CPI and Circular Chemistry and sustainable manufacturing

Catapult Support for UK industry

Circular Chemistry workshop 8 September 2021

Tom Taylor – tom.taylor@uk-cpi.com

We help companies to develop, prove, scale-up and commercialise new products and processes

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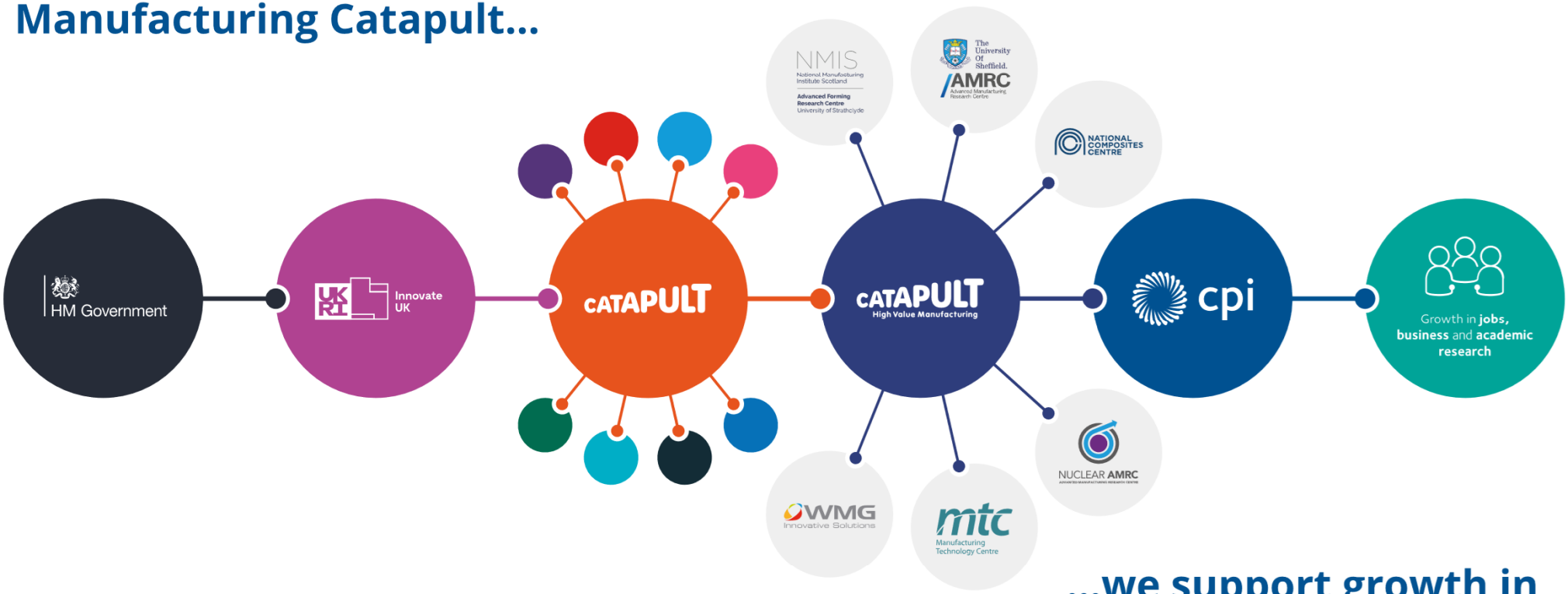
As part of the UK's High Value Manufacturing Catapult...



...we support growth in advanced manufacturing

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...alongside experienced, nationwide technology partners

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We help deliver, de-risk and accelerate...

...your concepts into successful products

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...using our integrated innovation services

Industry relevant expertise and assets

Delivering product development, proof of concept, and scale-up services.

Expertise in securing funding and investment for companies

Enabling the right partnerships, connections, and funding routes at the right time.

Knowledge and application of innovation processes

Business services and consultancy to reduce risk and speed up time to market.

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17+
years of experience
helping businesses succeed

