Thermal Technologies in the ESG Revolution – Friend or Foe?

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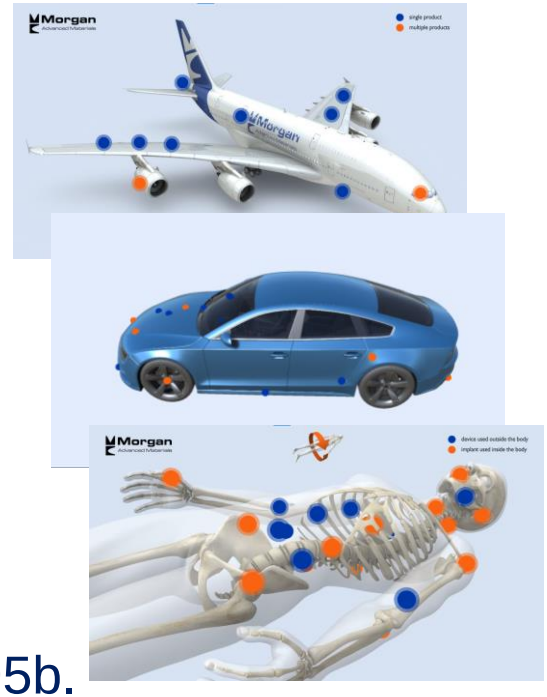
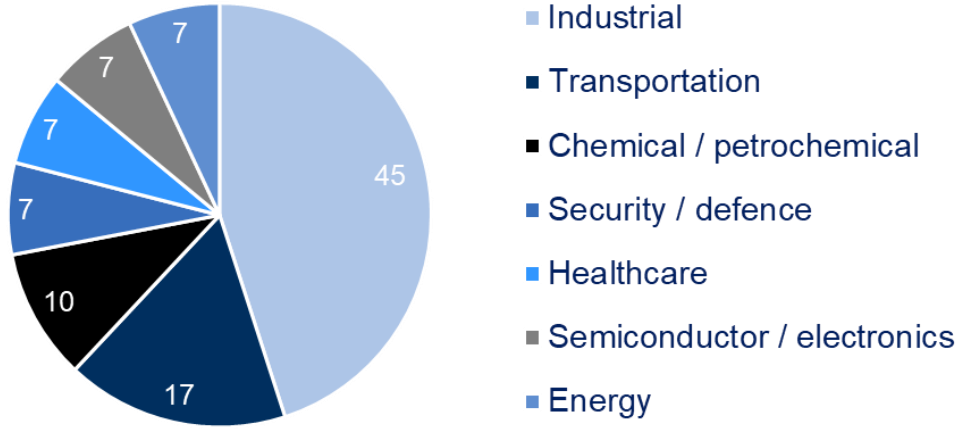
Morgan Advanced Materials (LON: MGAM)



