CLIMACT

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IDEA CONSULT thinking ahead

Socioeconomic impacts assessment of the climate transition in Belgium

Factsheet – Research and development sector

Santé publique
Sécurité de la Chaîne alimentaire
Environnement

Introduction

- **Disruptive technological advancements are key to the transition to a climate neutral Belgium**, whether we look at a technology-driven or a behaviour-driven scenario. Most of R&D expenses come from the private sector.

- **The R&D effort is highly concentrated**. The world's top 2000 R&D investors own 70% of global climate change mitigation or adaptation patents.

- Young firms develop more radical innovations and are therefore more likely to generate the breakthrough discoveries needed to achieve net-zero emissions (Amoroso et al., 2021). In terms of employment, this may lead to two different dynamics, with a globalised labour market for top R&D investors, and a more local market for disruptive companies.

- **Detailed information on research and development (R&D) spending of the private sector is very limited**. This factsheet uses a series of proxies to frame a discussion on the need for high STEM skills that the climate transition could generate in Belgium, given the R&D priorities set out by the Regions and the progressive structuring of clusters and innovative ecosystems.

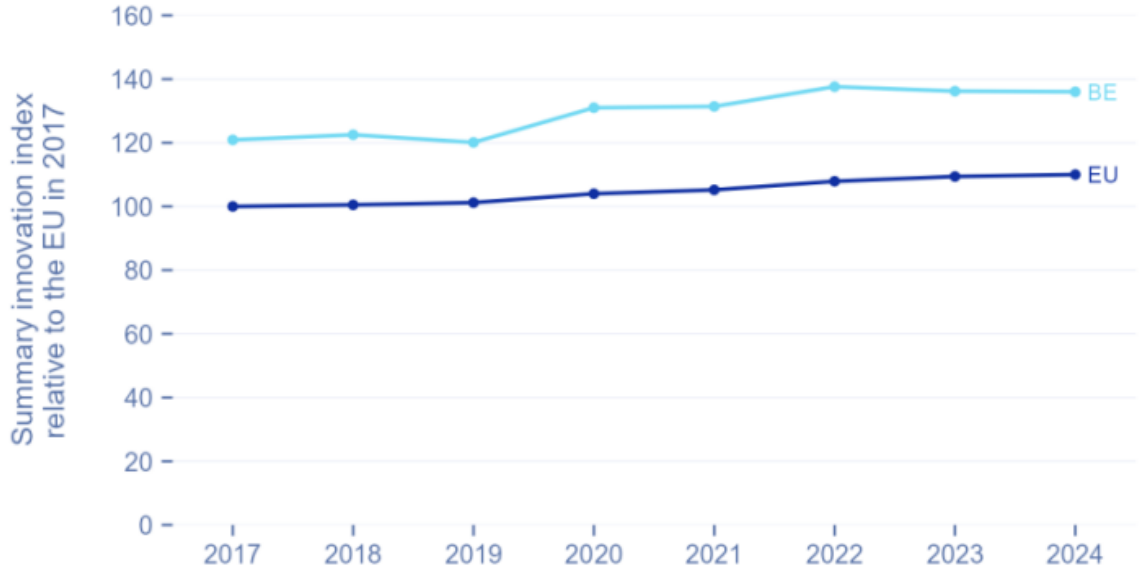
- **The redirection of R&D investments towards low-carbon technologies will lead to a job loss in some R&D activities. Due to time constraints, these job losses are not studied in this factsheet.**

- **Besides R&D in energy efficient and/or low-carbon technologies, research in human and social sciences is fundamental to better understand the sociotechnical challenges of the transition and support the needed evolution of social practices**.

PART 1. R&D dynamics in Belgium

Belgium ranks as a strong innovator with significant performance growth above EU average since 2017

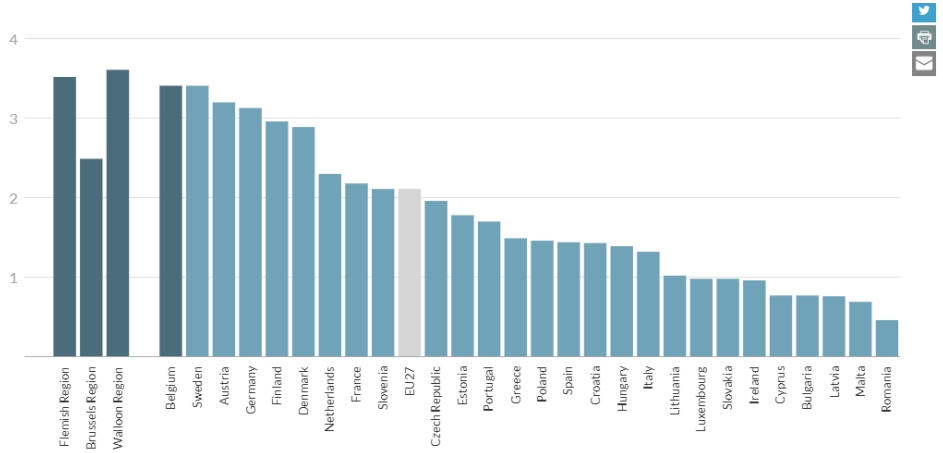
- Belgium is classified as a "**Strong Innovator**" in the European Innovation Scoreboard (EIS), holding **the 6th position among EU countries.**
- Its Summary Innovation Index (SII) is 136, indicating **its innovation performance is 36%** above the 2017 EU average.
- Its innovation performance has **significantly improved since 2017**, increasing by 15,1 percentage points.



