



**EVER-GREEN
ENERGY™**

The *Rapidly* Evolving Energy System

NADO Annual Training Conference – October 23, 2024

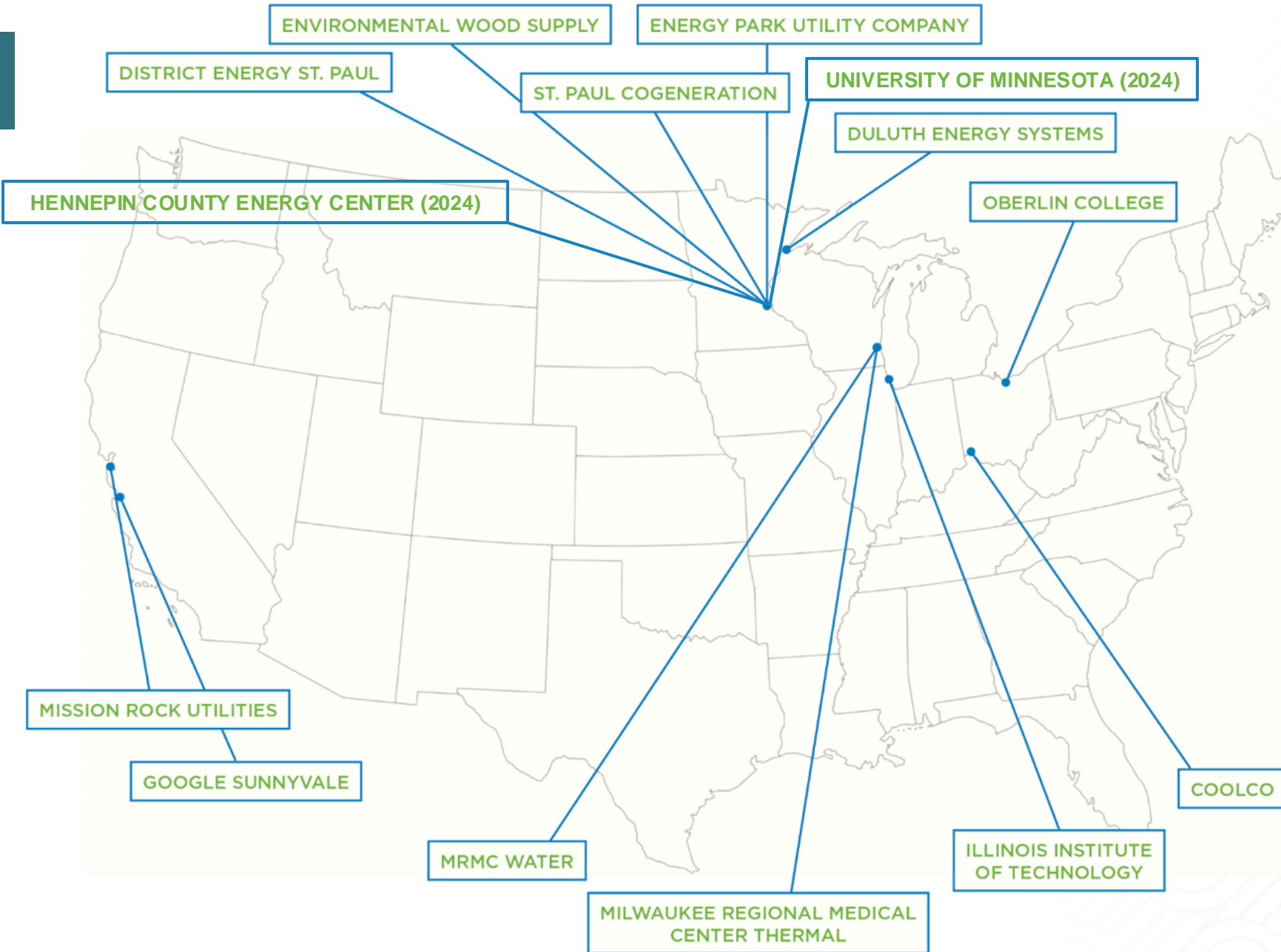
Ken Smith, P.E., MBA





Over 40 years of operations & management experience
Based in Saint Paul with projects across North America