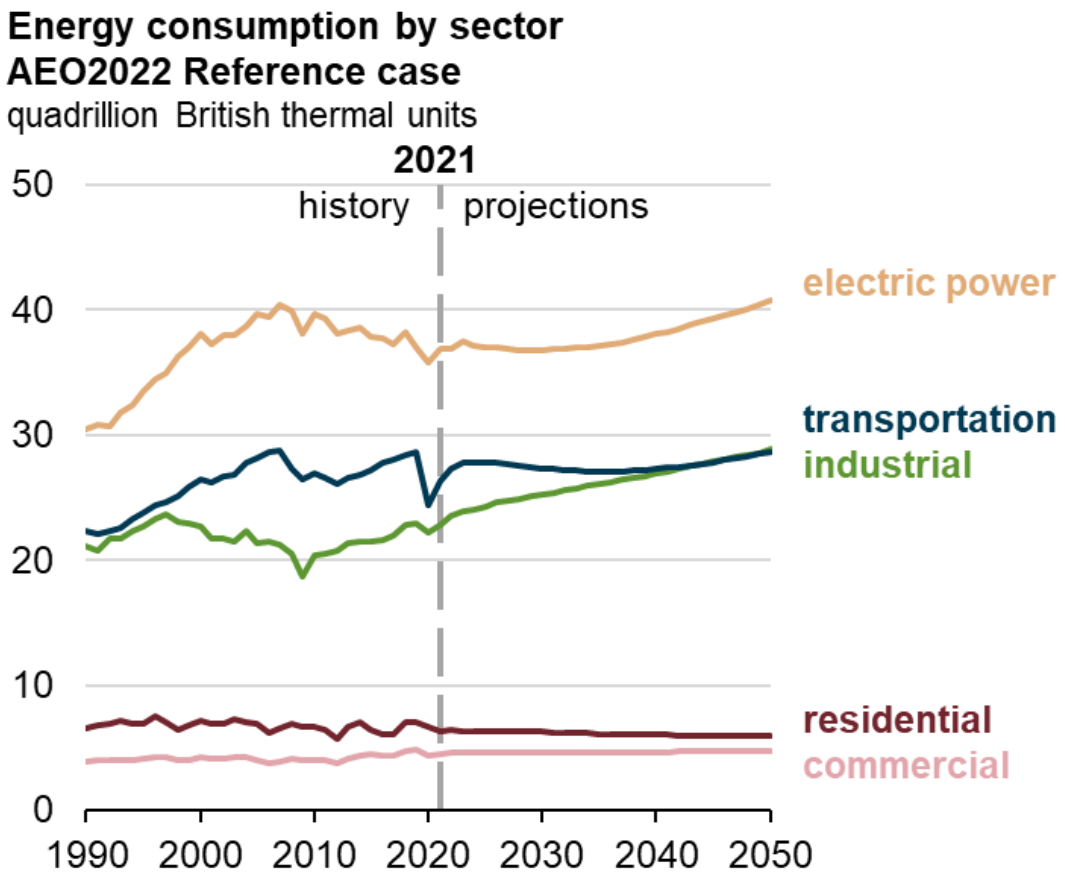
Revenue £0.95b.
7,800 employees

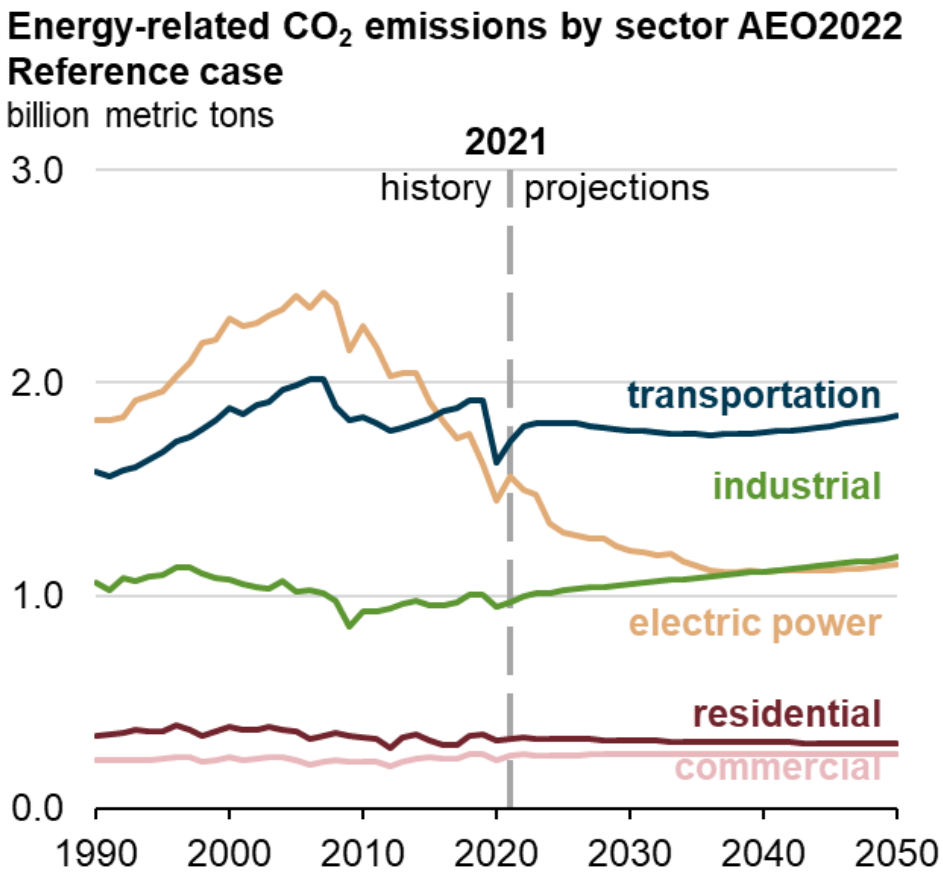


Primary markets addressed
(split by 2021 revenue, %)