Source : European Commission (2024). European Innovation Scoreboard 2024: Belgium Country Profile.

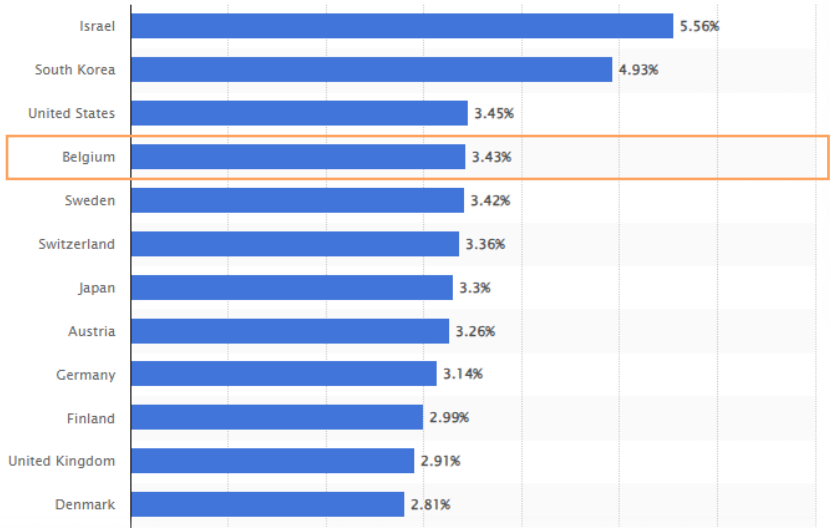
Belgium is the 1st EU country in terms of R&D intensity, and the 4th country worldwide

R&D intensity
Belgian regions and EU-countries, 2022, in % of GDP



Source : Vlaanderen.be (2024). R&D Intensity

R&D intensity
Worldwide, 2021, in % of GDP



Source : Statista

- Part of R&D expenditures is spent to finance internal R&D activities. The other part is spent to finance R&D by third parties. The intramural expenditures account for a little bit more than 50% of total expenditures, however this varies from one industry to other. For example, in the pharmaceutical industry, these parts are respectively 70 and 30%.
- There is no clear view on (1) the share of R&D for climate change mitigation and (2) their potential evolution.

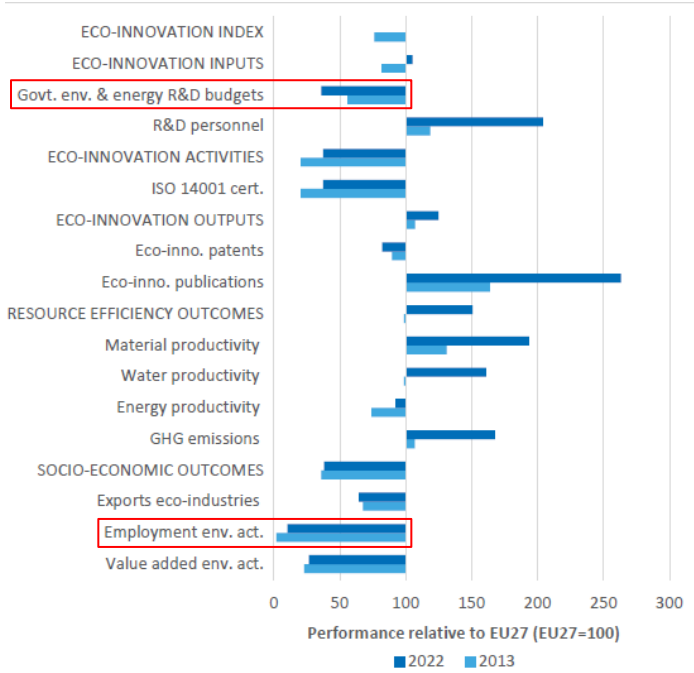
Belgium shows mixed progress in environmental sustainability with strengths in circular economy but gaps in eco-innovation and technology

Indicator	Performance relative to the EU in 2024	Performance change 2017-2024	Performance change 2023-2024
SUMMARY INNOVATION INDEX	**123.6**	15.1	-0.2
Environmental sustainability	**106.4**	18.8	1.9
Resource productivity	164.5	66.8	25.7
Air emissions by fine particulates	99.2	3.6	0.3
Environment-related technologies	63.2	2.6	-14.5

Emerging Innovators | Moderate Innovators | Strong Innovators | Innovation Leaders

- There is a **mixed performance in transitioning towards environmental sustainability**. While circular material use is well above the EU average, **investment gaps persist** in areas **like sustainable management**.
- **Belgium performs poorly in environment-related technologies**, achieving only 63,2% of the EU average. This is a significant concern as it ranks Belgium as an "emerging innovator" in this crucial filed.

