Using prospective life cycle assessment to support EU policy making

Insights from EU Joint Research Centre

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Overview

- Introduction to JRC and unit
- Application of prospective LCA in RecalibrateCE project
- Case study on cement

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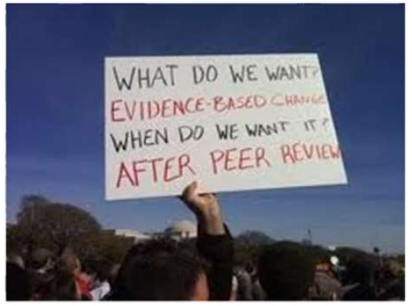
Joint Research Centre (JRC)

- The Joint Research Centre (JRC) is the **European Commission's science and knowledge service** which employs scientists to carry out research in order to provide independent scientific advice and **support to European Union (EU) policy**.
- Around **30%** of all EU legislation contains work from the JRC

JRC sites

Headquarters in **Brussels** and research facilities located in **5 Member States:**

- Belgium (Geel)
- Germany (Karlsruhe)
- Italy (Ispra)
- The Netherlands (Petten)
- Spain (Seville)



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Joint Research Centre

- The JRC plays a key role at multiple stages of the EU policy cycle. It contributes to the overall objective of **Horizon Europe**.
- We work closely with research and policy organizations in Member States, EU institutions and agencies, and scientific partners in Europe and internationally, including the UN.
- Core strengths:
  - **Anticipation** to provide the scientific underpinning for future policy initiatives.
  - **Integration** means enhancing our ability to build links between the different scientific and policy areas inside the Commission and beyond.
  - **Impact** is about assisting policymakers to track and assess the impact of their policies.

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JRC facts & figures

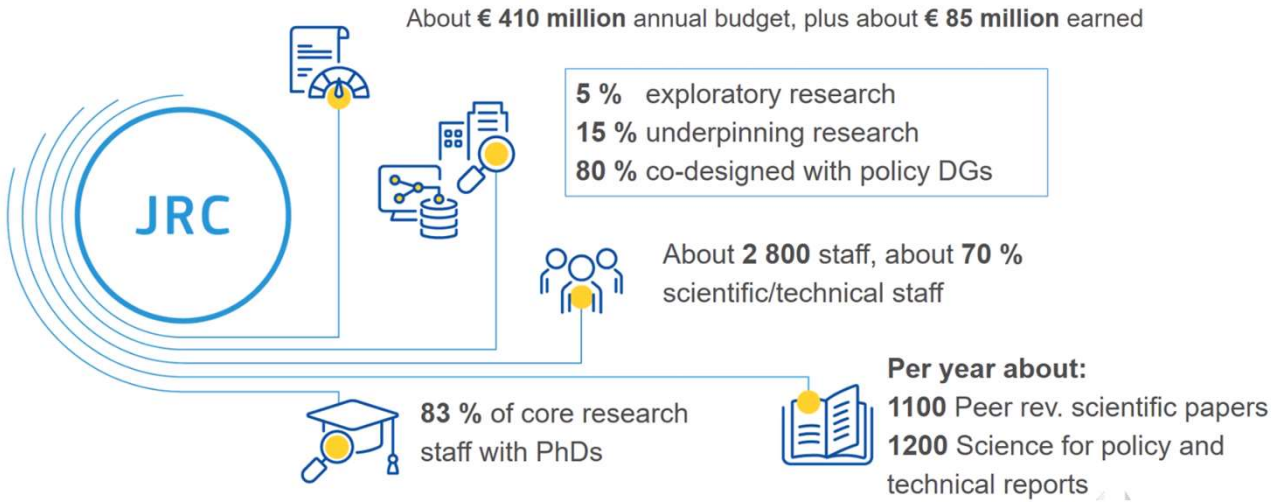
IDEAS Economic literature Authors Institutions Rankings Help/FAQ MyIDEAS

