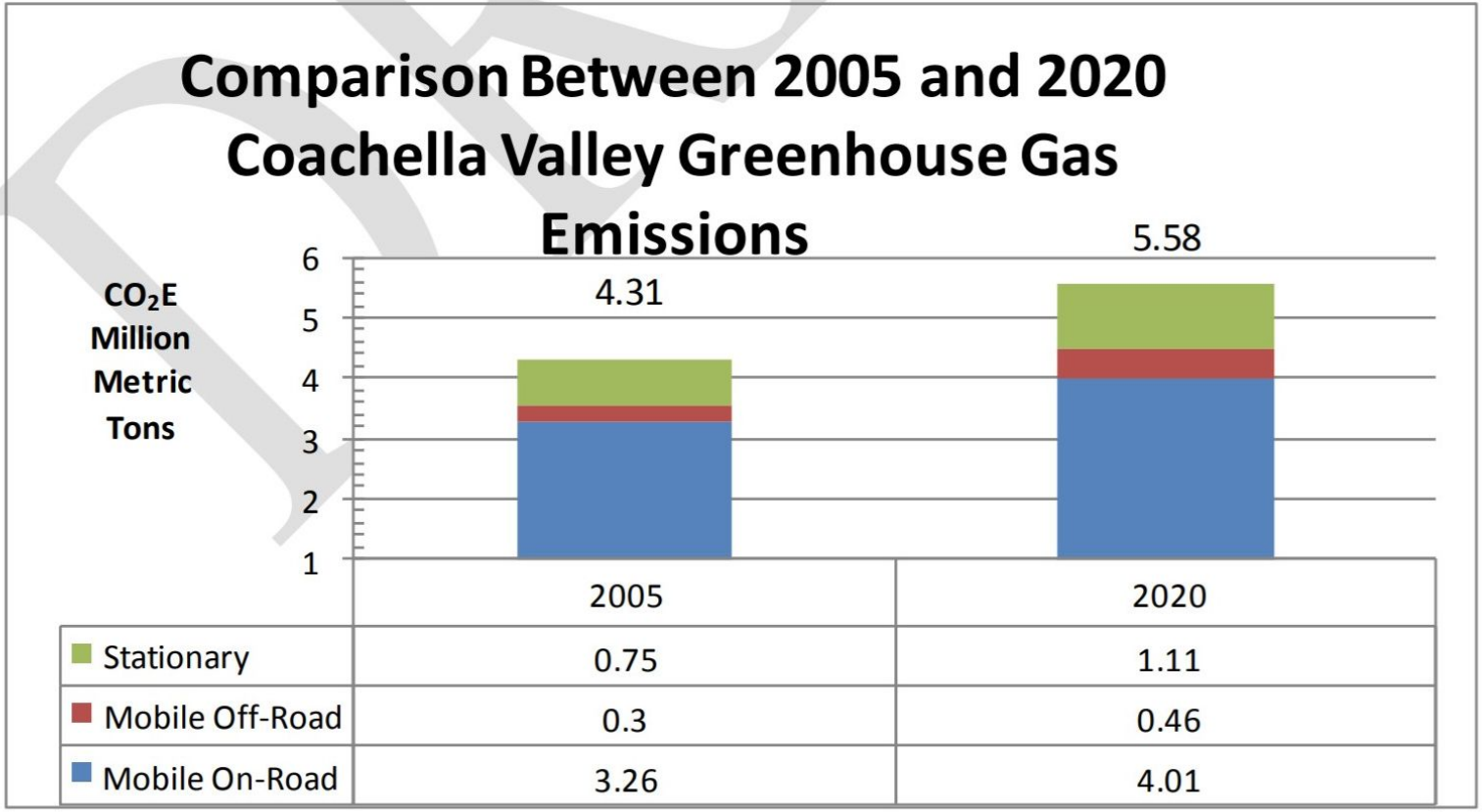
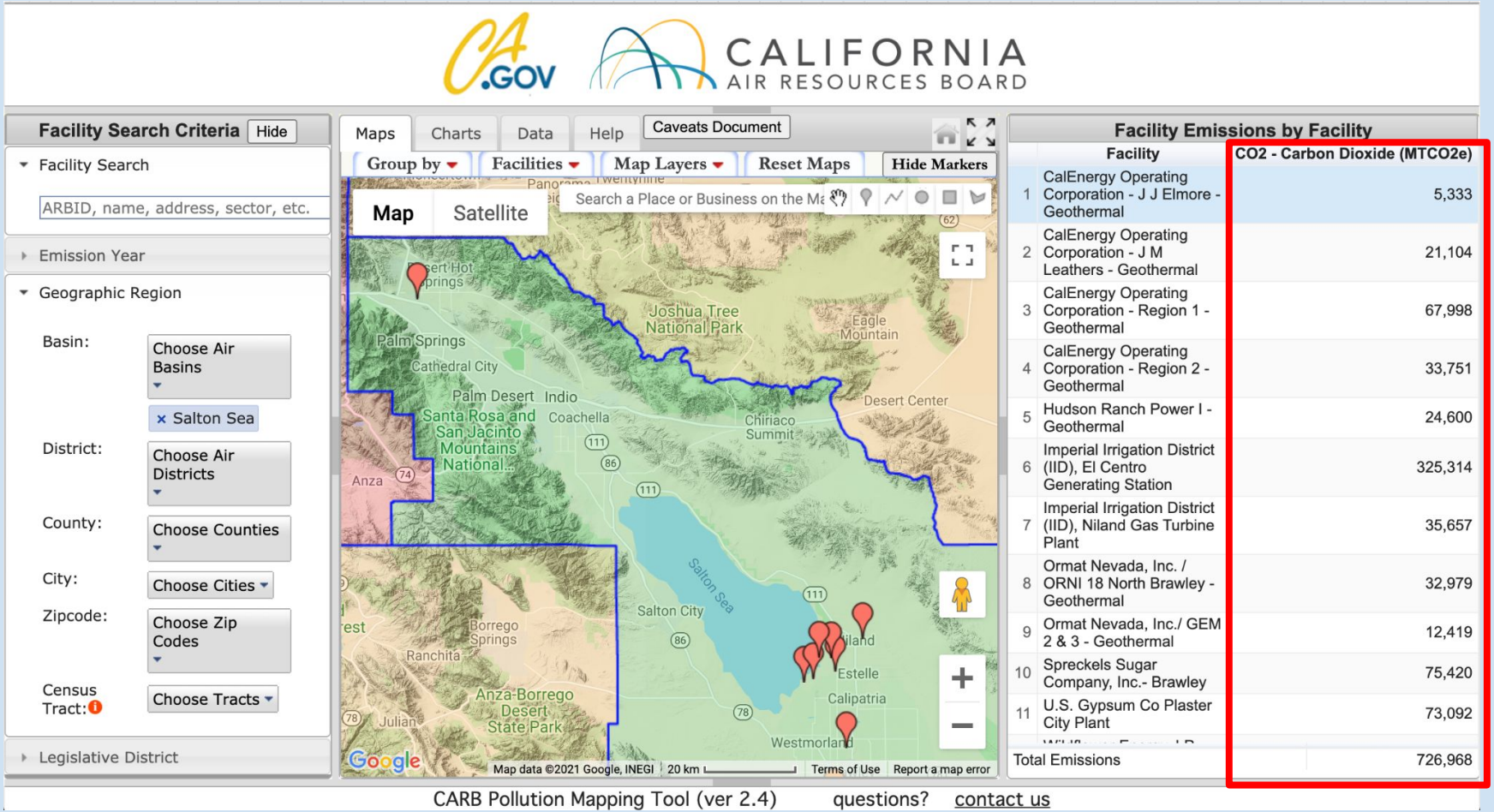


