



34th Annual **INCOSE**
international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024



Designing Sustainable Products

Submission 175

2-6 July 2024

www.incose.org/symp2024 #INCOSEIS



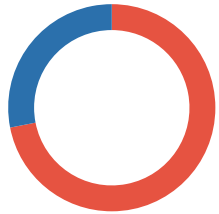
Jim Marsh
IBM Sustainability Software



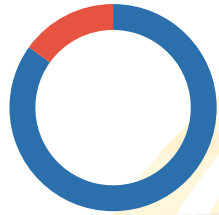
Edmund Mayer, PE
IBM Sustainability Software



Why are we concerned with sustainability?



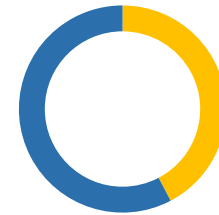
Government Entities
sustainability mandates –
current and upcoming



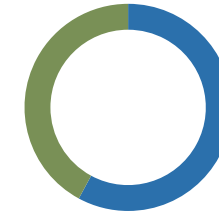
Industry or corporate goals



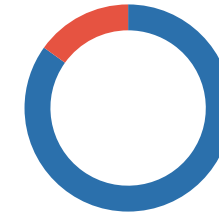
Be a good global citizen



EU Taxonomy Regulation



Singapore 2025



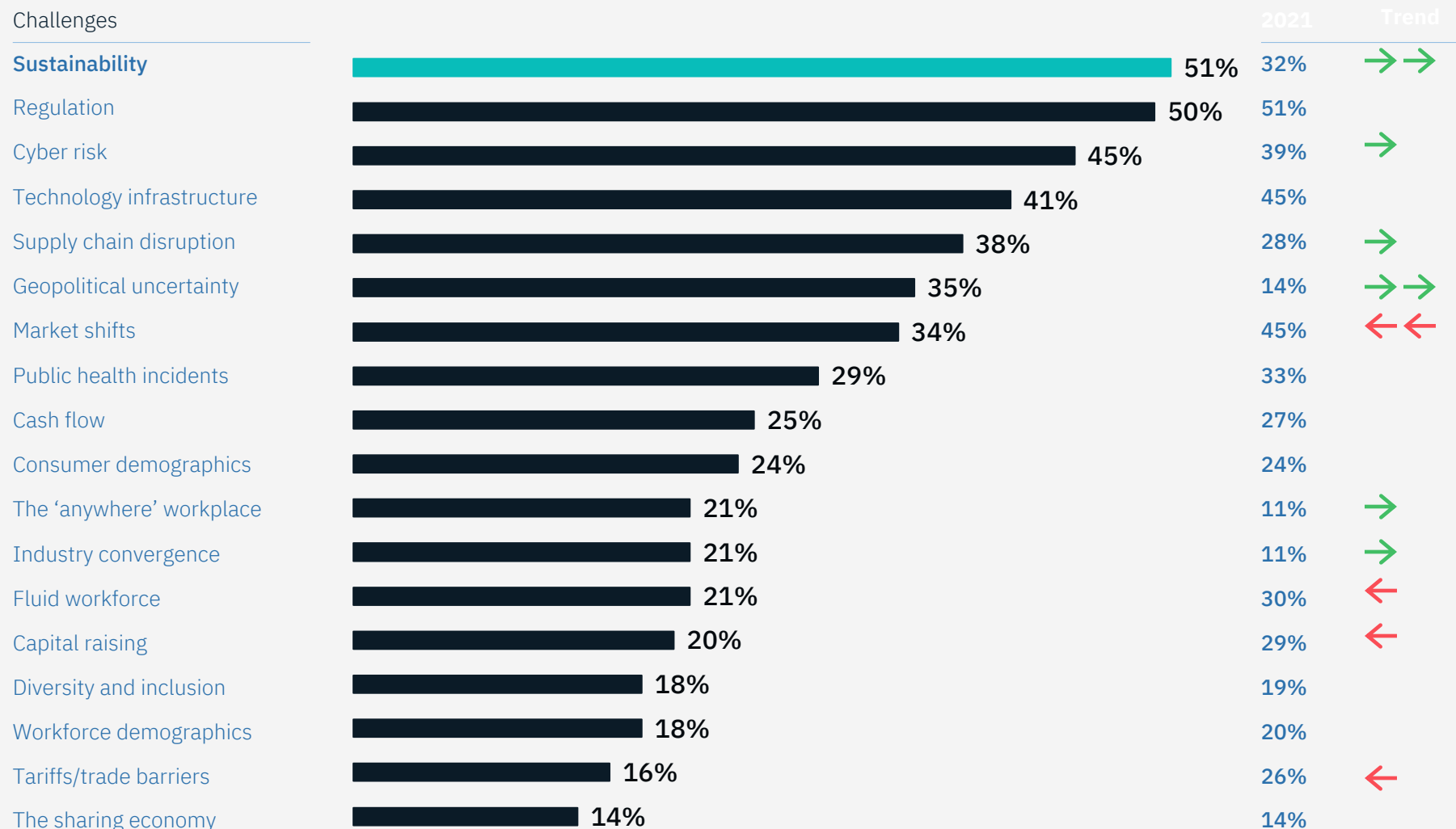
US Securities and
Exchange Commission
(SEC)