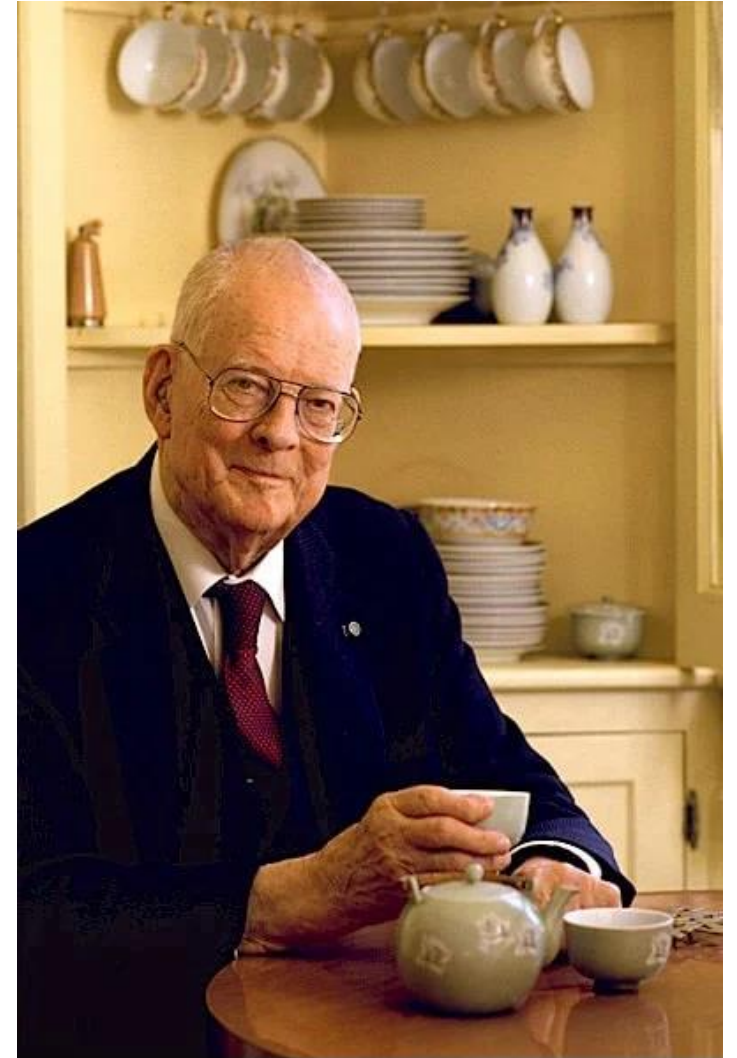


We leverage decades of **operations, planning, and engineering** experience to develop and advance smart and sustainable **community and campus energy systems.**



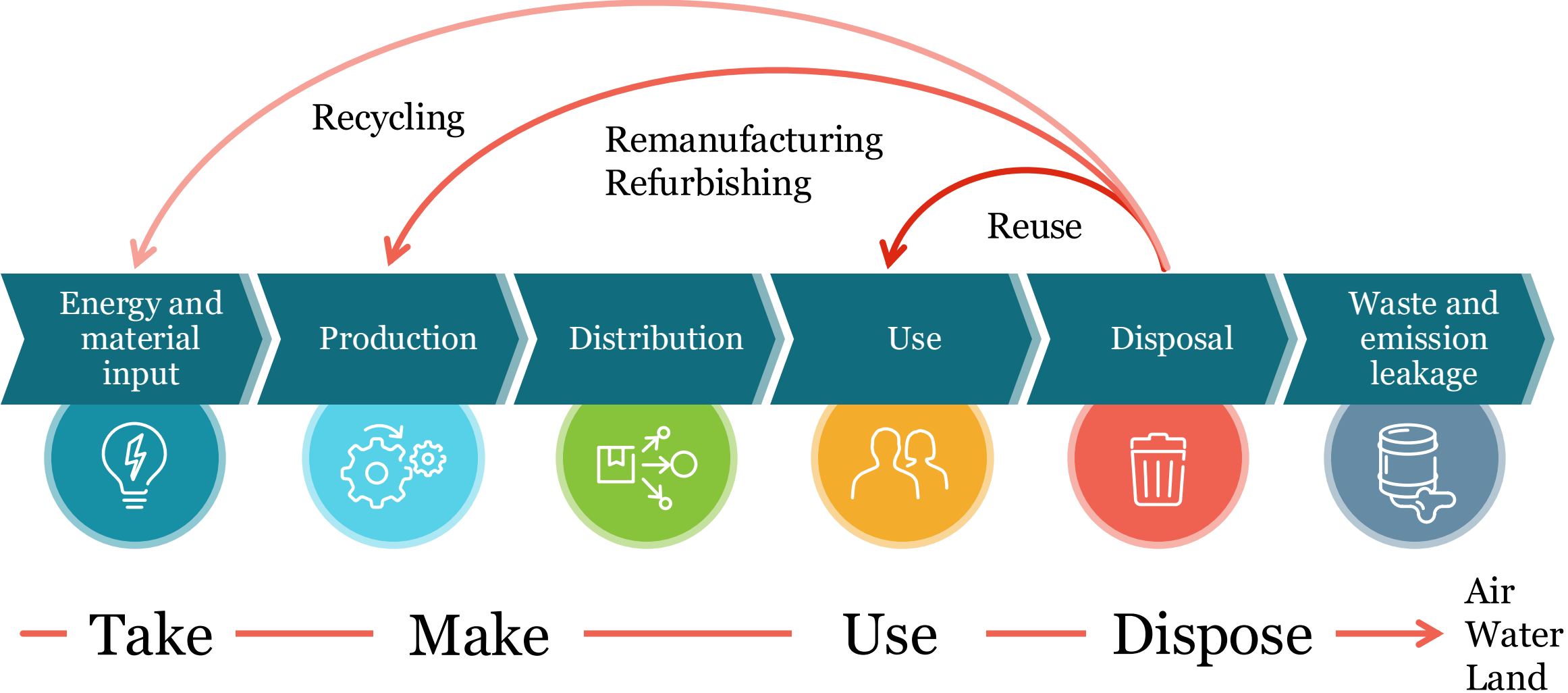
“Every system is perfectly designed to get the result that it does.”

“Without data, you're just another person with an opinion”



W. Edwards Deming

Much of the U.S. Economy is principally linear



Environment

State officials add dozens of lakes and streams to impaired waters list for sulfate and PFAS pollution

Dan Kraker Duluth November 15, 2023 3:39 PM

SOUTH METRO

Minnesota's largest landfill is set to get bigger even as the state tries to cut waste

Pine Bend landfill in Inver Grove Heights has been targeted for expansion; public comment on a permit is open through Dec. 15.