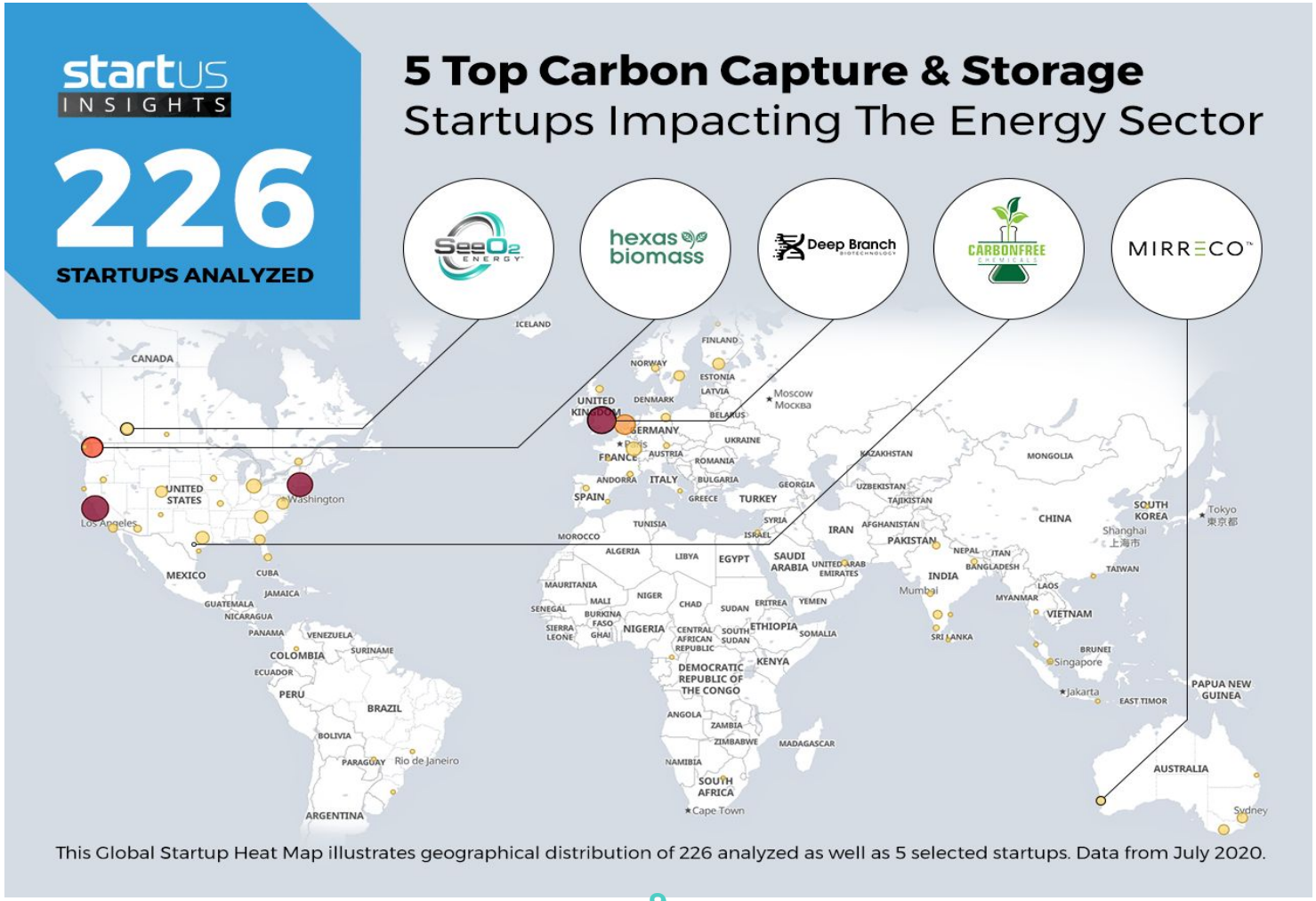
Figure 1. Greenhouse gas emissions in the Coachella Valley in 2005 and in the year 2020



Facility emissions in Salton Sea basin (2018), using CARB Pollution Mapping Tool

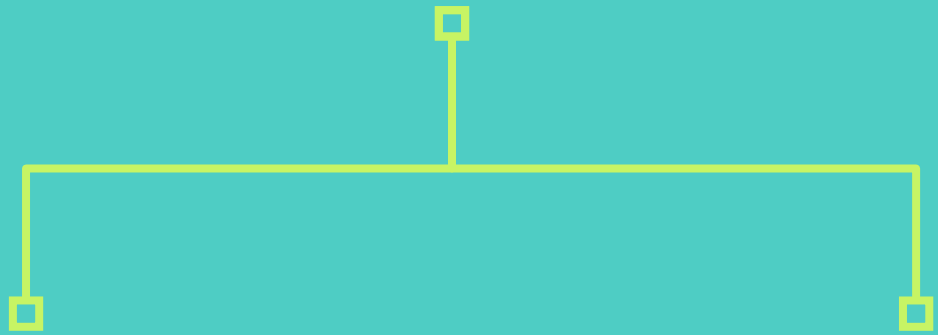
2.