1100
projects completed
worth over £480m

1000
business collaborations
including 60% SMEs

434
highly skilled staff
to support your business

£136m
investment
in innovation assets

£53.7m
annual turnover
in 2019/20

Information updated on 31 March 2020

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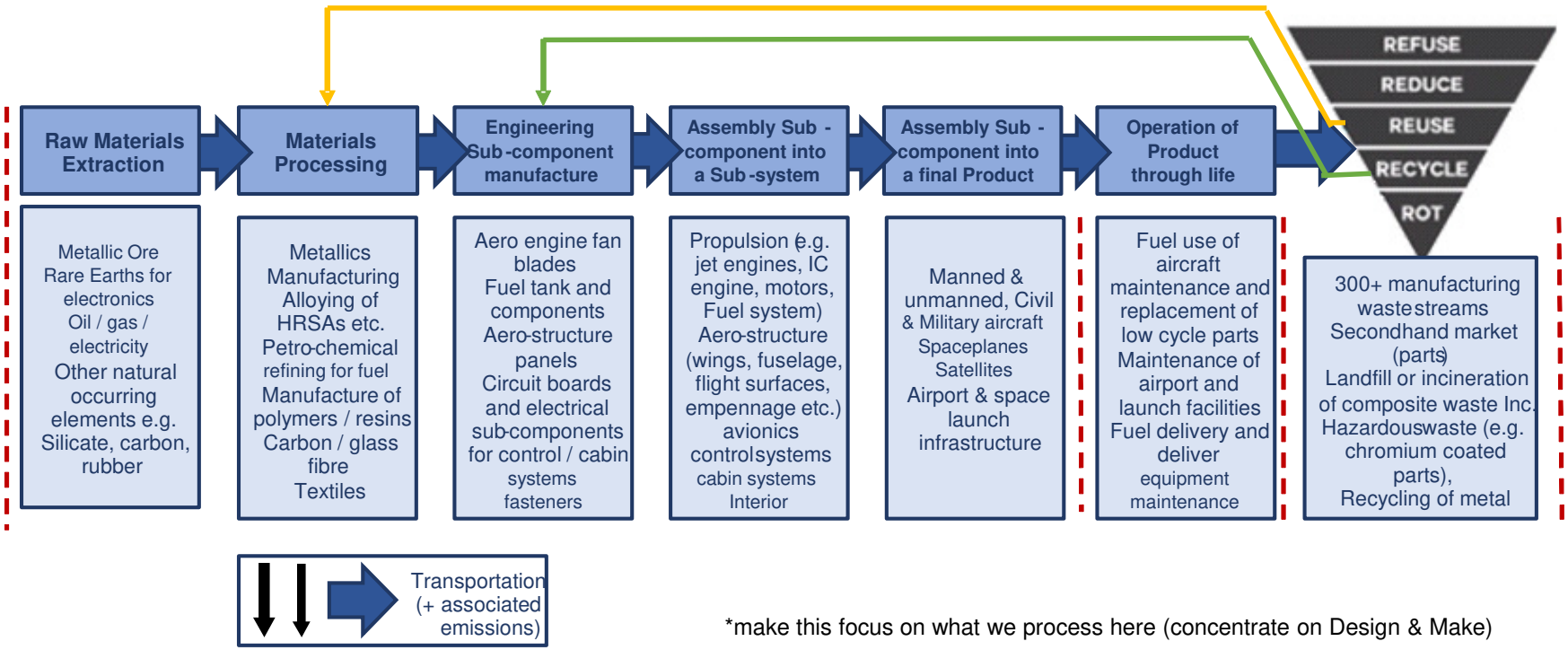
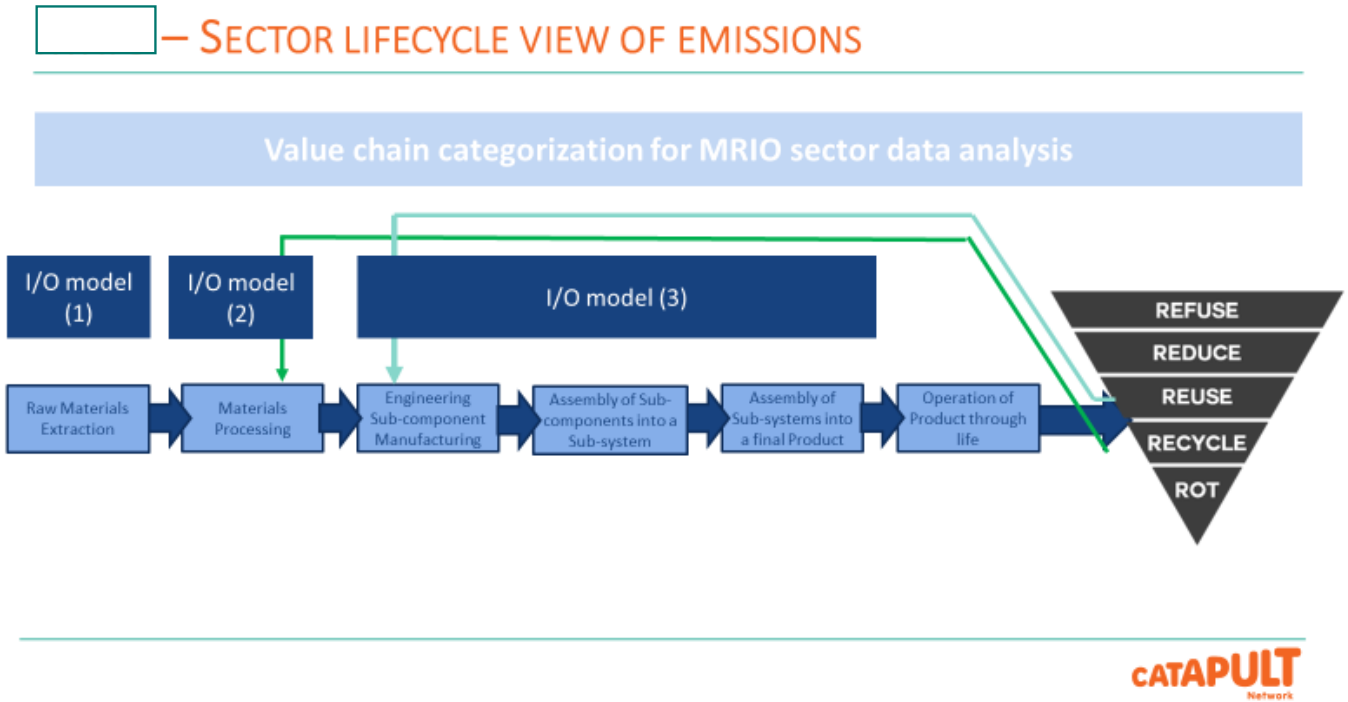
Supply Chain Diagram for manufactured goods

(curtesy of HVM Catapult)



*make this focus on what we process here (concentrate on Design & Make)