By Erin Adler (<https://www.startribune.com/erin-adler/6370491/>) Star Tribune |

DECEMBER 2, 2023 — 7:00AM

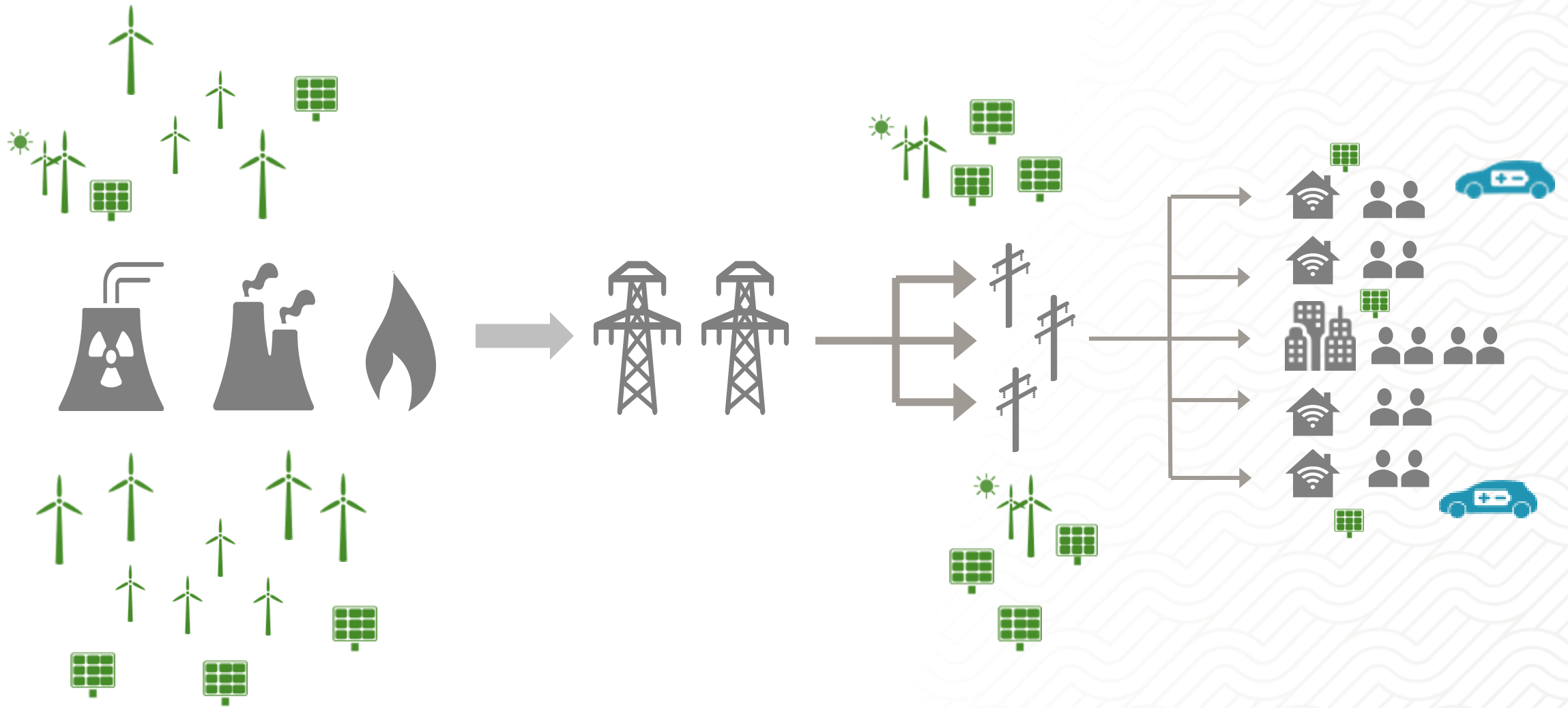
Environment

The Twin Cities area has a trash problem, state pollution control agency says

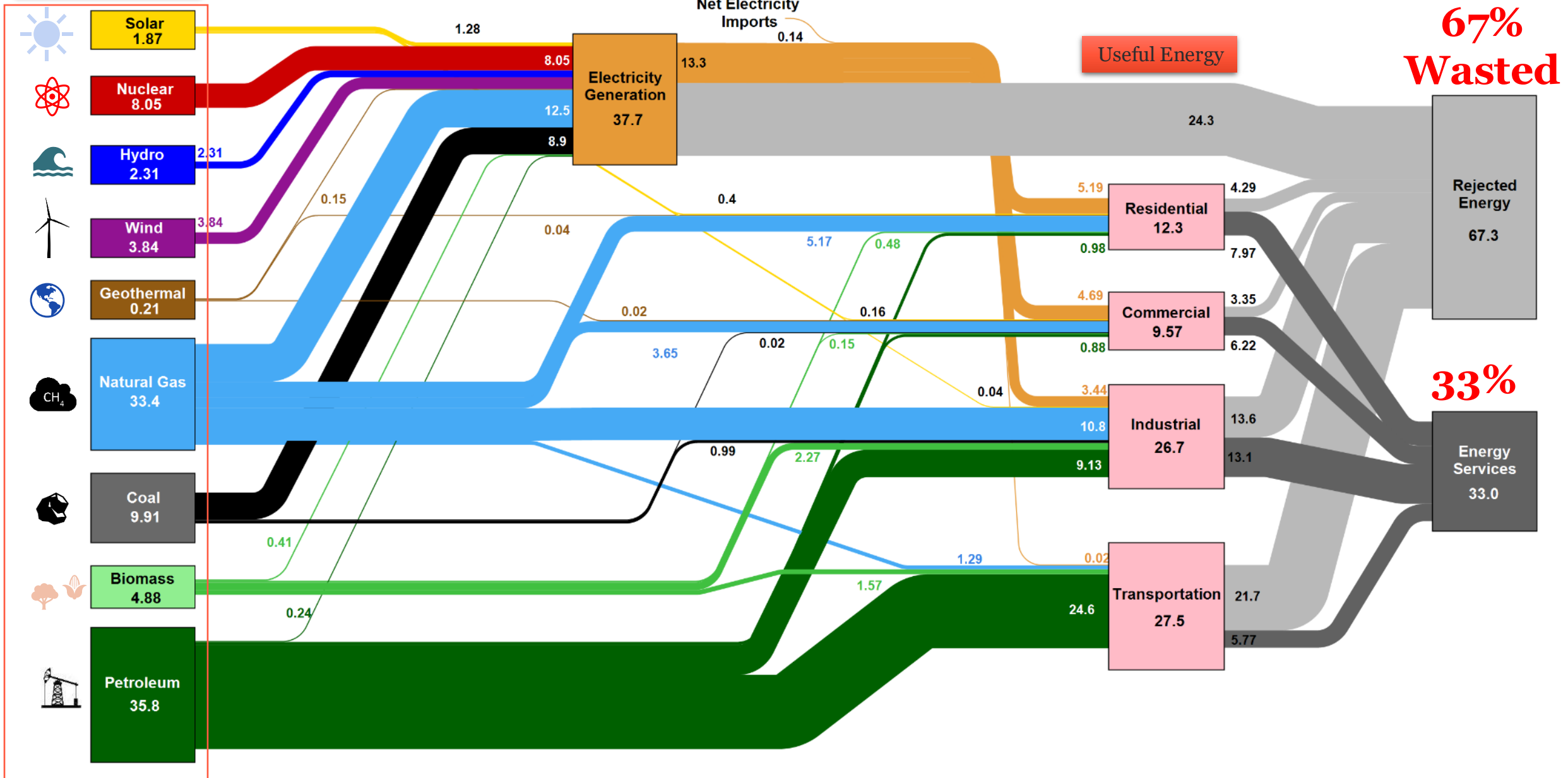
Mark Zdechlik June 7, 2023 2:45 PM



A garbage truck dumps a load of trash at an unidentified landfill in Minnesota. The metro area is falling short of its 75 percent recycling goal as more landfills run out of space. Minnesota Pollution Control Agency



Estimated U.S. Energy Consumption in 2022: 100.3 Quads



Source: LLNL July, 2023. Data is based on DOE/EIA SEDS (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.49% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MT-410527

What is being Electrified?

Transportation

- Public Charging Stations
 - Electric Vehicles
 - Fleet Electrification



Commercial and Industrial

- Heat recovery chillers
- Replace pneumatic equipment with electric
- Install induction furnaces for non-ferrous metal melting



Residential

- In-Home Charging Stations
 - Air-source Heat Pumps
- Lawn maintenance equipment (mower, trimmer, hedger, blower, etc.)