Big Picture



This Global Startup Heat Map illustrates geographical distribution of 226 analyzed as well as 5 selected startups. Data from July 2020.

The Coachella Valley Regional Baseline Greenhouse Inventory



The Coachella Valley Association of Governments.

The South Coast Air Quality Management District (South Coast AQMD).

Big Picture (cont.)

Technological and economic barriers.

- Not enough innovation in Carbon Capture technology.
- Expensive to develop Carbon Capture technology.

3.

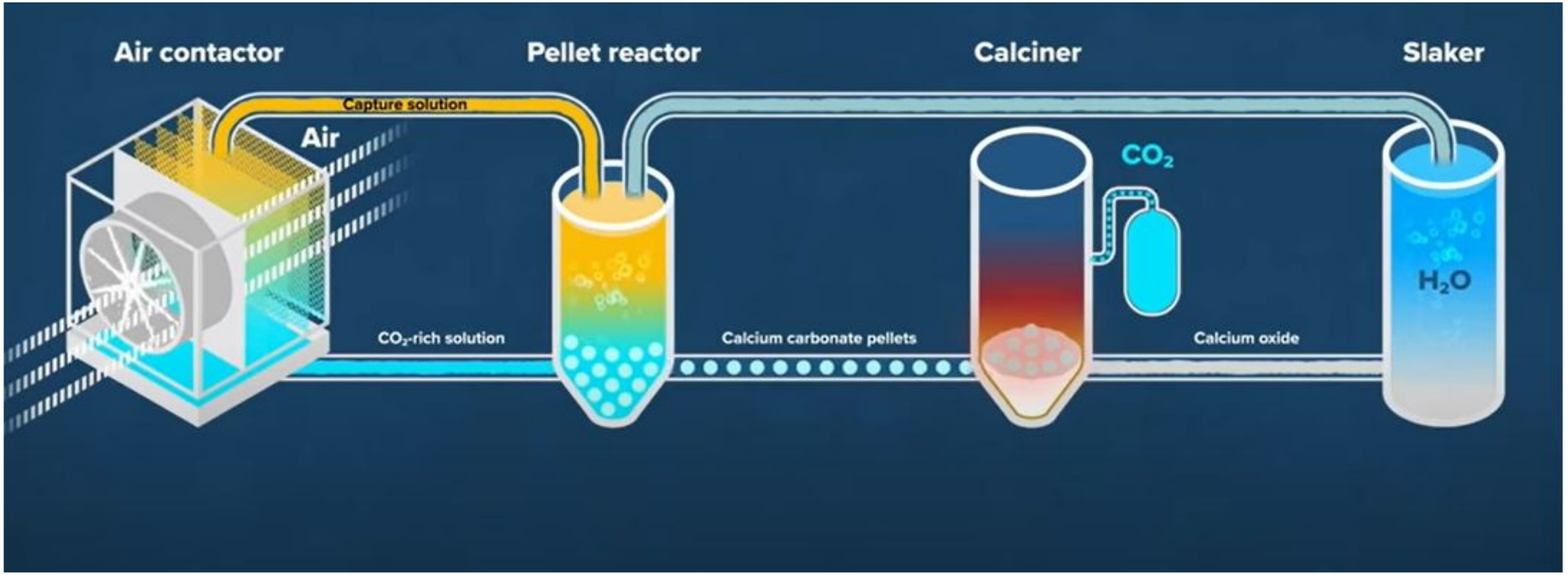
The Processes

1. Direct Air Capture (DAC)

What is it?

- Process of pulling air through a filter and capturing the carbon dioxide that comes through the filter.
- The CO2 is either repurposed for commercial uses, or buried underground where it can't do further harm to the climate.

DAC Overall Process



Direct Air Capture (cont.)

- **Long-term goals**

  More Carbon capture plants throughout the East Coachella valley in order to meet CO2 reduction goals and improve the health the people in the area.

- **Projected growth**

  As more CO2 reduction goals are introduced,

  we predict the demand for these plants will increase.

Timeline for East Coachella Valley

By 2030 the Eastern Coachella Valley aims to reduce air pollution from

- Salton Sea
- Pesticides
- Fugitive road dust
- Greenleaf Desert View Power Plant
- Diesel mobile sources
- Open burning
- Illegal dumping

Through implementing more air monitoring, cleaner technology, and new policies.

Direct Air Capture Costs

- The range of costs for DAC vary between $250–$600 today (Per tonne CO_2 removed)

- Depending on the rate of deployment, costs for DAC could fall to around $150–$200 per tonne over the next 5-10 years.

Direct Air Capture Feasibility

Status of the Leading DAC Companies

	Cimeworks	Global Thermostat	Carbon Engineering
Location	Switzerland	United States	Canada
System type	Solid sorbent	Solid sorbent	Liquid solvent
Thermal energy needs	80-120°C / 176-248°F	80-100°C / 176-212°F	900°C / 1652°F
Thermal energy source	Non-fossil energy resources (geothermal, waste heat, etc.)	Energy resource agnostic	Natural gas with CCS
Projects	Commercial operation with 16 plants globally with a collective capacity of 2,000 tonnes of CO2 captured from air per year	Pilot plants in Oklahoma and Colorado	Pilot plant in British Columbia; in the process of building a facility in the Permian Basin that will be capable of 1 million tonnes of CO2 per year
Investments	Around $170 million in equity investment since founding in 2009, including $110 million in the most recent round of funding this year Investors include Zurich Cantonal Bank, Horizon 2020, and others	Partnered with companies including ExxonMobil, NRG, BASF Investments from Zero-Carbon Partners, Goldman Sachs, and others	Received investments of $68 million in most recent round of funding in 2019 Investors include BHP, Chevron, Bill Gates, Oxy Low Carbon Ventures, and others

Source: Climeworks 2020, Carbon Engineering 2020, Global Thermostat 2020, Bipartisan Policy Center 2019, Beuttler et al. 2019