At Morgan Advanced Materials our purpose is to use advanced materials to help make more efficient use of the world's resources and to improve the quality of life

“Industrial” is a major user of energy…and generator of CO_2



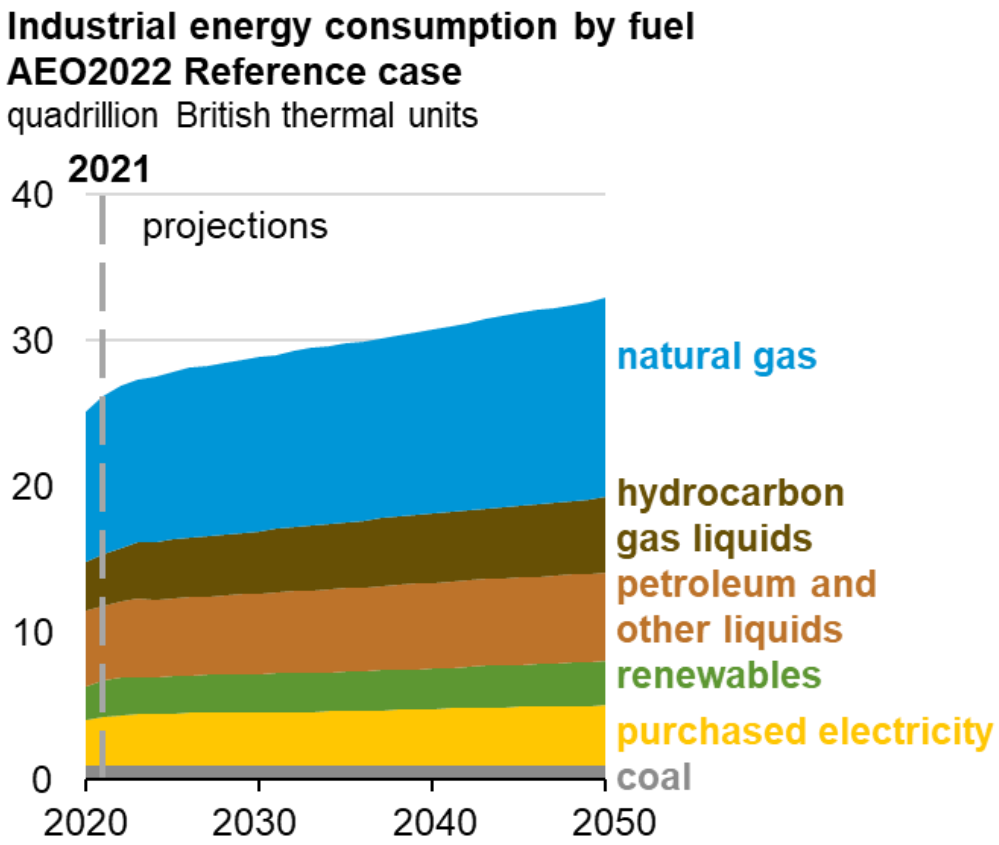


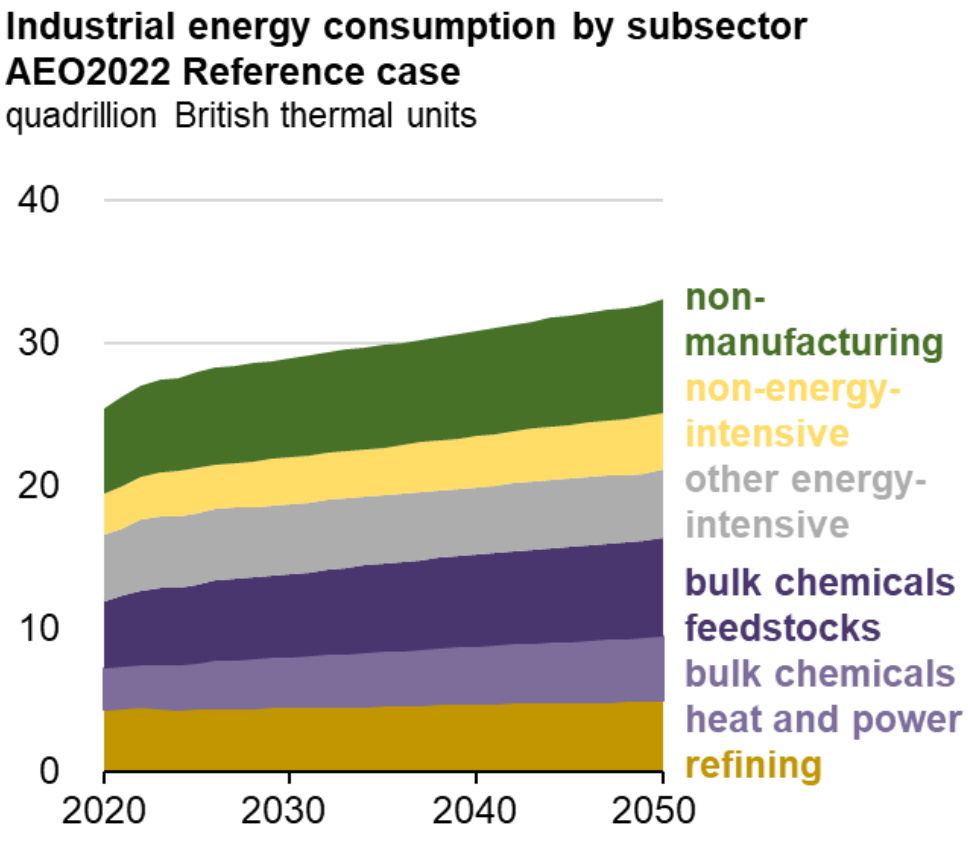
1 quadrillion BTU = 293 TWh

Above are for U.S. markets (not global)

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022* (AEO2022)

…and only a small percentage of the fuel is from renewable sources





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If we move to renewables such as wind and solar