- Transformational sustainability—
Priority and challenge

CEOs most frequently identify sustainability as their greatest challenge

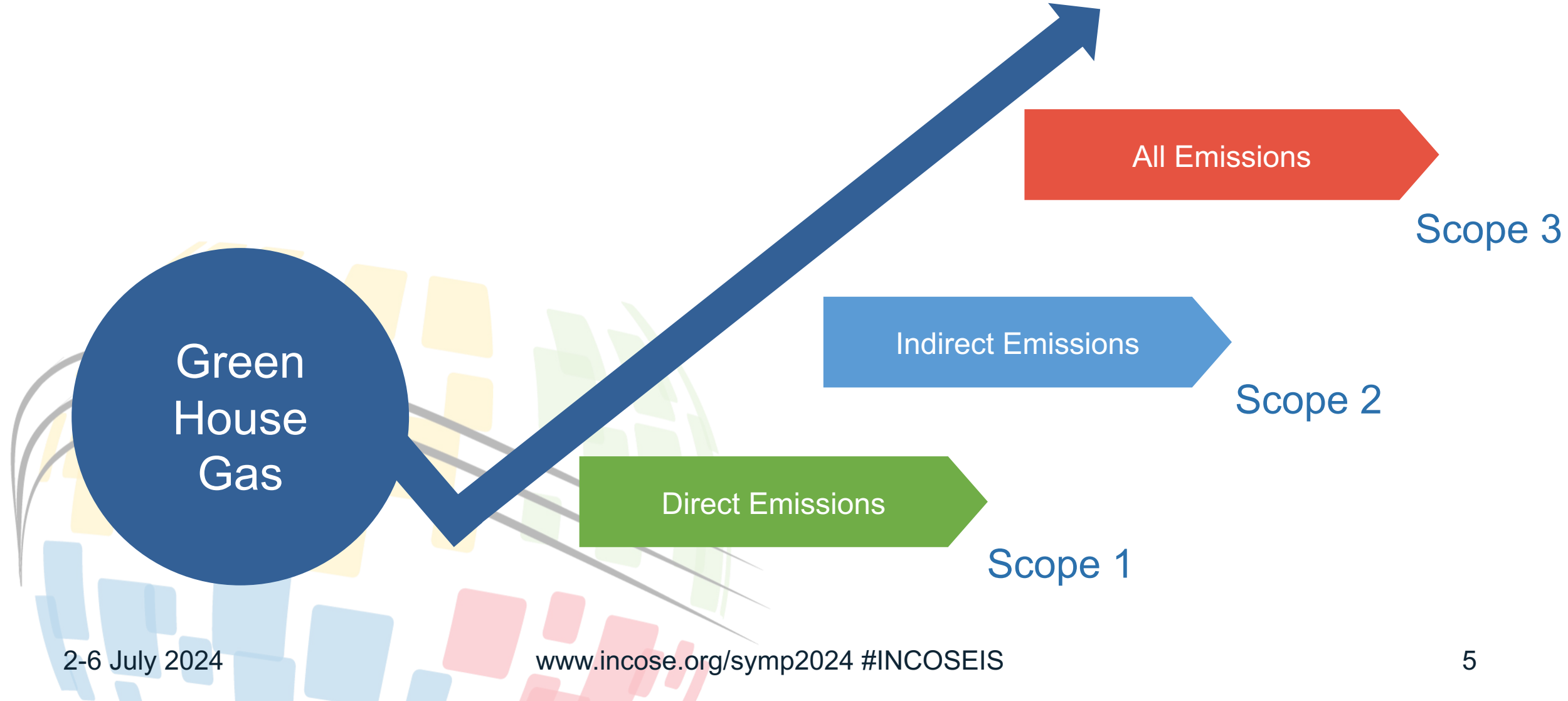
- Q2. What do you expect will be the greatest challenges for your organization over the next 2–3 years?

Expected greatest challenges for your organization over the next 2–3 years



→→ Increase >10% → Increase 5-10% ←← Decrease >10% ← Decrease 5-10%

Sustainability Emissions Tracking and Reporting



Two Engineering Dimensions

- Sustainably Designing Products
 - Becoming more efficient in the actual development, building, creation of products process.
- Designing Sustainable Products
 - Building Products that meet efficiency goals
 - Consume less raw, materials, less energy, new efficiency methods, reusable products

“Sustainable Design” is a series of deliberate choices to create products with a positive impact on the world

Definition

Sustainable design is an approach to creating products that have minimal negative impact on the environment and society, while maximizing positive economic, social and environmental benefits

Sustainable design aims to...