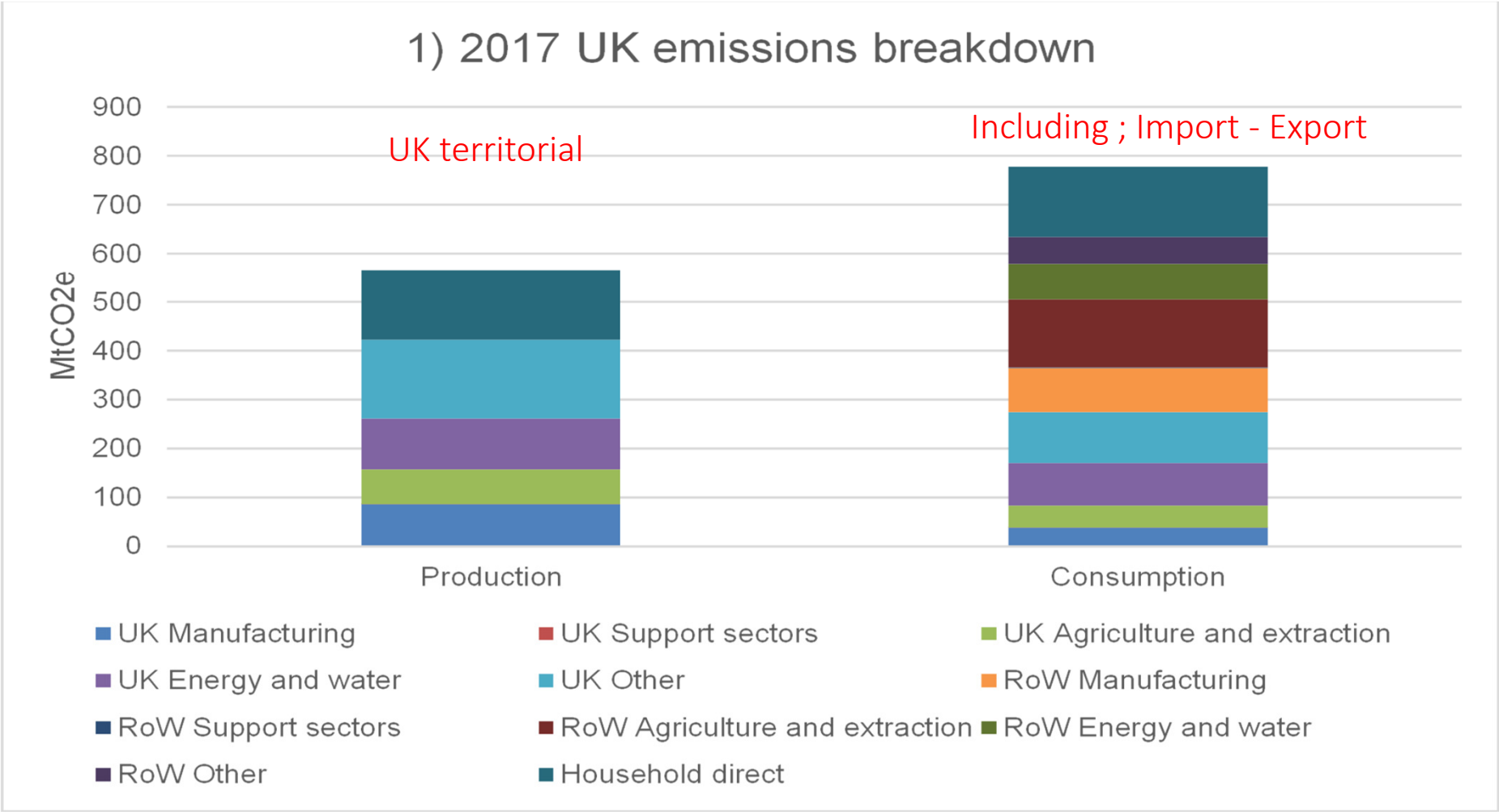
INTERVENTION & INNOVATION OPPORTUNITIES - HVMC



Sector supply chain mapping will identify high emitting steps in the chain and opportunities for UK innovation and ‘Green-shoring’

Whole lifecycle and embodied carbon analysis will pinpoint opportunities and enable businesses to evidence their net zero credentials

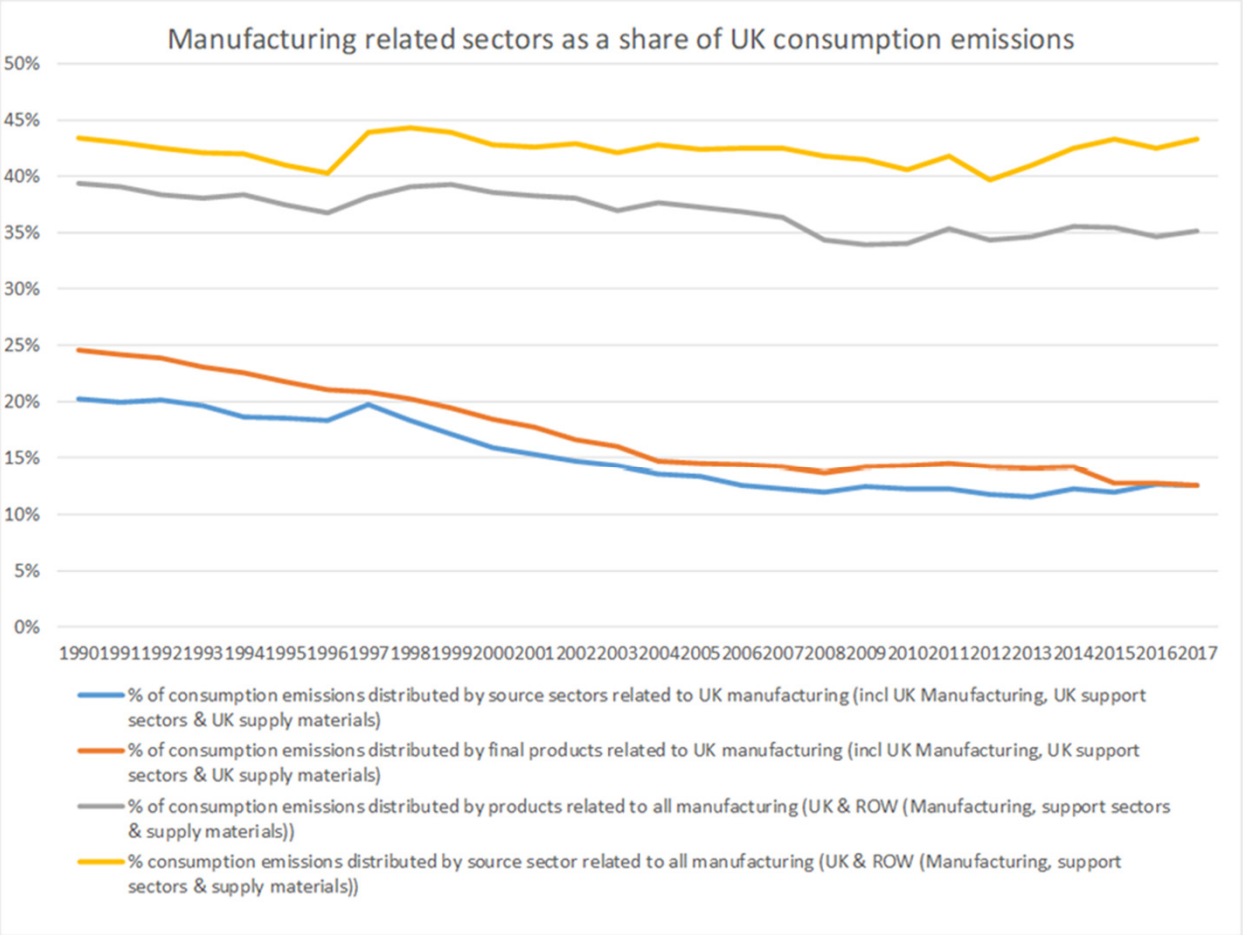
Manufacturing Industry contribution to CO2 emissions



Slide Source – HVM Catapult

UK Manufacturing emissions headlines

- Emissions from Manufacturing could be as high as 43% of the total UK consumption emissions
- UK Consumption emissions have flatlined while UK territorial Manufacturing emissions have halved

