



Engineering
Technologies, Inc

ENERGY EFFICIENCY AND DECARBONIZATION FOR GRAIN AND OILSEEDS INDUSTRIES AS ELEMENTS OF CIRCULAR ECONOMY

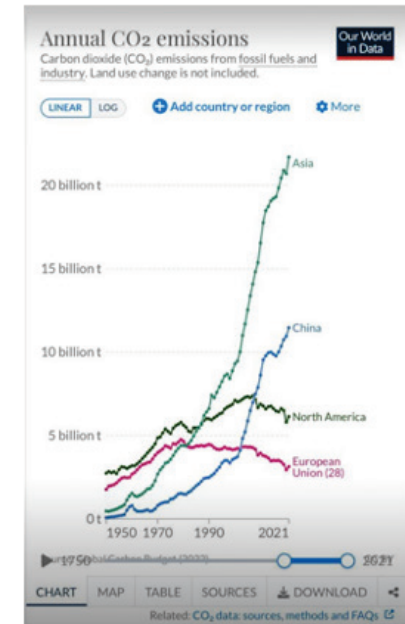
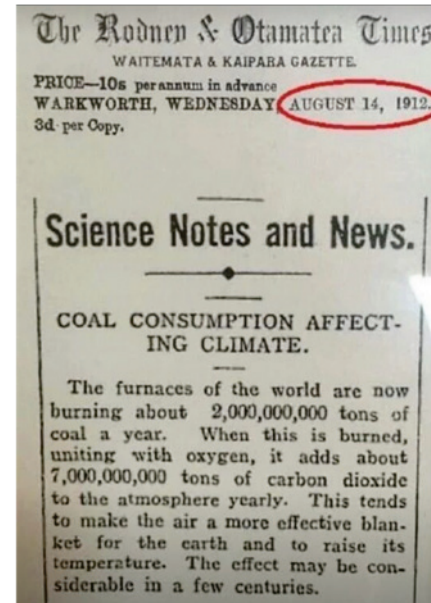
Dr. Olexiy Buyadgie,
California, USA

08.31.2023

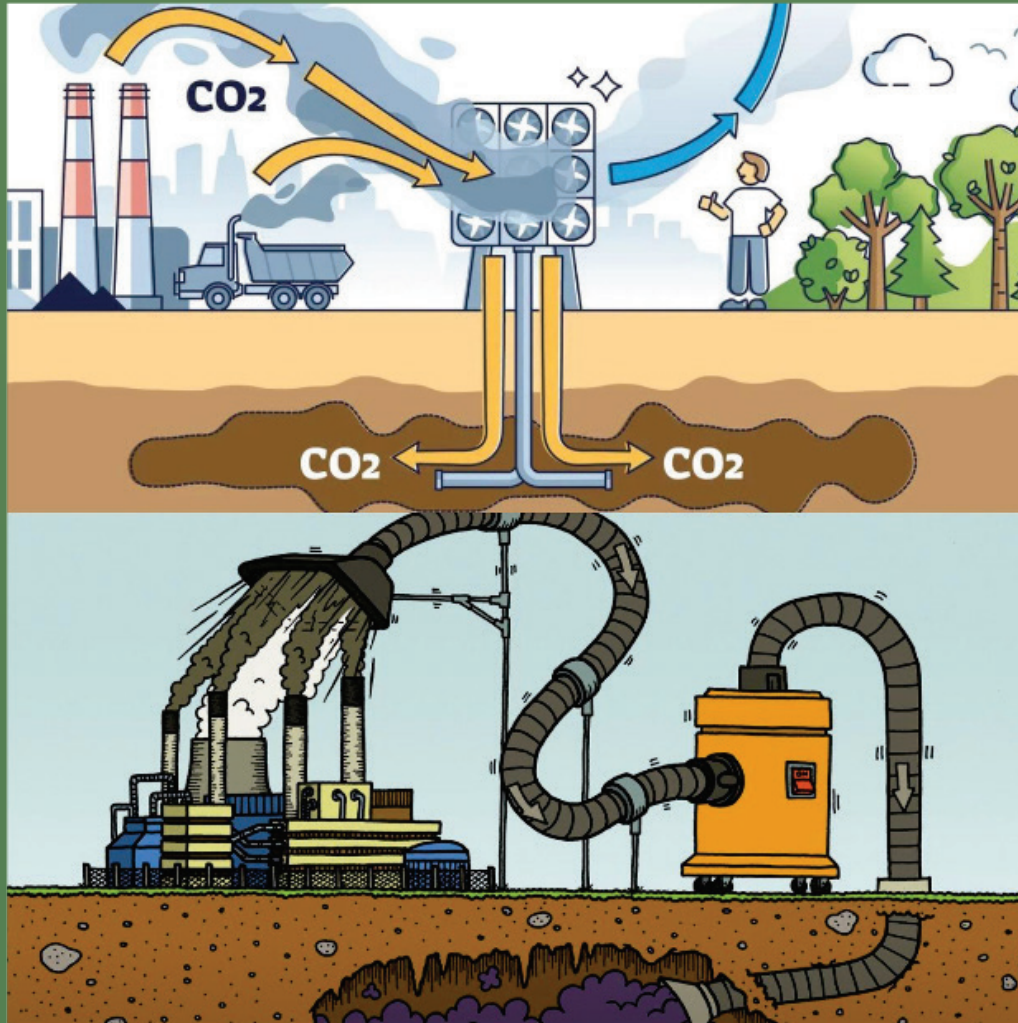
FACTS ABOUT CARBONIZATION



Experts Warn We Have Only 12 Years Left Until They Change The Timeline On Global Warming Again

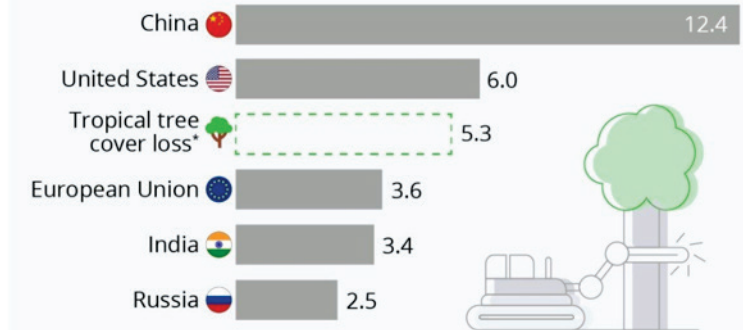


FACTS ABOUT DECARBONIZATION



The Huge Carbon Footprint of Tropical Deforestation

Estimated annual CO₂ equivalent emissions (in Gt/year)



* Gross emissions from deforestation and other disturbances. Country data (2018) excludes the effects of land-use change and forestry. Tree cover figure is the average from 2001 to 2019.

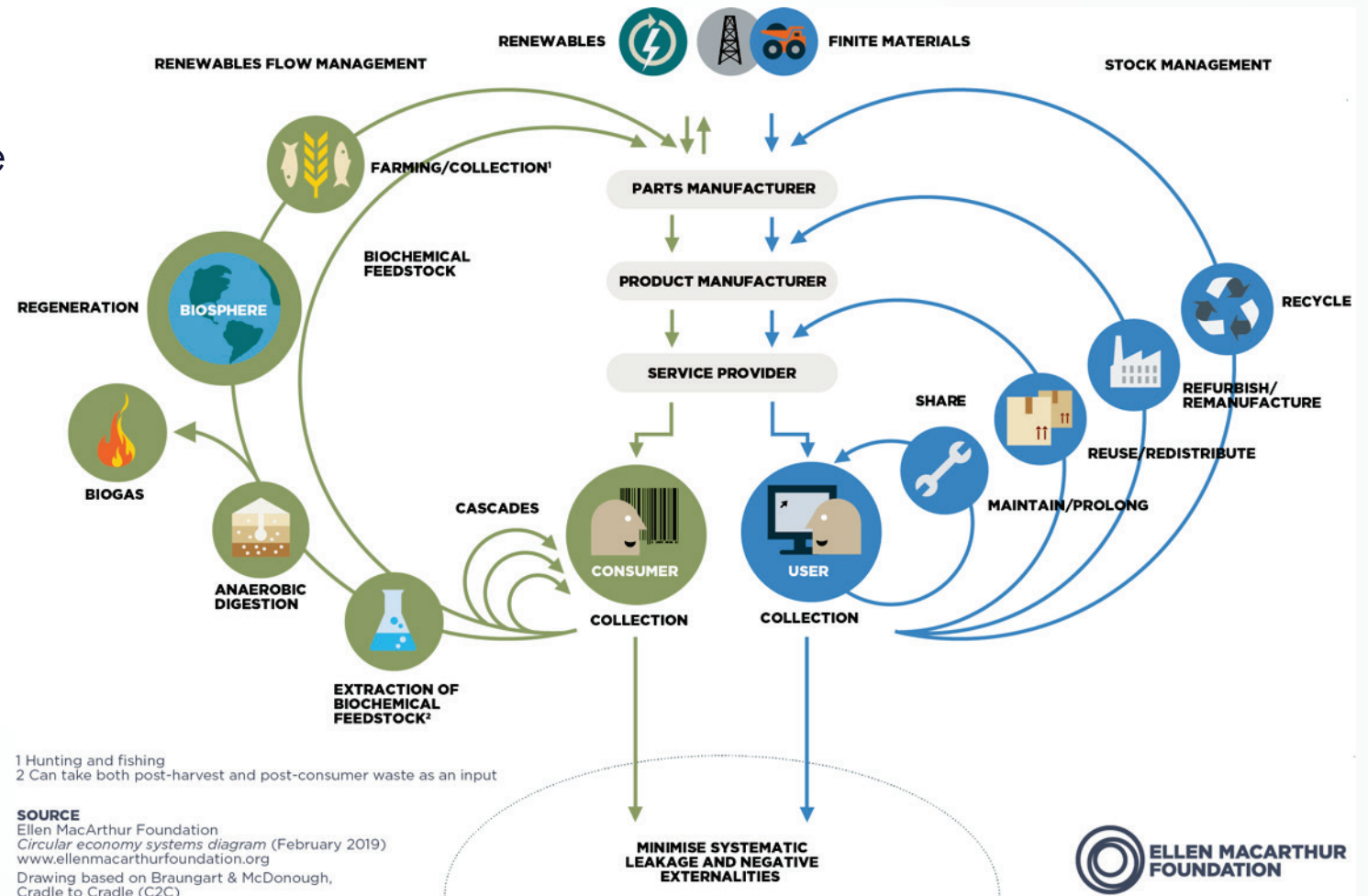
Sources: World Resources Institute, Global Forest Watch