Heavy Duty Off-Road

- Replace propane/gas forklifts with electric
- Eliminate Truck Stop idling
- Convert rail yard cargo handling equipment to electric



Aviation

- Pushbacks
- Belt Loaders
- Baggage Tugs



Agriculture

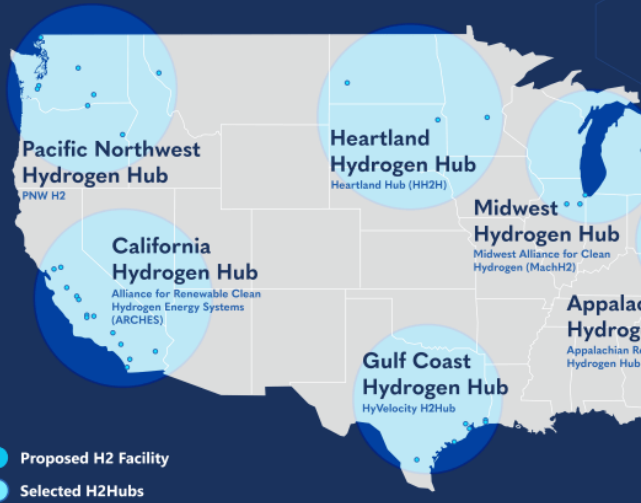
- Retrofit Diesel Irrigation Pumps to Electric
- Indoor agriculture (controlled lighting, and space-conditioning)
- Infrared drying and peeling of vegetables



Source: Resource Innovators



SELECTED REGIONAL CLEAN HYDROGEN HUBS



ANALYTICS

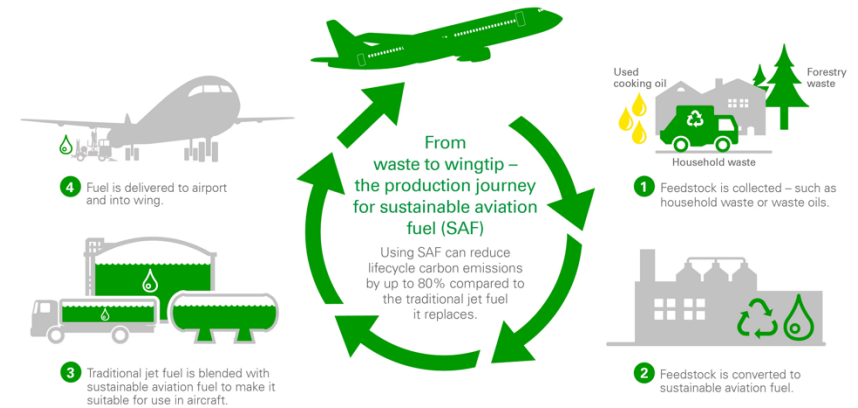
Texas Politicians Weigh Energy Regulation to Accommodate Data Centers

Data centers like the proposed one that sparked controversy in Fort Worth last week are putting a strain on power grids and water resources, and state lawmakers are considering restrictions on such facilities.

September 23, 2024 • James Osborne, Houston Chronicle



How is sustainable aviation fuel made?



airbp

Fuelling a sustainable future

The surging demand for data is guzzling Virginia's water

The commonwealth is home to the data center capital of the world.
Can it handle AI's thirst?