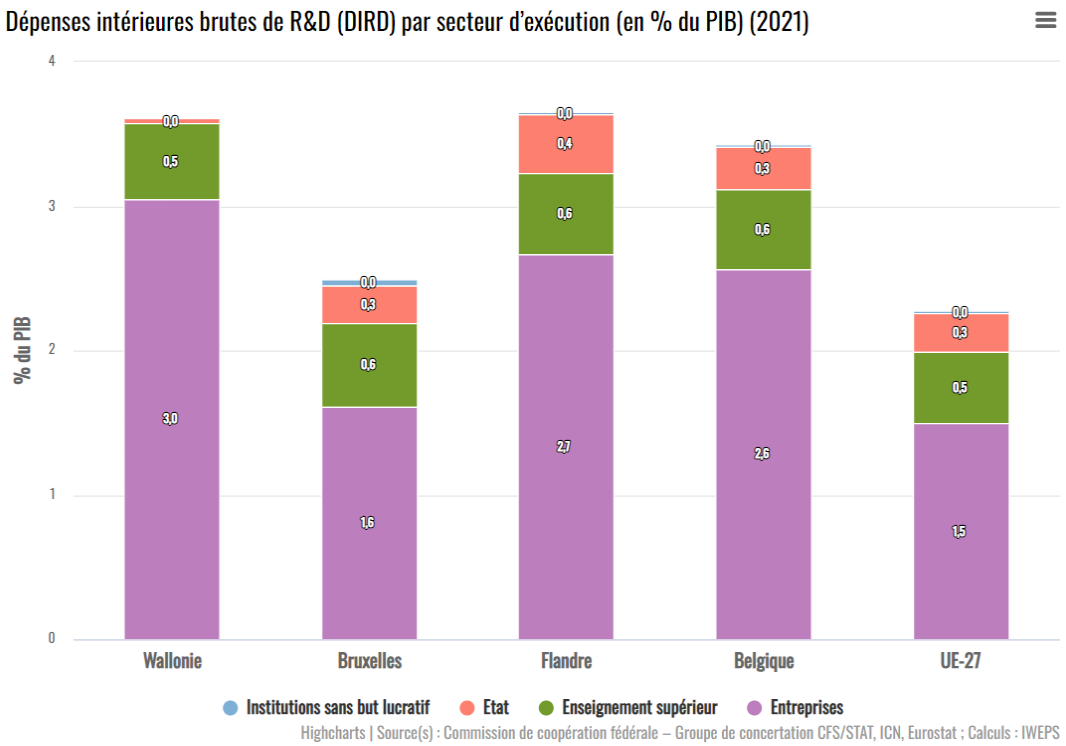
Source : European Commission (2024). European Innovation Scoreboard 2024: Belgium Country Profile.



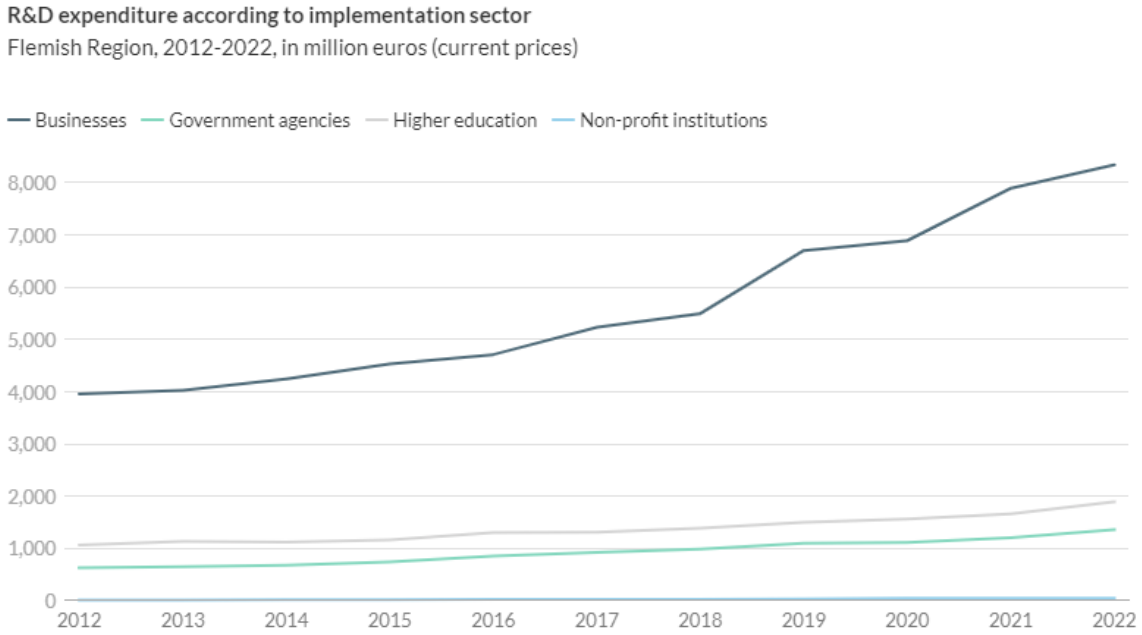
- Belgium is ranking among the **catching-up countries** in the Eco-Innovation Index. This is attributed to **low government spending on environmental and energy R&D** and **weak performance in employment** and value-added related to environmental protection.

Source : Zomer and Bourneix (2022). Eco – Innovation Country Profile 2022 : Belgium.

R&D is mostly (and more and more) driven by the private sector



Source : IWEPS (2024). Indicateurs statistiques. Intensité de R&D.