- ✓ Optimize the product lifecycle
- ✓ Extend the life cycle by designing products to last
- ✓ Design for disassembly and plan for the product's next life
- ✓ Make recycling part of your design strategy
- ✓ Prioritize energy efficiency with:
 - efficient design
 - sustainable power sources and
 - materials with low embodied energy
- ✓ Use fewer resources by light-weighting designs
- ✓ Avoid materials that increase pollution
- ✓ Choose materials that are abundant and sustainable

The demand for sustainable design is growing as consumers and regulators demand sustainable products

Consumers

“Over 70% of respondents are willing to pay a premium for sustainable products”

- McKinsey & Company (2021)

“Sales of sustainable products in the U.S. grew by 20% between 2014 and 2019”

- Nielsen (2019)

“Sustainable brands grew 69% faster than the rest of the business”

- Unilever (2019)

“Products with sustainability claims on their packaging outperformed their counterparts in sales growth by 5.6%”

- Nielsen (2018)

“60% of consumers in the U.S. and Canada said they are more environmentally friendly today than they were 5 years ago, and 76% said they intend to be even more environmentally friendly in the next 5 years”

- Accenture (2018)

“61% of Gen Z consumers are willing to pay more for eco-friendly products”

- Global Web Index (2019)

Regulators

EU 2005

The **Ecodesign Directive** aims to reduce the environmental impact of energy-related products throughout their lifecycle

EU 2008

The **Waste Framework Directive** sets out waste hierarchy, which prioritizes waste prevention, reuse, and recycling over disposal

EU 2007

REACH regulation requires companies to register and assess the risks of chemicals used in their products

US Government
1993

Federal Green Procurement Program requires federal agencies to purchase environmentally preferable products and services

EU 2022

Sustainable Products Initiative aims to make products more sustainable throughout their lifecycle, from design to disposal

EU 2015

The **Circular Economy Action Plan** is a set of initiatives and policies developed to transition to a more circular economy

The demand for sustainable design is particularly strong within auto and aerospace

The auto industry



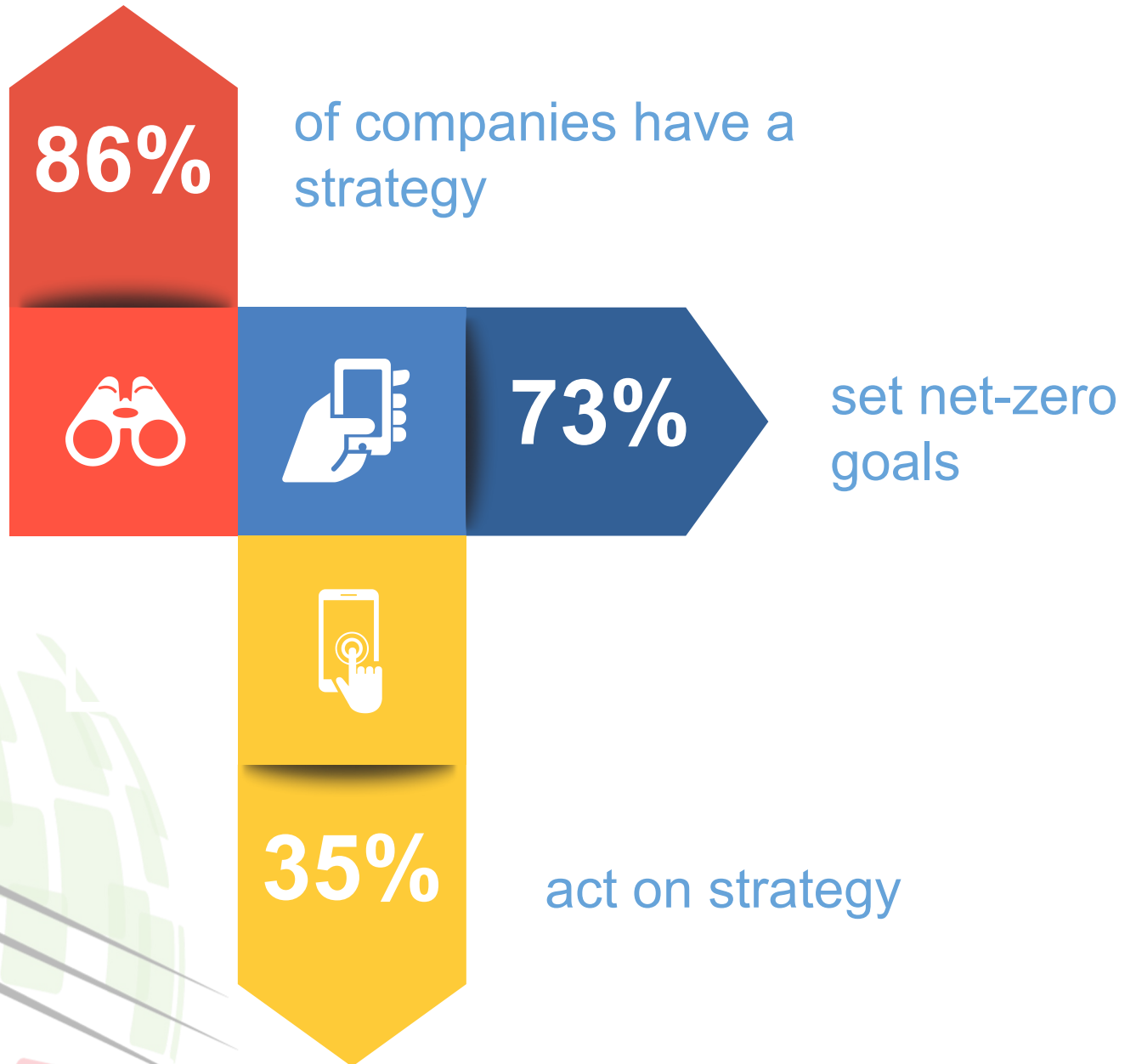
- OEMs have stated goals to **slash CO₂ emissions**, often by **more than 50%** within the **next 10 years**
- A key focus is on adjusting and **reducing the quantities** of raw materials used per vehicle
- They are also incorporating **full product lifecycle perspectives**, such as designing products and operations to support battery recycling
- OEMs are embedding **sustainability approaches into the design and development** of all vehicles