WORLD RESOURCES INSTITUTE

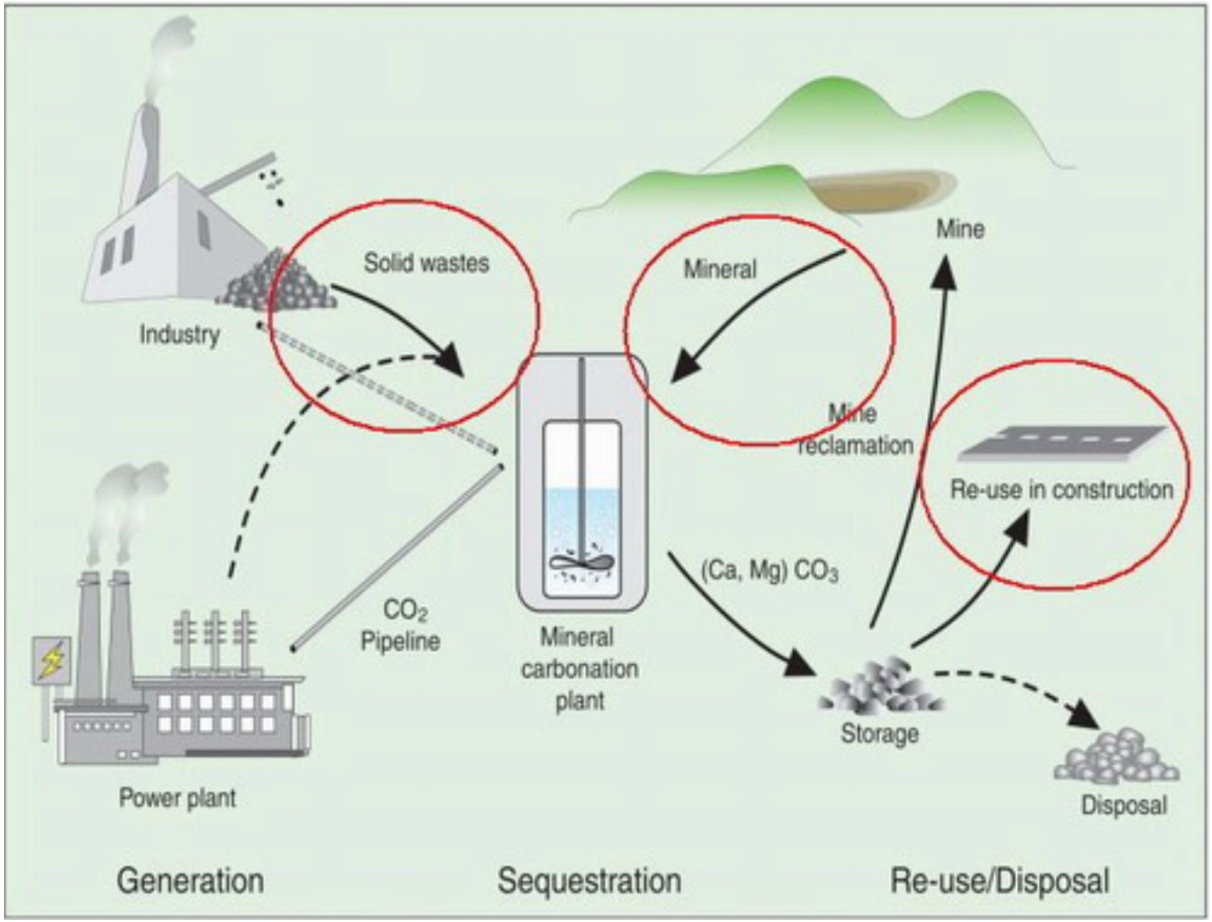
2. Direct Mineral Carbonation

What is it?

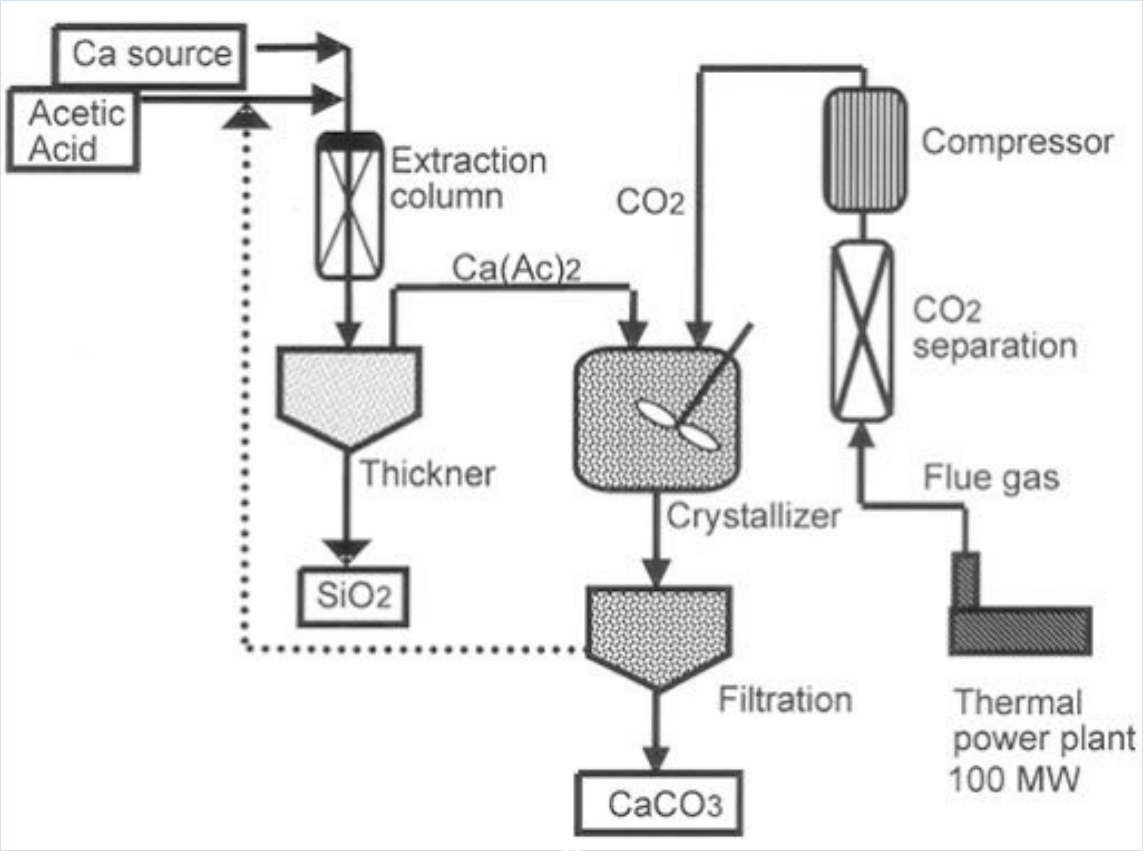
- Process of CO_2 gas reacting with other minerals to deposit the CO_2 into solid carbonates
- Solids are permanent
- Stable over millions of years

Direct Mineral Carbonation

- More immediate solution
- Byproduct benefits



Direct Mineral Carbonation Overall Process



Mineral Carbonation Costs

- Cost of CO_2 mineral sequestration is about $50 ~ 100 per ton.
  (Intergovernmental Panel on Climate Change, IPCC)

- Estimated initial cost by direct aqueous carbonation is around $54 ~ 69 per ton.

