Decarbonising the petrochemical sector

Why it's so **tricky** and **sticky**...

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9th September 2025

What are petrochemicals and why do they matter?

- Petrochemicals are chemical products derived primarily from **oil and gas**, including:
  - Plastics (e.g., polyethylene, polypropylene)
  - Fertilisers (e.g., ammonia, urea)
  - Solvents, detergents, synthetic rubber, resins, etc.
- In the UK, petrochemicals are a **critical industrial sector**:
  - Support other industries: construction, agriculture, healthcare, packaging, etc
  - Account for **~20–30% of industrial emissions**

Petrochemical emissions come from both energy use and material feedstock - making it unique and more complex!

The petrochemical sector is both TRICKY and STICKY — and that's the focus of this talk!

Tricky => technical barriers

High-temperature and energy intensive:

- Chemical manufacturing requires **extremely high temperatures (~850°C)**
- Hard to electrify using current technologies -> fossil fuels still the norm

Long asset lifetimes:

- Plants are expensive and built to last 30–50 years
- Retrofitting or replacing them is a **huge financial and logistical challenge**

Carbon embedded in feedstocks:

- Many chemical products are **made *from*** hydrocarbons, not just powered by them
- **Replacing carbon content** is much harder than just swapping energy sources

Lack of mature alternatives:

- Technologies like green hydrogen, CO_2-based polymers, or bio-feedstocks exist but are **nascent, expensive, and not yet scalable**

Sticky => slow progress despite available solutions

Low demand-side pressure:

- Consumers don't see or understand the **emissions embedded** in products
- **No incentive for companies** to invest when there's no premium or demand

Policy gaps:

- The UK has limited **regulation targeting embedded carbon** in materials
- Subsidies and tax incentives for green alternatives are **still insufficient or inconsistent**

Cost and competitiveness concerns:

- Virgin chemical products **often cheaper than recycled** or bio-based alternatives
- Without carbon pricing or regulatory mandates, **companies stick with the status quo**

Infrastructural inertia:

- Supply chains, storage, distribution — **all tailored for fossil-based systems**
- Transitioning to low-carbon alternatives would require **systemic change**, not just switching out one component