The aerospace industry



- In 2019, Airbus announced the development of **three zero-emission** concept aircraft and in 2020, Boeing announced plans to test a **fully electric aircraft**
- Boeing's 787 is designed to be **20% more fuel-efficient** than previous models, and uses **lighter materials** to reduce weight and increase efficiency
- In 2020, the Air Transport Action Group launched a campaign encouraging travelers to make **more sustainable choices**

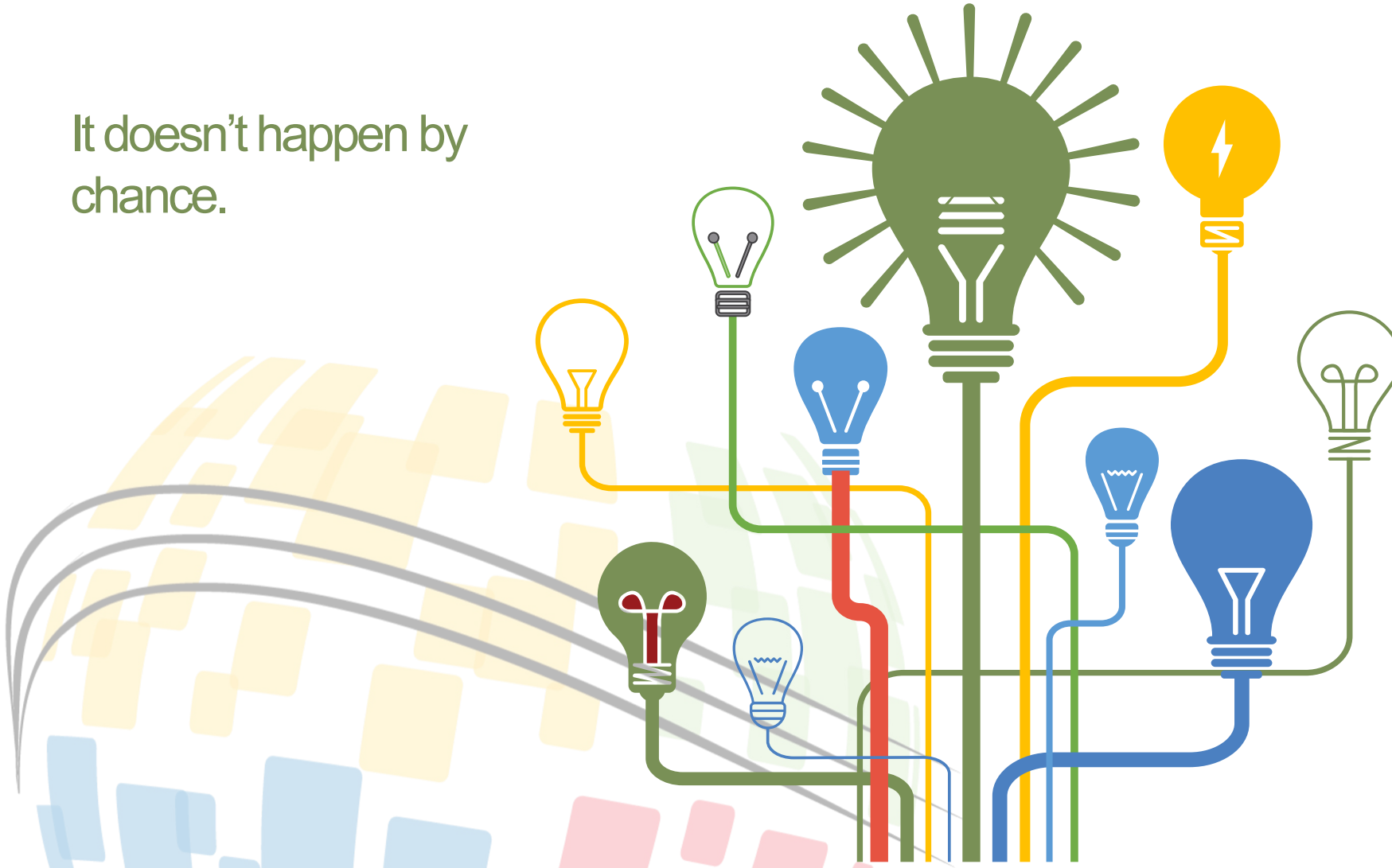
Achieving
sustainability demands
a transformation of
thought



How do we meet our sustainability goals?