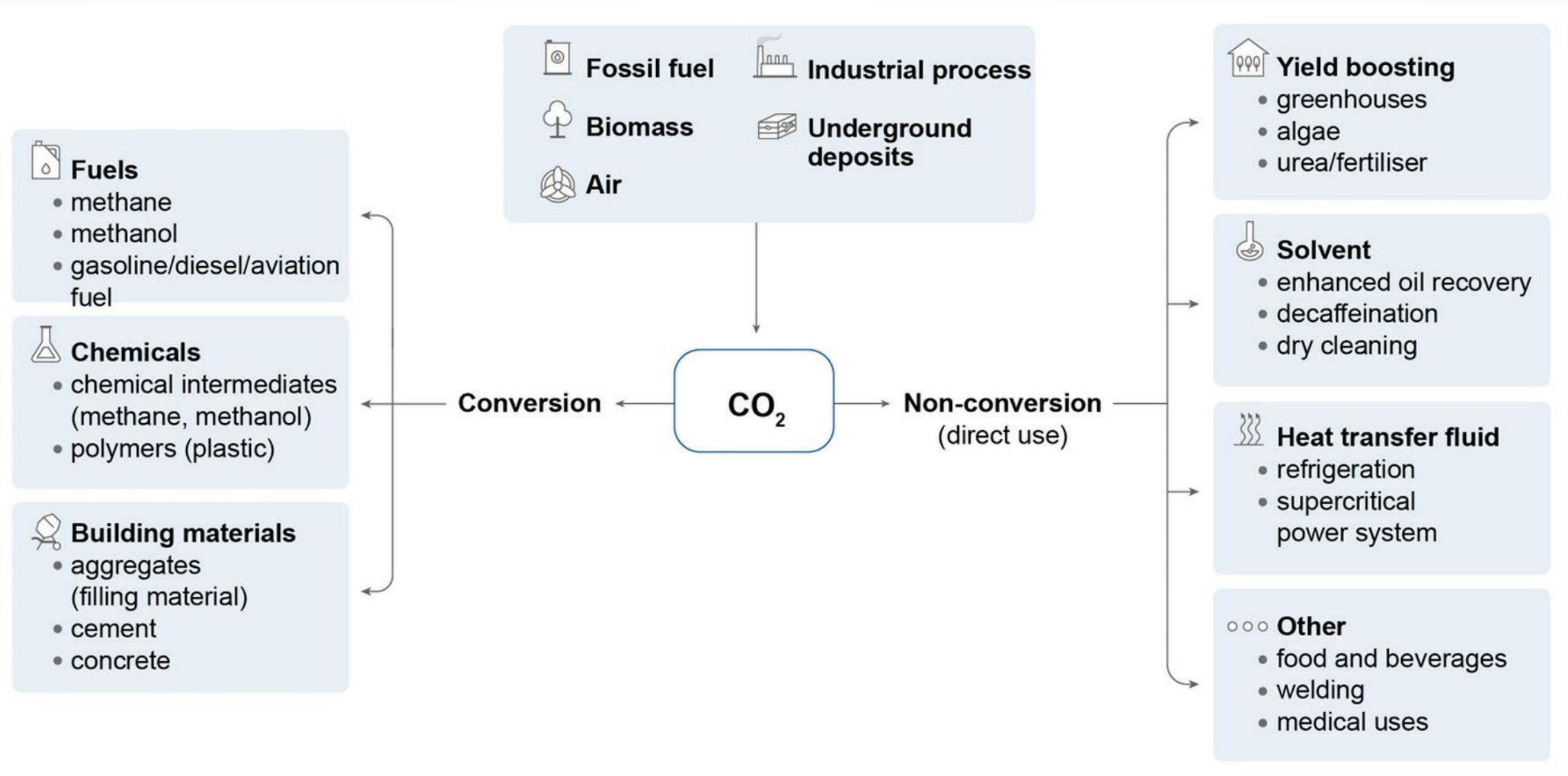
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THE BUTTERFLY DIAGRAM: VISUALISING THE CIRCULAR ECONOMY

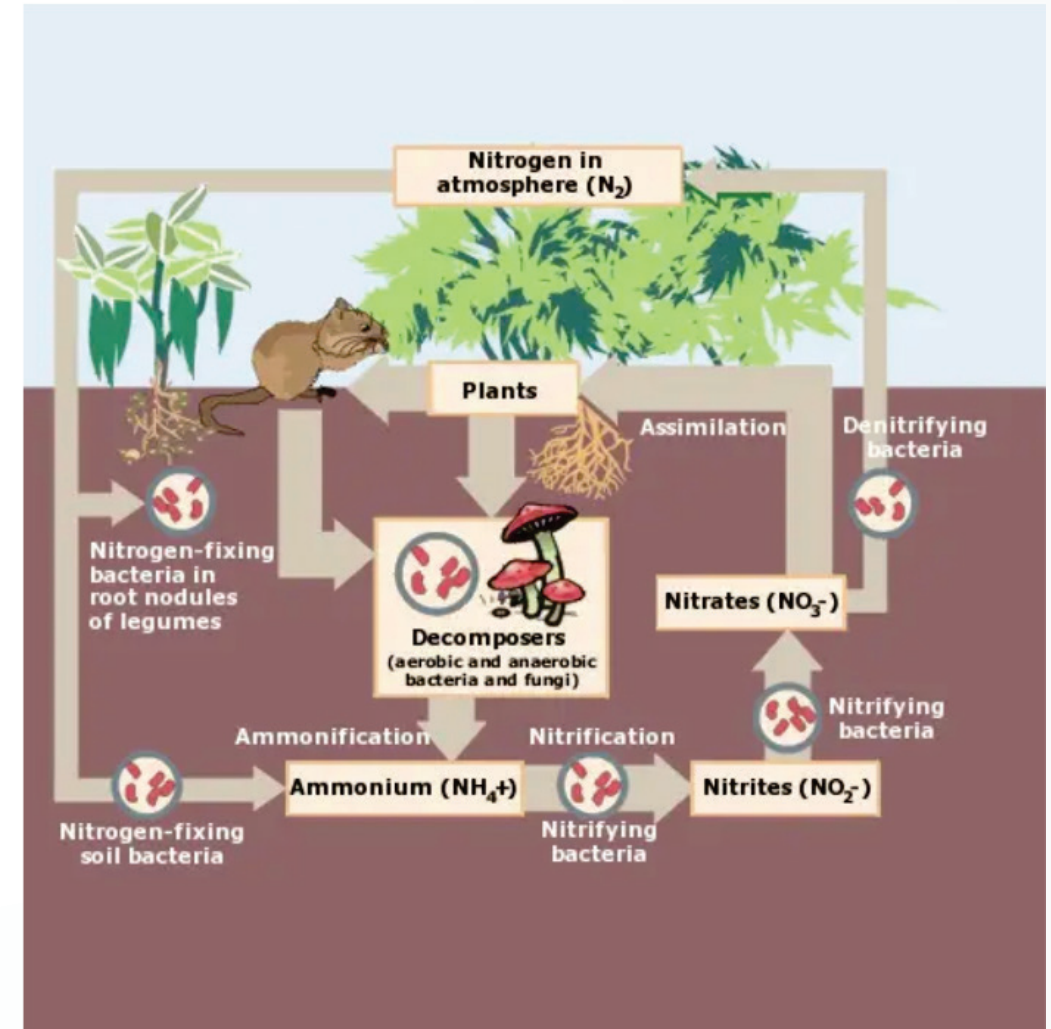
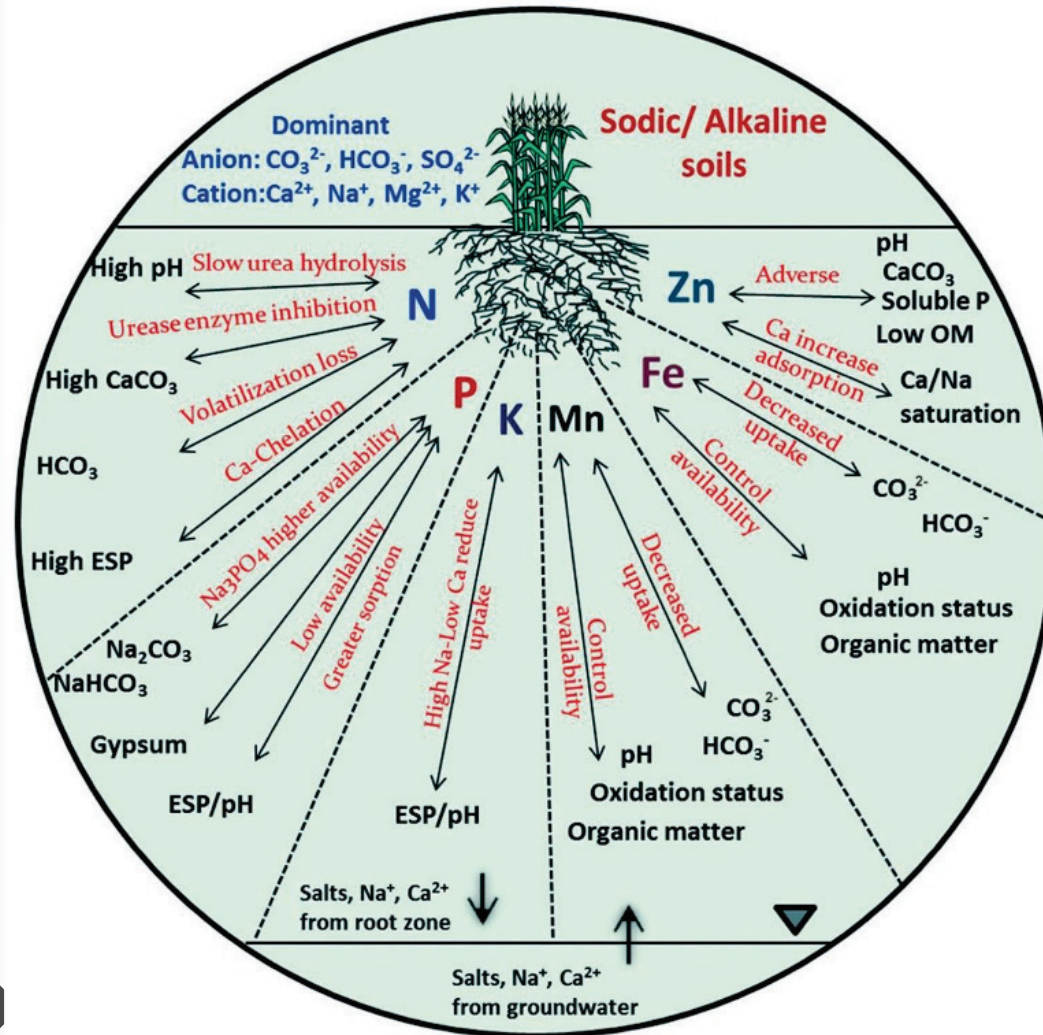
The circular economy system diagram, known as the butterfly diagram, illustrates the continuous flow of materials in a circular economy. There are two main cycles – the technical cycle and the biological cycle. In the technical cycle, products and materials are kept in circulation through processes such as reuse, repair, remanufacture and recycling. In the biological cycle, the nutrients from biodegradable materials are returned to the Earth to regenerate nature.