Top 10% Economic Institutions (Last 10 Years Publications), as of March 2024

Explanations | Ranking | More

The rankings

Rank	Institution	Score	Authors	Author shares
1	London School of Economics (LSE) London, United Kingdom	1.77	315	210.39
2	International Monetary Fund (IMF) Washington, District of Columbia (USA)	3.44	421	389.02
3	National Bureau of Economic Research (NBER) Cambridge, Massachusetts (USA)	4.09	466	88.84
4	World Bank Group Washington, District of Columbia (USA)	4.39	531	468.98
5	Department of Economics, Harvard University Cambridge, Massachusetts (USA)	5.39	66	56.23
6	Economics Department, Massachusetts Institute of Technology (MIT) Cambridge, Massachusetts (USA)	7.09	60	52.17
7	European Central Bank Frankfurt am Main, Germany	7.14	244	221.2
8	Department of Economics, University of California-Berkeley Berkeley, California (USA)	9.41	60	44.95
9	Department of Economics, University of Chicago Chicago, Illinois (USA)	9.6	79	68.34
10	Federal Reserve Board (Board of Governors of the Federal Reserve System) Washington, District of Columbia (USA)	10.8	206	200.6



29	Bank of England London, United Kingdom	30.69	182	163.85
30	Joint Research Centre, European Commission Sevilla, Spain	30.81	300	287.92
31	Department of Economics, University College London (UCL) London, United Kingdom	31.15	62	47.88

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JRC B5 – CE & sustainable and fair industry
Seville

Are you our next visiting scientist or PhD student?
- Option of visiting from 3 months up to 1.5 years
- Collaborative Doctoral Partnership programme

Circular Resource Management	Product Policy Analysis	EU-BRITE (industrial transformation & emissions)	Applied Environmental Economics	Green Expertise for Investment
• LCA/LCC for circular economy (CE) • Design for circularity • CE policy	• Product labelling • Eco-design • Ecolabel • Green public procurement	• BREF (BAT) • Decarbonisation Innovation platform (INCITE) • 'Sevilla' process	• Economic & market impact assessment • Economic complexity	• Sustainable investments • Sustainable transition plans
Ca. 9 people	Ca. 15 people	Ca. 20 people	Ca. 6 people	Ca. 5 people

Ca. 60 people

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Prospective life cycle assessment

How to use LCA for ex-ante assessments

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Prospective LCA – use in policy making

- Identify policy measures that are robust in different scenarios → positive effect no matter changing circumstances
- Identify best and worst case scenarios to be more prepared for quick decision-making (current example: Trump's tariffs)
- Interest not necessarily on emerging technologies (though also modelled), but on effect of policies implemented through technologies or economic/administrative instruments
- Tendency to use normative scenarios (net-zero) to identify suitable transition pathways

Requirements for inventories

- Flexible
- Transparent
- Compatible with different software
- Well-documented → inducing trust
- Ideally based on EU level scenarios or global shared socio-economic pathways scenarios

The RecalibrateCE project

Using prospective life cycle assessment for policy making

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Background

Why the CE is key to reach green transition goals

RecalibrateCE

Green Deal

- **Climate neutrality by 2050**
- Economic **growth decoupled** from resource use
- No person and no place left behind

Circular Economy

- No specific climate goals, but **necessary** to achieve the Climate goals
- **CEAP2:** 'Double the amount of material recycled into the economy'
- Can contribute via innovation and new jobs, also at a local level

Challenges

- **Data and methodologies** to quantify CE effects not mature
- Not clear **which strategies** are most effective towards that goal
- Not clear **costs & savings** of CE & distributional effect

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Research purpose

Assessing the contribution of circularity to the green transition

Research questions	Objective
What are the **potentials** of the CE that policies need to unlock to deliver effectively on the Green Transition and competitiveness objectives?	Develop **analytical tools** to assess: The impact of CE levers on material flows, environment and socio-economic aspects

Case studies

- 4 carbon intensive sectors (cement, steel, aluminium, plastics) → 86% of GHGs of EU industry & hard-to-abate
- Covering past, present and future CE policies in EU27
- Quantification of changes in material flows, environmental & socio-economic impacts due to CE levers

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Research design

Future CE scenarios

We investigate **four scenarios** for four carbon-intensive material sectors:

1) **Status Quo** (2019-2022), i.e. current situation
2) **Baseline** (2050), i.e. continuation of historic CE trajectory (with decarbonisation of energy)
3) **Compliance** (2050), i.e. compliance with selected CE targets
4) **Circularity** (2050), i.e. attainment of higher circularity by implementing *'circular economy levers'*

*A **circular economy lever** is a specific intervention (based on one or more circular economy policies), applied in the context of a specific material and sector, to decrease virgin material input **(Reduce)**, increase material durability **(Reuse)** and enhance material recirculation **(Recover)**.*