Plastic production: A tricky and sticky example – the current

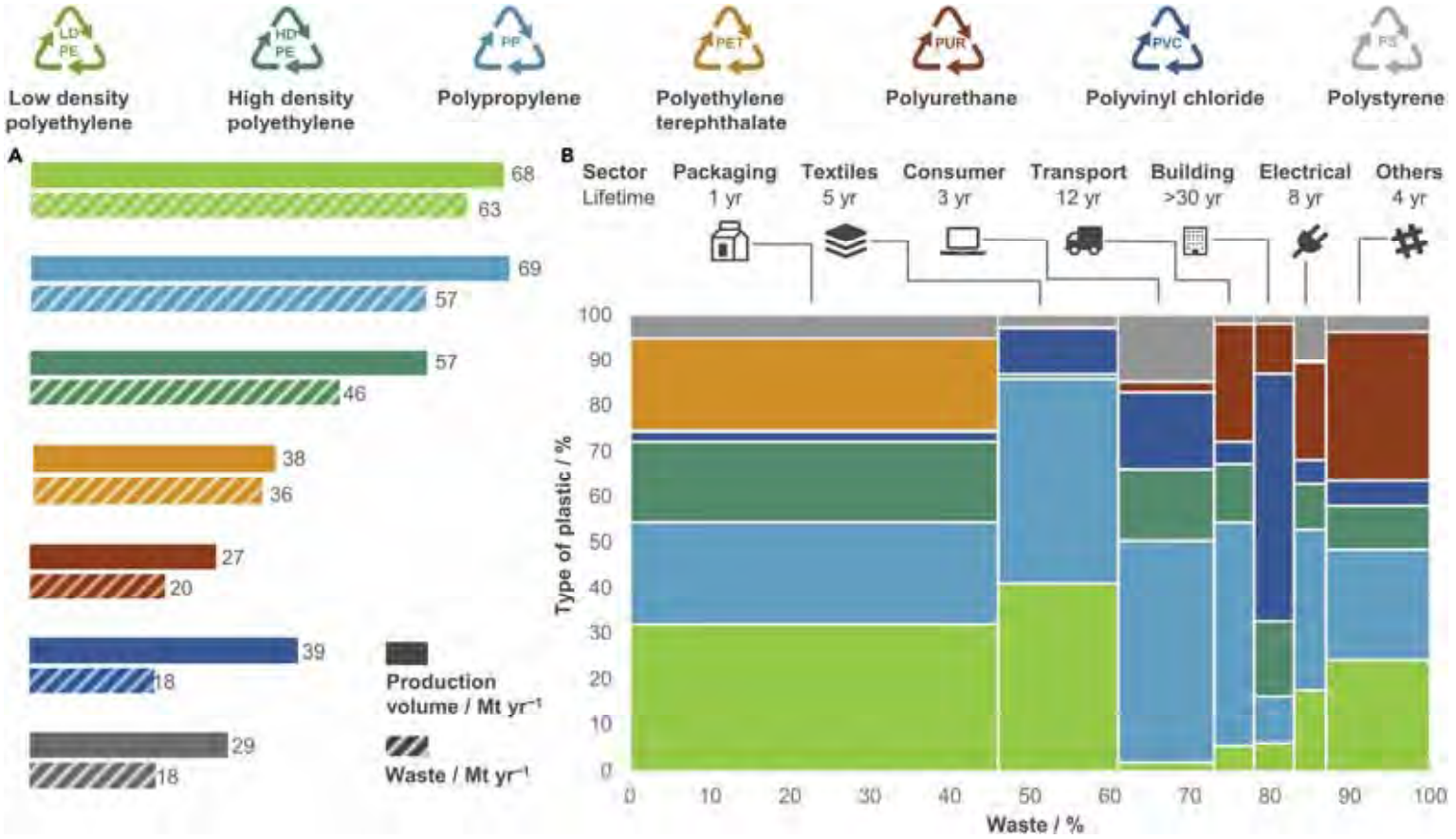

Image taken from : Martin, et al. **2021**: https://www.sciencedirect.com/science/article/pii/S2451929420306380