VISUALISING THE CIRCULAR ECONOMY: CO₂



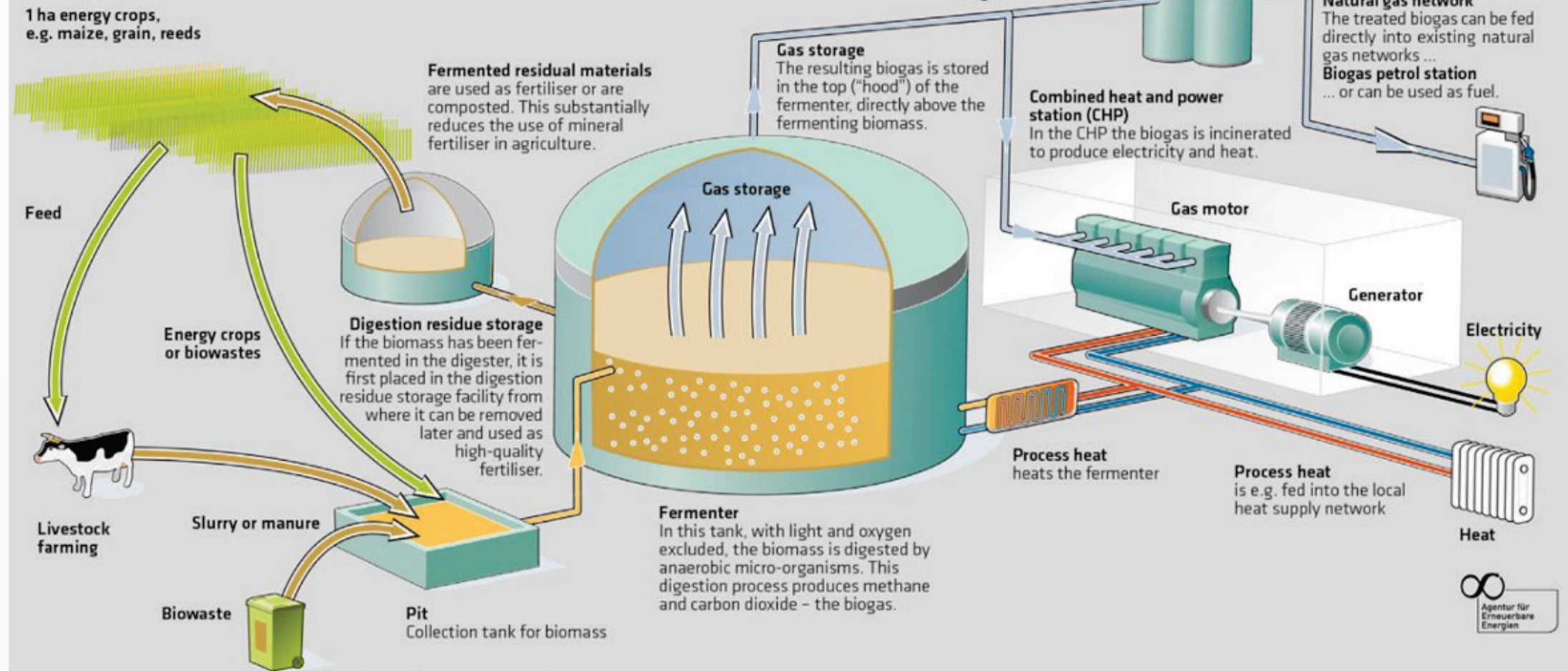
VISUALISING THE CIRCULAR ECONOMY: FERTILIZERS



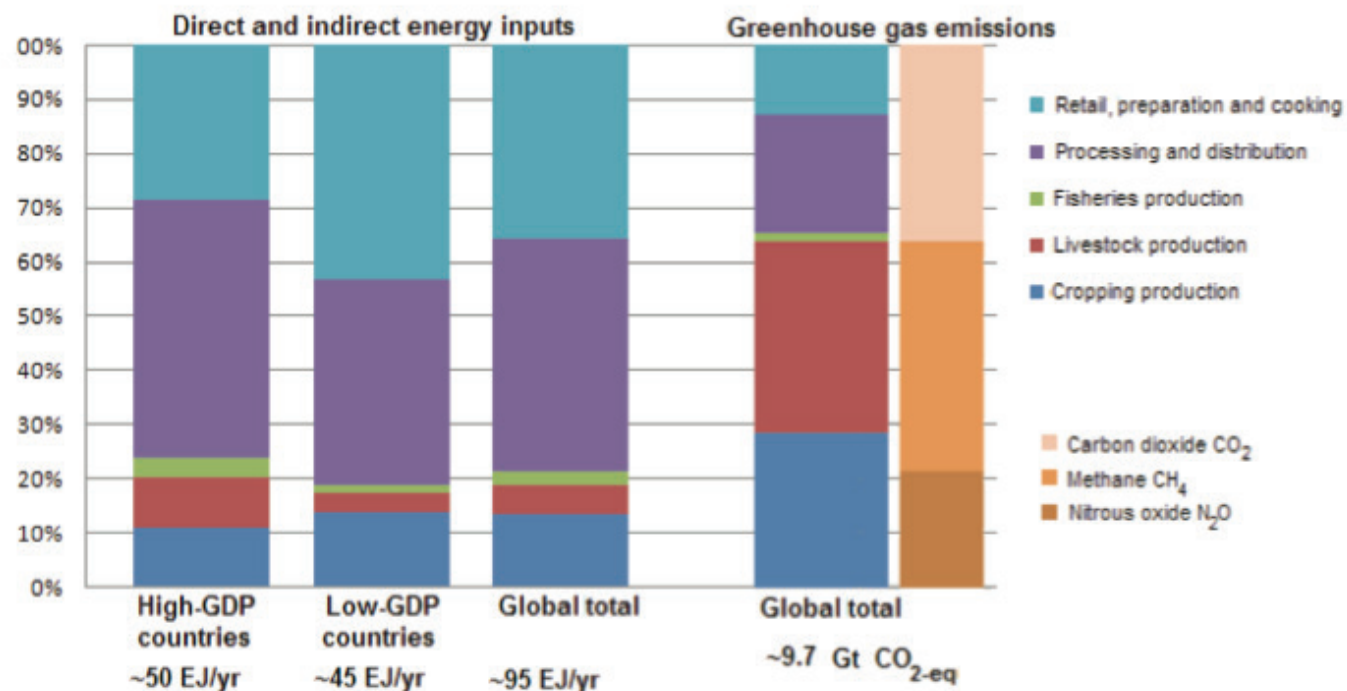
VISUALISING THE CIRCULAR ECONOMY: BIOGAS

Biogas system

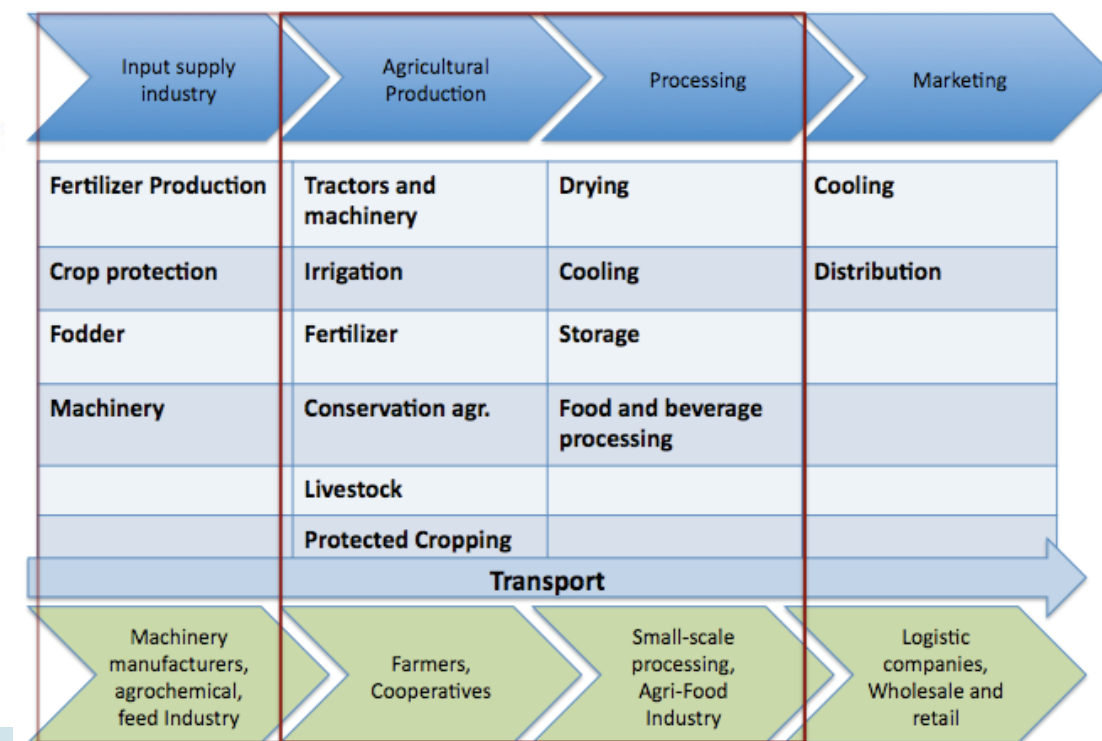
Slurry and solid biomass are suitable for biogas production. A cow weighing 500 kg corresponds to e.g. a gas yield of maximum 1.5 cubic metre per day. In energy terms, this equates to around one litre heating oil. Regrowable raw materials supply between 6,000 cubic metre (meadow grass) and 12,000 cubic metre (silo maize/fodder beet) biogas per hectare arable land annually.



Energy within Food and Agricultural Value Chains



Energy consumption for high- and low-GDP



Energy within Agricultural Value Chains

Source: FAO, 2011: "Energy-smart" food for people and climate – Issue Paper: <http://www.fao.org/docrep/014/i2454e/i2454e00.pdf>
https://energypedia.info/wiki/Energy_within_Food_and_Agricultural_Value_Chains

U.S. Food Loss and Waste

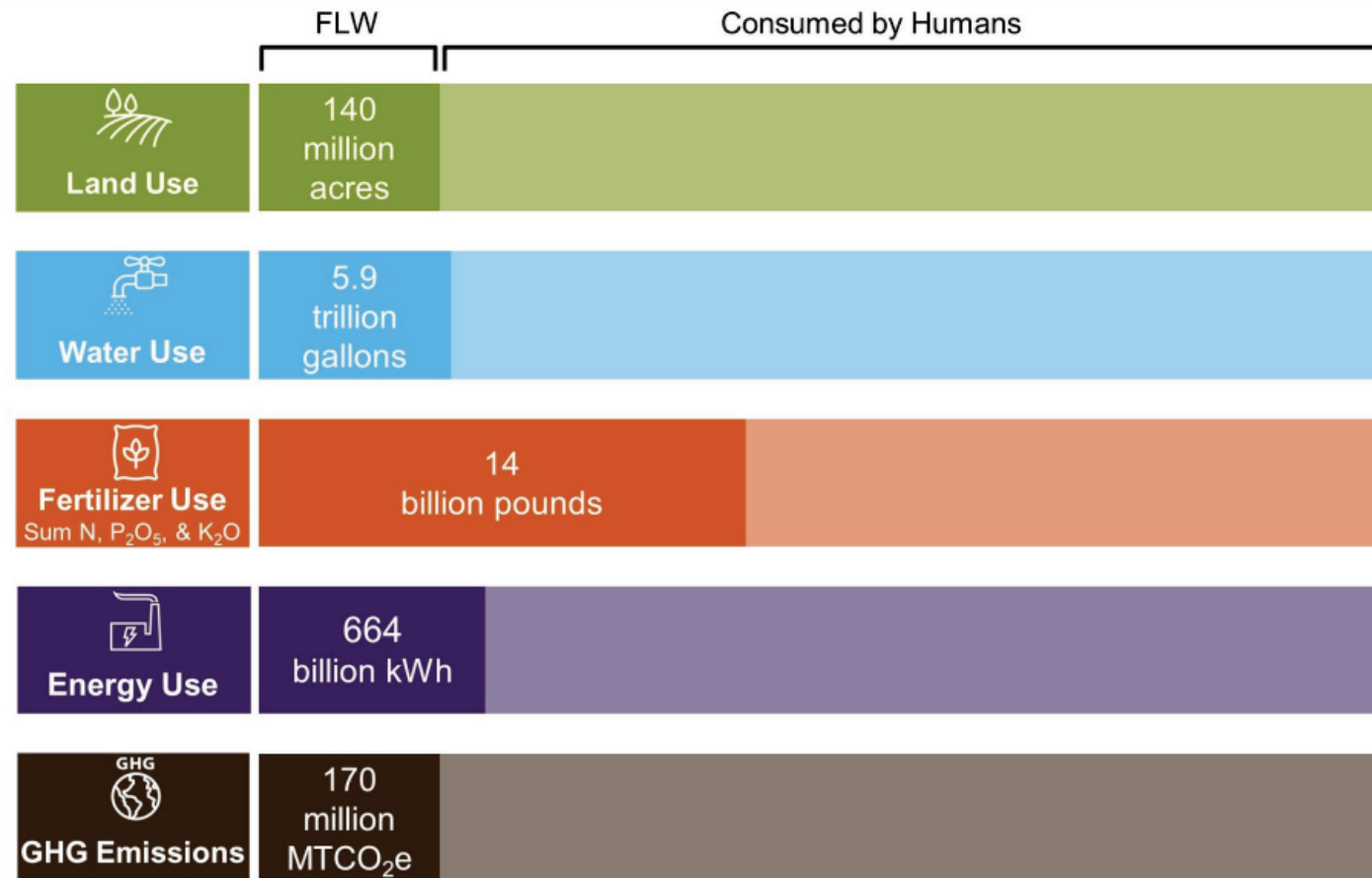


FIGURE 4-10. ANNUAL ENVIRONMENTAL FOOTPRINT OF U.S. FARM TO KITCHEN FOOD SUPPLY CHAIN

Data Source: Read et al. (2020) (land, water- blue water, and GHG) – noting that these are calculated values based from per capita data received in personal communication; Toth and Dou (2016) (fertilizer); Pagani et al. (2020) & Vittuari et al. (2020) (energy)

Source: EPA. From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste. 2022

U.S. Food Loss and Waste

Environmental Benefits of Reducing U.S. Food Loss and Waste

- Halving U.S. FLW could achieve the following annual savings:
 - Agricultural land: More than 300,000 km² (75 million acres)
 - Blue water: 12 trillion L (3.2 trillion gallons)
 - Fertilizer: Nearly 290,000 metric tons (640 million pounds) bioavailable nitrogen
 - Energy: 940 million GJ (262 billion kWh)
 - GHG emissions: 92 million MTCO₂e
- Halving FLW in households, restaurants, and the food processing sector will have the greatest environmental benefits. Halving the FLW in retail and institutional food service (schools) will have minimal environmental benefits.
- Reducing loss and waste of meats, cereals, and fresh fruits and vegetables will have the greatest environmental benefits, among food categories.