Mineral Carbonation Benefits

- Valuable byproducts offset costs, used in multiple industries.

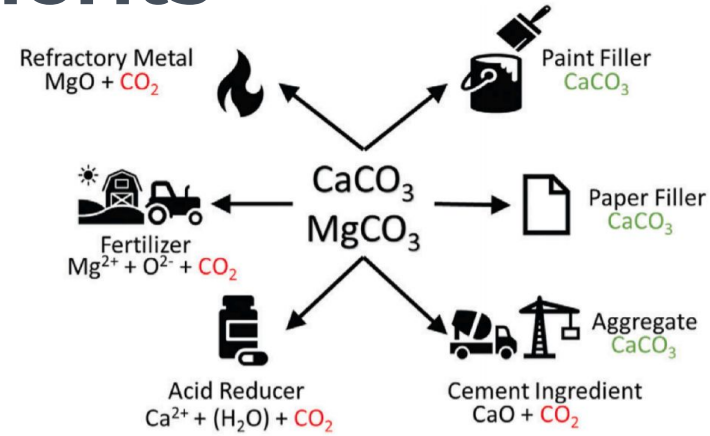


Fig. 8. Illustration of uses of carbonated products in different fields [144].

- 45Q Carbon Tax Credit (Carbon Capture Coalition)
  - Value increase incrementally over 10 years:
    $10 → $35/ton stored geologically via enhanced oil recovery.
    $20 → $50/ton for saline/other forms of storage.
  - $35/ton CO_2 captured.

Mineral Carbonation Feasibility

- Integration of technology into industry facilities mitigates extreme costs
  - Approximate cost of $120/ton of CO_2 broken down by percent for standalone operation
  - Ex. power plant integration reduces feedstock pretreatment cost

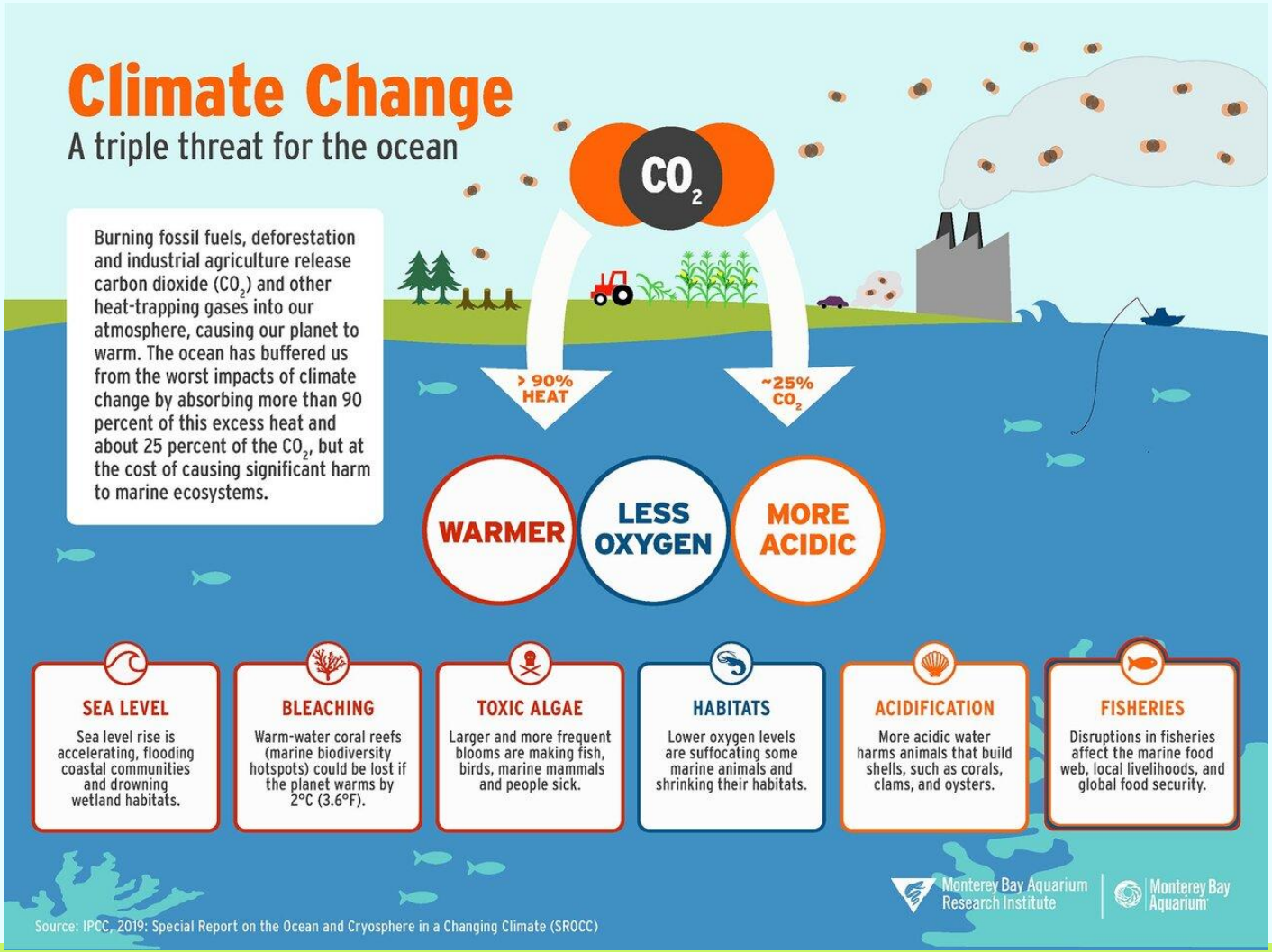
Cost element	Relative cost	Comment
Feedstock cost	53%	Wollastonite assumed in this example
Electricity cost	26%	Of which 18% for feedstock grinding
Capital cost	10%	Depreciation basis
Other costs	11%	Maintenance, staff, etc.