and we all drive Electric Vehicles,
is everything great?

How green is a wind tower?

- Building and erecting wind turbines require hundreds of tons of materials – steel (e.g., from combustion of metallurgical coal in blast furnaces), concrete (manufacturing process with significant carbon dioxide generation), fiberglass, copper, rare earths (mined – energy intensive) in permanent magnets etc.

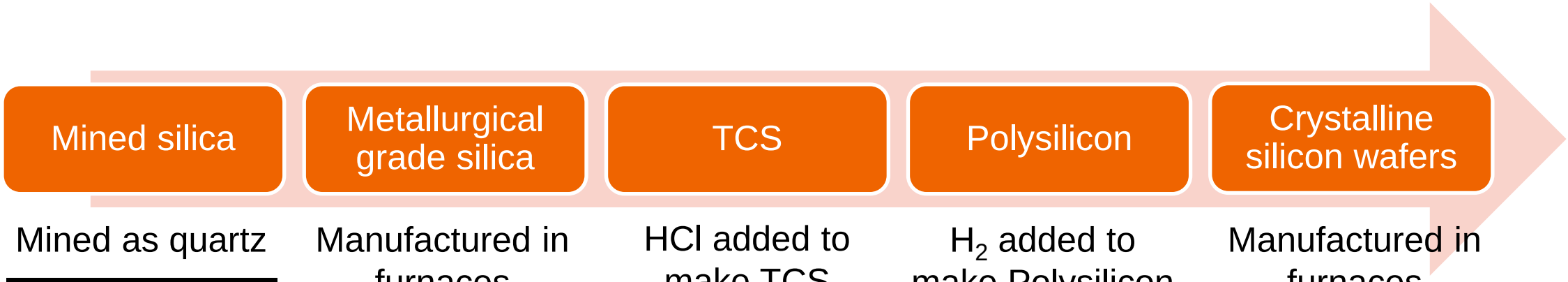
- Major contributors to the carbon footprint of wind turbines are steel tower (30% of carbon impact); concrete foundation (17%); carbon fiber and fiberglass blades (12%)

