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REnewable Energy for Future UK Net-Zero Cooling REEF-UKC

Transition to a Sustainable Cooling: Business and Financing Perspectives

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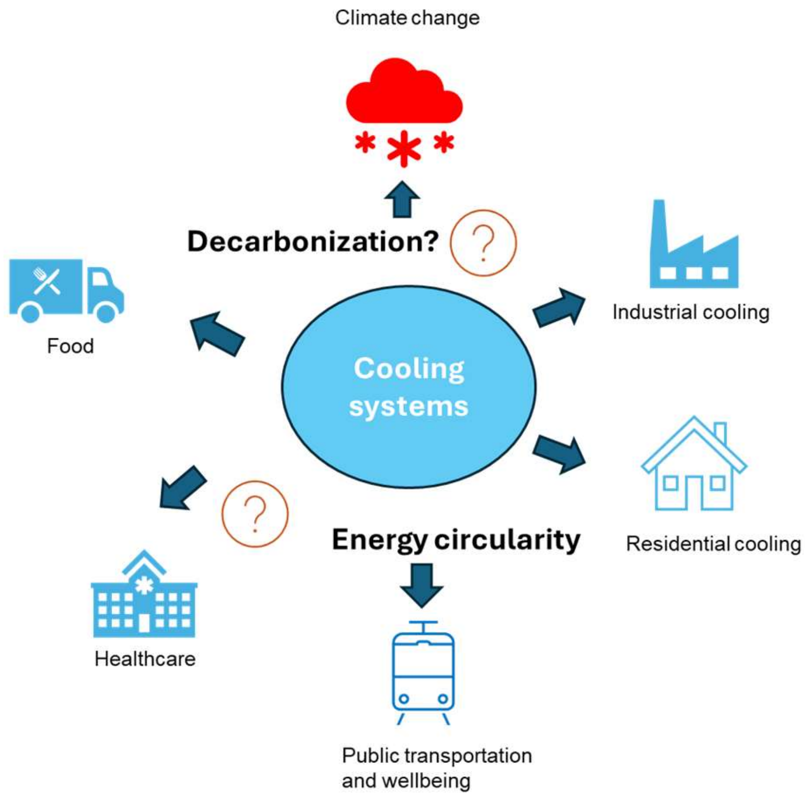
Problem Statement

- **Cooling Systems** play a vital role across sectors (e.g., food, healthcare, data centres, industry).
- **Environmental Impact (UK):**
  - **14%** of electricity consumption.
  - **10%** of total GHG emissions.
- Despite the urgency, decarbonisation of the cold sector remains slow.
- It requires a systemic approach that ***foster technological innovation and accelerate investment into robust, resilient, and flexible cooling systems.***