4.

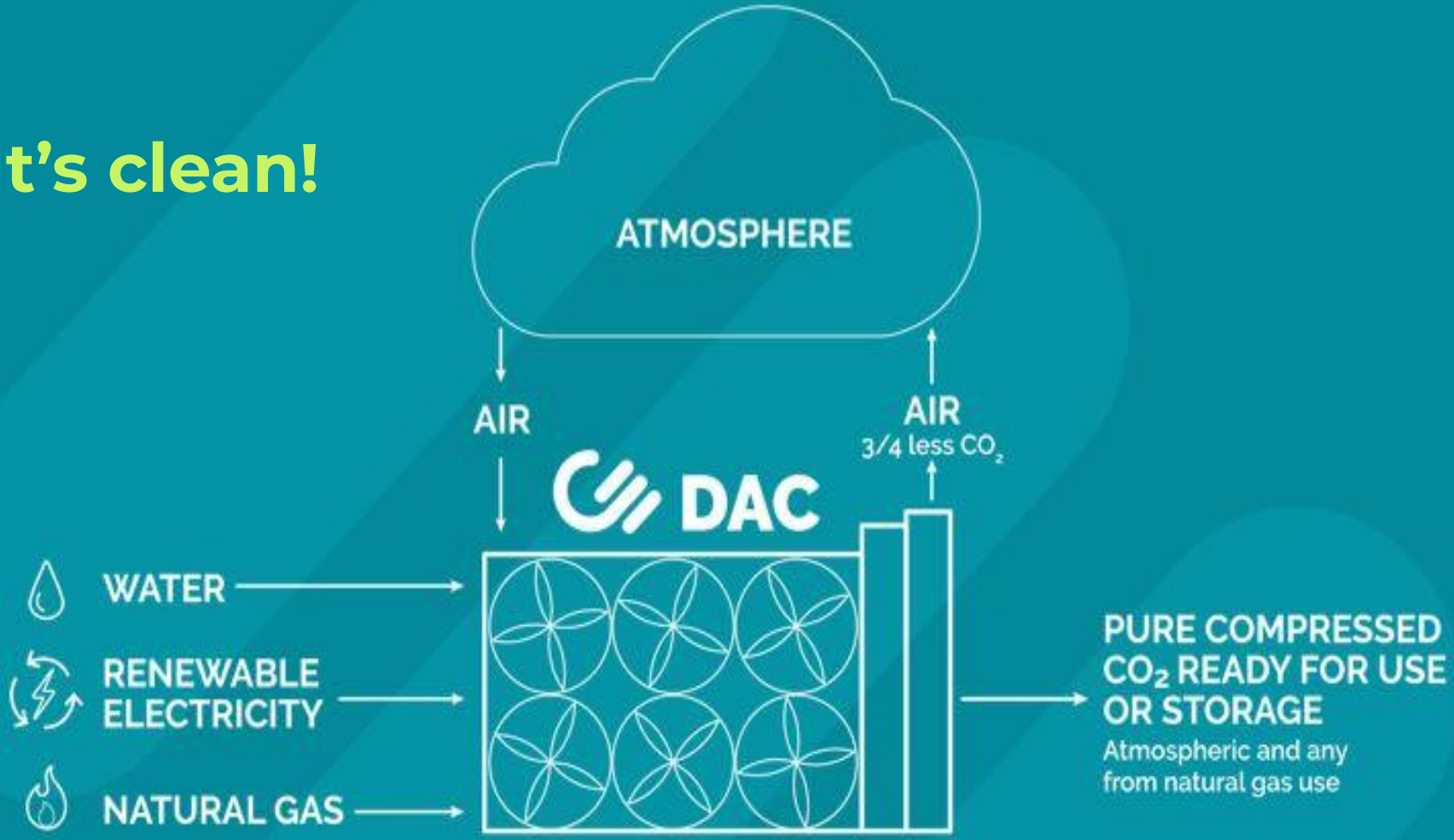
End Result

End Result

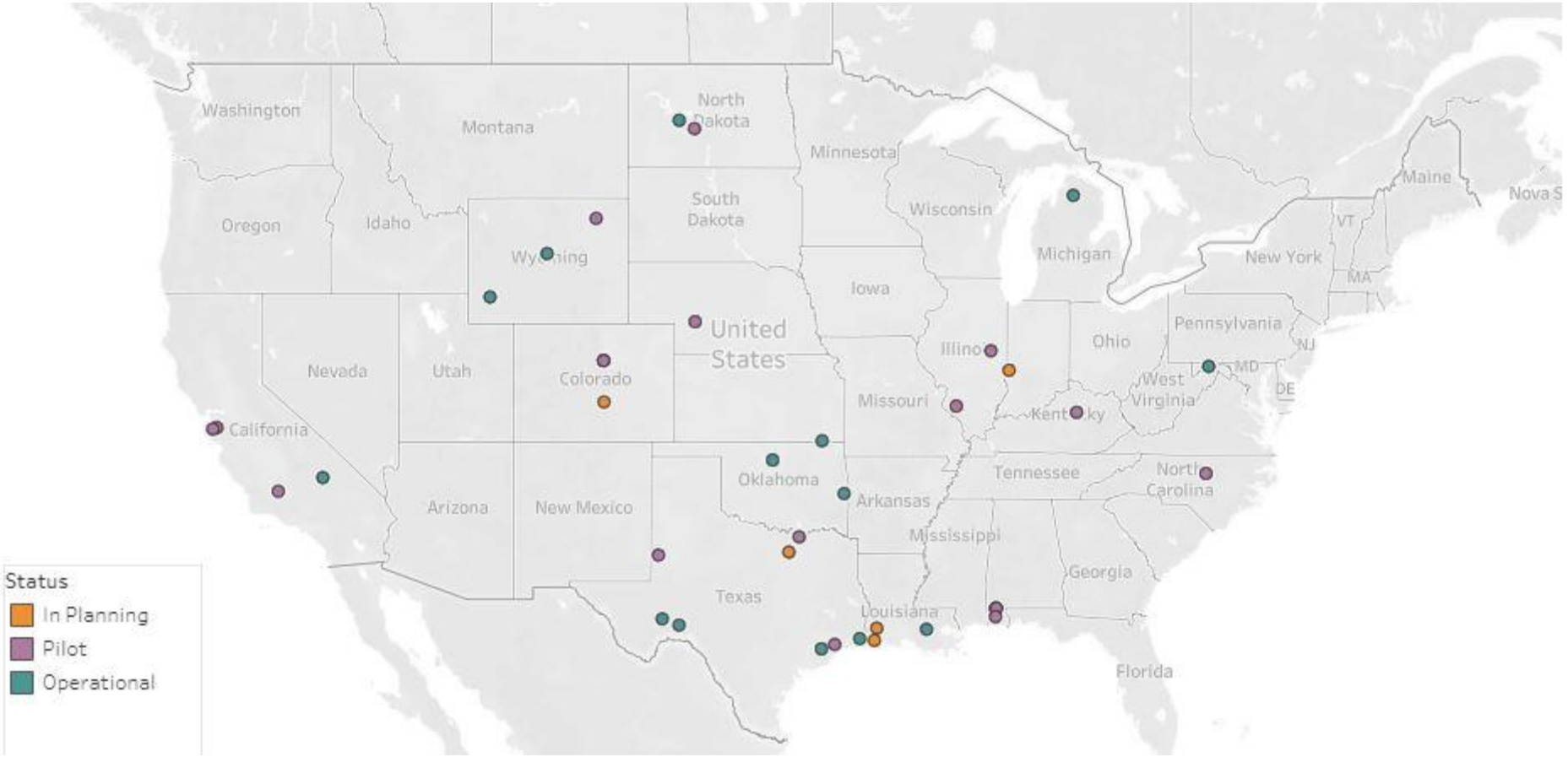
- CO2 removed from the atmosphere
- Reduced carbon dioxide emissions in industrial processes
- Carbon dioxide that is captured can be used in other processes as a feedstock or as an energy source
- Increases job opportunities


Climate Change
A triple threat for the ocean
Burning fossil fuels, deforestation and industrial agriculture release carbon dioxide (CO_2) and other heat-trapping gases into our atmosphere, causing our planet to warm. The ocean has buffered us from the worst impacts of climate change by absorbing more than 90 percent of this excess heat and about 25 percent of the CO_2, but at the cost of causing significant harm to marine ecosystems.
CO_2
> 90% HEAT
~25% CO_2
WARMER
LESS OXYGEN