- Amortizing the carbon cost over equipment lifespan, wind power has a carbon footprint of 11 g. of CO_2 / kWh of electricity generated, compared with 9 g./kWh for nuclear power, 44 g./kWh for solar, 450 g./kWh for natural gas and 1 kg./kWh for coal

- **Numbers can be reduced** – work on "green steel" using green hydrogen in the steel making process e.g., HYBRIT and H_2 green steel

Source: "How Green Is Wind Power, Really?" A New Report Tallies Up The Carbon Cost of Renewables, Forbes, April 28, 2021

How green is a (crystalline silicon-based) solar panel?



Mined as quartz

Risk of silicosis

Manufactured in furnaces

Emissions of CO_2 and SO_2

HCl added to make TCS

H_2 added to make Polysilicon – biproduct $SiCl_4$

$SiCl_4$ recycling equipment is expensive – but $SiCl_4$ releases HCl if exposed to water

Manufactured in furnaces

Wafer cleaning, removal of saw damage and surface texturing typically uses HF

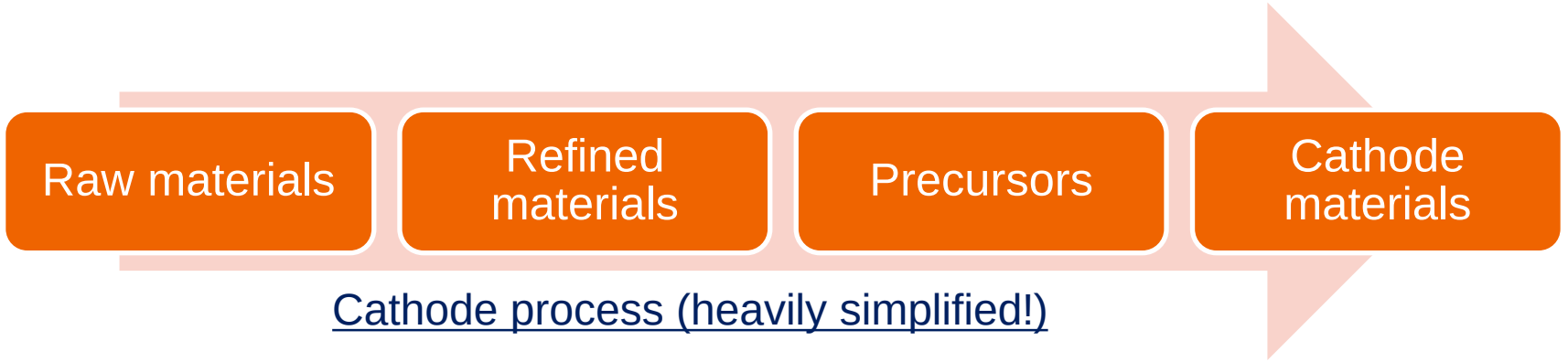
Production requires lots of energy (and can be carbon generated in production of that energy) and water (for cooling, chemical processing, air-pollution control, cleaning during installation and use)

But energy payback is 6 months to 2 years

Much progress made in recent years!

Source: “Solar Energy Isn’t Always as Green as You Think,” IEEE Spectrum, Dustin Mulvaney, 13 November 2014

How green is an EV battery?



- Raw materials are mined or otherwise obtained, e.g., from brine, then refined prior to processing into precursors and subsequently into cathode materials
- Extraction uses fossil-fuel powered mining equipment
- Moved vast distances by multiple modes of fossil-fuel-powered transport
  - >70% of cobalt mining is in DRC, but >70% of cobalt refining is in China
- Conversion requires 10 to 30 chemical steps, each with a waste stream
- Pollution to air and water, mine tailings and other human factors….