It doesn't happen by chance.

It must be designed and engineered



European Union Taxonomy Regulation

“The EU Taxonomy is a green classification system that translates the EU’s climate and environmental objectives into criteria for specific economic activities for investment purposes”.

It is a transparency tool that will introduce **mandatory disclosure** obligations on some companies and investors, requiring them to disclose their share of Taxonomy-aligned activities.” ec.europa.eu, 2023.

https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-taxonomy-faq_en.pdf

EU Taxonomy Regulation Objectives



Climate change mitigation



Climate change adaptation



The protection and restoration of biodiversity and ecosystems



The transition to a circular economy



Sustainable use of water & marine sources



Pollution prevention and control



How do we consume the directives?

Dabbling at the edges no longer suffices, must start at the design phase. “80% of a product’s lifetime emissions is determined by product design”. Fuchs, 2022.

80%

Emissions



Compliance

Coverage Analysis



Mitigating Risks

What could go wrong?



Single Version of Truth

Transparency



Audit Ready

Built in Process

EU Taxonomy Compass

EU Taxonomy Compass

Construction of new buildings contribution to climate mitigation

Q

const

Sector ▾	Activity ▾	Climate mitigation	Climate adaptation	Water
Construction and real estate activities	Construction of new buildings	+	+	
Construction and real estate activities	Renovation of existing buildings	+	T	+
Construction and real estate activities	Installation, maintenance and repair of energy efficiency equipment	+	E	+
Construction and real estate activities	Installation, maintenance and repair of charging stations for electric vehicles in buildings (and parking spaces attached to buildings)	+	E	+

Description ▾

Substantial contribution criteria ^

Constructions of new buildings for which:

- The Primary Energy Demand (PED)⁽²⁸¹⁾, defining the energy performance of the building resulting from the construction, is at least 10 % lower than the threshold set for the nearly zero-energy building (NZEB) requirements in national measures implementing Directive 2010/31/EU of the European Parliament and of the Council⁽²⁸²⁾. The energy performance is certified using an as built Energy Performance Certificate (EPC).
- For buildings larger than 5000 m² ⁽²⁸³⁾, upon completion, the building resulting from the construction undergoes testing for air-tightness and thermal integrity⁽²⁸⁴⁾, and any deviation in the levels of performance set at the design stage or defects in the building envelope are disclosed to investors and clients. As an alternative; where robust and traceable quality control processes are in place during the construction process this is acceptable as an alternative to thermal integrity testing.
- For buildings larger than 5000 m² ⁽²⁸⁵⁾, the life-cycle Global Warming Potential (GWP)⁽²⁸⁶⁾ of the building resulting from the construction has been calculated for each stage in the life cycle and is disclosed to investors and clients on demand.

Do no significant harm criteria ^

Climate adaptation ▾

Water ▾

Circular economy ▾

Pollution prevention ▾

Biodiversity ▾

Minimum safeguards ▾

Sustainability Steps in Systems Engineering

Step 1: Allocate Requirements

Step 2: Develop design requirements and show compliance

Step 3: Validate the requirements using MBSE and model validation

EU Taxonomy Regulations

Structured document view with links and metadata

IBM Engineering Requirements Management DOORS Next (Jm)

Olive Oil Requirements

Project DashboardArtifactsReviewsReports

← | ... / 07-EU Regulation / | :: 5298 EU Taxonomy Regulation ?

CreateType to filter artifacts by text or by ID ?

Views

Search Views

ID	Contents
5306	Building designs and construction techniques support circularity for assessing the disassembly or adaptability of buildings, how dismantlable to enable reuse and recycling.
5315	Building components and materials used in the construction of buildings shall have low levels of volatile organic compounds (VOC) and formaldehyde per m³ of material or component upon testing in accordance with EN ISO 16000 methods(292).
5307	Where the new construction is located on a potentially contaminated site, measures shall be taken to ensure that the construction process does not release contaminants, for example using standard ISO 18400(293).
5316	Measures are taken to reduce noise, dust and pollutant emissions from construction activities.
5316	The activity complies with the criteria set out in Appendix D. The new construction is not built on one of the following: <ul style="list-style-type: none">a. arable land and crop land with a moderate to high level of biodiversity value and greenfield land of recognised high biodiversity value and European Red List(295) or the IUCN Red List(296);b. land matching the definition of forest as set out in national legislation in accordance with the FAO definition of forest(297);
5353	• 1.2 Renovation of existing buildings
5354	Construction and civil engineering works or preparation thereof. The economic activities in this category could be associated with several NACE codes, in particular F41 and F43 in accordance with the statistical classification of economic activities established by Regulation (EC) No 1893/2006. An economic activity in this category is a transitional activity as referred to in Article 10(2) of Regulation (EU) 2020/852 where it complies with the technical screening criteria set out in this Section.
5355	• 1.2.1 Climate mitigation
5356	• 1.2.1.1 Substantial contribution criteria
5357	The building renovation complies with the applicable requirements for major renovations(298).
5358	Alternatively, it leads to a reduction of primary energy demand (PED) of at least 30 % (299).