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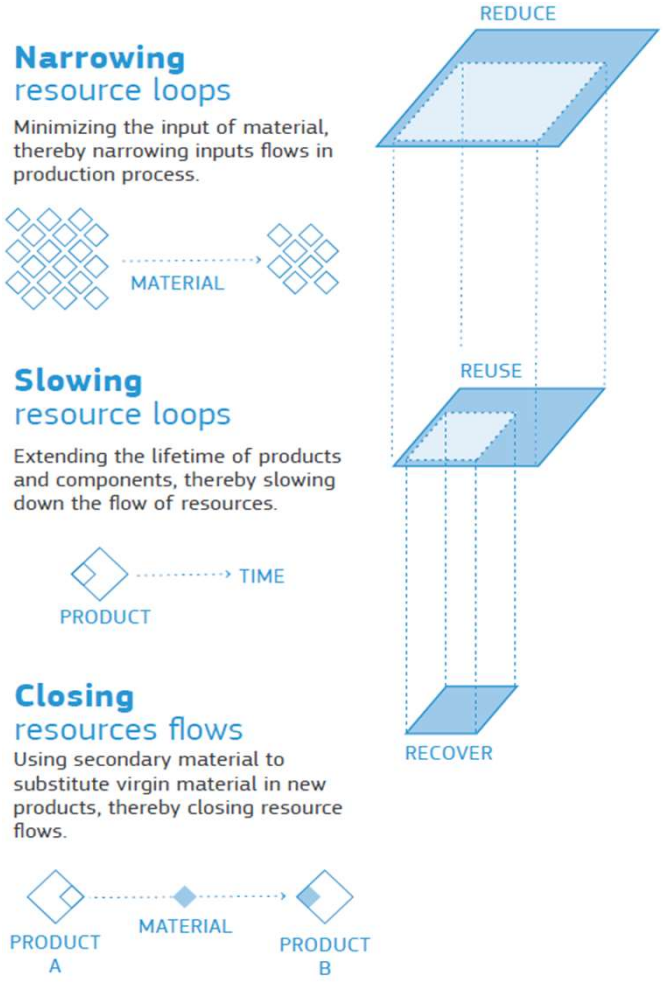
Circular economy levers



Reducing use of concrete in buildings

Reducing packaging

Extend lifetime of cars

Reuse of concrete pre-cast

Improve high quality recycling

Sorting plastic from mixed (residual) waste

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Take-home messages (I)

Climate change mitigation (i.e. decrease in GHGs emission) relative to Baseline:

	Compliance scenario	Circular Scenario
Cement & concrete	-	-37%
Aluminium	-3%	-14%
Steel	-0.3%	-49%
Plastic	-12%	-45%

	Reduce	Reuse	Recover
Cement & Concrete	-27%	-8%	-3%
Aluminium	-1%	-11%	-6%
Steel	-21%	-10%	-22%
Plastic	-18%	-9%	-29%

'Circularity' is the combined effect of Reduce, Reuse, Recover

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Take-home messages (II)

Current CE policies (targets) are not enough to unlock the potentials of CE levers for decarbonisation and resource savings.

Cement/concrete requires measures to unlock the potentials of **Reuse & Reduce**. For **metals & plastic**, while Reuse/Reduce are clearly important, **Recover** still represents a 'low hanging fruit'.

CE levers **decrease dependency** on primary fossil and non-renewable resources.

CE levers offer **co-benefits** in many other environmental categories (similarly to GHG mitigation).

The *societal* **costs decrease**, but this also comes with less 'sectorial' **employment** mainly because of Reduce & Reuse levers.

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Cement & concrete

Contribution of circular economy policies to climate change mitigation and more sustainable Europe