A new Denver data center could use as much water as 16,000 people every day. Should the city give it a tax break?



POWER GRAB

A bottle of water per email: the hidden environmental costs of using AI chatbots

AI bots generate a lot of heat, and keeping their computer servers running exacts a toll.



Green 20

Green & circular energy park + Technology enabler + National research facility

Christopher Sorensen, CEO – GreenLab A/S, Skive, Denmark
CDSO@GreenLab.dk

PROPERTY OF
GreenLab

<https://www.youtube.com/watch?v=RYrfOZxQ2Q0>

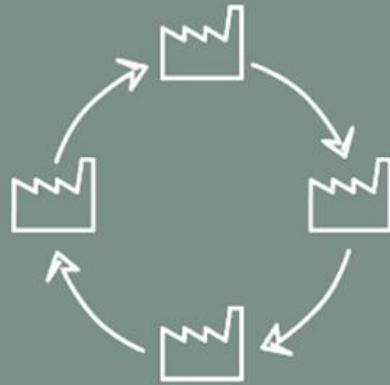


Green and circular industrial clusters

a model for sustainable growth



**Optimisation of energy through
co-location**



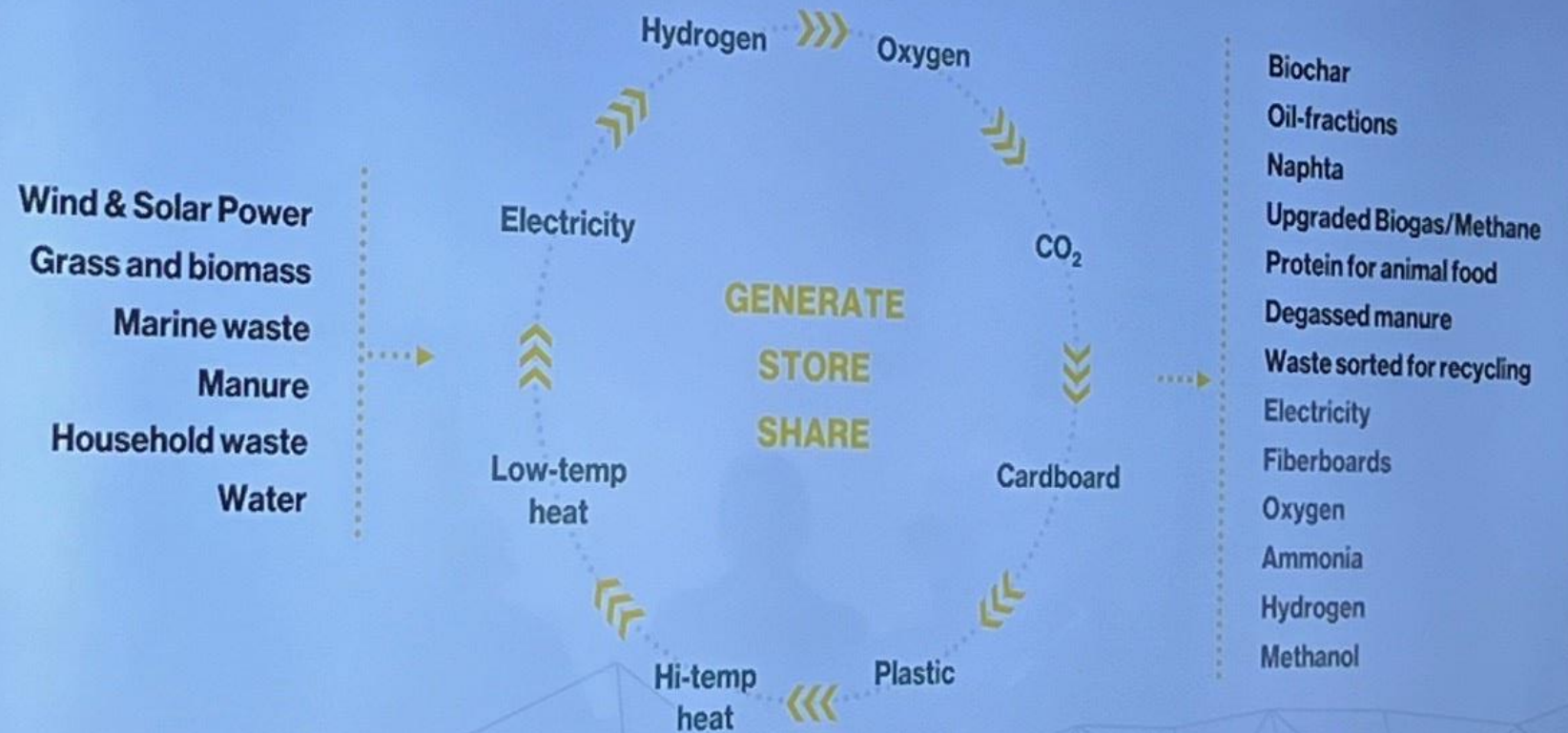
**Circular economy and
sector integration**