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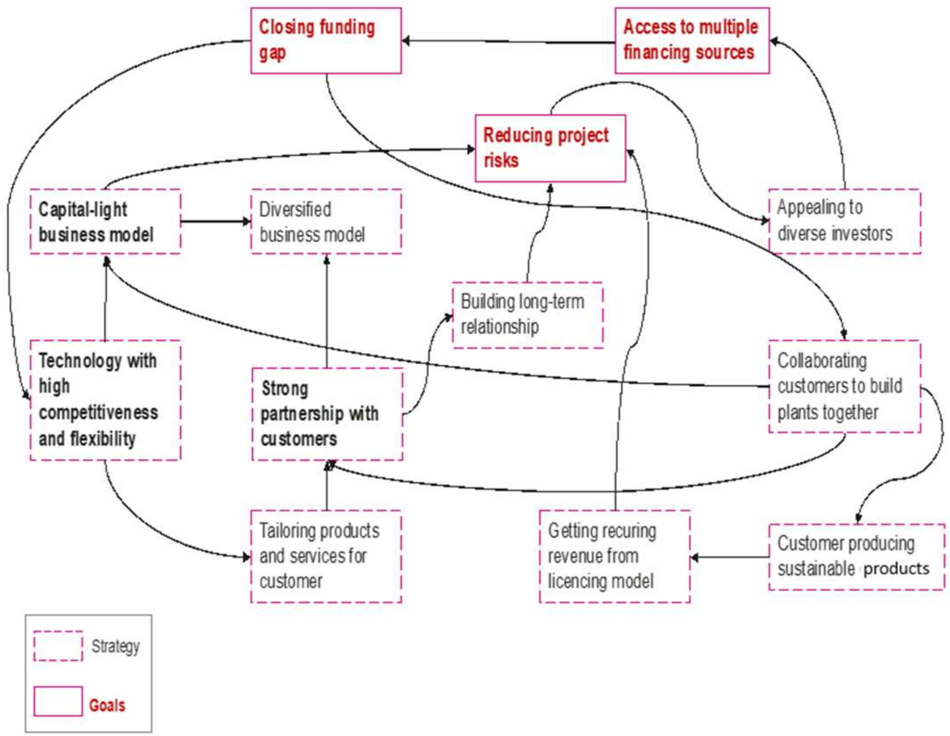
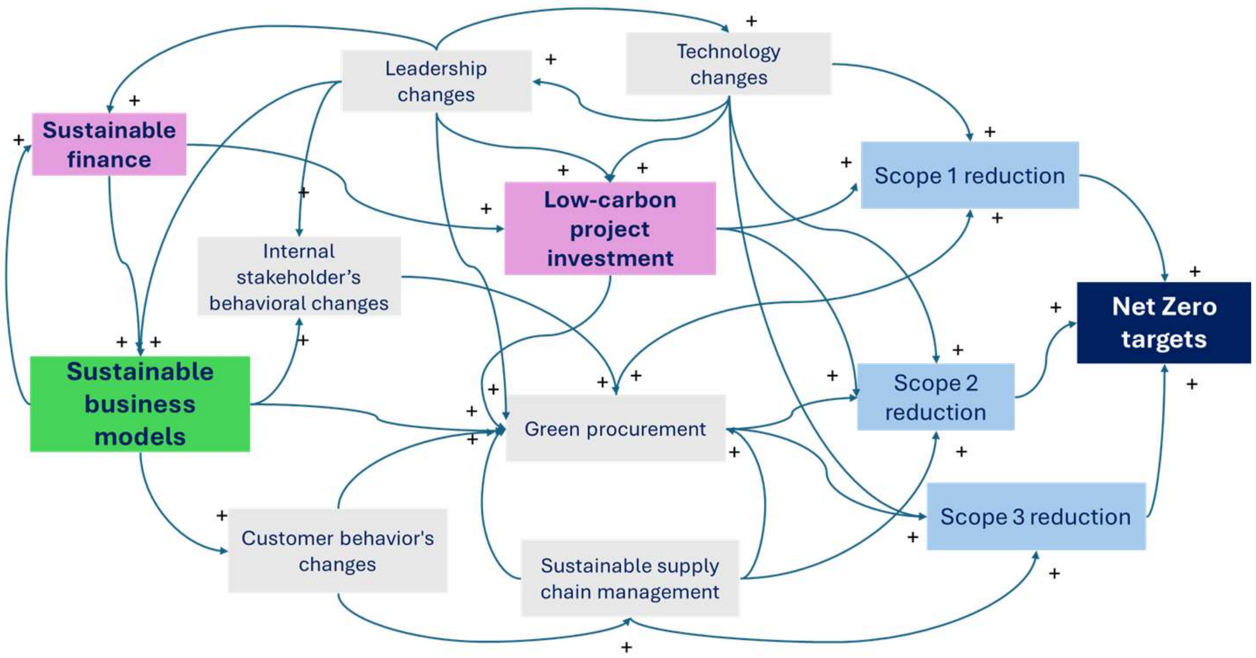
Interplay Between Business Models & Access to Finance

- **Business Models 📊:** A framework outlines how a company creates, delivers & captures value.
  - **Value proposition:** What unique value does the product/service offers to customers?
  - **Operating model:** How is the value delivered efficiently and effectively?
  - **Profit Formula:** How does the company generate revenue and earns profit from its activities?
- **Financing 💰:** Securing resources to cover operational expenses, investments, and other financial requirements.



The Strategic Role of SBMs

- Sustainable business models (SBM) integrate environmental, social and economic value creation into the core logic of how a firm operates.
- **Shape behaviors** of internal and external stakeholders, driving organizational transformation.
- Influence **financing strategies**, determine how investment decisions are made, and define approaches to risk management.
- The combination of SBMs with innovative financing strategies is essential to unlocking scalable solutions and achieving **Net Zero goals**.



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Research Questions

Business model shapes behaviors

Finance is the key

Questions

What ***motivates*** business to decarbonizing their cold chain?

What are the key ***challenges*** associated with financing innovations? and ***de-risk strategies***?

What is the role of ***business models*** in channeling financial resources and driving net zero?

Stakeholder Participatory Approach

Surveys, Interviews, Case studies (e.g., cost structures, investment dynamics, market demand).

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Methodology

- Methodological choice:
  - **Mixed approach**

- Techniques and procedures:
  - **Primary data** from **interviews & workshops.**
  - Secondary data from **databases** such as Refinitiv, Company websites (e.g., sustainability, financial reports), policy database.

- Coding data into categories.
- Thematic analysis
  - *A prior* themes from literature review.
  - *A posterior* themes from the process of exploring data.
- Case study analysis
- Cognitive mapping
- Machine Learning (e.g., Topic modelling) & Large Language Models (e.g., KIMI, reducing the rate of AI hallucinations).