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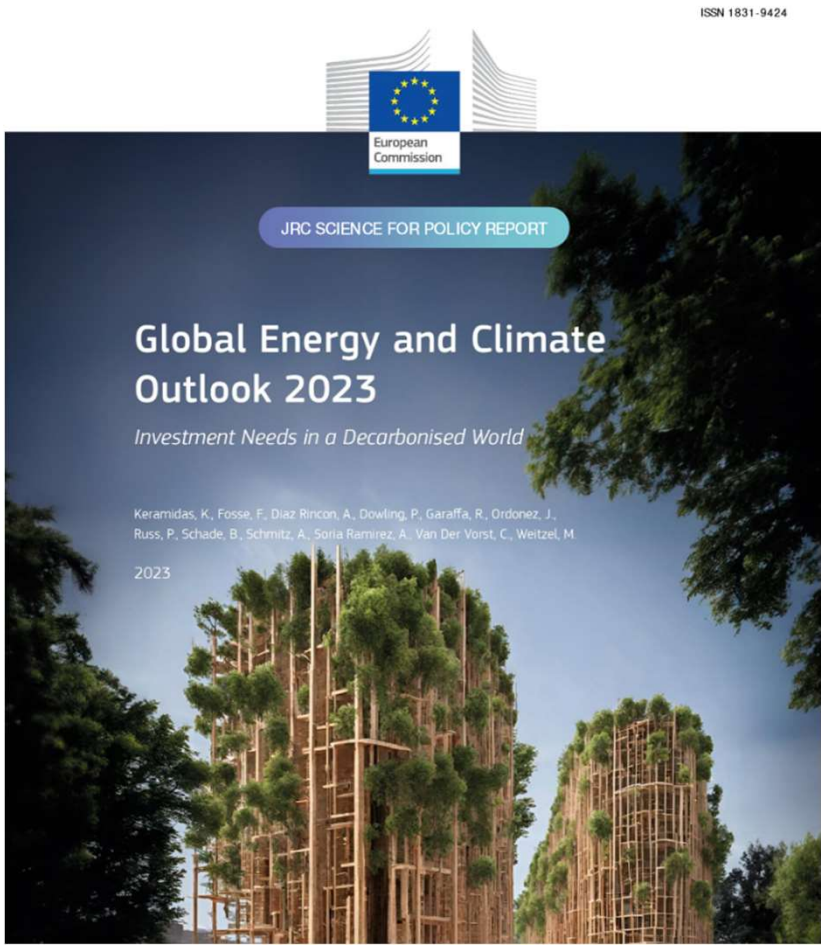
Prospective LCA

- Prospective LCA for the cement sector in 2050
- What part of the life cycle inventory changes?
  - Background energy system gets greener → used JRC energy projections by the Global Energy and Climate Outlook (GECO) 2023 (Keramidas et al., 2023)
  - Modelled new cement production and novel recycling technologies