**A replicable model designed to
scale-up and globalise**

Clustering Activities and Integrating Infrastructure to Enable Circularity

GreenLab



The Progression of the Energy System ~~Transition~~ Transformation

Renewables

Electrification



Power to X

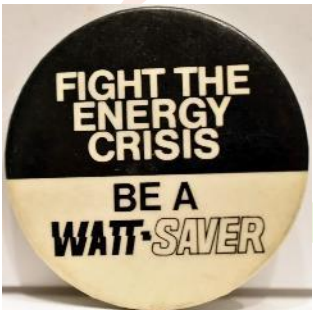
Integration

Sector Coupling



Conservation & Efficiency

Efficiency of Things



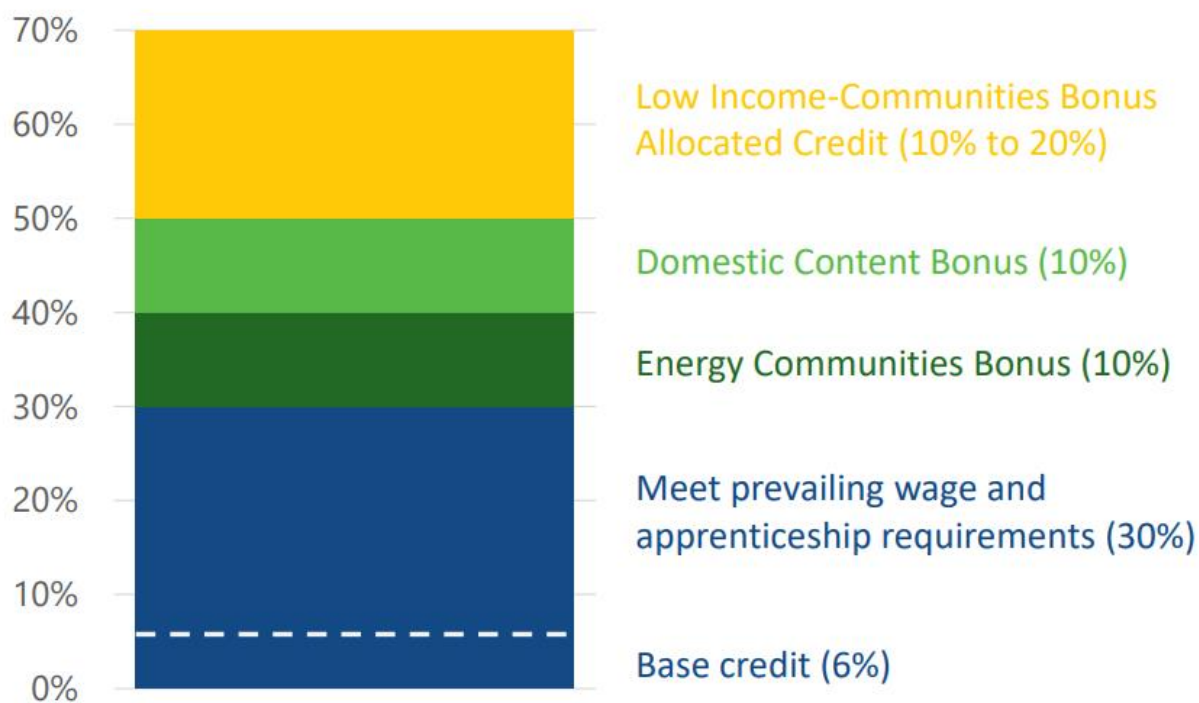
Ken Smith ©



Tax Credit Adders & Stacking

Clean Energy Layer Cake

Total Investment Tax Credit



A hypothetical 1 MW community solar facility costing \$1 million could earn a **70% tax credit** worth \$700,000

If it is owned by a tax-exempt entity, this could be a **direct cash payment** from the IRS

Applies to clean electricity investment and production tax credits, available till at least 2032