“Savings” from Halving U.S. Food Loss and Waste

(excluding impacts of waste management, such as landfill methane emissions)

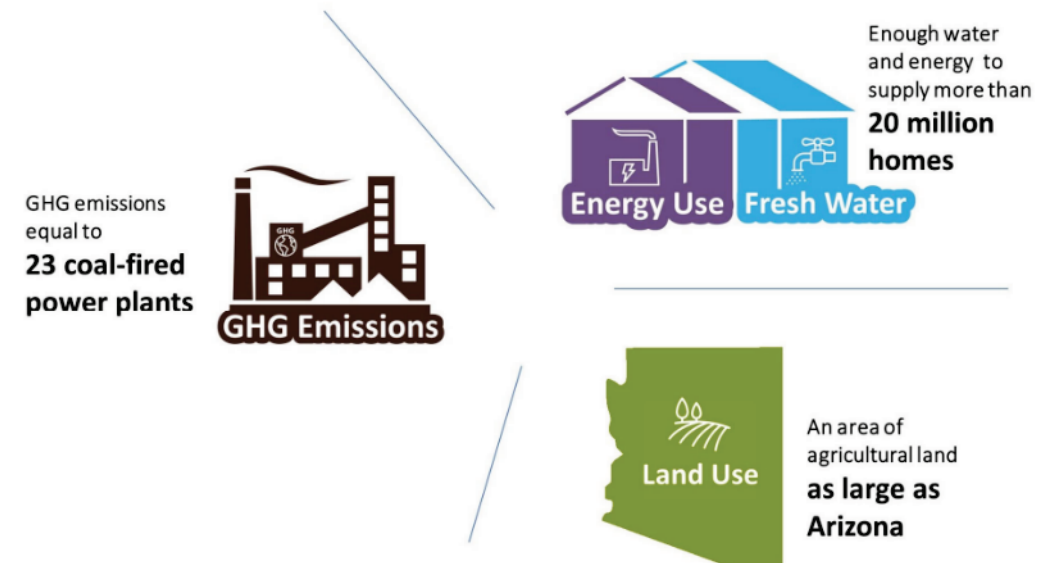
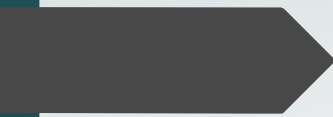


FIGURE 5-1. MAXIMUM ENVIRONMENTAL BENEFITS OF HALVING U.S. FLW

This figure depicts the projected annual savings from halving U.S. food loss and waste. The figure examines the cradle-to-consumer food supply chain only and thus excludes additional savings of methane emissions from landfills.

Data Source: Read et al. (2020); U.S. EPA (2021a, 2018); USCB (2021); U.S. DOE (2020)



ABOUT WILSON ENGINEERING TECHNOLOGIES

Wilson Engineering Technologies, Inc. was established in 2015 with the following major missions:

- ▶ to combine achievements of education, theoretical and applied researches in sustainable energy technologies area for practical solutions and industrial application;
- ▶ to promote multidisciplinary approach among industries and communities for energy emerging technologies deployment.

Wilson's projects portfolio consists of revolutionary concepts that are cross-cutting by nature and commercially competitive with the potential for game-changing energy and financial savings across many market segments.

Food industry represents the central point of Wilson's RDD&D projects focusing on edible oils refinery, crop/grain/beans/nuts thermo-vacuum drying, mobile and stationery food storage facilities, advanced greenhouses fertigation and fertilizers production from organic and non-organic wastes, transport refrigerating systems, freezing and sublimation, water treatment, gas liquefaction, etc.

Thermo-Vacuum Drying System

California Energy Commission: **2014-2019 PIER Natural Gas Funding (PIR-14-001)** “High Efficiency Indirect- Fired Dryer with Advanced Ejector Heat Pump for Bulk Foods Processing”

Operating Parameters:

Working Fluid: Water

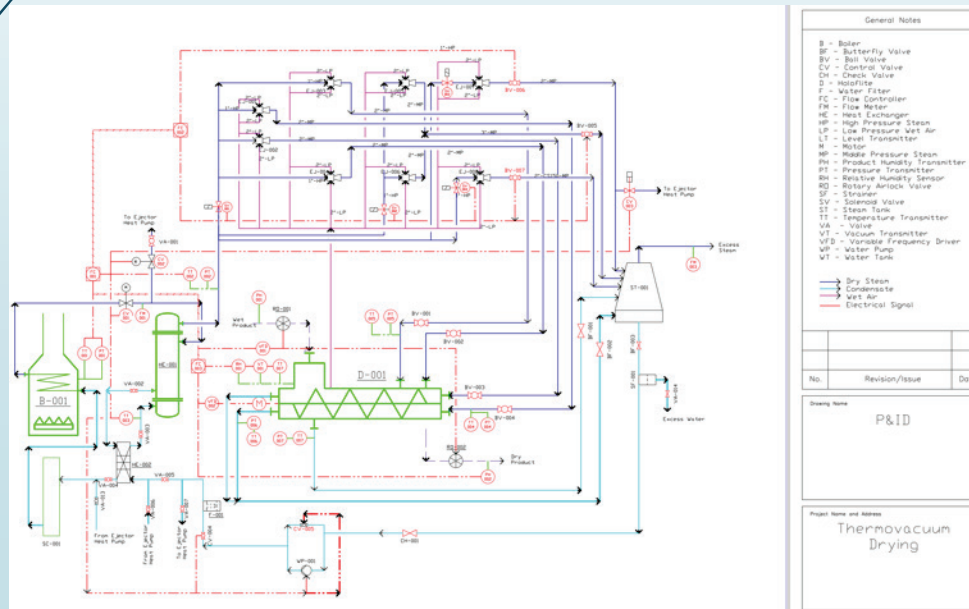
Generation Temperature: 338F (170°C)

Vacuum Level: 10.15 psi(70 kPa)