EN

Location
Olive Oil Requirements EU Taxonomy Regulation

Attributes
Type: Information Format: File
Description: Team Ownership: Olive Oil Requirements

In Modules
Standard Specification: 5298

Category	EU Taxonomy Criteria Type	EU Taxonomy Category
y buildings	Do no significant harm criteria	Pollution prevention
y buildings	Do no significant harm criteria	Biodiversity

Showing 57 of 57 (100%)

EU Taxonomy Regulations

Structured document view with links and metadata

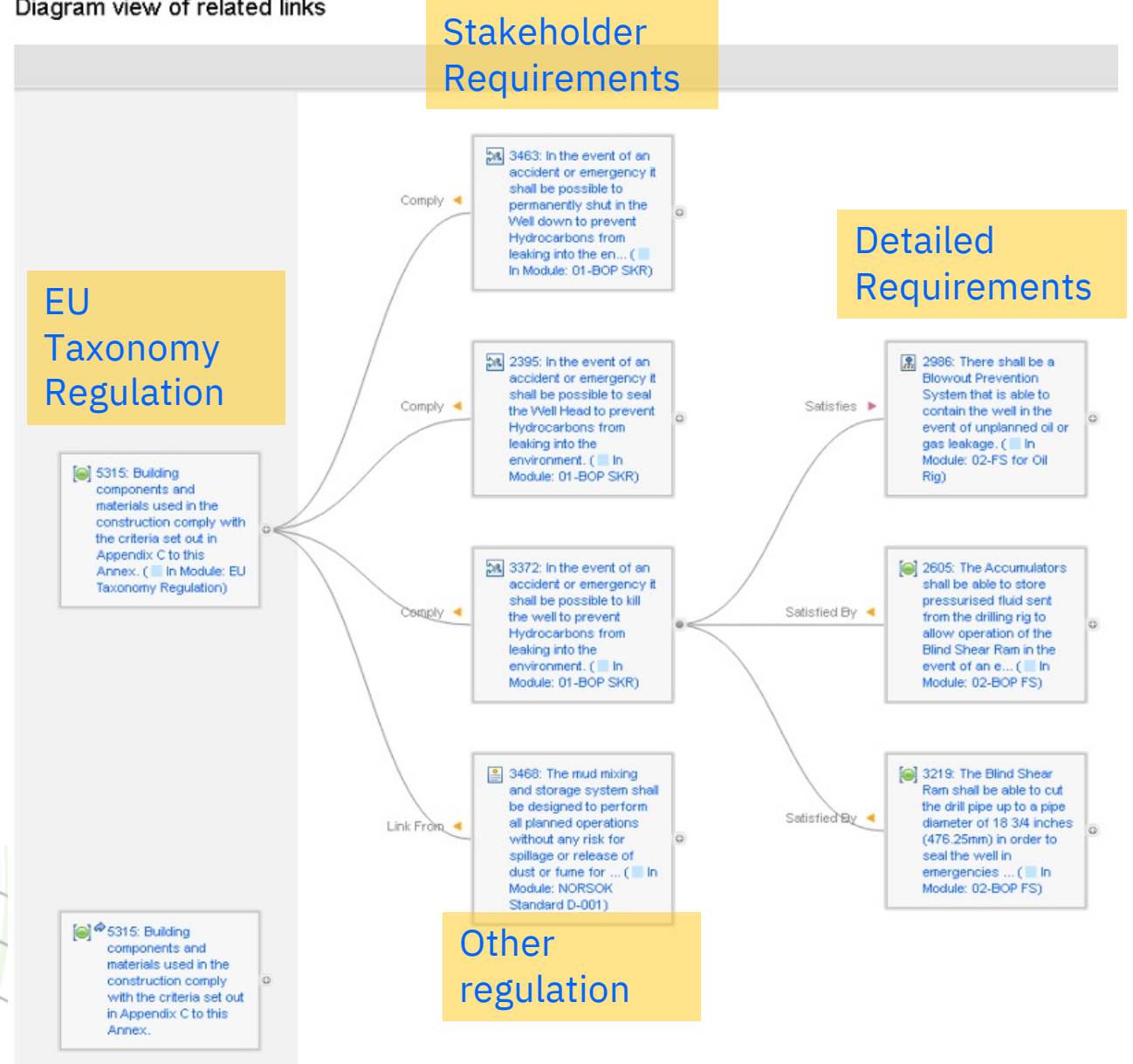
ID	Contents	EU Taxonomy Activity	EU Taxonomy Category	EU Taxonomy Criteria ...	Comply
	demonstrate, with reference to ISO 20887(288) or other standards for assessing the disassembly or adaptability of buildings, how they are designed to be more resource efficient, adaptable, flexible and dismantlable to enable reuse and recycling.				
141525	• 1.1.5 Pollution prevention				
141248	<p>Building components and materials used in the construction comply with the criteria set out in Appendix C to this Annex.</p> <p>Building components and materials used in the construction that may come into contact with occupiers(289) emit less than 0,08 mg of formaldehyde per m³ of material or component upon testing in accordance with the conditions specified in Annex XVII to Regulation (EC) No 1907/2006 and less than 0,001 mg of other categories 1A and 1B carcinogenic volatile organic compounds per m³ of material or component, upon testing in accordance with CEN/EN 16516(290) or ISO 16000-3:2011(291) or other equivalent standardised test conditions and determination methods(292) .</p> <p>Where the new construction is located on a potentially contaminated site (brownfield site), the site has been subject to an investigation for potential contaminants, for example using standard ISO 18400(293) .</p> <p>Measures are taken to reduce noise, dust and pollutant emissions during construction or maintenance works.</p>	Construction of new buildings	Pollution prevention	Do no significant harm criteria	141559:In the event of an accid... 142868:In the event of an accid... 142835:In the event of an accid...