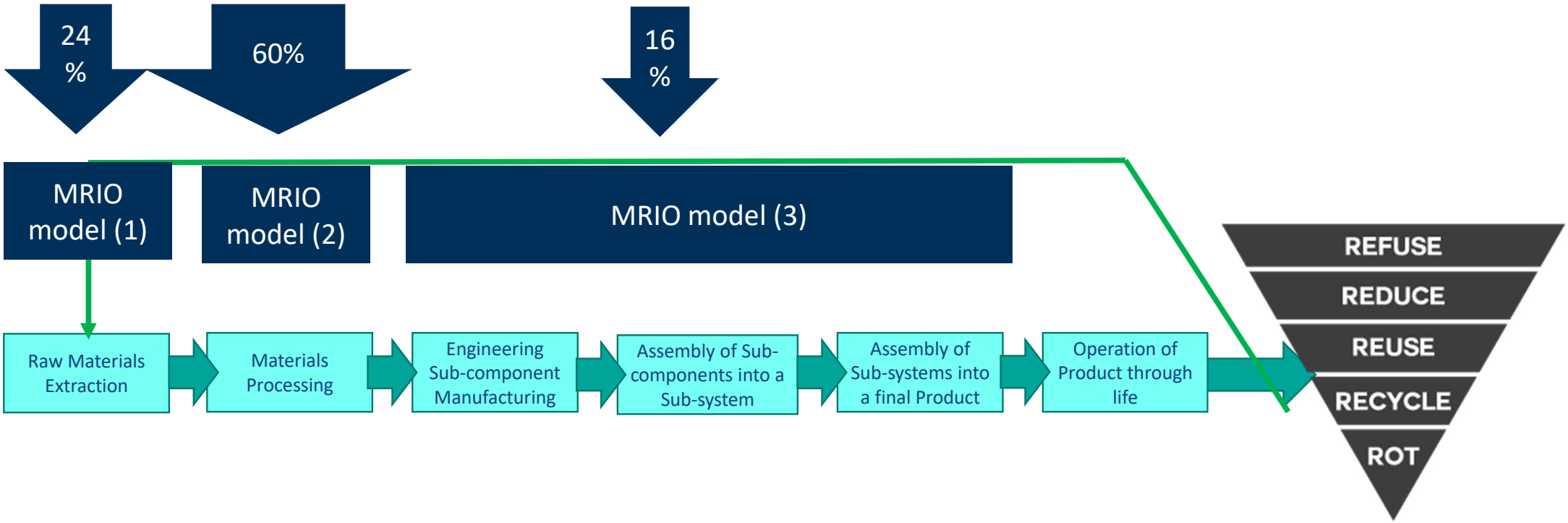


Slide Source – HVM Catapult

– SECTOR LIFECYCLE VIEW OF EMISSIONS

UK Aerospace sector manufacturing apportionment of emissions from MRIO model

(Top 20 attributable SIC codes- scaled from 52% total sector manufacturing emissions)



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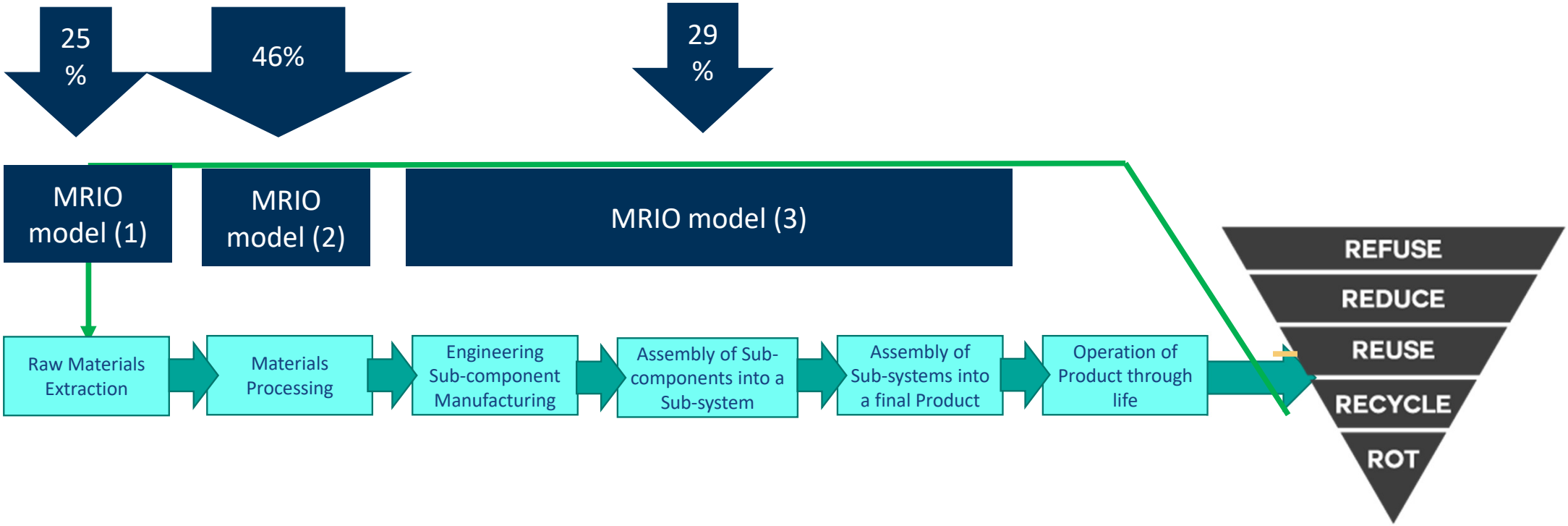
MRIO – Sector lifecycle view of emissions

UK Automotive sector manufacturing apportionment of emissions from MRIO model

(Top 20 attributable SIC codes- scaled from 54% total sector manufacturing emissions)



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Circular Economy and Sustainable materials capabilities

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We can accelerate Battery Technology development

Materials Capability

- Support development of scalable processes for existing & next generation electrode materials – such as solid-state batteries and the recovery of high-value battery electrode materials.
- Surface engineering of materials and structures to maximise performance

Formulation Capability

- Screening and optimising existing chemistries by utilising high throughput experimentation
- Processing using a wider range of mixing technologies to maximise performance (g to kg).
- Optimising Evaporation & drying of slurries

Coating Capability

- Wet and vacuum coating process development and optimisation (e.g. slot die, ALD)
- Photonic/Plasma processing for high efficiency and improved surface adhesion
- Optimising electronic structures and interfaces to obtain maximum benefits in electrode performance

Sensors for Battery Management System

- Developing Integrated and multifunctional smart sensors for high-value BMS solutions.
- Distributed BMS enabling individual cell monitoring
- Embedding intelligent sensors in cells to better inform use for 2nd life applications

Sustainable production of materials

Life cycle analysis

Recycling and recovery

Recycling by design – choice of binder/solvents

High solids/solventless processing

Energy efficient formulation, coating and drying processes/equipment

Monitoring of cell performance to better inform end of life or 2nd life applications

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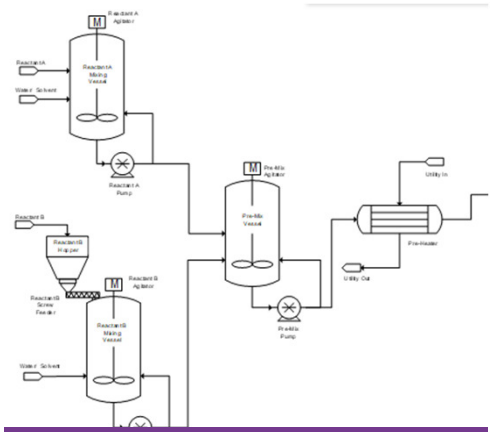
Scale Up Evaluation