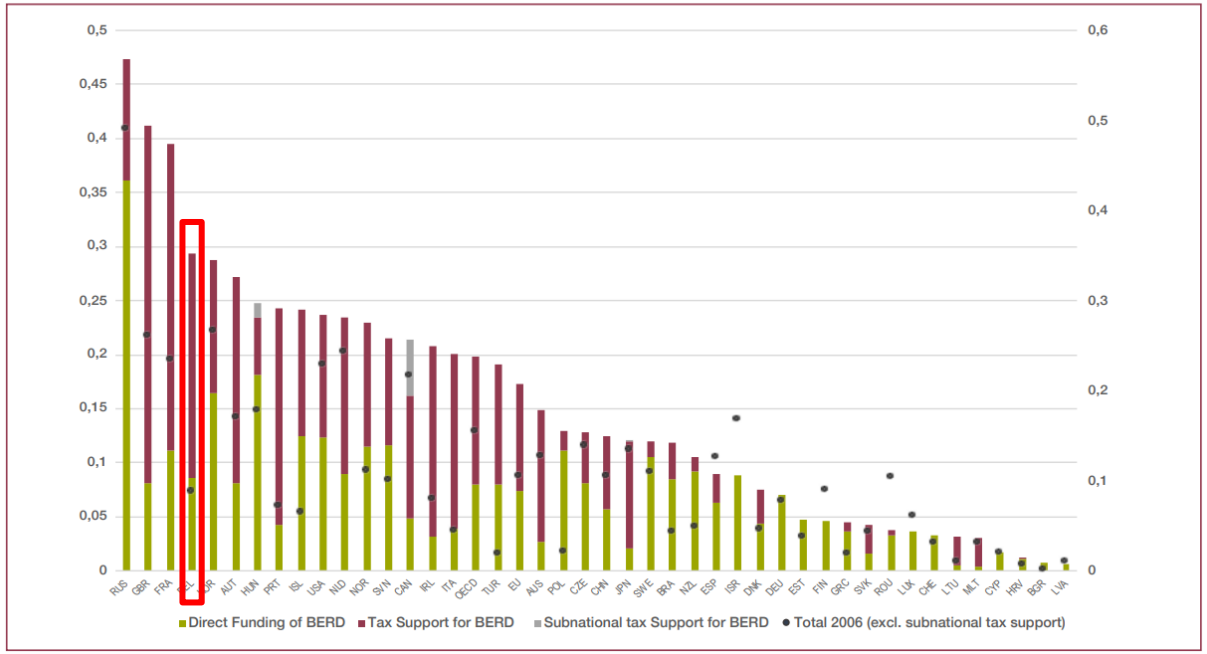


Source : ECOOM

Public support (funding, tax incentives) is key, but lacks focus on sustainability

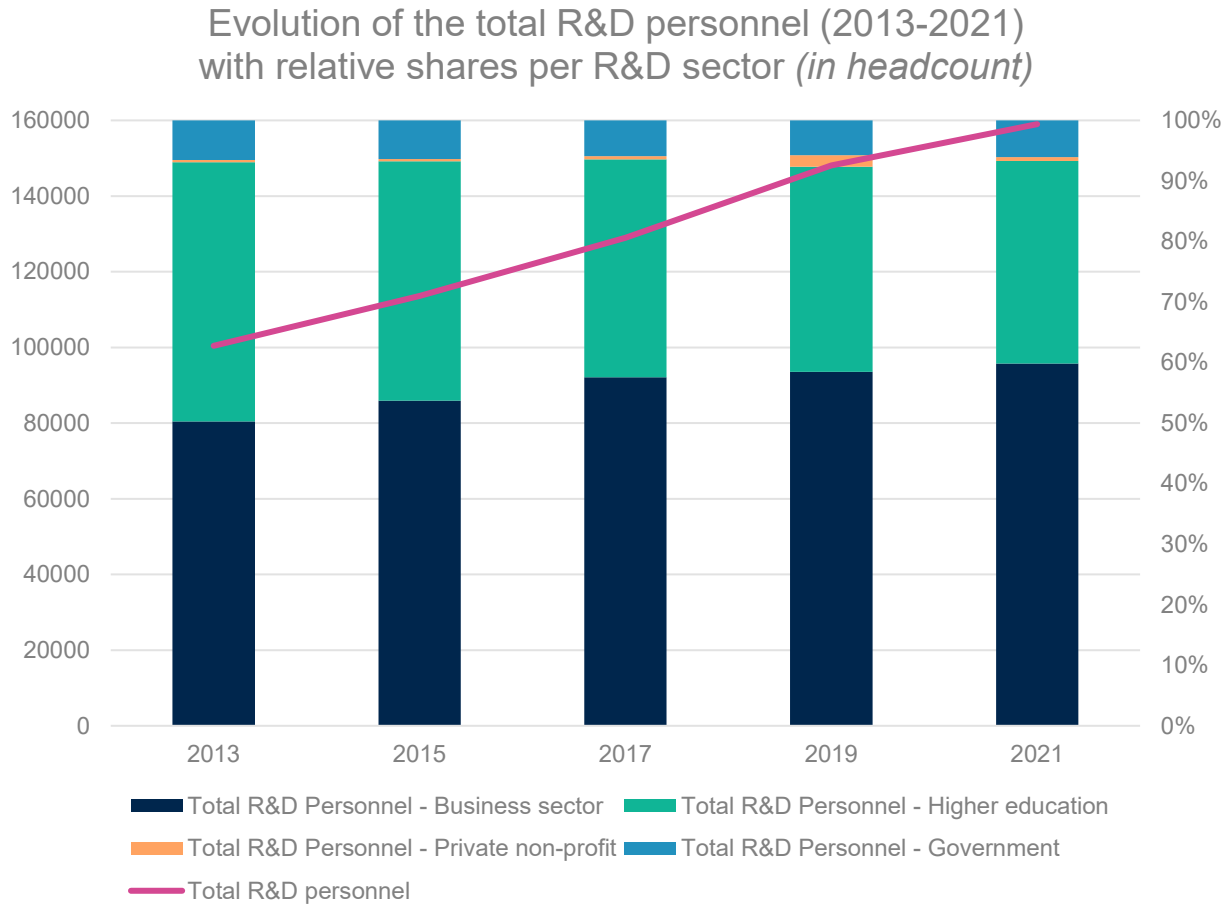
- Growth in business R&D expenditure is **partly attributed to R&D tax credits**, which incentivice companies to invest in innovation. While these credits have driven overall R&D growth**, they lack specific sustainability constraints**.
  - ➢ *This presents an opportunity to leverage tax incentives to promote sustainability-focused R&D*.
- Belgium has the **fourth highest share of R&D personnel and researchers** in total employment in the EU.