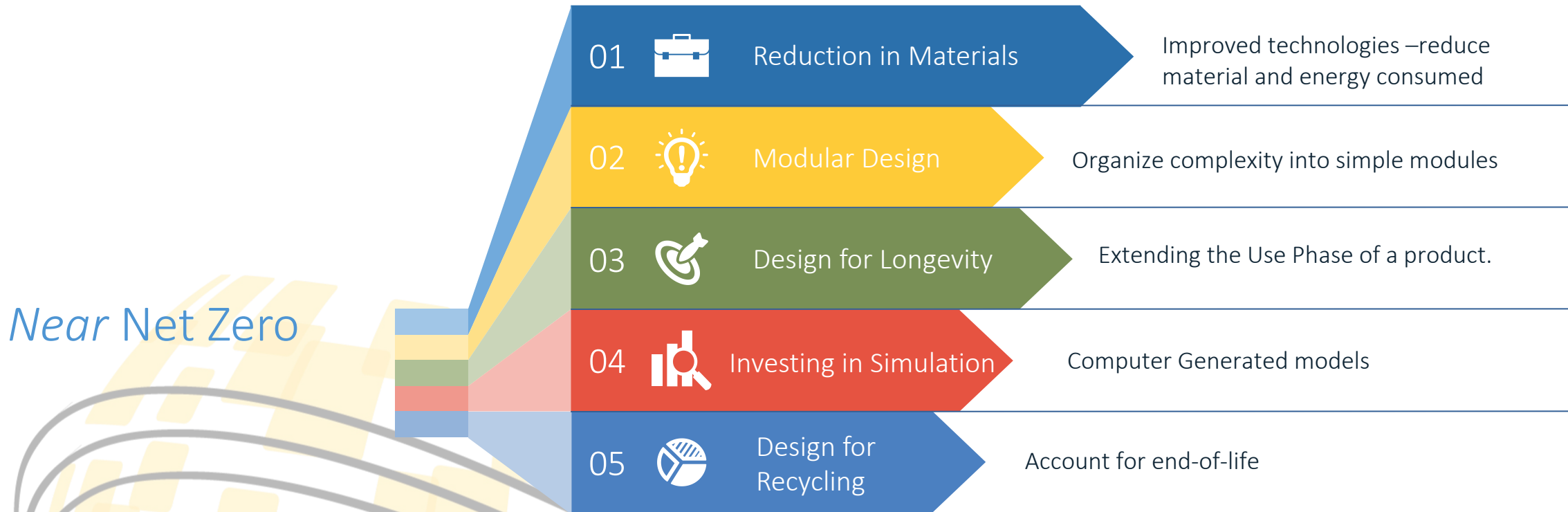
EU Taxonomy Regulations

Digital Transformation view of linked data to do impact assessments and get an overview of compliance links