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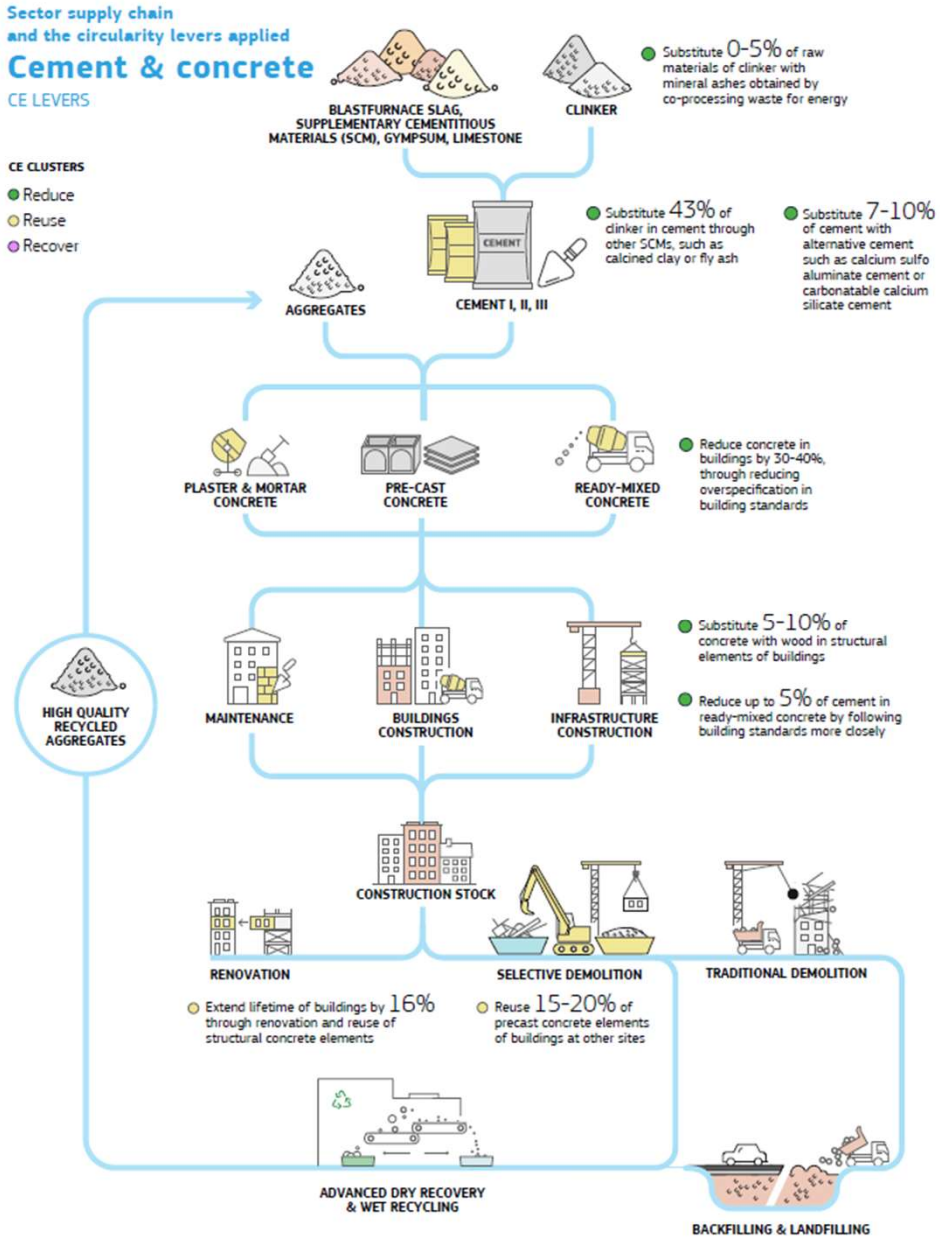
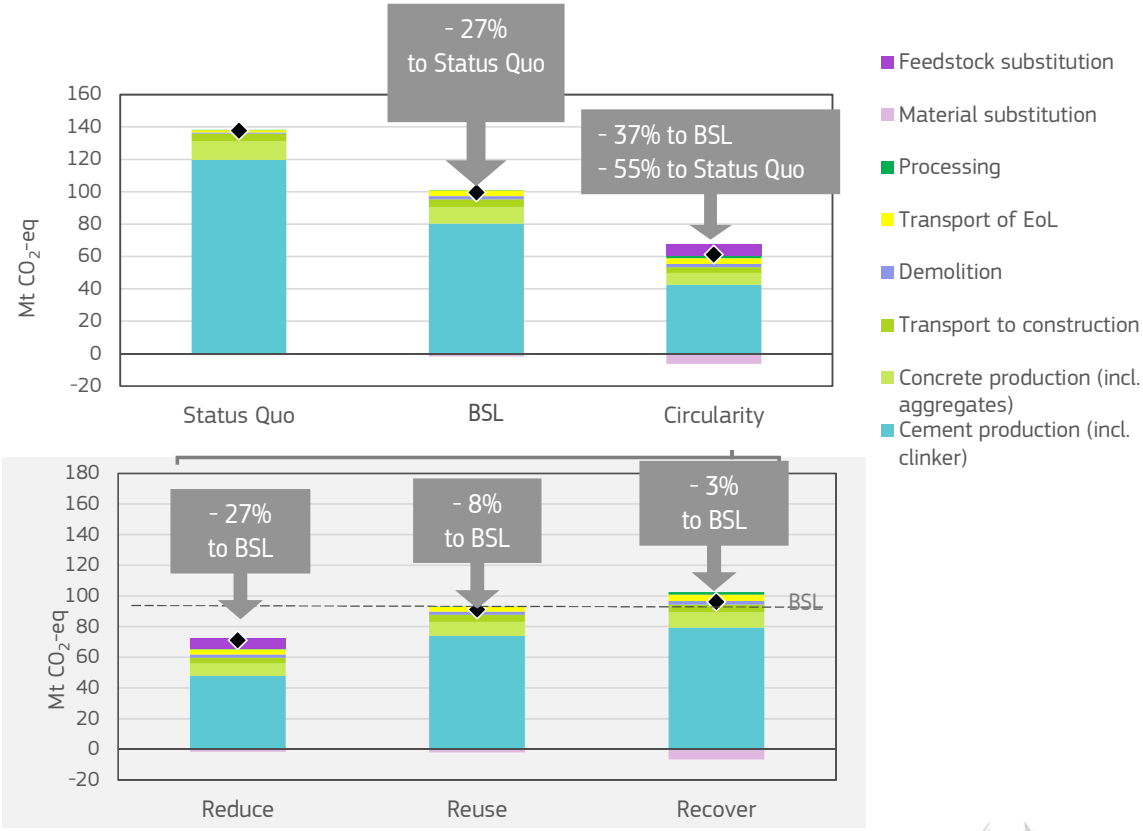
CE levers