Figure 23: Direct government funding of business R&D and tax incentives for R&D (2019 or nearest year) as a percentage of GDP



Source : BELSPO (2022). Belgian Report on Science Technology and Innovation. Brussels, Belgium.

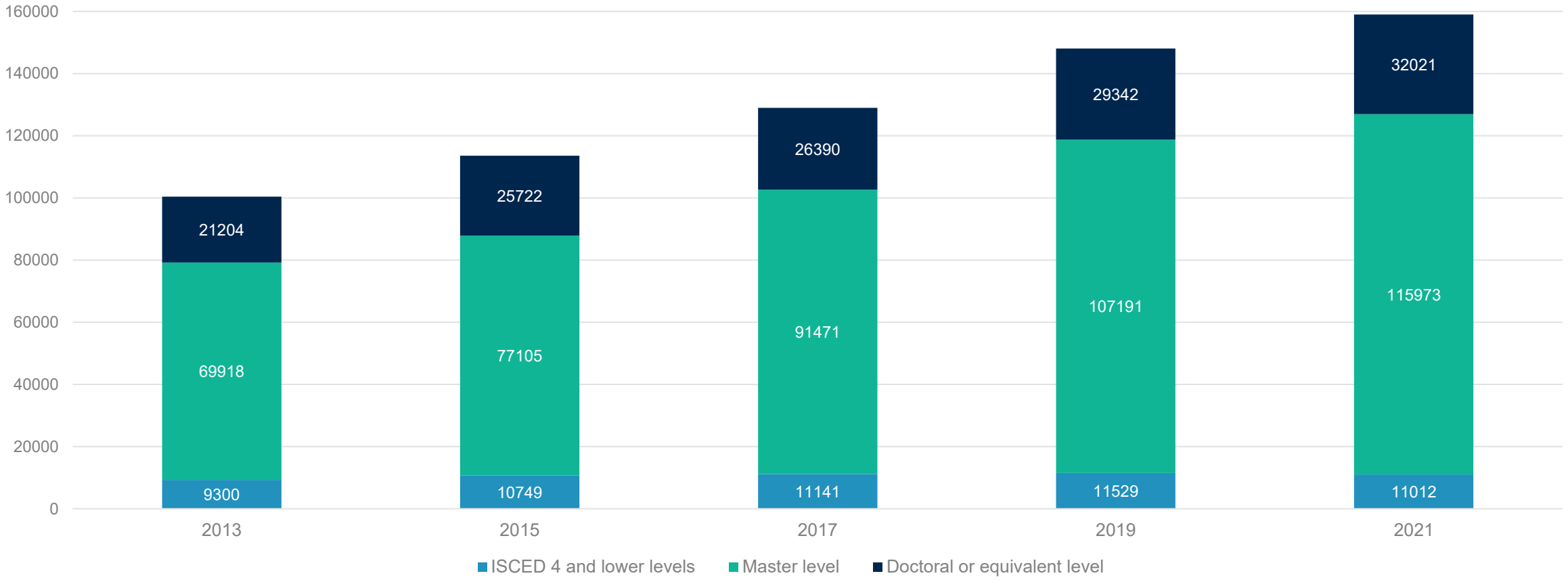
R&D growth translates into a very large increase in R&D personnel, especially in the private sector



Source : Monitoring and Evaluation of Research and Innovation (MERI), department of BELSPO.

- **The total R&D personnel *(in headcount)* has increased by 60% between 2013 and 2021.**
- **The increase is mostly driven by the Flemish Region**, whose R&D personnel has almost doubled between 2010 and 2021.
- **The share of researchers working for private businesses has increased** by 6 points in the same period, from 28 to 34% of the total headcount. **However, the global share of researchers is slightly decreasing**, from 68% to 62%.
- It is however impossible to evaluate precisely the number of researchers who work on climate change mitigation topics.

This increase is mostly driven by Master's degree graduates, while the number of PhDs remains stable



Source : Monitoring and Evaluation of Research and Innovation (MERI), department of BELSPO.