Making a 1000 lb. car EV battery by current processes “consumes” 500,000 pounds of earth – i.e., 5 lbs./mile versus an ICE which consumes 0.2 lb. of liquid per mile – needs innovation!

Sources: “Sustainability of the Battery Raw Materials Supply Chain” Walter van Schalkwijk; “Mines, Minerals and “Green” Energy: A Reality Check” Mark P. Mills, Manhattan Institute

Not great, but better than the alternative!
How about basic thermal process industries – can we make a difference?

Thermal technologies

- **High temperature processes are still fundamental for our society** (production of metals, petrochemicals and energy, etc.)
- Most effective use of the energy employed is critical
- Designs must consider efficiency…and also sustainability at 360˚ (ethics, health & safety, environment)
- Performance of the products and solutions is important and so is their lifecycles
- Thermal insulation and heat containment can play a major part when designing for optimum safety and energy efficiency

Importance of optimizing insulation performance

- **Insulating systems help high-temperature processes operate safely and efficiently**

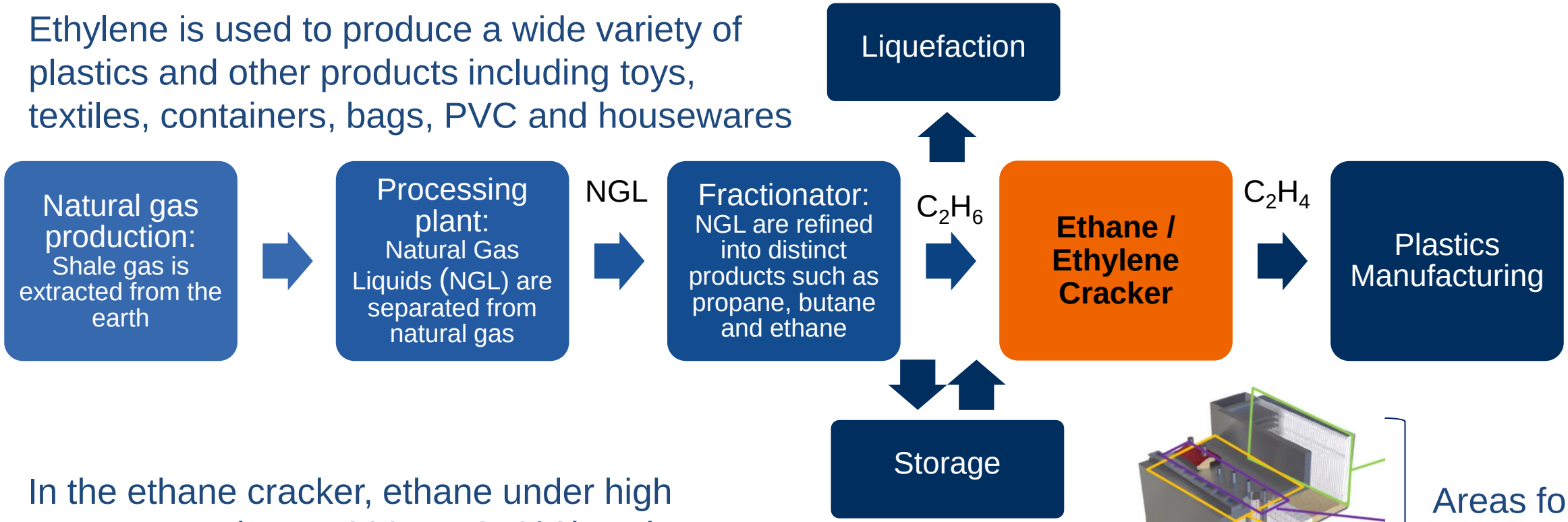
- Thermal insulation
  - provides fuel and energy saving, reducing CO_2 emissions
  - enhances safety (fire retardant / fire containment)

- Thermal solutions are not only needed in fossil-fuel fired units, but also in electrified units operating at high temperatures (high versatility)

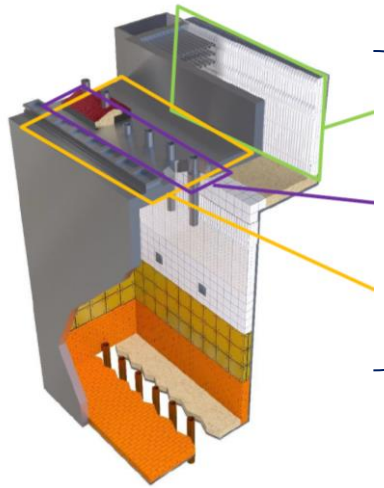
- The contribution is typically lower than savings generated by other aspects like efficiency in combustion…so is it worth the effort?