- 6 reduction levers
- 2 reuse levers
- 3 recovery levers



Climate change mitigation

- CE levers **double** GHGs reduction potential vs. decarbonisation only
- Reduce levers have highest impact on GHGs reduction
- Recover levers apply to lower mass flows → less impactful



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Main findings

- CE levers **double** GHGs reduction potential vs. decarbonisation only

  → CE levers have untapped potential to be activated by policies

- Given the high rate of construction vs. rate of demolition, CE levers related to reduction are most effective for GHG reduction

  → policy should aim at reducing use of cement

- It is favourable to recycle concrete back to cement, instead of recycling it to aggregates

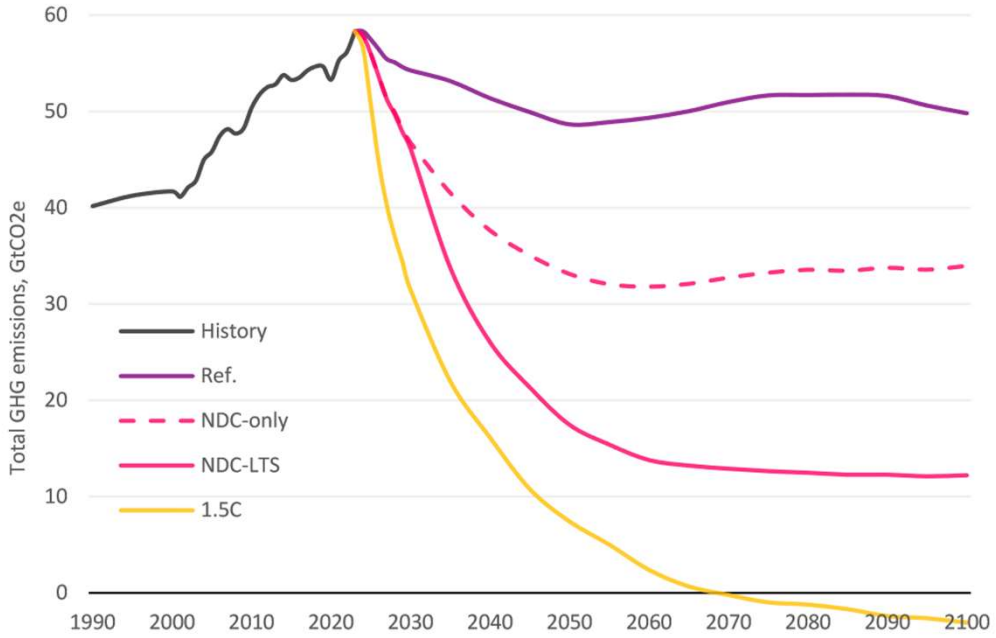
  → policy should aim at supporting innovation of cement recycling

Prospective LCA – sensitivity analysis 1

- Change in energy system

→ what happens, if e.g. don't achieve a net zero energy system as assumed in our Baseline scenario?