Key Findings

Motivations

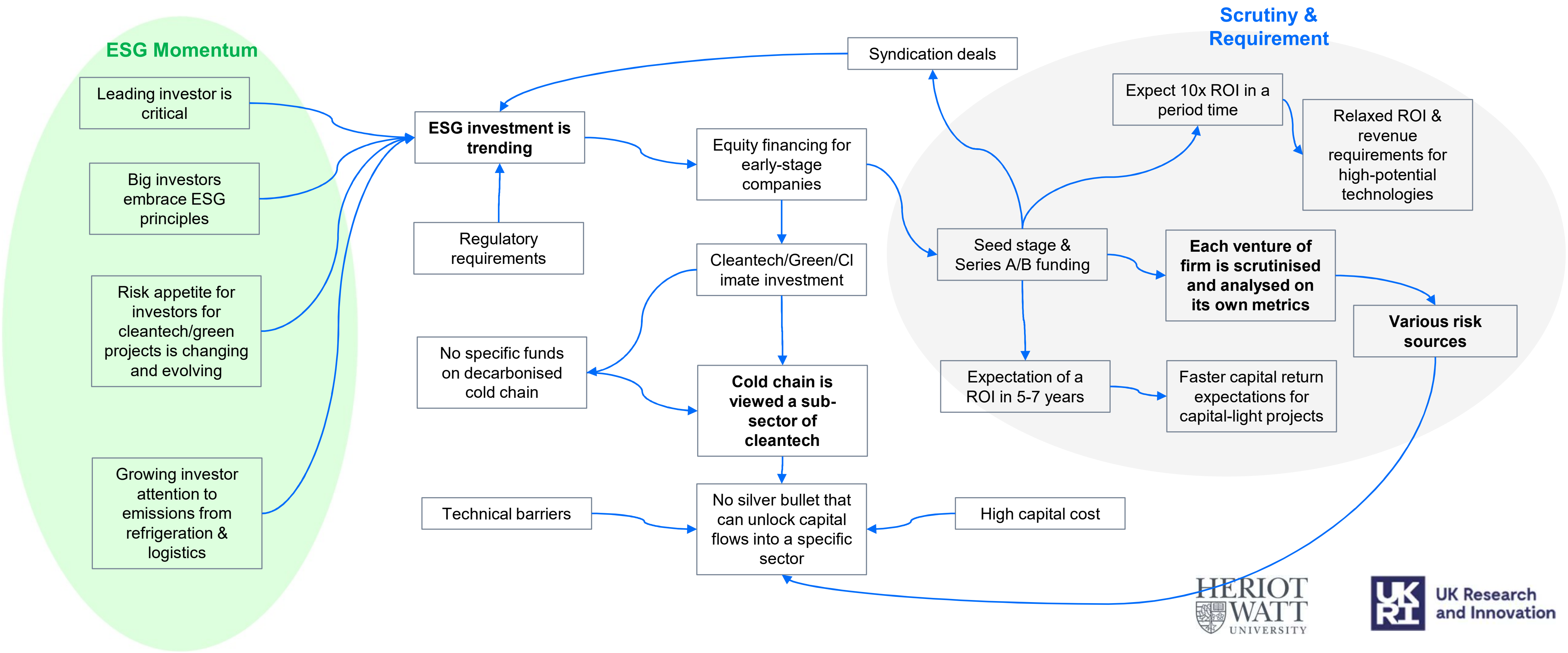
Motivations	CE Business	Investor
Policy Push e.g., ESG, Emission control, carbon pricing etc.	☑	☑
Market Pull e.g., Customer preferences; Competitor pressures.	☑	☑
Strategic & Stakeholder Relationships e.g., Access to sustainable finance; Resilience & risk management; catering stakeholder demands.	☑	☑
Reputation e.g., Self-realisation; Reputation risk management; ESG ratings.	☑	☑

- **Investment appraisal** based on a simple risk-return relationship, where Project/Firm A (Sustainable) dominates B (Alternative) if:

$$\boldsymbol{E(r_A) \geq E(r_B) \geq E(r_i)}\ \&$$
$$\boldsymbol{\sigma_A \leq \sigma_B \leq \sigma_i}$$

- How to reduce the ***risks/uncertainties*** associated with the sustainable options?
- How to demonstrate predictable ***cash flows*** and wider ***societal*** (e.g., policy, market, strategic, environment, well-being) benefits?