MORE ACIDIC
SEA LEVEL
Sea level rise is accelerating, flooding coastal communities and drowning wetland habitats.
BLEACHING
Warm-water coral reefs (marine biodiversity hotspots) could be lost if the planet warms by 2°C (3.6°F).
TOXIC ALGAE
Larger and more frequent blooms are making fish, birds, marine mammals and people sick.
HABITATS
Lower oxygen levels are suffocating some marine animals and shrinking their habitats.
ACIDIFICATION
More acidic water harms animals that build shells, such as corals, clams, and oysters.
FISHERIES
Disruptions in fisheries affect the marine food web, local livelihoods, and global food security.
Monterey Bay Aquarium Research Institute
Monterey Bay Aquarium
Source: IPCC, 2019: Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)

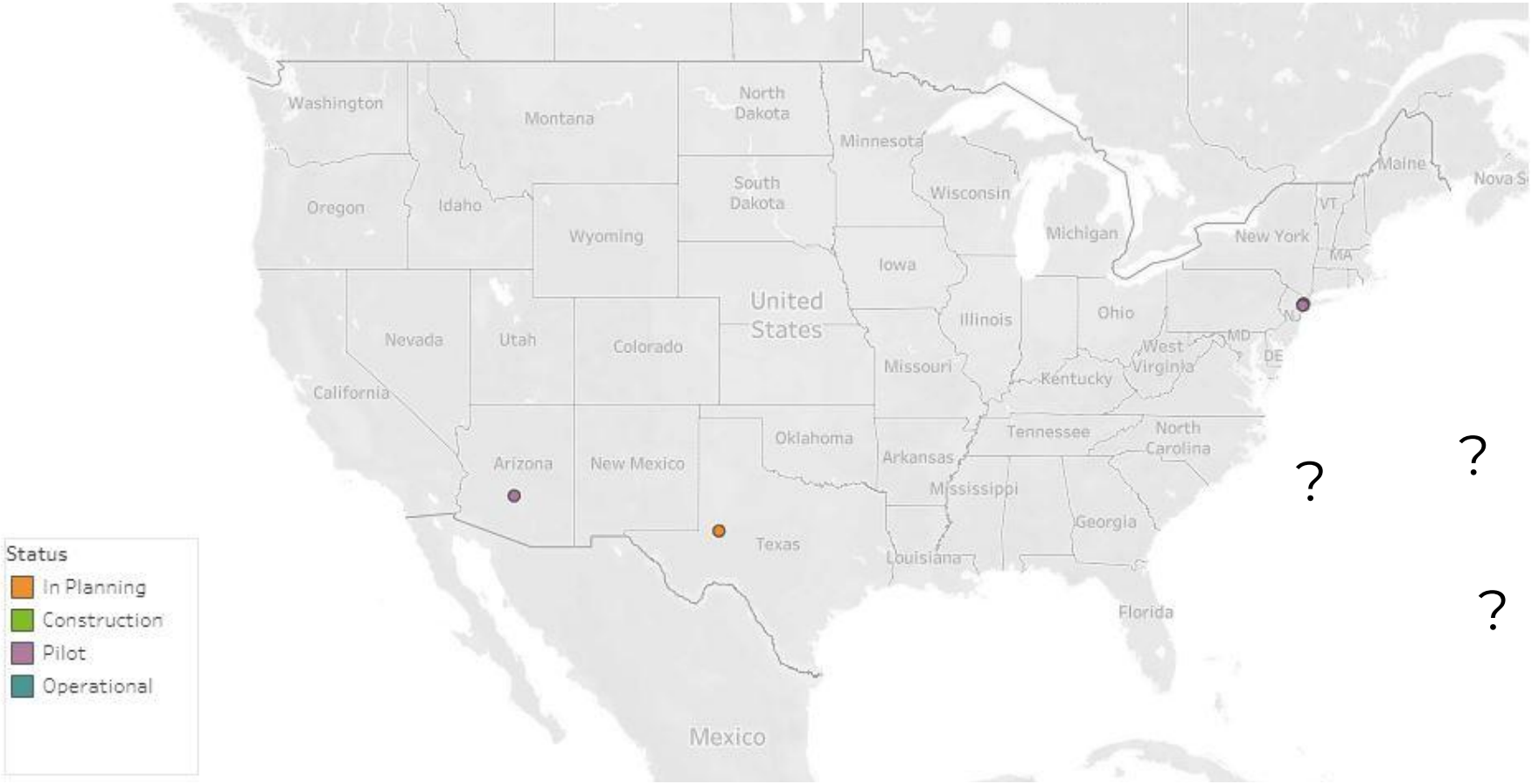
It’s clean!