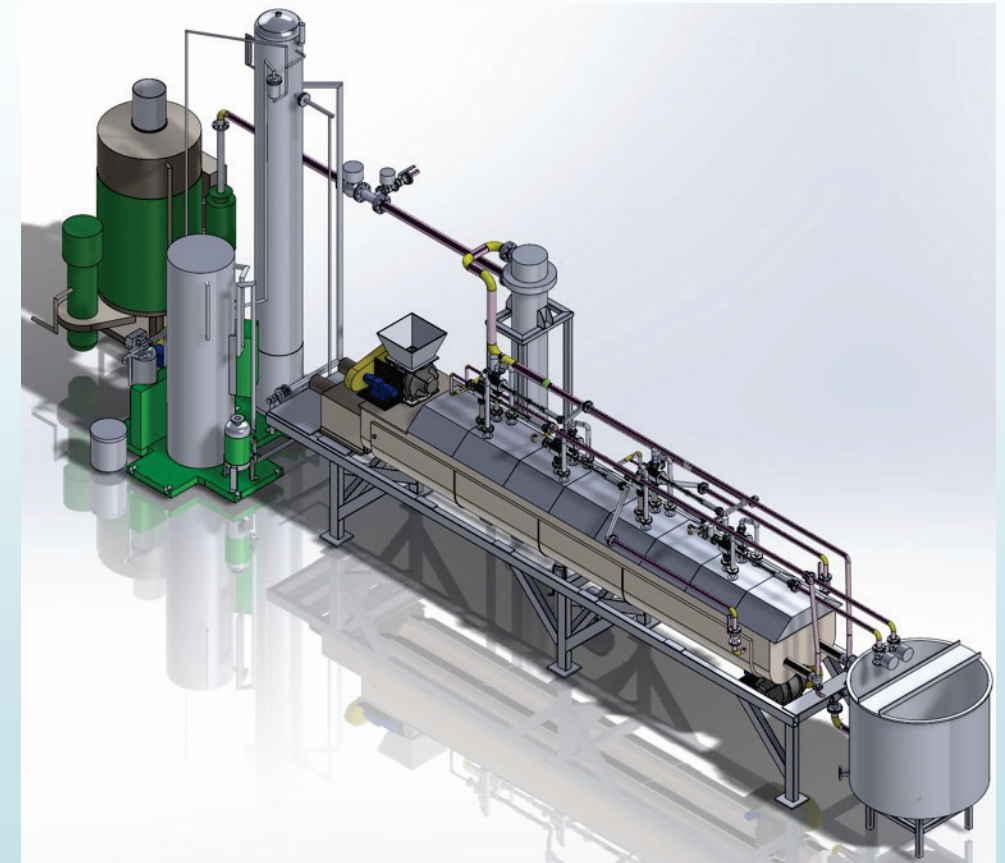
Initial moisture: 35%

Final moisture: 12%

Drying Capacity: 10 ton/hr



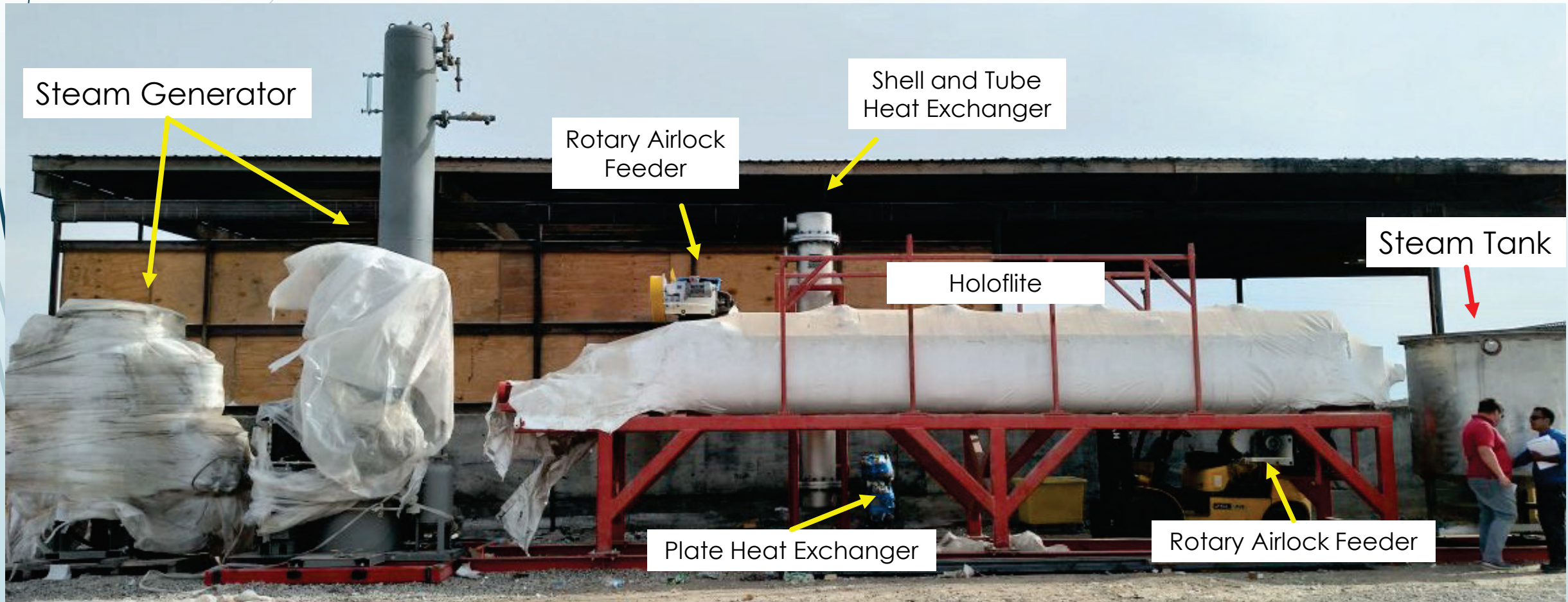
P&ID Diagram of the system



3D assembly model

Thermo-Vacuum Drying System

California Energy Commission: **2014-2019 PIER Natural Gas Funding (PIR-14-001)** "High Efficiency Indirect- Fired Dryer with Advanced Ejector Heat Pump for Bulk Foods Processing"



Thermo- Vacuum Drying System. Components



Thermo- Vacuum Drying System. Assembly



Thermo-Vacuum Drying System. Commissioning



Thermo-Vacuum Drying System. Deployment

NEW NATURAL GAS TECHNOLOGY THERMO-VACUUM DRYING SYSTEM SAVES ENERGY



Many agricultural, food, and chemical manufacturing operations that make products like livestock feed, textiles and pharmaceuticals include drying or heat processing as one of their key functions.

60%
less natural gas

40%
less electricity

A new technology being developed uses nearly 60 percent less natural gas and 40 percent less electricity than conventional industrial drying systems. This new system also recovers a substantial amount of water.

Known as Thermo-vacuum Drying (TVD), the new technology has been demonstrated at Martin Feed LLC, an industrial livestock feed processing site based in Corona, California. The site collects waste bakery material such as dough, crackers and pastries, then dries and processes it to sell to dairy farms for feed.

In contrast with existing systems that apply heat directly to the product to drive off moisture, TVD uses natural gas to produce steam that is forced through ejectors to generate a vacuum that accelerates the evaporation rate. The system

captures the excess heat from the steam process to preheat the incoming material being dried. The combination of vacuum and product heating intensifies the drying process and shortens the drying time by two-to-five times compared to ambient pressure-drying. The higher energy efficiency of the system also results in reduced carbon emissions, helping to address the issue of climate change, and other pollutant emissions, helping to improve local air quality.

Prior to implementing the TVD system, processing the bakery waste at Martin Feed was an extensive and time-consuming process of sun-drying that was affected by weather conditions such as wind and rain.

Working the new technology system, the waste bakery material is loaded into a feeding hopper and supplied into a drying chamber where controlled heat is applied to the continuously-moving product on a conveyor while a vacuum draws out the moisture, allowing the product to be dried to specified moisture requirements in a shorter time.

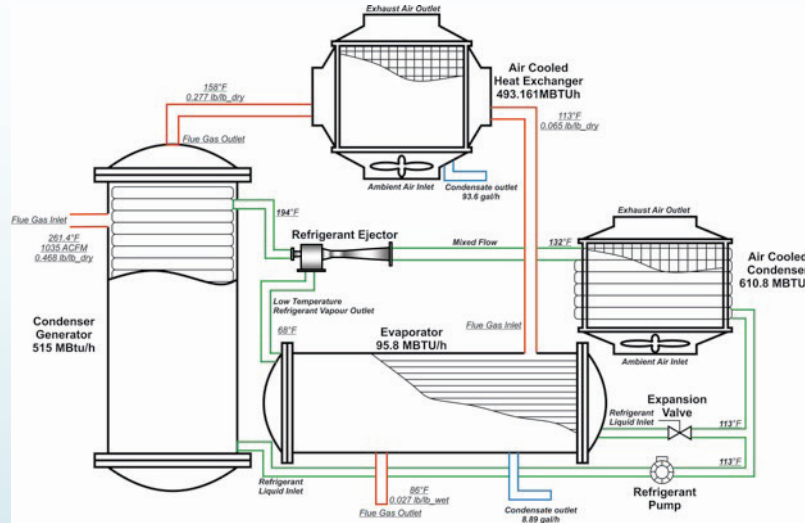
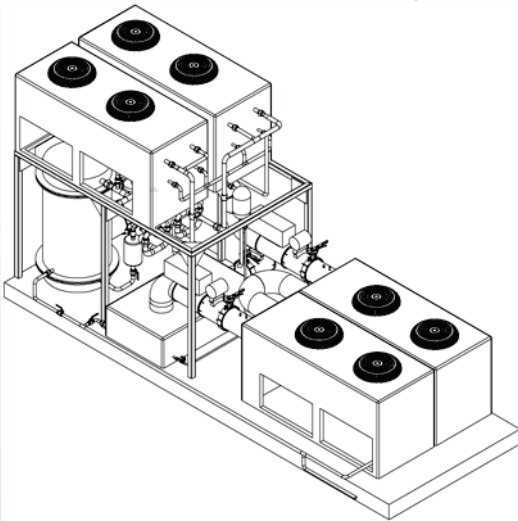
The product can be dried over a wide range of temperatures and production rates providing reliable operation, better product quality, and improved energy efficiency. Once the product is dried to the required specification, it exits the system and is collected and stored in a loading area.



The Demonstration Project was developed by Gas Technology Institute (GTI) and Wilson Engineering Technologies, Inc. Funding was provided by SoCalGas, the California Energy Commission (CEC) and the non-profit organization, Utilization Technology Development (UTD).

Water Regeneration From Flue Gas

California Energy Commission: **2016-2020 Industrial Natural Gas Energy Efficiency Grants (GFO-15-505)** "CLEAR (Clean Liquid Water by Ejector-Assisted Recovery)"



Waste Heat Utilizing System

Flue Gas Inlet Parameters:

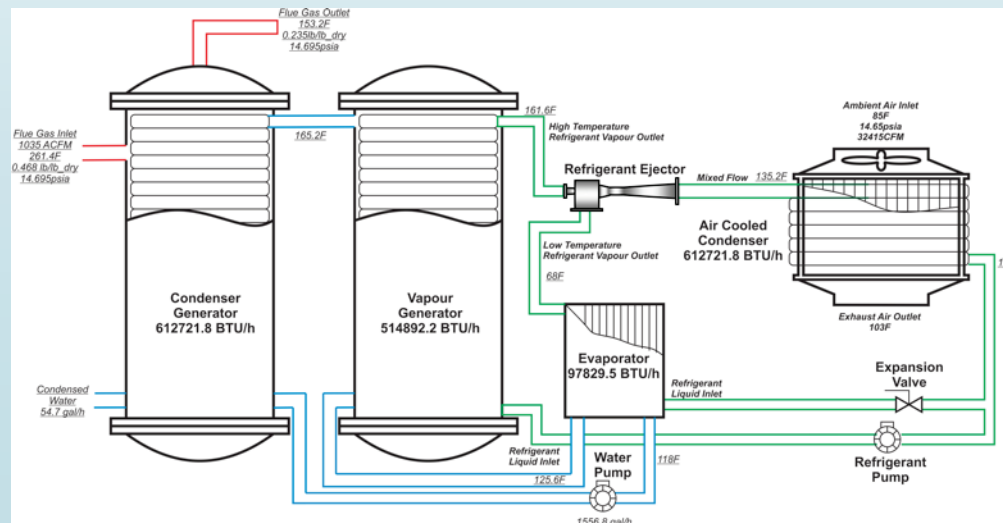
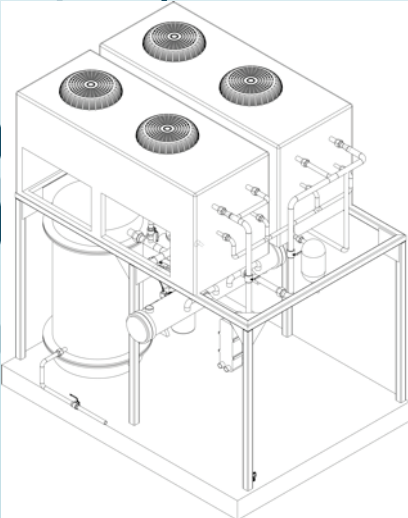
Flow Rate: 1035 ACFM