Investor Perspectives



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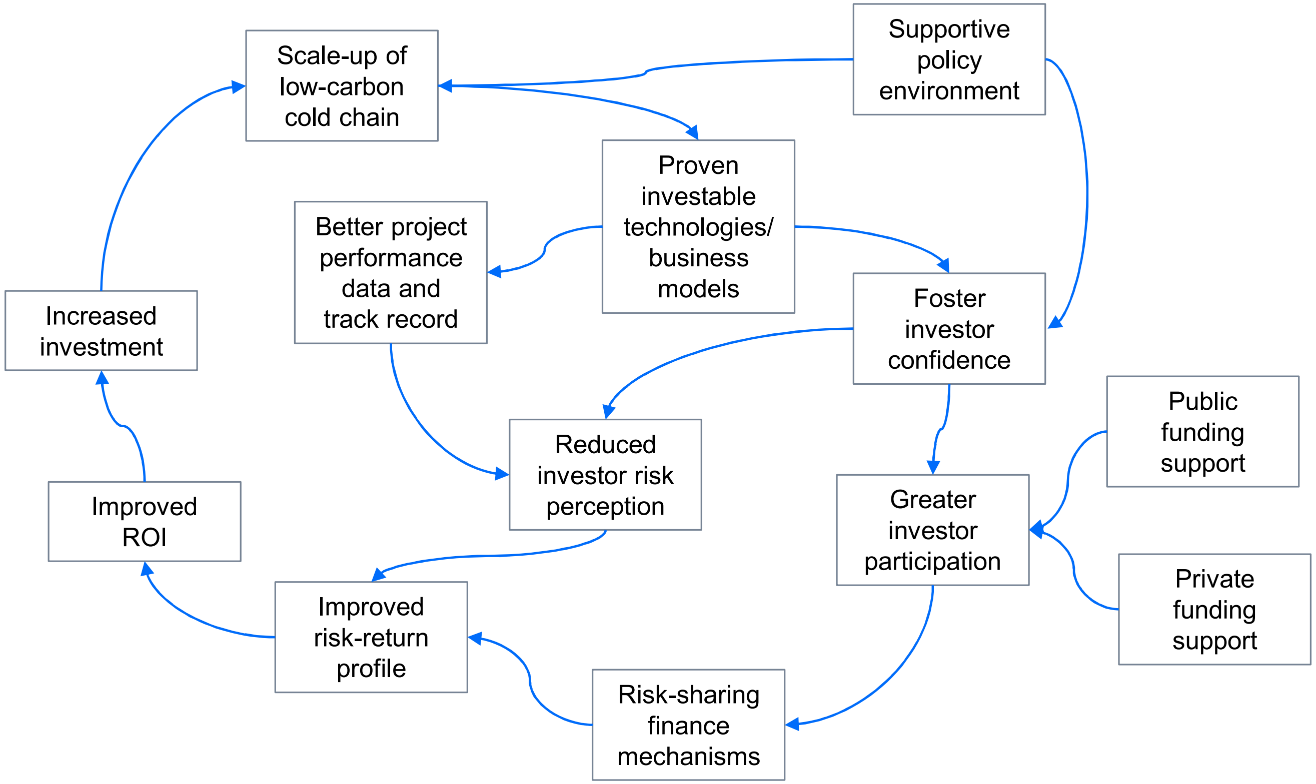
Foster Investor Confidence

Reinforcing loop:

Confidence-driven investment growth for low-carbon cold chain

- Greater investor confidence **(+)**, supported by policy, risk-sharing, and strong project performance, encourages more investment **(+)** in cold chain technologies/business models/ projects.
- Leads to higher returns **(+)**, scalable models, and stronger investor participation, which in turn further **(+)** builds confidence.



Business Perspectives

Lower-Tier Suppliers	B2B – Cooling Technology Companies	B2C-Retailers	End-used Customers
	STAR REFRIGERATION	TESCO	
	Eja-iCe	Sainsbury's	
	J&E Hall International	Morrisons Since 1899	
		ocado	

Upstream

Downstream

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Case Study
- Star Refrigeration (Technology Provider)

50+ Years of Cooling Innovation |
UK's Leading Refrigeration Engineering Company

Background

- **Est. 1970**: Over 50 years of engineering excellence.
- **Trusted Partner**: Serving SMEs to multinational blue-chip clients.
- **Core products & services**: Packaged refrigeration systems, custom cooling solutions (freezing & chilling), CO2 solutions, heat pumps & heat recovery, maintenance & support, consulting.
- **Sectors Served**: Food manufacturing, cold storage & logistics, dairy, brewing/distilling, HVAC, data centres, pharmaceuticals, petrochemical/nuclear, district heating & more.
- **The largest industrial refrigeration contractor** in the UK with a turnover of over £50 million per year.

Sustainability Leadership

- Exclusively utilise natural refrigerant.
- Specialise in constructing low charge ammonia chillers.
- Prioritise safety & efficiency in cooling systems.
- At the forefront of green/sustainable engineering with innovative climate-friendly equipment, durable system designs, energy optimised control software and aftercare to maximise operational efficiency.

Key Barriers

Barriers for Using low-GWP Refrigerants

High Synthetic Refrigerant Use

- ~42% of customers still use high-GWP refrigerants.

High Investment Costs

- Significant CAPEX required for upgrades, despite long-term savings.
- Rising interest rates add further financial pressure.

Long Payback Period

- ROI often exceeds business expectations.
- Short-term gains are prioritised over long-term benefits.