In Belgium, 12 organisations (11 private) own 50% of the patents granted since 2018 (for climate change mitigation and adaptation)

Organisation	Sector	Number of patents owned
Umicore NV	Manufacturing - Materials	232
GSK	Phamarcy	181
KUL	Education	143
Solvay	Chemistry	140
Plastic Omnium	Automotive	83
AGC Glass Europe	Manufacturing – Materials	72
Safran Aero Boosters	Transportation	67
Toyota Motor Europe	Transportation	64
Total Energies	Energy	53
IMEC	Manufacturing – Electrical equipments	50
VITO	Services	50
ZF Wind Power	Energy	45

Source : Espacenet, Patent search.

3 sectors concentrate half of the total R&D personnel

NACE Code	Description	Total R&D personnel in 2021 (in headcounts)	Share in total R&D personnel	Cumulated share	Share in total R&D personnel within the private business sector	Evolution between 2016 and 2020 (FTE)
C	**Manufacturing**	**33022**	**21%**	**20,8%**	**34,7%**	**14%**
M	**Professional, scientific and technical activities**	**23597**	**15%**	**35,6%**	**24,8%**	**23%**
J	**Information and communication**	**21756**	**14%**	**49,3%**	**22,9%**	**75%**
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	4175	3%	51,9%	4,4%	12%
N	Administrative and support service activities	1923	1%	53,1%	2,0%	36%
F	Construction	2272	1%	54,6%	2,4%	21%
H	Transportation and storage	911	1%	55,1%	1,0%	87%
D	Electricity, gas, steam and air conditioning supply	1383	1%	56,0%	1,5%	N/A
E	Water supply; sewerage, waste management and remediation activities	679	0%	56,4%	0,7%	N/A
A	Agriculture, forestry and fishing	176	0%	56,5%	0,2%	43%

Source : Monitoring and Evaluation of Research and Innovation (MERI), department of BELSPO.

Zoom on manufacturing sector

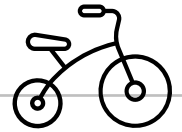
NACE Code	Description	Total R&D personnel in 2021 (in headcounts)	Share in total R&D personnel	Share in total R&D personnel within the private business sector	Evolution between 2016 and 2020 (FTE)
C.21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	7584	4,8%	8,0%	7%
C.26	Manufacture of computer, electronic and optical products	3829	2,4%	4,0%	1%
C.28	Manufacture of machinery and equipment n.e.c.	3643	2,3%	3,8%	0%
C.20	Manufacture of chemicals and chemical products	3145	2,0%	3,3%	22%
C.25	Manufacture of fabricated metal products, except machinery and equipment	2108	1,3%	2,2%	51%
C.29	Manufacture of motor vehicles, trailers and semi-trailers	1372	0,9%	1,4%	46%
C.24	Manufacture of basic metals	1307	0,8%	1,4%	-7%
C.23	Manufacture of other non-metallic mineral products	1212	0,8%	1,3%	37%
C.22	Manufacture of rubber and plastic products	1152	0,7%	1,2%	11%
C.27	Manufacture of electrical equipment	1124	0,7%	1,2%	N.A
C.30	Manufacture of other transport equipment	901	0,6%	0,9%	21%
C.32	Other manufacturing	750	0,5%	0,8%	239%
C.33	Repair and installation of machinery and equipment	467	0,3%	0,5%	36%
C.31	Manufacture of furniture	242	0,2%	0,3%	18%
C.18	Printing and reproduction of recorded media	202	0,1%	0,2%	42%
C.17	Manufacture of paper and paper products	188	0,1%	0,2%	19%
C.16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	150	0,1%	0,2%	-7%
C.19	Manufacture of coke and refined petroleum products	N.A	N.A	N.A	N.A

Source : Monitoring and Evaluation of Research and Innovation (MERI), department of BELSPO.

PART 2. Focus on key technologies in Belgium

Different pathways could lead Belgium to net-zero by 2050, each involving varying levels of technological development

BEH



- Major societal changes
- Examples: reduction of demand for products and transport, shift to public transport, shared mobility, bicycles