Scale-up Development and Validation

- Understand process chemistry
- Make lab scale process more robust, scalable, safer
- Investigate batch to continuous processing

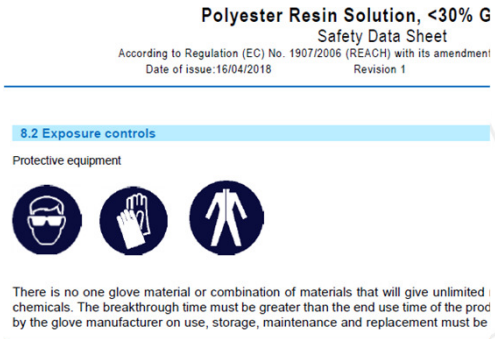
Process Analytical Techniques (PAT)

- Understand key process parameters
- Generate lab data to inform plant design
- Understand and control product quality
- Soft sensor development



Preliminary Commercial Plant Design

- Process Flow Diagram
- Mass and Energy Balance
- Key risks identified with suggested mitigations
- Process Economics (Capex, Opex)



Polyester Resin Solution, <30% G
Safety Data Sheet
According to Regulation (EC) No. 1907/2006 (REACH) with its amendment
Date of issue:16/04/2018 Revision 1

8.2 Exposure controls

Protective equipment

There is no one glove material or combination of materials that will give unlimited
chemicals. The breakthrough time must be greater than the end use time of the prod
by the glove manufacturer on use, storage, maintenance and replacement must be

Safety and Sustainability

- Chemical Safety (COSHH, CHA, MSDS etc)
- Process Safety (HS2, HAZOP etc)
- Life Cycle Analysis

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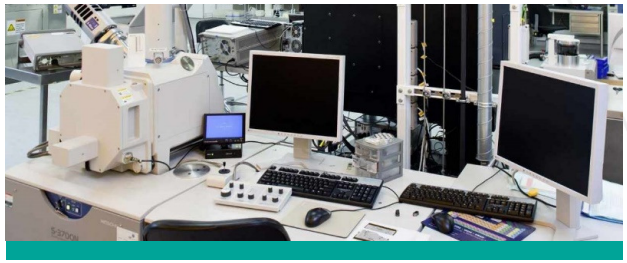
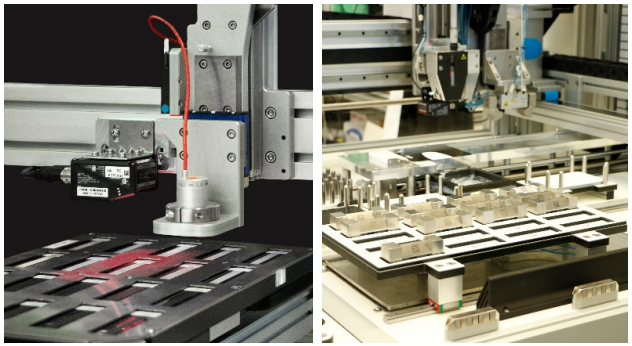
Capabilities in Formulation