Policy & Regulatory risks

- Uncertainty around Frequency Control Ancillary Services (FCAS) and other evolving regulations.
- Approval delays from councils can hinger project rollout.

Internal Funding Competition

- Sustainability initiatives can lose out to production-related investments.

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Required Changes

Accelerate Sustainable Cooling Adoption

1. Unlock Financial Incentives

- Leverage government subsidies, tax reliefs, and grant programs to offset high upfront costs of low-carbon technologies.

2. Innovative Business Models

- *Cooling-as-a-service:* Shift from capital-intensive investments to flexible, pay-per-use models that remove adoption barriers and incentivise efficiency.

3. Strengthen Public-Private Collaboration

- Foster deeper partnerships between industry and government to align policy, optimise incentive delivery, and scale sustainable cooling solution effectively.

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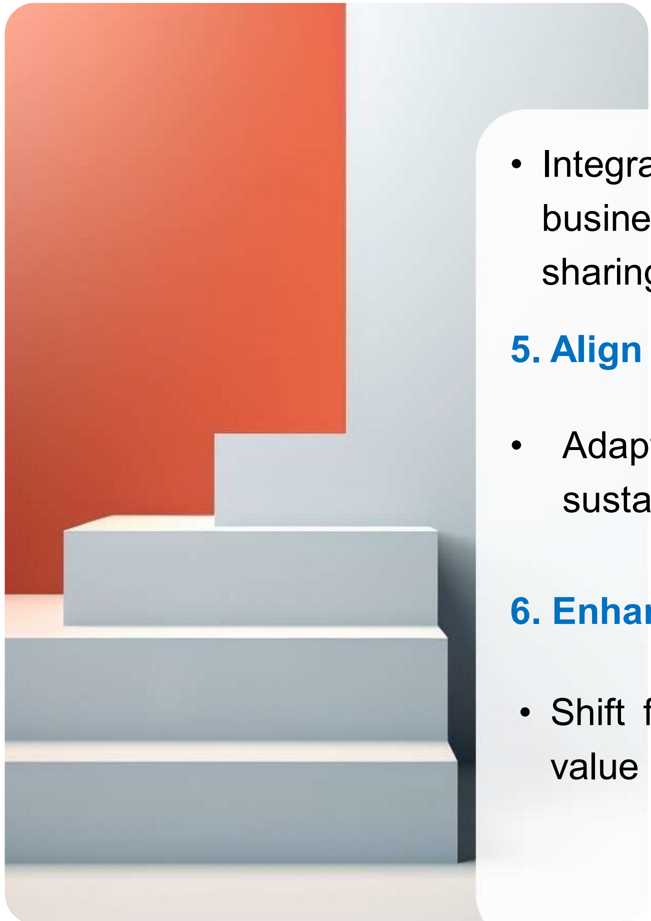
Required Changes



4. Adopt Circular Economy (CE) Models

- Integrate CE principles (e.g., reuse, refurbishment, industrial symbiosis) into business models to reduce waste & environmental impact, promote resource sharing, and extend equipment lifecycles.

5. Align with Institutional & Regulatory Drivers

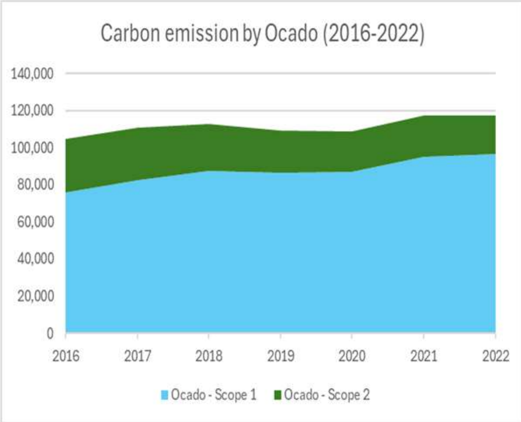
- Adapt to evolving regulations and market pressures by integrating long-term sustainability planning into core strategies.