  - change in background system by replacing NDC-LTS with REF



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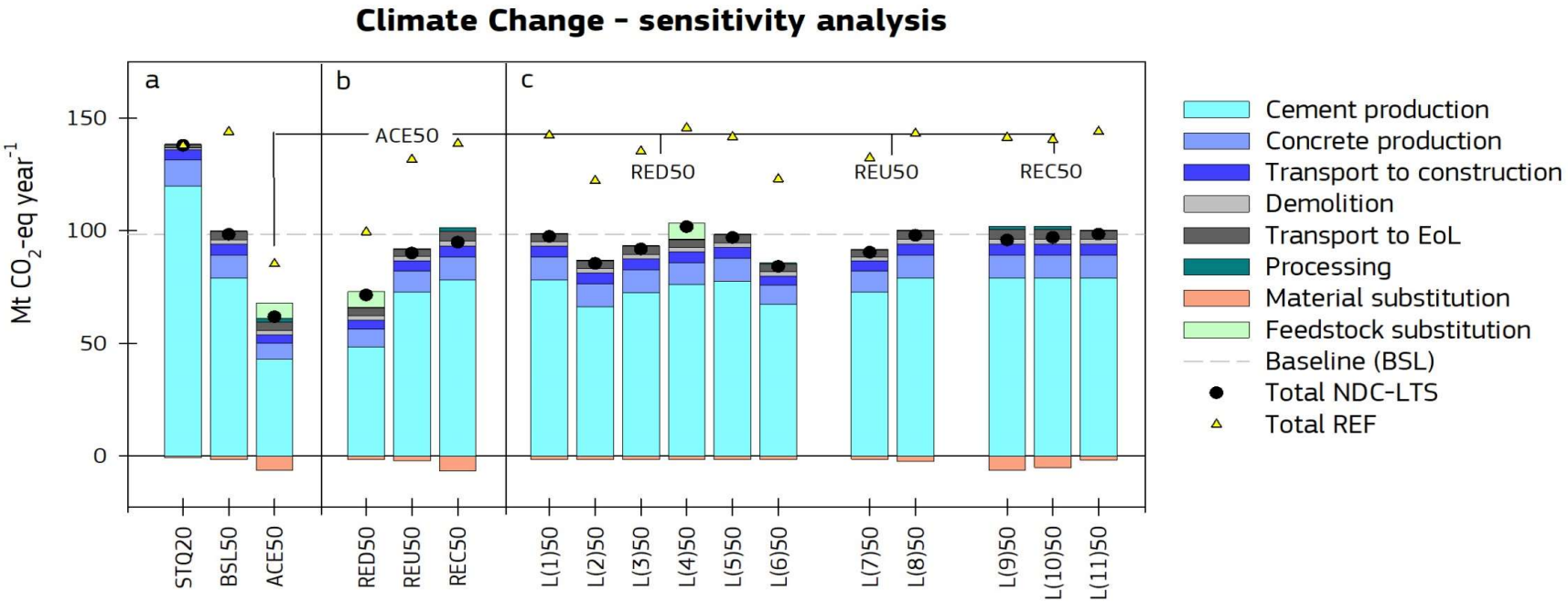
Sensitivity analysis on different energy mix



Implementation: Different GECO energy scenario (REF) with less decarbonisation

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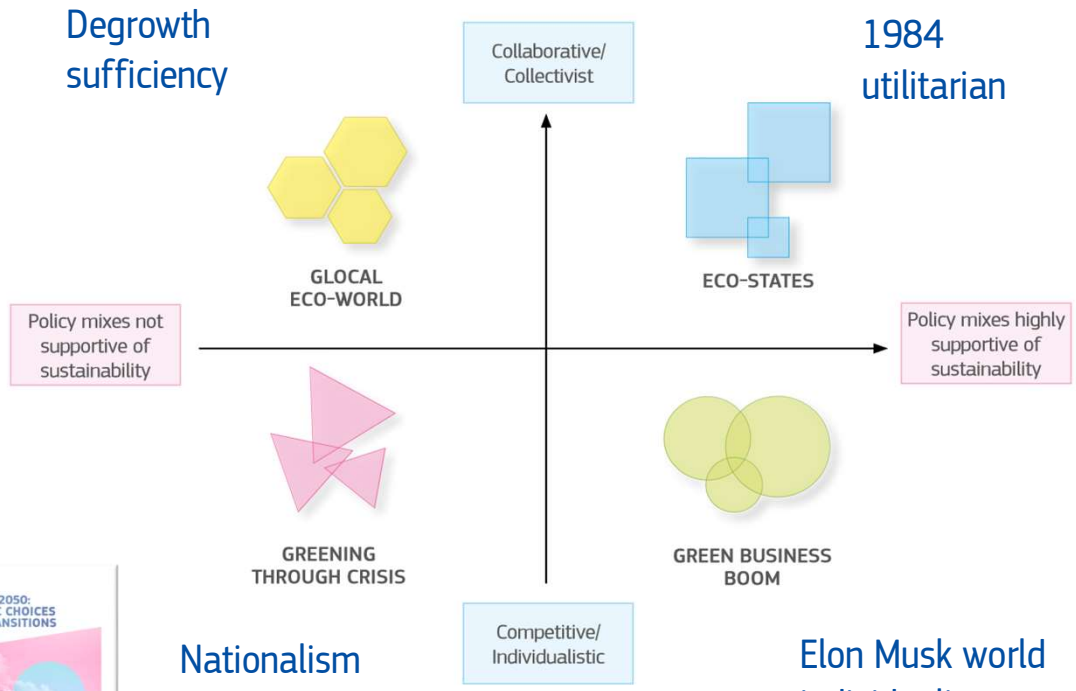
Prospective LCA – sensitivity analysis 2

- Change in socio-economic system

→ what happens, if the world develops differently than what we expect? (spoiler: it usually does)