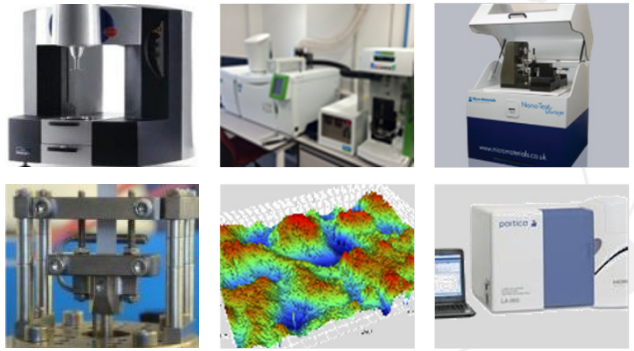
Automated formulation

Dispersion and scale-up

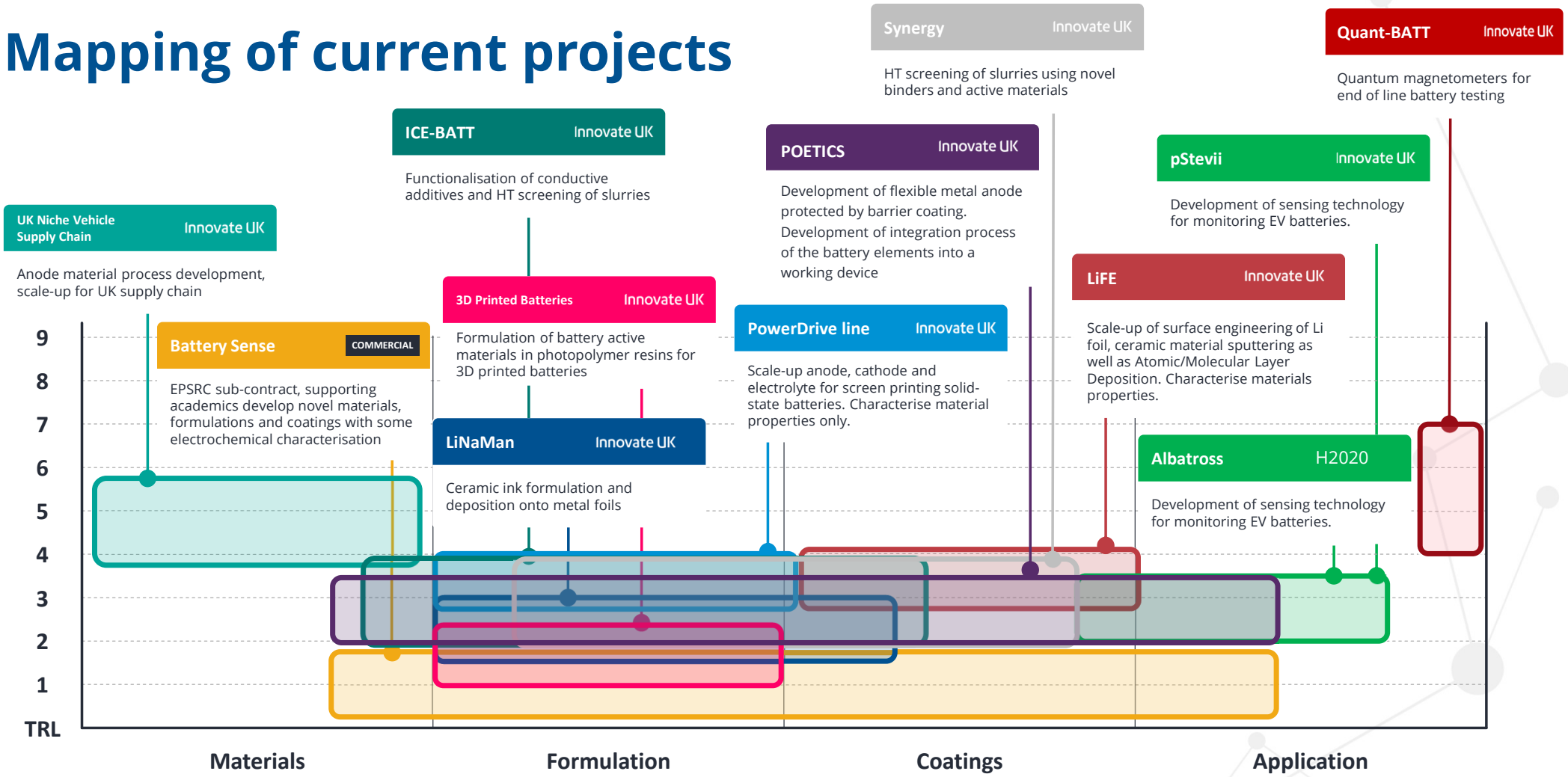


Characterisation





Mapping of current projects



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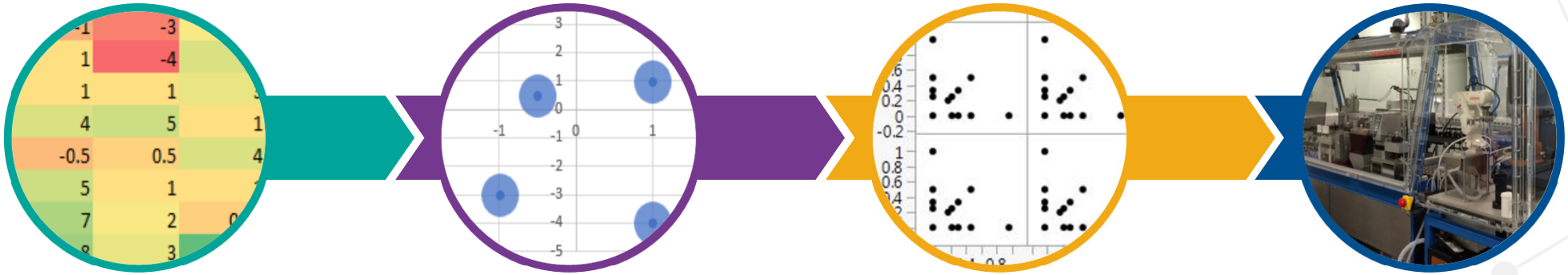
Solvent and binder replacement for battery electrodes



Collect data on solvent properties

Collect all relevant data on a wide range of possible solvents that could be used, such as Hansen solubility parameters and boiling point

Create solvent map

Principle Component Analysis to analyse the solvent parameter space and variability to allow targeting of a subset of solvents

Design of experiments

DOE to approach formulation development systematically whilst **reducing the number of experiments required,** accelerating process development for the customer

Determine optimised formulation

High throughput experimentation to produce and characterise formulations rapidly

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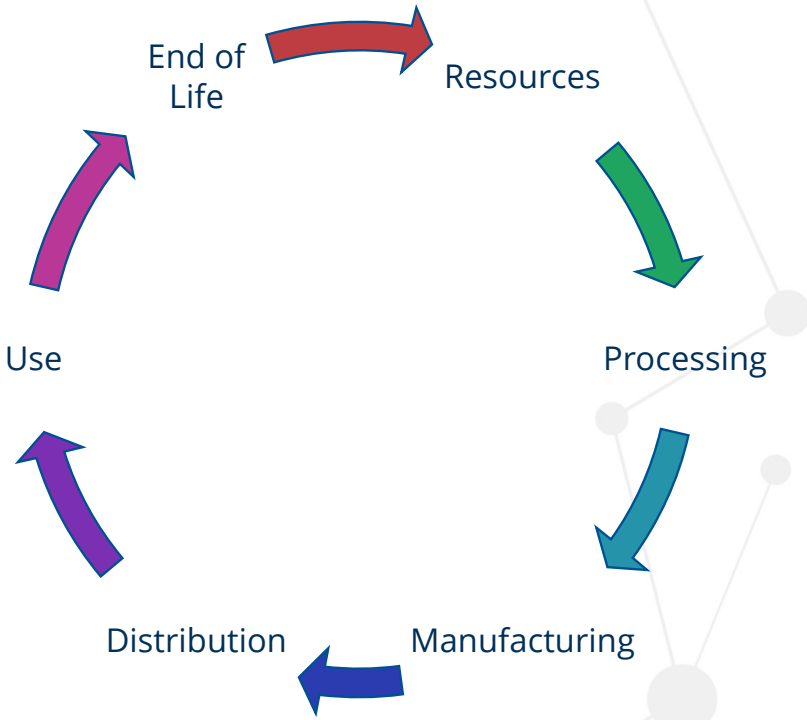
Life Cycle Analysis (LCA)

- LCA measures the environmental impact of a product from raw materials, throughout its use and finally when it reaches its end of life
  - Takes into account energy use and materials required across the value chain of the product

- CPI carries out transparent carbon accounting or full Life Cycle Analysis as required, complying with standard methodologies e.g. ISO 14044 and RED II.

- We use our expertise to define system boundaries, goal, scope and functional unit, to determine the hotspots and overall environmental impact for a new product, manufacturing process or technology
  - Sensitivity analysis for the hotspots
  - Compare results to existing equivalent products, processes or technologies



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LCA case study: What are CPI doing?

- Determined global warming potential for bioplastic packaging tray
- Compared to
  - Existing fossil fuel derived plastic tray
  - Recycled plastic tray
  - PE-lined cardboard tray

PET Tray | R-PET Tray | New Bioplastic Tray | PE Lined Cardboard Tray | t CO_2e/ Tray results | Recommendations