Diagram view of related links



Design for Sustainability -- DfS



Design for Circular Economy

Recycle

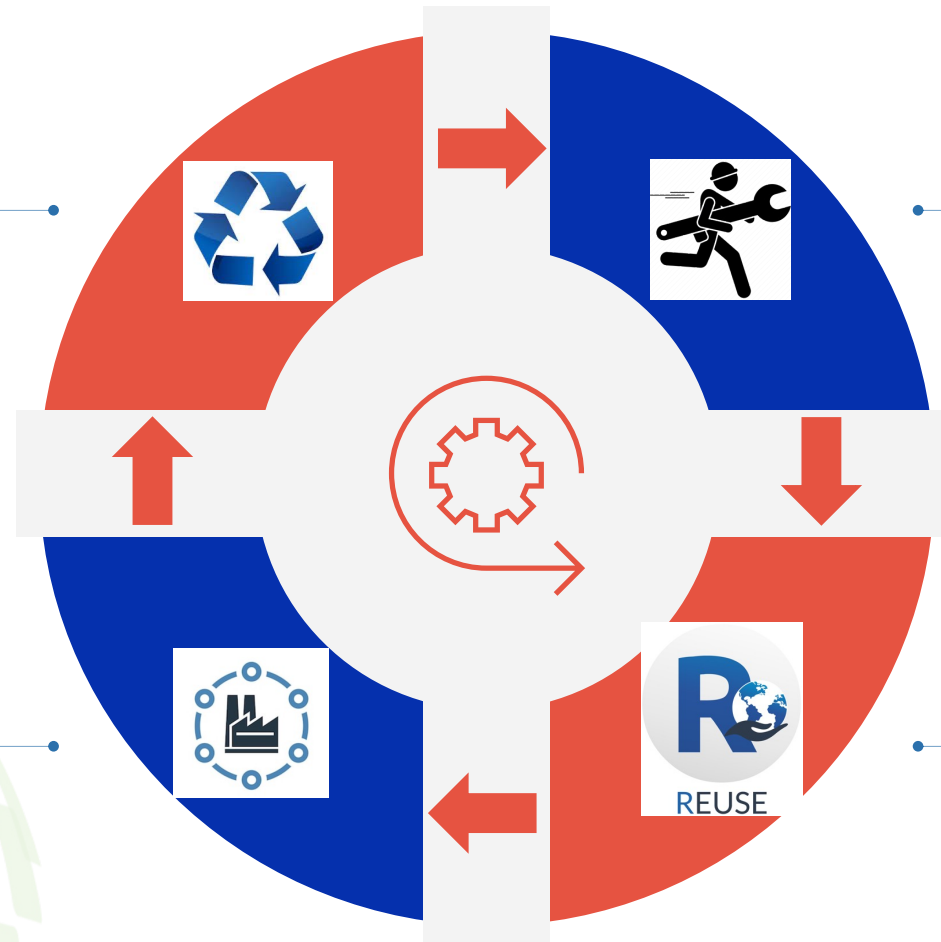
Refurbish

Reman

Reuse

4R Strategy

Target Markets:
Automotive
Aerospace & Defence
Electronics
Medical Devices
Universities & Research Centers



Cross Compliance – Automotive Space

In **2022**, the European Parliament approved a **new directive on battery management**.

-- **govern the entire product life cycle**, from design to consumption and all the way to recycling into new products

"...propose stronger **requirements on sustainability**, performance and labelling,"



New regulations → demonstrates **compliance**

New regulations → to adopt **4R strategy: Reman - Recycle - Reuse - Repair**

DfS in Action



- Reduce use of nonrenewable resources and lower product carbon and water footprint
- Lifecycle approach: design □ manufacturing □ use □ end of life
- Reduction of Scope 3 emissions by 65% (2005 – 2022)
- Recent washer saves up to 45% water and 30% energy per load.

<http://whirlpoolcorp.com/2022SustainabilityReport/environmental/sustainable-products/innovation.php>

Honeywell



- The Micro Vapor Cycle System is a cooling solution for urban air mobility aircraft and military & civil helicopters
- 35% lighter and 20% more efficient than conventional vapor cycle systems
 - Reduce product development cycle time by half
 - Reduce R&D investment by 30%
 - Leverage common base design across multiple variants

<https://aerospace.honeywell.com/us/en/about-us/blogs/honeywell-micro-vcs-game-changing-cooling-system-boosts-military-capabilities>

A man with a beard, wearing a white long-sleeved shirt and dark trousers, is riding a silver bicycle towards the camera on a modern bridge. He has a maroon bag slung over his shoulder. The bridge features a complex steel truss structure with diagonal beams. The ground is paved with light-colored bricks. The sky is clear and blue. The overall scene is bright and sunny, with shadows cast on the bridge deck.

Turn sustainability
ambition into action

Chríochnaigh
& Ceisteanna

Finish
& Questions

References

Fuchs, Stephan, et al. “Product Sustainability: Back to the Drawing Board.” McKinsey & Company, McKinsey & Company, 7 Feb. 2022, www.mckinsey.com/capabilities/operations/our-insights/product-sustainability-back-to-the-drawing-board.

Council Adopts New Regulation on Batteries and Waste Batteries, www.consilium.europa.eu/en/press/press-releases/2023/07/10/council-adopts-new-regulation-on-batteries-and-waste-batteries/.

Commission Notice on the Interpretation and Implementation of Certain ..., eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C_202300305.

whirlpoolcorp.com/2022SustainabilityReport/environmental/sustainable-products/innovation.php

<https://aerospace.honeywell.com/us/en/about-us/blogs/honeywell-micro-vcs-game-changing-cooling-system-boosts-military-capabilities>



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