One example: an ethane/ethylene cracker

Ethylene is used to produce a wide variety of plastics and other products including toys, textiles, containers, bags, PVC and housewares



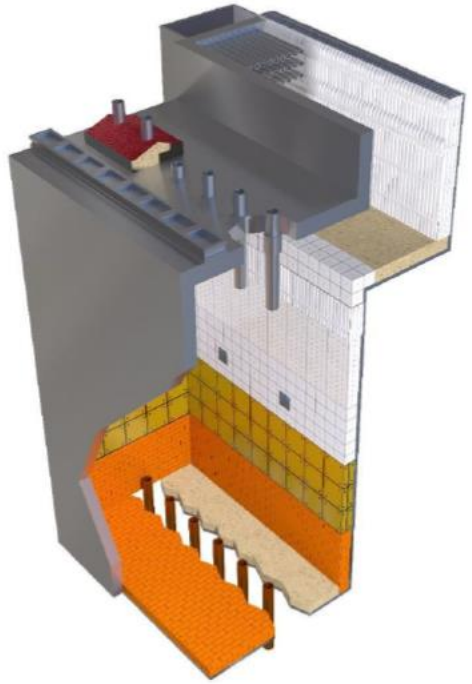
In the ethane cracker, ethane under high temperature (e.g., 1200 to 1250°C) and pressure is broken down into ethylene



Areas for insulation

Based on graphic from PAUL HORN / InsideClimate News

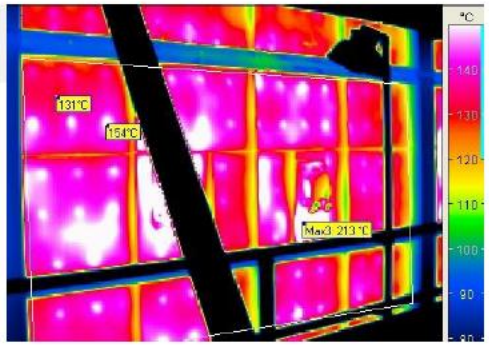
With the right insulation, casing temperature can be greatly reduced



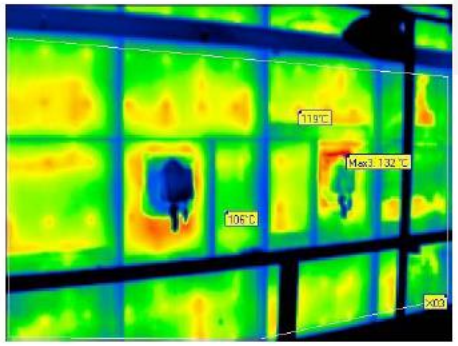
Ethylene cracker, lining wall thickness: 225mm

Casing temperature reduction – Case study

A



B



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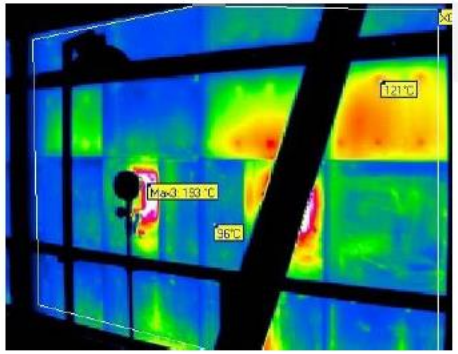
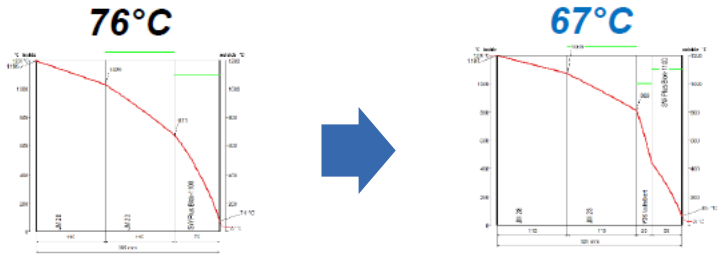