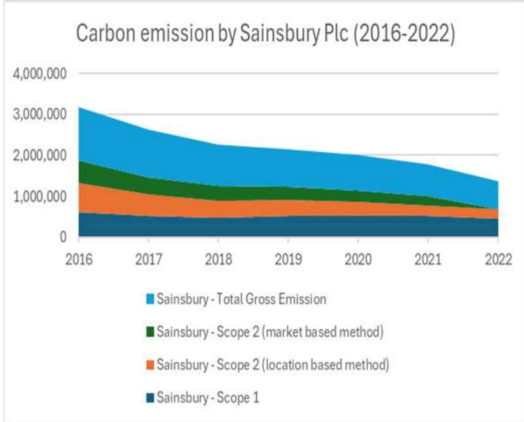
6. Enhance B2B Collaboration

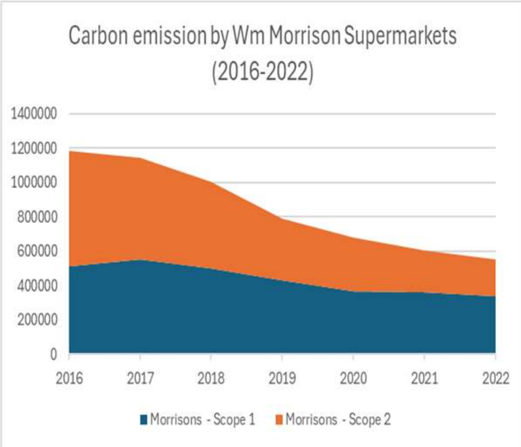
- Shift from transactional relationship to strategic lifecycle partnerships across the value chain to unlock efficiency, innovation, and resilience.

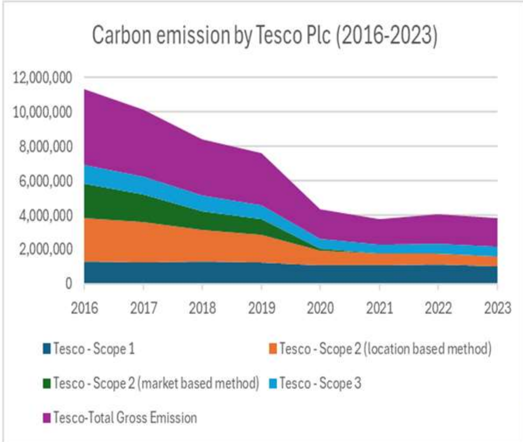
Case Study
- Supermarkets

- **Major emitters & refrigeration** is essential for maintaining quality and longevity of a variety of food products.
- Significant ***opportunities for emission reductions*** through targeted actions.
- **Integrated Systems**: Combine logistics, transportation & cold storage.
- **Industry Influence**: Business model shifts impact the entire cold chain.
- **Data Availability**: Robust data supports informed decisions.
- Direct interaction with consumers offer valuable insight into behavioral change and education.

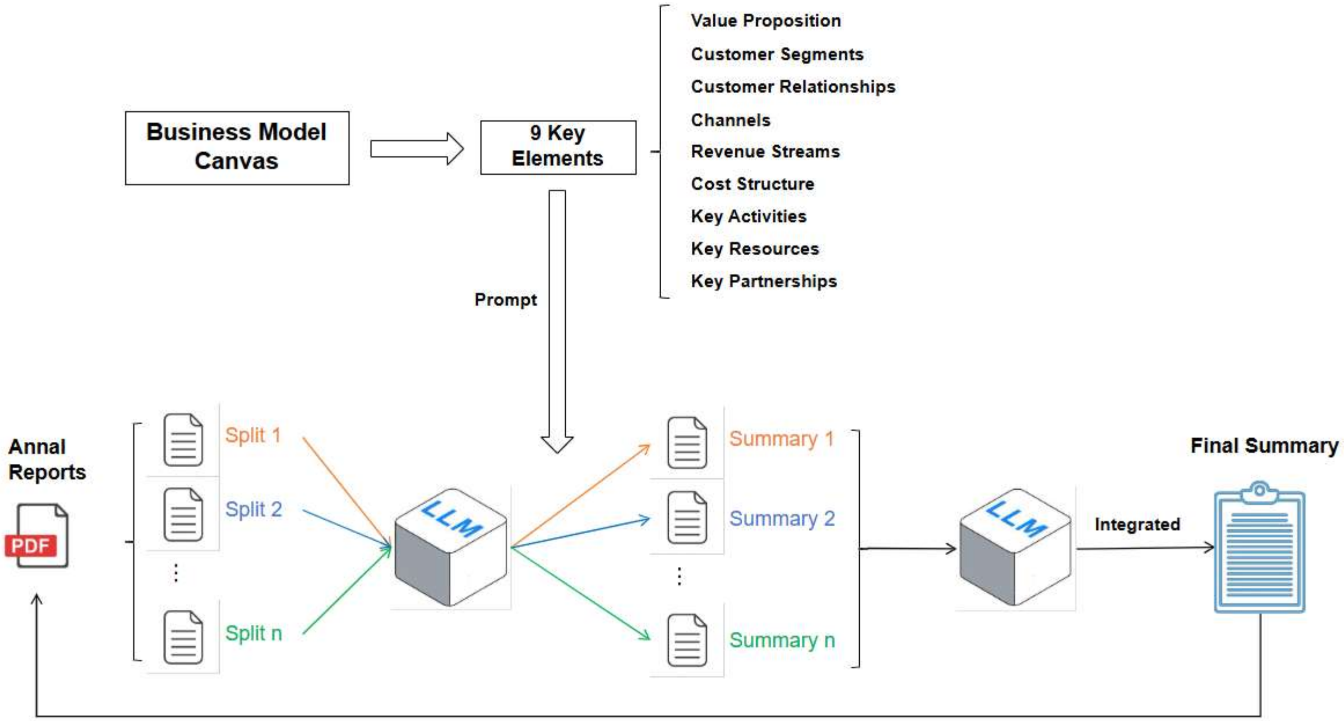








Large Language Model (LLM)



LLM - Key Steps

- Divide reports into ***n*** equal parts.
- Generate a summary by LLMs based on the Business Model Canvas keywords, net zero & cooling strategies.
- To merge these ***n*** summaries to create a unified summary of the annual report.
- **Benefits**: scalability; speed & efficiency' consistency; expert validations.