Slide Credit:
Paul Donohoo-Vallet, US DOE

Integrated Systems & Applied Circularity

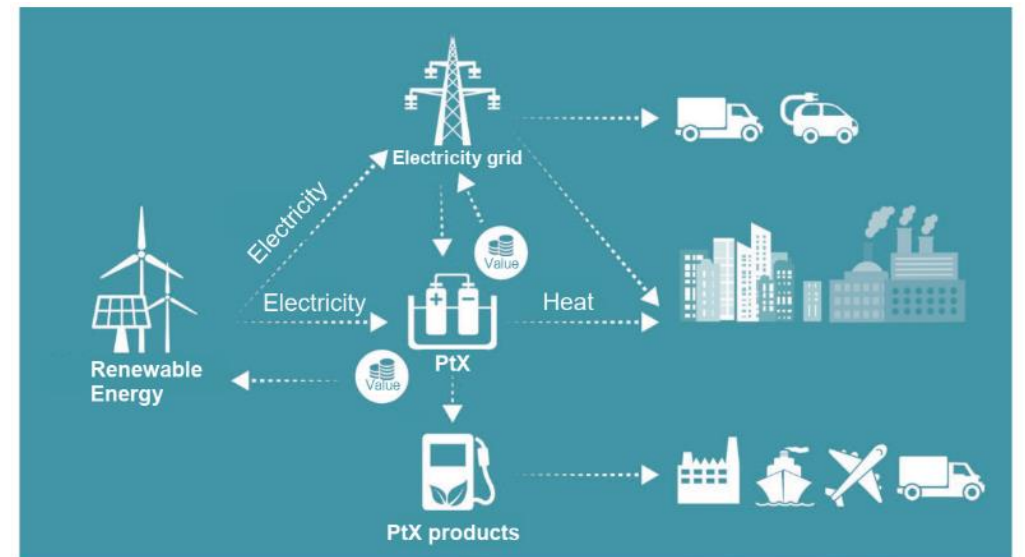
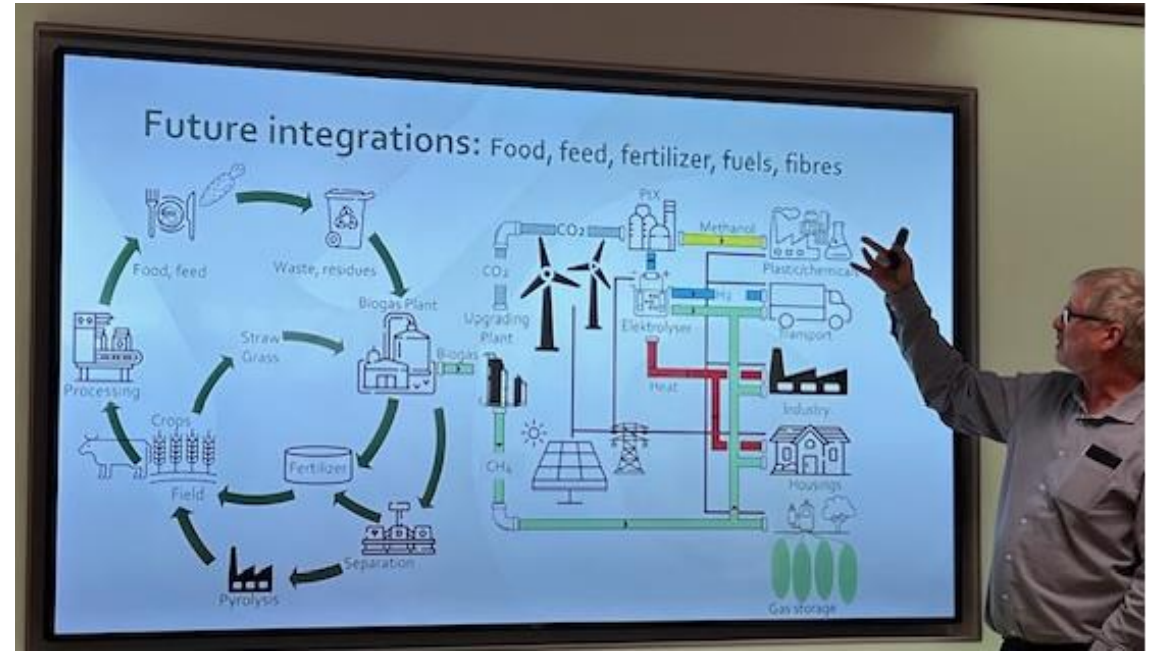
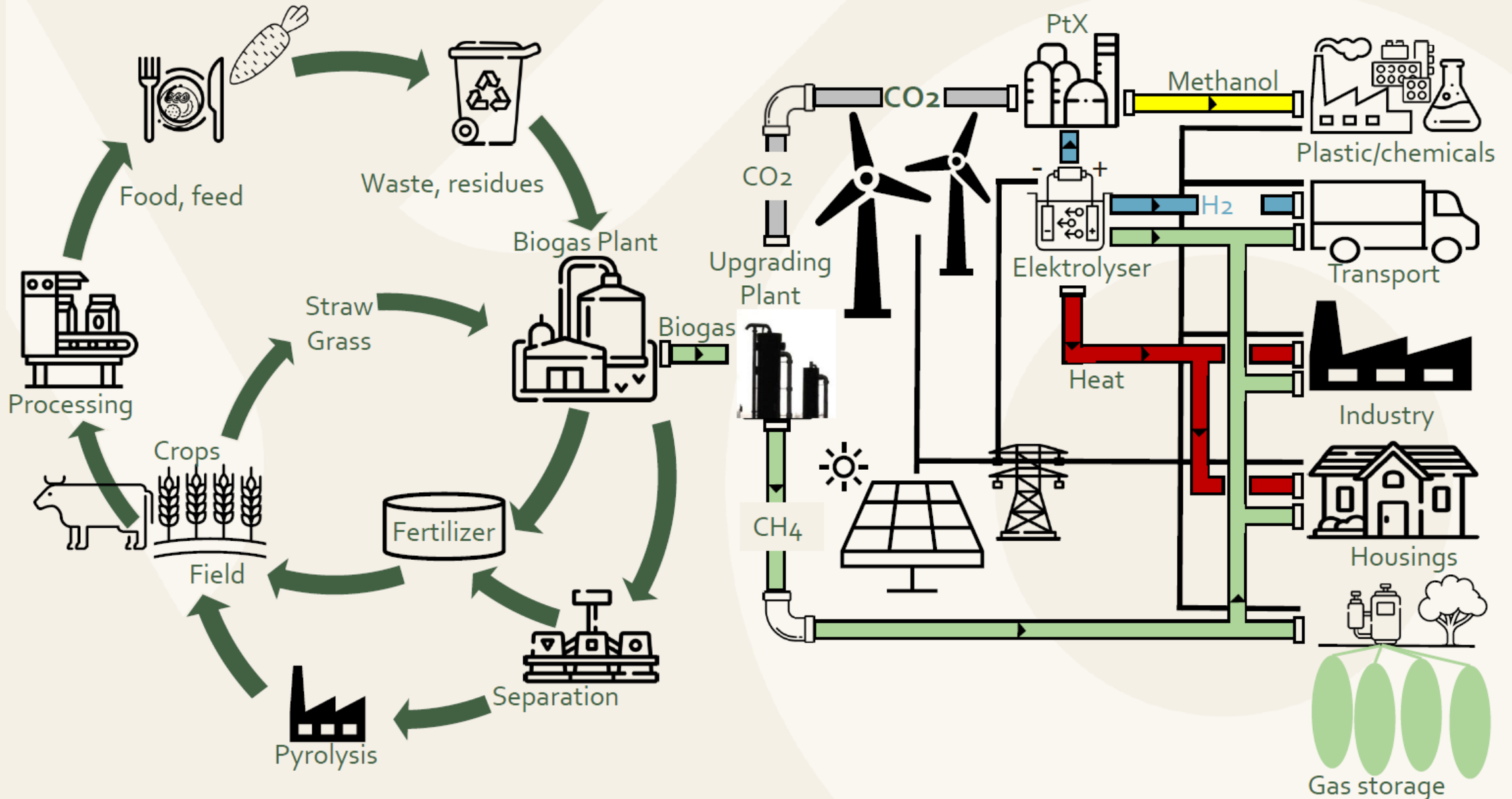