ATMOSPHERE
AIR
AIR
3/4 less CO_2
DAC
WATER
RENEWABLE ELECTRICITY
NATURAL GAS
PURE COMPRESSED CO_2 READY FOR USE OR STORAGE
Atmospheric and any from natural gas use

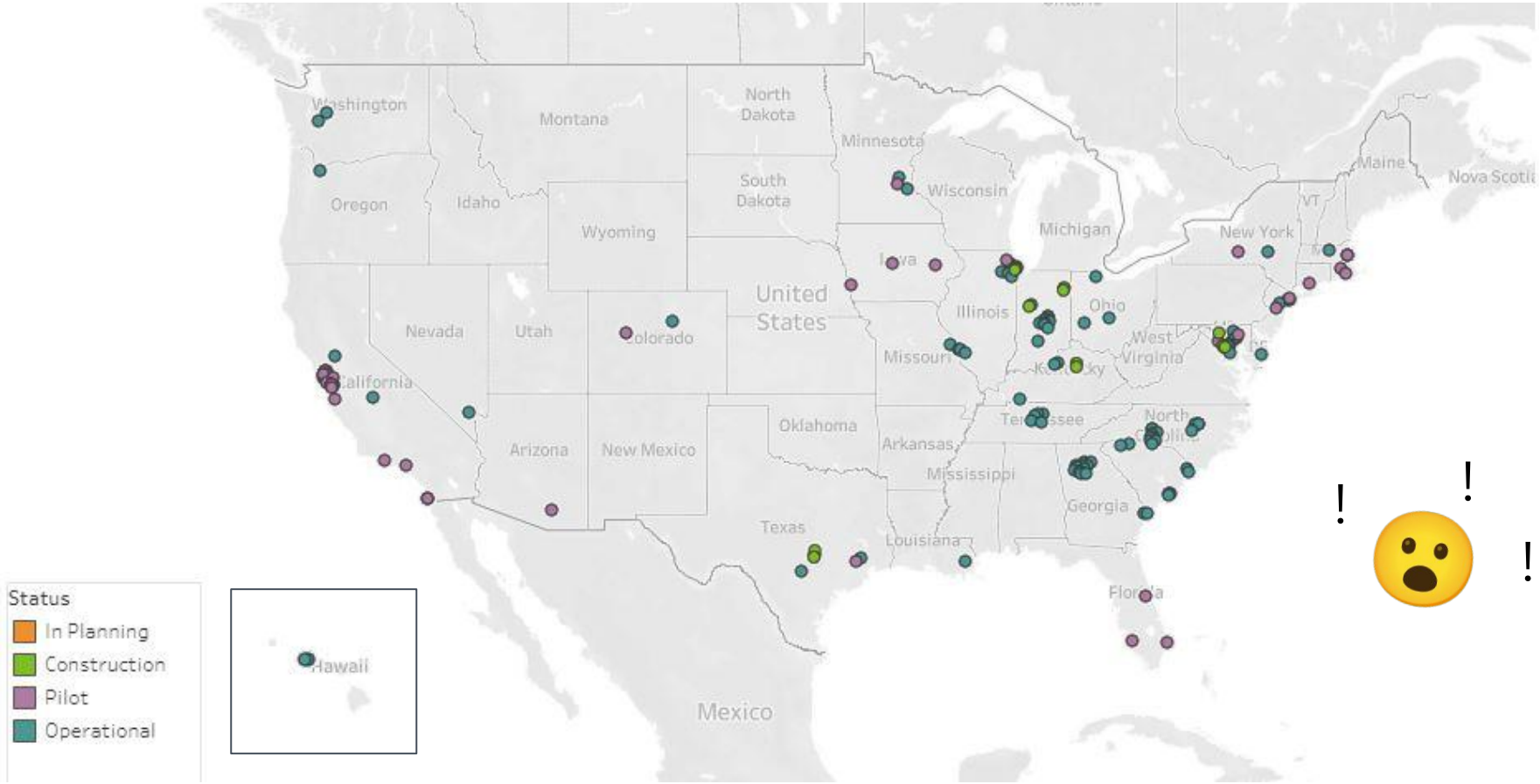
Carbon Capture in Industrial Processes



Direct Air Capture



Carbon Reuse in the U.S.



The Uses are Endless!!

Construction Materials

- Cement and concrete
- Asphalt
- Aggregate
- Timber/super hardwood

Fuel

- Synthetic (methanol, butanol, natural gas, syngas, etc.)
- Micro-algae fuel
- Macro-algae fuel

New materials

- Carbon fiber
- Carbon nanotubes and fullerenes
- Graphene

Industrial gas & fluids

- Enhanced oil recovery
- Enhanced coal bed methane recovery
- Enhanced water recovery
- Semiconductor fabrication
- Power cycles

Polymers

- Polyurethene foams
- Polycarbonate (glass replacement)
- Acrylonitrile butadiene styrene
- Many more

Agriculture & food

- Algae-based food or animal feed
- Microbial fertilizer
- Biochar, bio-pesticides, bio-cosmetics

Chemicals

- Preservatives (formic acid)
- Medicinal
- Antifreeze (ethylene glycol)
- Carbon black
- Many more

Source: Independent study commissioned by CO_2 Sciences

End Results in East Coachella Valley

- Tackles air pollution issue
- Creates job opportunities
- Furthers economic development

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Thanks!

Any questions?