CORE 95

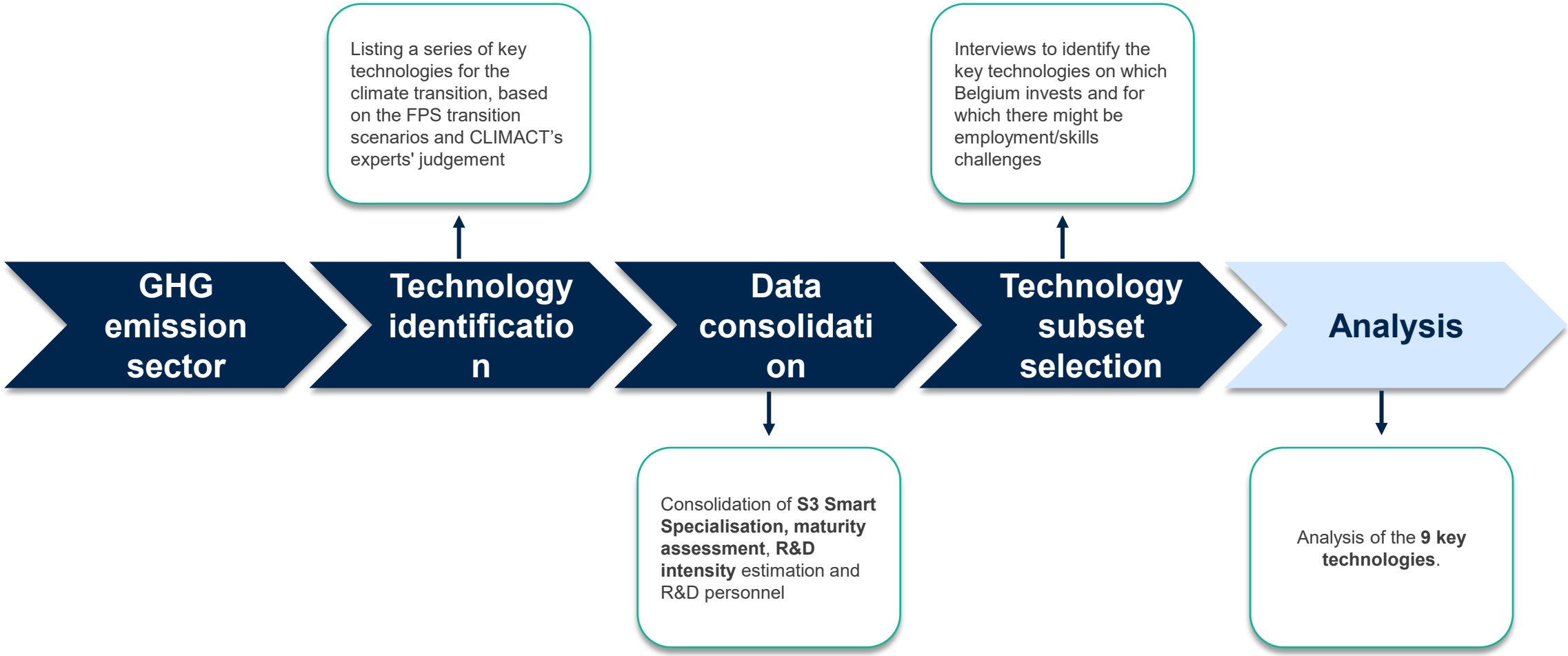
- Balance between TECH and BEH
- Strong societal and technological ambitions

TECH

- Strong technological ambitions
- Examples: energy efficiency, new technologies, innovative energy carriers (hydrogen, synthetic fuels), autonomous vehicle fleet

Source : SPF (2021). Scenarios pour une Belgique climatiquement neutre d'ici 2050.

Preliminary analysis



Methodology

Given the limited availability of precise data on employment generated by R&D activities, the analysis adopts a primarily **qualitative approach**. It concentrates on **R&D efforts within the business enterprise sector**, which represents approximatively **74%[1] of total R&D investment** in Belgium.

The analysis consists of three main steps:

1

Preliminary analysis
Conducted using employment proxies based on NACE Rev. 2, Level 2 codes (R&D workforce, intensity) and strategic documents (regional S3s), along with an internal CLIMACT analysis of key technologies and their maturity, to identify an initial list of technologies for a climate-neutral Belgium.

2

Interviews
In-depth interviews with sector experts provided detailed insights to validate, refine, or challenge preliminary findings.

3

Workshop
Discussion of the analysis results, identifying challenges and opportunities, and developping actionable policy recommendations based on the findings.

[1] *Indicateurs statistiques. Intensité de R&D. IWEPS.*

Belgium invests in a series of key technologies, mainly through the Region's Smart Specialisation Strategies (S3)

GHG EMISSIONS SECTORS	KEY TECHNOLOGIES FOR THE TRANSITION	S3 PRIORITISATION	MATURITY	R&D INTENSITY
TRANSPORT	Electric light vehicles (vehicle efficiency, batteries, etc.)		High	Medium high
	Charging infrastructure (charging speed, deployment, location, etc.)		Medium	Medium high
	Eco-design of batteries (end-of-life optimization)		Low	Low
	Hydrogen fuel cells		Low	Low
	Road infrastructure (inland waterways, etc.)		High	Low
BUILDINGS	Construction/renovation techniques (bio-based materials, prefabrication, etc.)		Medium	Medium low
	HVAC technologies (heat pumps, solid biomass, etc.)		High	Medium high
	Appliance efficiency		Medium	Medium high
MANUFACTURING	Low-carbon materials and recycling (steel, bio-based materials, concrete)		Low	Medium
	Electrification of processes (energy efficiency of equipment)		Medium	Medium high
	CCUS (infrastructure)		Low	Medium low
	Industry 4.0 (IoT, digitalization of production processes)		High	Medium high
ENERGY PRODUCTION	Low-carbon fuel synthesis (e-fuels or biofuels) for heavy transport (maritime, aviation) or industry		Medium	Low
	Hydrogen synthesis (steam methane reforming, electrolysis, etc.)		High	Low
	Photovoltaics (research on solar cells, etc.)		High	Low
	Onshore and offshore wind (maintenance using IoT, etc.)		High	Low
	Energy storage (batteries)		High	Low
	Recycling chain (batteries, wind turbine blades, PV panels, etc.)		Medium	Low
	IT integration (EMS, PMS, smart grid)		Medium	Medium high
Food & AFOLU	Precision agriculture and remote sensing		Low	Medium high
	Fertilizers		High	Medium high
	Agroecological and regenerative agriculture techniques		Low	Low

- ***Maturity*** *is defined here as the stage of development and readiness for practical application, categorized into a simplified three-level scale: low, medium, and high.*
- ***R&D Intensity*** *is defined as the R&D expenditure as a percentage of gross domestic product (GDP). Source: European Commission.(n.d.). R&D Intensity. Eurostat. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:R_%26_D_intensity*