Water Content: 0.468 lb/lb_dry

Water Recovery

ERS + Heat Rejection to Ambient - up 94%
(102.49 gal/h)

ERS Generation Only – up to 70% (75 gal/h)



Electrical Power Consumption: 8HP

ERS Operating Parameters:

Generation: 149 – 162 F

Condensation: 86 – 113 F

Evaporation: 68 – 86 F

COP: 0.18 – 0.5

Water Regeneration From Flue Gas

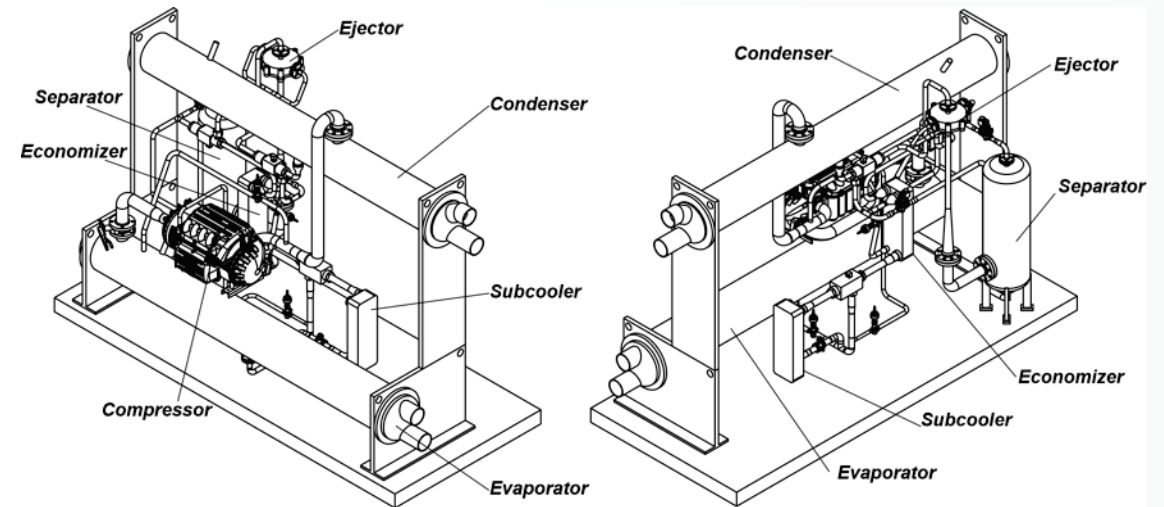
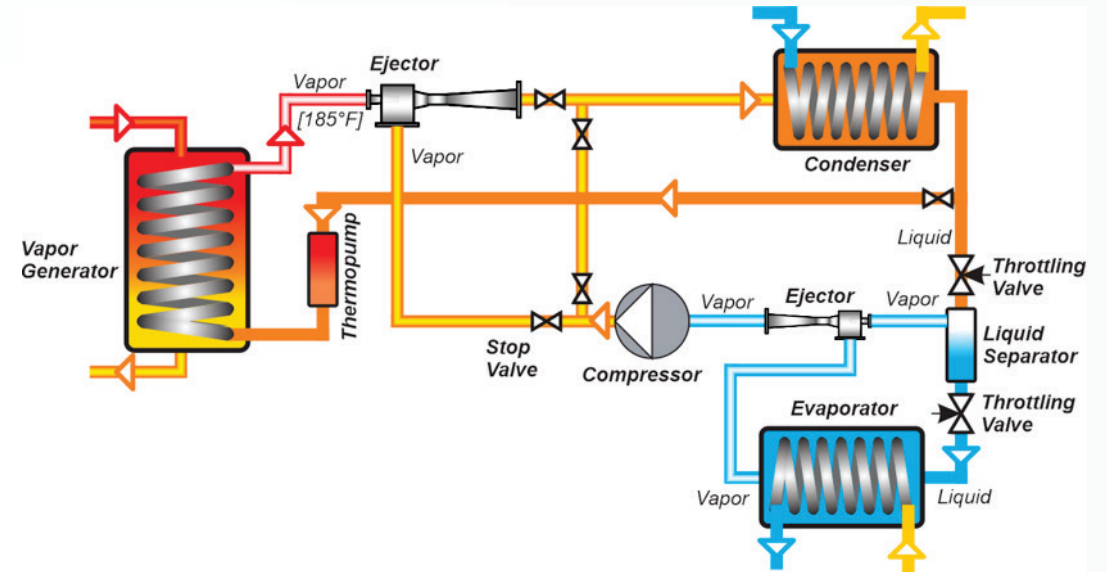
California Energy Commission: **2016-2020 Industrial Natural Gas Energy Efficiency Grants (GFO-15-505)** "CLEAR
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BOOSTER ENHANCED COOLING & HEATING

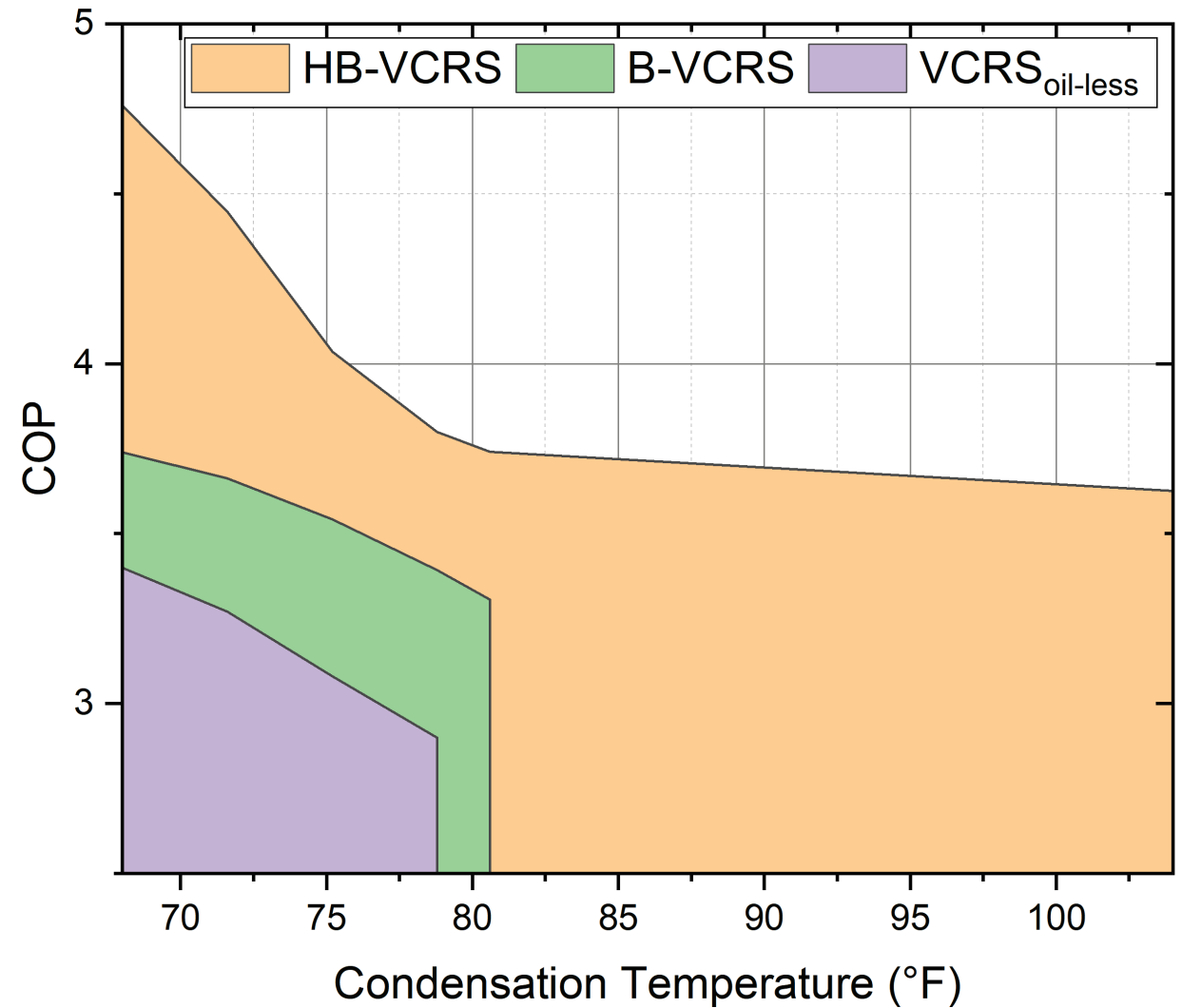
■ The advanced design of booster enhanced Vapor-Compression Refrigerating or Heat Pump System is equipped with additional ejector compression stages that allow to:

- Improve system's reliability and durability
- Increases range or condensation temperatures
- Up to 40% reduction of power consumption
- Utilizes low-grade heat (exhaust or renewable)
- Up to 5 % increases specific cooling capacity
- Up to 10% increases compressor suction pressure*
- Up to 20% increases an overall efficiency
- Up to 50% of CO₂ emission reduction



BOOSTER ENHANCED COOLING & HEATING

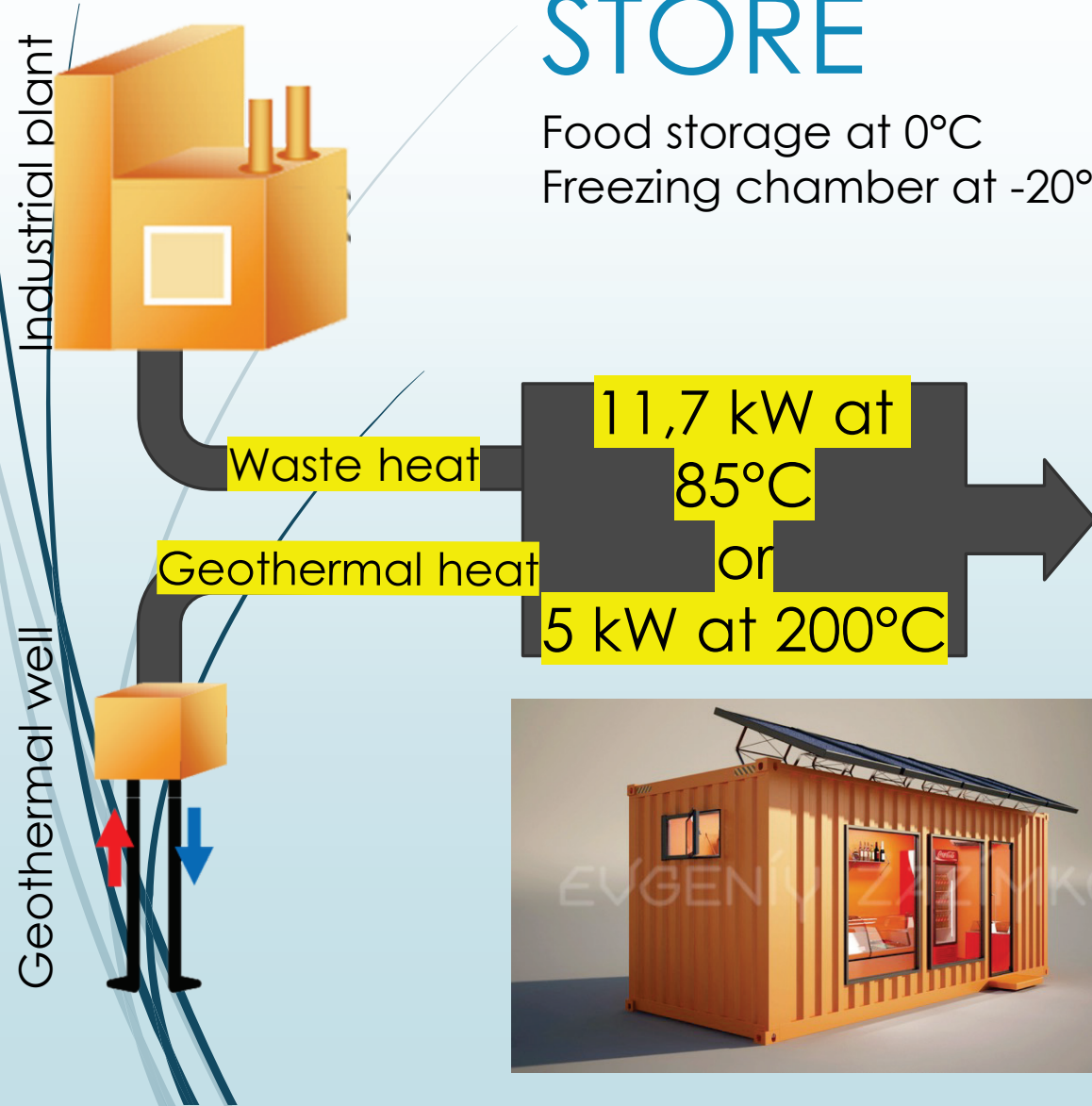
▶ The figure represents the COP comparison between VCRS, B-VCRS and HB-VCRS. Assuming the maximum pressure ratio of compressor equals to 6*, the highest condensation temperature is 26°C (79°F).



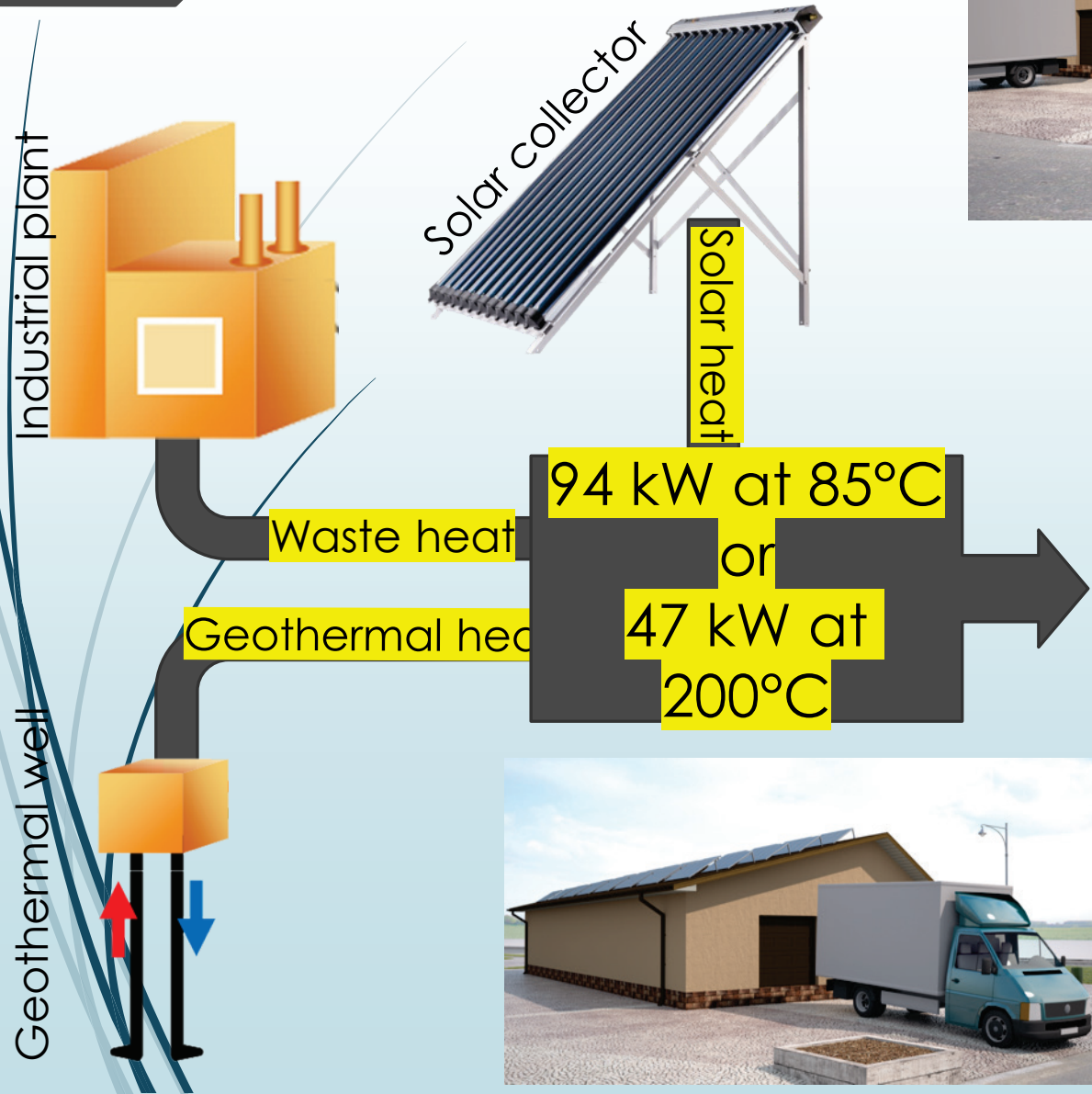
* According to Danfoss, the higher pressure lift for TTH is up to 6.2
<https://www.danfoss.com/en/products/compressors/dcs/turbocor/turbocor-tth-tgh>

GROCERY STORE

Food storage at 0°C
Freezing chamber at -20°C



FOOD STORAGE





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