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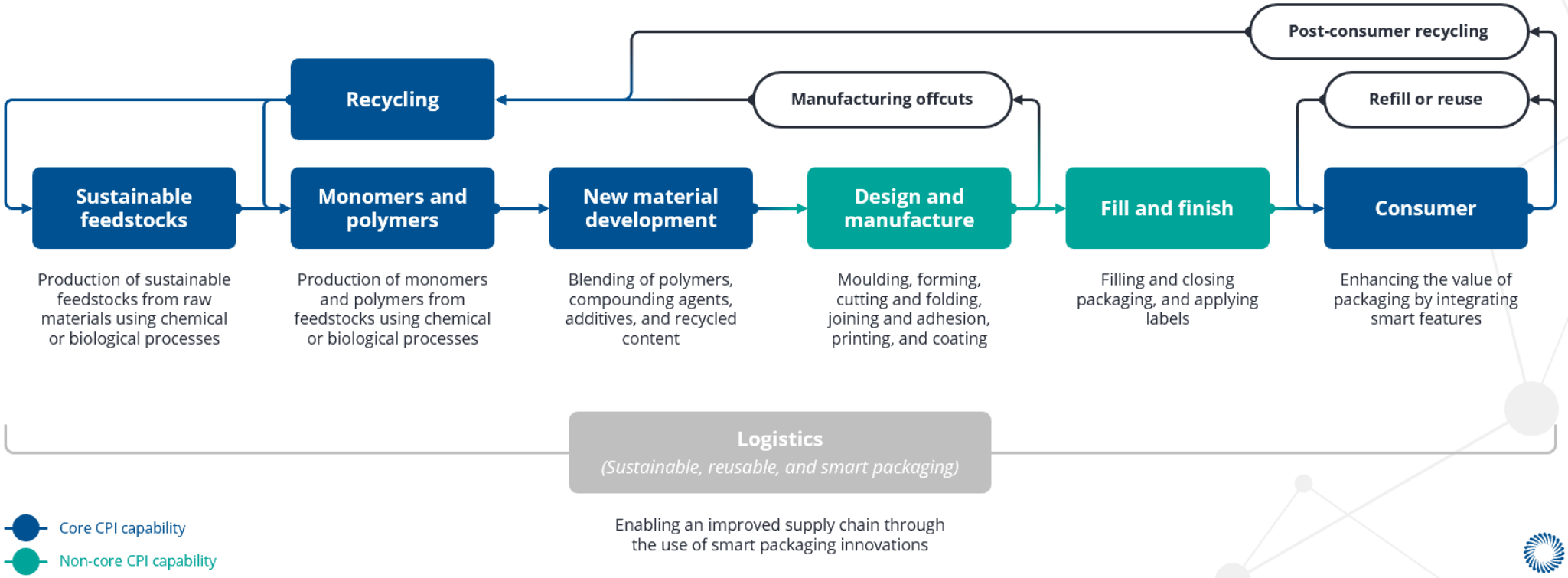
Circular Economy in Packaging Solutions



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New Material Development at CPI (InnovateUK Project: ENVPAC)

EnvPAC

NEW PRODUCT (PROTOTYPE)
Bio-polymer based, thermo-formed and compostable food tray

Cutting plastic packaging pollution

Developing next generation biodegradable packaging to achieve the same performance as the industry standard, e.g., PET packaging.

COMMERCIAL BENCHMARK
Fossil-oil based, thermo-formed, environmentally persistent Polyethylene Terephthalate (PET) food tray

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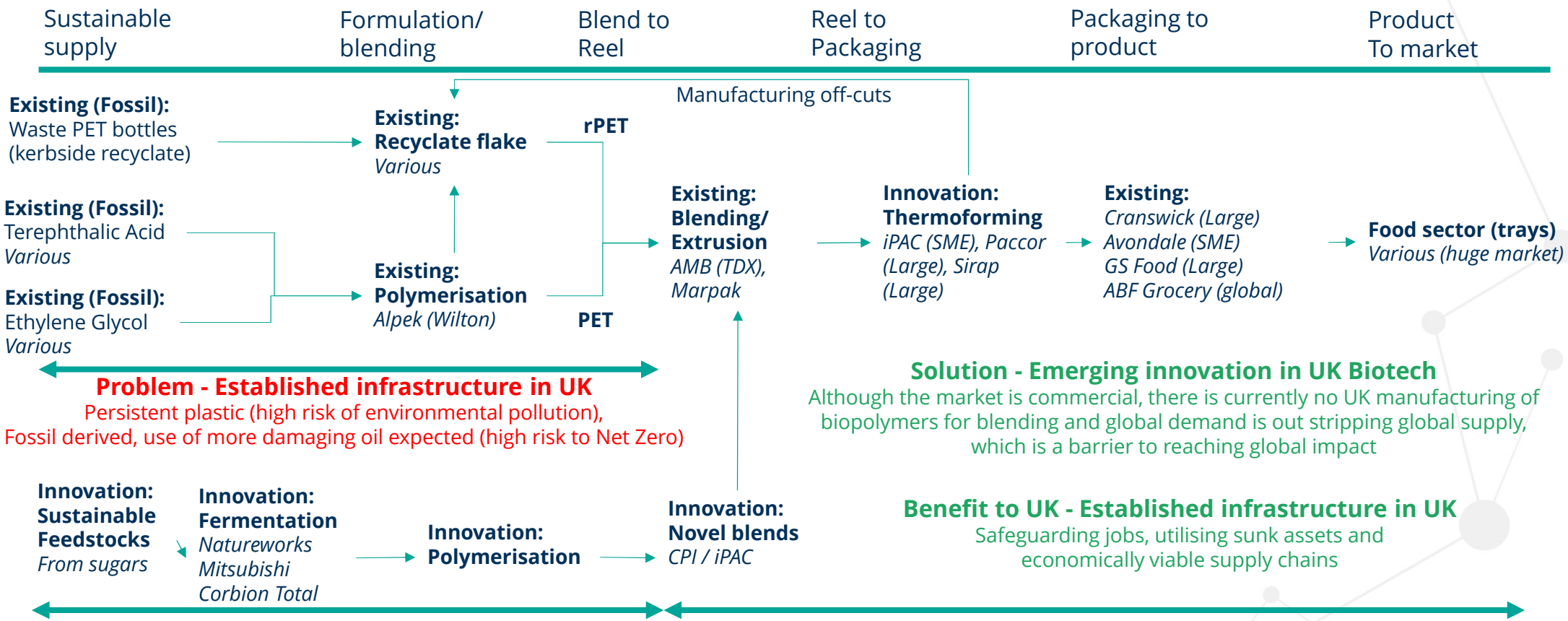
CPI's ENVPAC biopolymer packaging – Circular Economy approach to overcome packaging waste in food sector

Fossil oil based, thermo-formed Polyethylene terephthalate (PET) food trays sold into the fruits, are often landfilled or incinerated after single use

Bio-based ENVPAC is a compostable biopolymer material that can be thermo-formed and outperforms PET, offering better end-of-life options that avoid landfill and incineration (hence circular economy).