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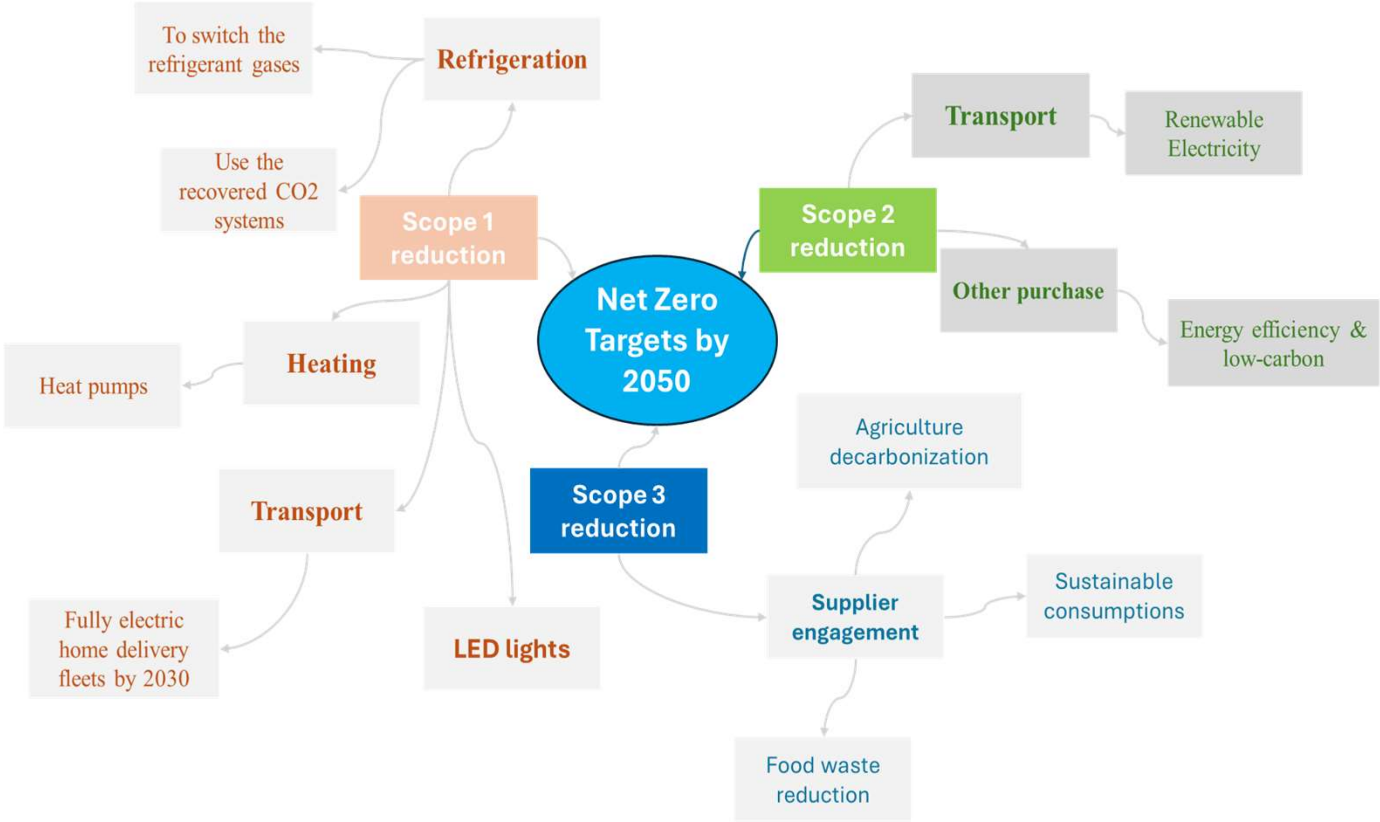
Decarbonization Efforts

- ✓ A variety initiatives being implemented to reduce S1 & S2 across ***key emission hotpots:*** Refrigeration; Heating; Transport.
- ✓ ***Supplier engagement*** activities are being implemented to decarbonize the whole supply chain (S3).
- ✓ Business models' ***limitations*** across all key elements of the business model.
- ✓ Shortage in SBMs ***hinder financing strategies*** for decarbonization practices.