The Belgian R&D effort is focused on only a limited list of these technologies. For the others, it is rather a matter of implementation

GHG EMISSIONS SECTORS	KEY TECHNOLOGIES FOR THE TRANSITION
TRANSPORT	*Electric light vehicles (vehicle efficiency, batteries, etc.)* *Charging infrastructure (charging speed, deployment, location, etc.)* Eco-design of batteries (end-of-life optimization) Hydrogen fuel cells *Road infrastructure (inland waterways, etc.)*
BUILDINGS	Construction/renovation techniques (bio-based materials, prefabrication, etc.) *HVAC technologies (heat pumps, solid biomass, etc.)* *Appliance efficiency*
MANUFACTURING	Low-carbon materials and recycling (steel, bio-based materials, concrete) *Electrification of processes (energy efficiency of equipment)* CCUS (infrastructure) *Industry 4.0 (IoT, digitalization of production processes)*
ENERGY PRODUCTION	Low-carbon fuel synthesis (e-fuels or biofuels) for heavy transport (maritime, aviation) or industry *Hydrogen synthesis (steam methane reforming, electrolysis, etc.)* *Photovoltaics (research on solar cells, etc.)* *Onshore and offshore wind (maintenance using IoT, etc.)* *Energy storage (batteries)* *Recycling chain (batteries, wind turbine blades, PV panels, etc.)* IT integration (EMS, PMS, smart grid)
Food & AFOLU	Precision agriculture and remote sensing *Fertilizers* Agroecological and regenerative agriculture techniques

Could the level of concentration of R&D by sector affect employment dynamics differently?

GHG Emission Sector	Key technologies	Concentration *(estimated)*
TRANSPORT	Eco-design of batteries Hydrogen fuel cells	**Strong** around a few mondialised players: Toyota, Umicore, Plastic Omnium, Solvay
BUILDINGS	Construction / renovation technics	**Low** Innovation carried by a large network of players
MANUFACTURING	Low-carbon materials (inc. recycled) CCUS (infrastructure)	**Contrasted** carried by big industrial players for materials to decarbonize, and by smaller players for the biosourced materials
ENERGY PRODUCTION	Low-carbon fuel synthesis Network IT Integration (EMS, PMS, smart grid)	**Strong** for the low-carbon fuel synthesis around a few mondialised actors (Total Energies) **Low** for the IT integration of the energy networks, with a combination of major EU players and start-ups
Food & AFOLU	Precision farming and remote sensing Agroecological and regenerative agriculture technics	**Low.** Sector that generates only a few R&D investments, with not much employment volume.

- Multinational companies play on an international (skills) market. Potential skills gaps (e.g. in battery technology) are an international issue. Public institutions play a crucial role in supporting the structuring of innovative industrial ecosystems (clusters, smart innovation initiatives, etc.).
- When ecosystems are less concentrated, driven by smaller companies, public institutions may have a more important role to play in
  - ensuring that skills are available at local level.
  - supporting the conversion of R&D applications into the development of new markets

PART 3. Non-STEM set of skills to support the R&D for climate change mitigation

Highly-skilled financial and legal profiles are required to scale up R&D outputs and valorisation

Strong R&D performance in BE will be offset or sub-critical unless some framework conditions (and related capabilities / human resources) are adjusted / improved, i.e.:

- **Funding – Financial profiles to design long-term business cases and support measures**
  - Financial instruments, able to support also OPEX, in addition to CAPEX, and over a long period (20+ years)
  - Funding volumes: e.g. IPCEI + recovery plan for decarbonisation of Carmeuse, but this is just one case... what about others?
  - CfDs or "Contracts for Difference“ = support for OPEX de facto (cfr. Feb2024 Call in Flanders)

- **Legal Framework – Legal profiles to develop regulatory sandboxes**
  - New legal instruments for upscaled ‘testbeds’ such as "regulatory sandboxes". Critical, everyone speaks about them, but very few have them (cfr. Energyville since March 2024)

- **Systemic approach**
  - Across public instruments/sectors: look beyond isolated R&D instruments towards true industrial symbioses (“portfolio approach”).
  - Across regions, e.g. to better exploit industrial deployment of green H_2
  - Community(ies) of Practice(s)

Source : European Commission (2023). Policy-mix for R&I investments in deployment and uptake of low-carbon technologies – Mutual learning exercise on industrial decarbonisation – Second thematic report; European Commission (2023). Framework conditions for deployment and uptake of low-carbon technologies – Mutual learning exercise on industrial decarbonisation – Fourth thematic report

Literature suggest new set of strategies and practices to develop growth-boosting innovations for climate change mitigation

Table 1
Growth-boosting sustainable innovation strategies and signature organizing practices.

Innovation Strategy	Signature organizing practices
Nurturing entrepreneurial scientist	• Providing entrepreneurial training • Training environmentally concerned scientific cadres • Commercializing innovation ideas • Incorporating economic value into basic research • Promoting university-industry collaboration
Integrating scientific knowledge with innovation target	• Matching research output with industry needs • Initiating demonstration projects for innovation concepts • Developing eco-innovations with ubiq-uitous use • Measuring research impact on growth and sustainability
Catalysing experimental research	• Focusing on sustainability-oriented research • Providing research labs, material, and resources • Investing in hard-to-find talents • Adopting modern technology for research

Source : D. Sarpong et al. (2023). The three pointers of research and development (R&D) for growth-boosting sustainable innovation system.