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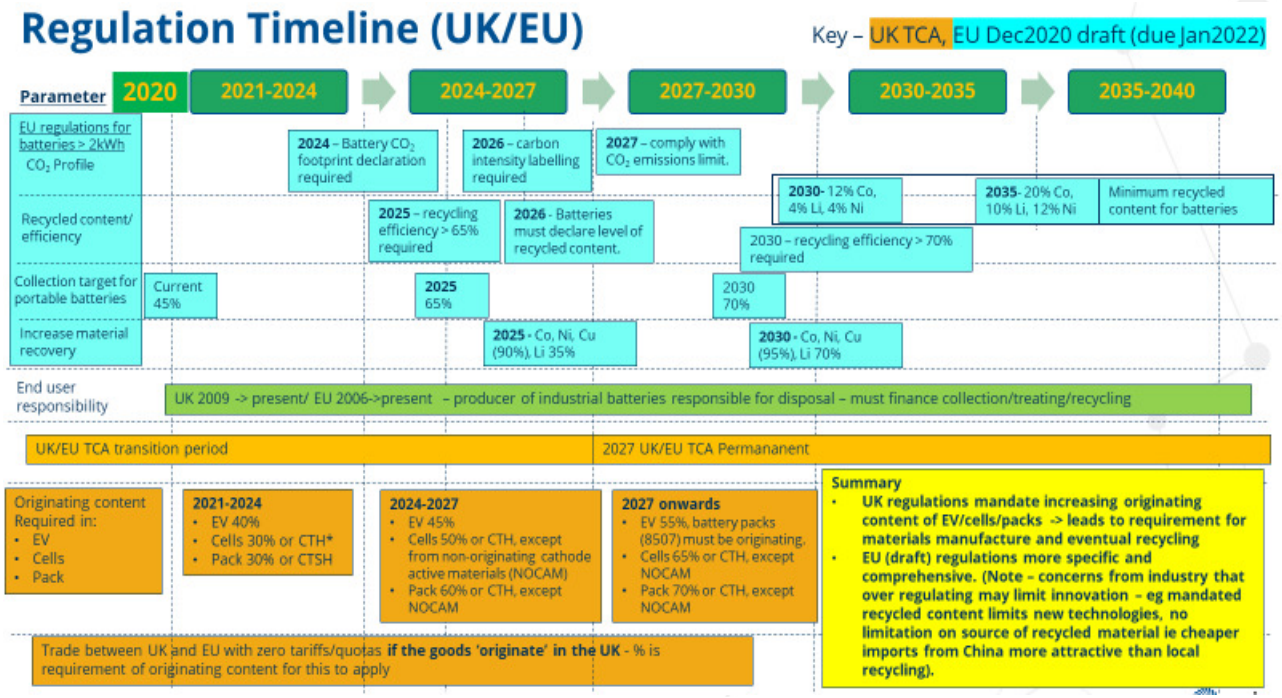
Scale Up Accelerator

Being aware of the **constraint profile** for a new technology, product or process is essential for effective scale-up, as it allows the **key risks** to be addressed and **mitigated**, maximising the probability of creating the **cheapest viable commercial process** in the **shortest** time.

Our **bespoke** Scale-Up Accelerator provides an overview of the key process risks for scaling-up and commercialisation, taking into consideration many aspects of the development process, including but not limited to:

- Scale-ability
- Economics
- Environmental Impact including Carbon Accounting
- Safety
- Process route and technology choice
- Process performance
- Regulations
- Development time
- Equipment selection/ availability
- Process operability/ robustness
- Process Control



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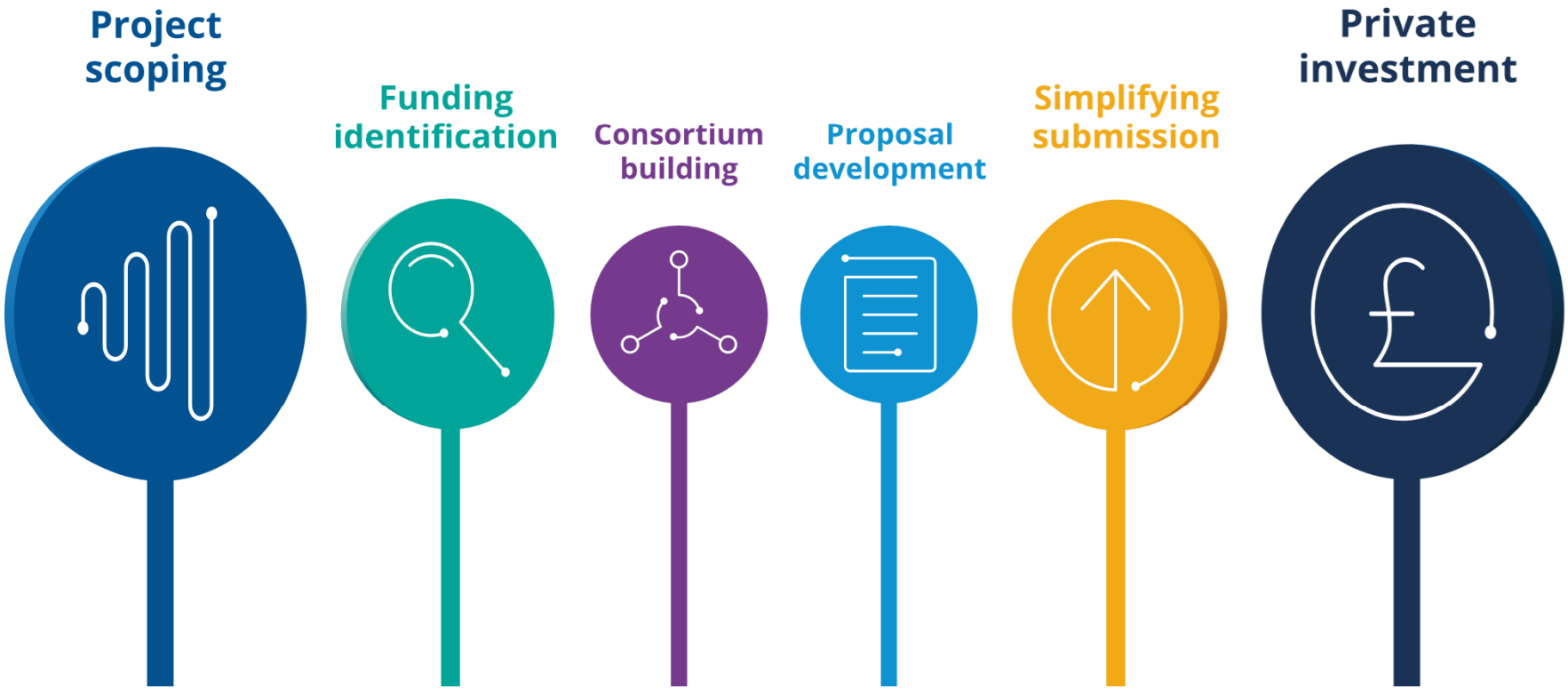
Supporting collaboration, investment, and grant applications...



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Proof of concept and scale-up

to prove the feasibility of your new ideas before approaching investors, stakeholders, or funding programmes

Reduce risk

by helping prove and refine your novel technologies before investing further in new facilities and equipment

Decreasing time to market

by providing access to proven demonstration assets and industry expertise

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Thank you

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