Plastic production: A tricky and sticky example – by 2050

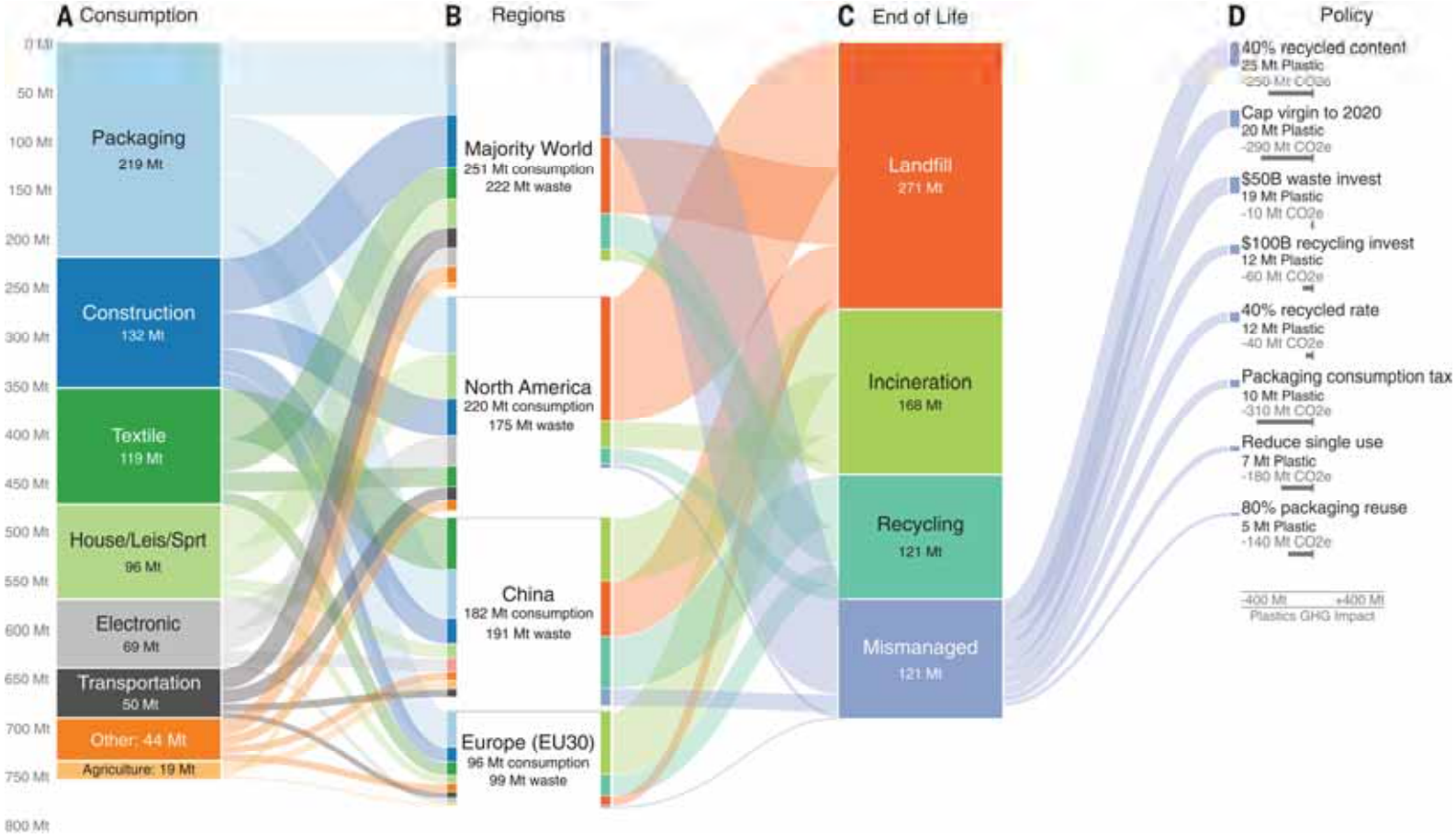

Image taken from : Pottinger, et al. **2024**: https://doi.org/10.1126/science.adr3837

Plastic production: A tricky and sticky example

Open question: why is this tricky?

- Complex feedstocks with chemical processes that are complex
- Catalysts need to be specialised and robust
- Manufacturing relies on steam cracking and oil-based feedstocks
- The high temperatures can cause toxic byproducts that need further processing
- …

Open question: why is this sticky?

- Recycled plastic is often lower quality and more expensive
- No requirement for recycled content in most products
- Waste collection and sorting systems are fragmented
- **…**

Unlocking progress in a sticky, tricky sector

Need for a whole-systems approach:

- Can't decarbonise in isolation - needs circular economy models, better waste infrastructure, demand reduction, etc

Stimulate demand:

- Public awareness campaigns and government procurement can drive uptake of low-carbon materials

Accelerate innovation funding:

- Government and private sector need to fund pilots and scale-up efforts

Stronger regulation and carbon pricing:

- Without firm policy drivers, the transition will be too slow

A critical decade for petrochemical decarbonisation

- The petrochemical sector isn't the largest emitter — but it's one of the **fastest growing** and most **deeply embedded**
- It's both **tricky (technical challenges)** and **sticky (slow change despite solutions)**
- Decarbonising this sector is essential to:
  - Achieve decarbonisation goals
  - Reduce plastic pollution and global emissions
  - Avoid carbon lock-in from long-lived industrial infrastructure

We need early, decisive action **NOW** to avoid much more expensive transitions later

YOUR QUESTIONS