Figure 12. PtX can create value for electricity supply and the electricity grid, provide heat for district heating and produce green fuels for transport and industry.
Source: The Danish Energy Agency

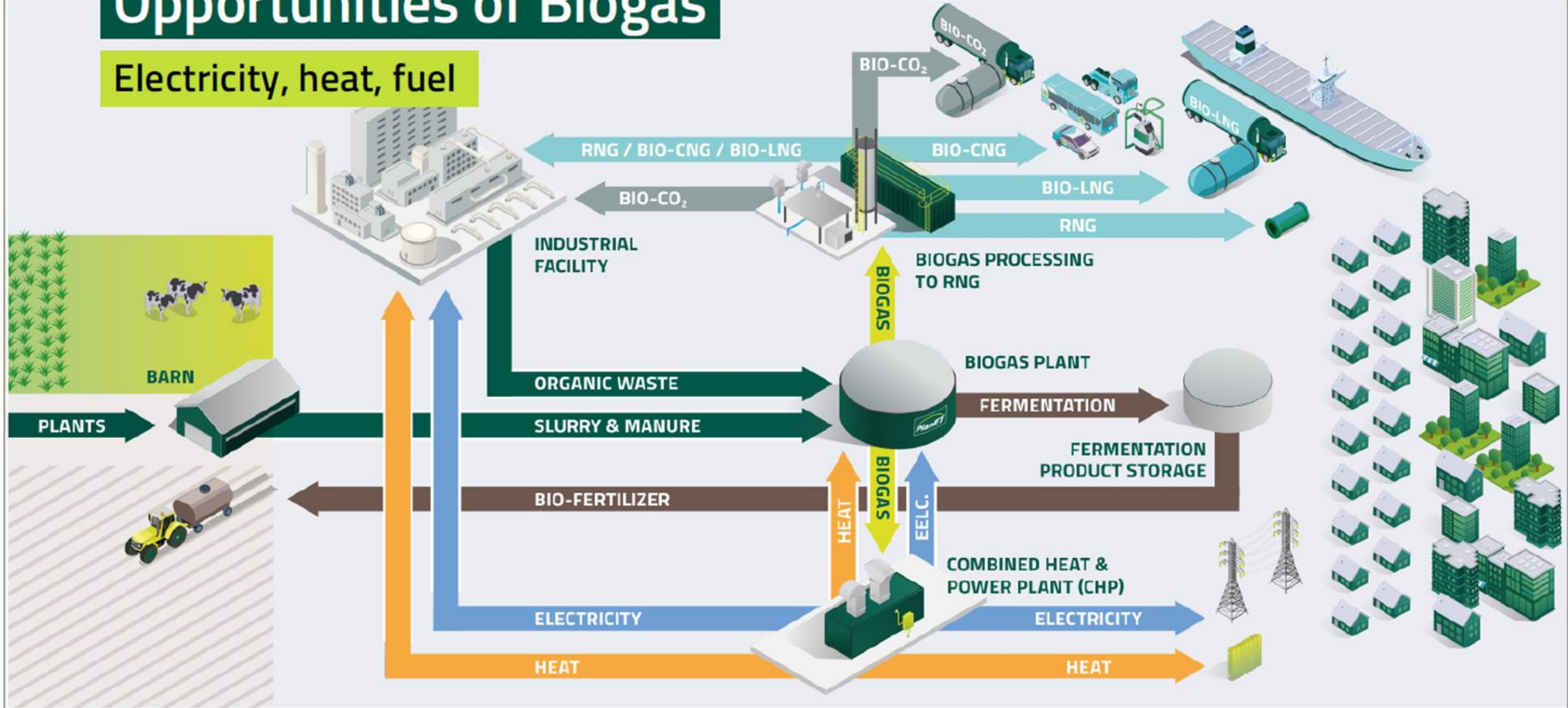
Future integrations: Food, feed, fertilizer, fuels, fibres





Opportunities of Biogas

Electricity, heat, fuel





The data center that warms homes with waste heat

By **Sarah Golden**

March 31, 2022



Microsoft's new data centers in Finland are designed to operate with 100 percent emission-free energy and will supply heat for the cities of Espoo and Kauniainen, and the municipality of Kirkkonummi, in a unique collaboration with Fortum. Image courtesy of Microsoft

Fortum and Microsoft announce world's largest collaboration to heat homes, services and businesses with sustainable waste heat from new data centre region

17 March 2022, 10:08 EET

Microsoft has also not detailed the size of the data center, but we are told its emissions (waste heat) will provide a reduction in CO2 emissions of 400,000 tonnes per year, enough to provide 40 percent of the heat demand of about 250,000 customers on the district heat system.

... about 60 percent of the area's heating will be generated by climate-friendly waste heat, 40 percent of which will come from the new data center area and the rest from sources including treated wastewater.

<https://www.datacenterdynamics.com/en/news/microsoft-announces-new-finland-cloud-region-with-district-heating-by-fortum/>

Opportunities to Apply Integrative/Circular Thinking & Solutions

- New multi-building developments and redevelopments
- Energy intensive industry (e.g. data centers, bitcoin mining)
- Wastewater treatment plants
- New innovation clusters or net zero innovation clusters where industries could be co-located to enable integration and circularity (e.g. new biogas, hydrogen, green ammonia, SAF)
- Industrial parks that have energy intensive industry or processing facilities (food/ag/pharma) with substantial hot water needs or wastewater pre-treatment
- Campuses and communities where district heating and/or cooling already exists
- Catalyzing events such as infrastructure renewal projects (streets, water, wastewater)





Thank you

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