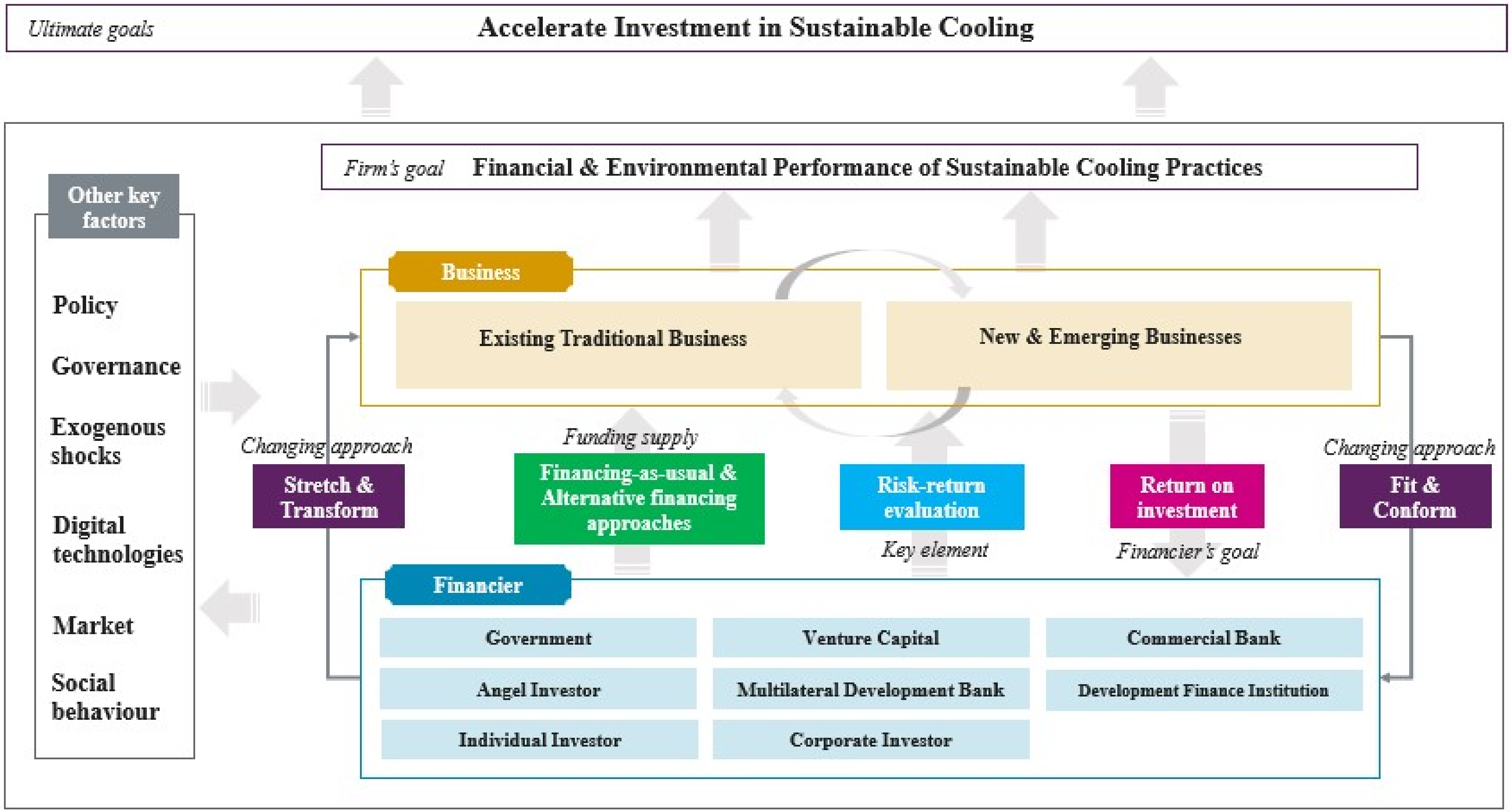


Reflections & Takeaways

Collaboration

- **Signalling effect [+]:** signal their decarbonisation commitment.
- **Herding behaviour [+]:** growing awareness of climate change; momentum around ESG, sustainable investment; ***reputation costs*** of companies not meeting, over/less committed.
- **Market demand [+]:** increased market demand for low-carbon cold chain technologies is generating both intangible (e.g., brand value) & tangible (e.g., financial return) value creation opportunities; enhance stakeholder relationships.
- **Expectations mismatch [-]:** gaps between investor expectations (e.g., short-term ROI) & business realities (e.g., long deployment cycles) slow decision-making & adoption.

Conceptual Model



Sustainable Cooling is A COMPLEX SYSTEM with WICKED PROBLEMS…

… We cannot wait for the STARS TO ALIGN naturally…

… we need to HELP THEM TO ALIGN by

- Looking at the big picture
- Policy, regulation and incentives
- Business models
- Financial flows
- Technology
- Changing perceptions

Thank You!

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