A. Existing lining. 123°C
B. New lining: 104°C
C. New lining with microporous: **82°C** (-41°C)

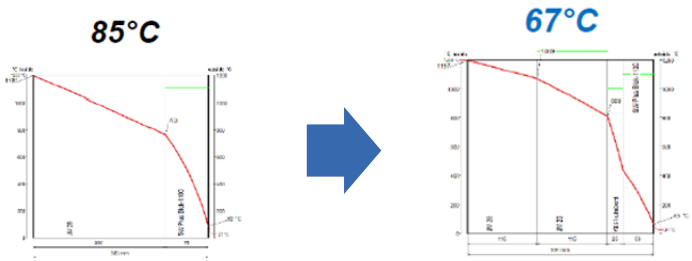
How does “reducing casing temperature” relate to the real world?

Ethylene cracker wall thickness 305 mm (Modern Unit)



- **Lower casing temperature by 9°C**
  - Worker safety
- **Lower heat loss by 20% and heat storage by 15%**
  - Fuel and CO_2 savings
  - Lower heat storage saves time (faster up/downs)

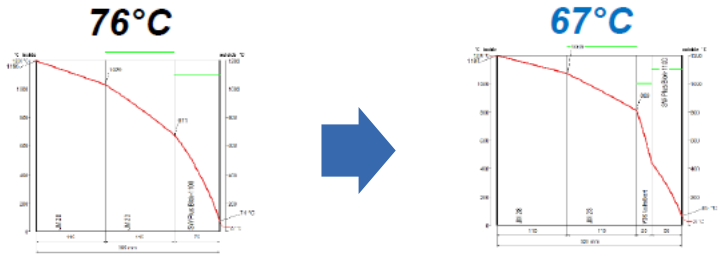
Ethylene cracker wall thickness 305 mm (Revamp)



- **Lower casing temperature by 18°C**
  - Worker safety
- **Lower heat loss by 38% and heat storage by 19%**
  - Fuel and CO_2 savings
  - Lower heat storage saves time (faster up/downs)

How does “reducing casing temperature” relate to the real world?

Ethylene cracker wall thickness 305 mm (Modern Unit)



CO_2 saved over life (16 years): 2,450 t

Energy saving (16 years): -13.8 GWh

Equivalent to CO_2 emissions from 2.7 million pounds of coal burned

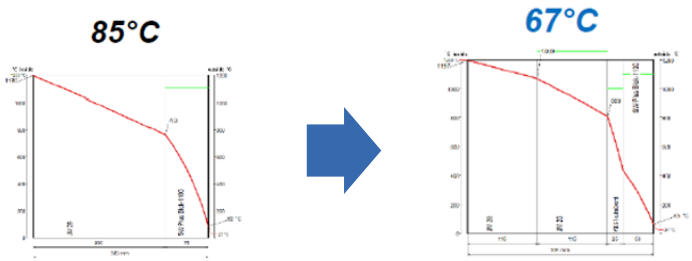
Equivalent to 77 homes’ energy use

Financial payback is short (often <12 months)

CO_2 savings are 27 to 60 times the CO_2 generated in materials manufacturing

Per cracker

Ethylene cracker wall thickness 305 mm (Revamp)



CO_2 saved over life (16 years): 4,870 t

Energy saving (16 years): -26.9 GWh

Equivalent to CO_2 emissions from 5.4 million pounds of coal burned

Equivalent to 150 homes’ energy use

Source: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Conclusions

- We still have some way to go even in processes and solutions considered to be leading the way in ESG;
- Thermal processes in industry are a major user of energy and a major contributor to carbon dioxide emissions;
- Even a seemingly small change in energy efficiency in one unit operation in one industry can make a big difference!

Thank you

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