- Participatory online workshop with 50+ stakeholders to stress test CE lever effectiveness in different futures
- Use magnitude of difference in growth paths from shared socio-economic pathway scenarios in line with narratives (Schandl et al., 2020)

Matti et al. (2023)



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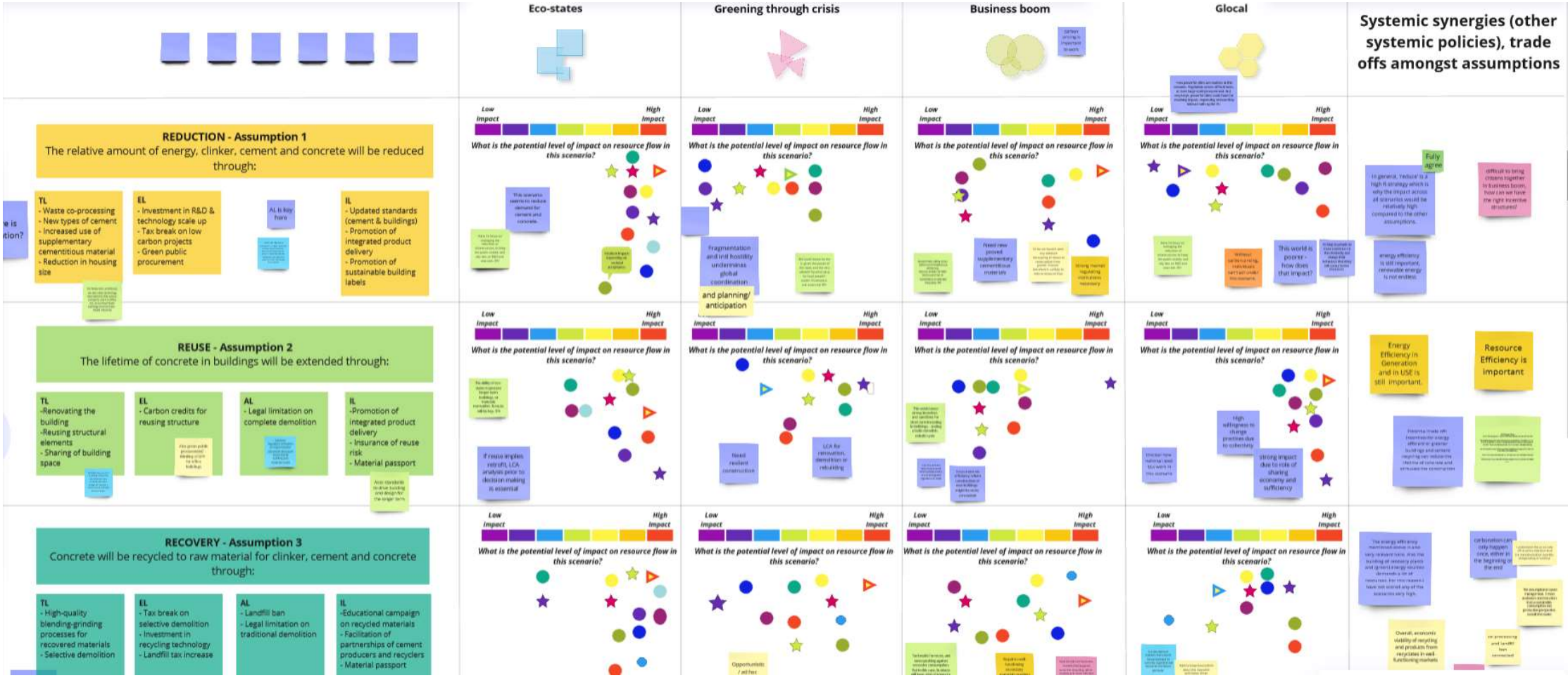
Methods

Foresight workshop – Stress testing



Results

Values for sensitivity analysis

- Multiply projected demand by scenario demand change (Demand)
- Multiply CE lever value (e.g. 18% recycling increase of concrete waste) by effectiveness (Recover)

	Demand	Reduce	Reuse	Recover
Glocal Eco-World	Shrinking -20%	Medium 67%	High 82%	Medium 67%
Ecostates	Growing +20%	High 82%	High 82%	High 82%
Green Business Boom	Growing +20%	Low 52%	Low 52%	High 82%
Greening through Crisis	Shrinking -20%	Low 52%	Medium 67%	Medium 67%

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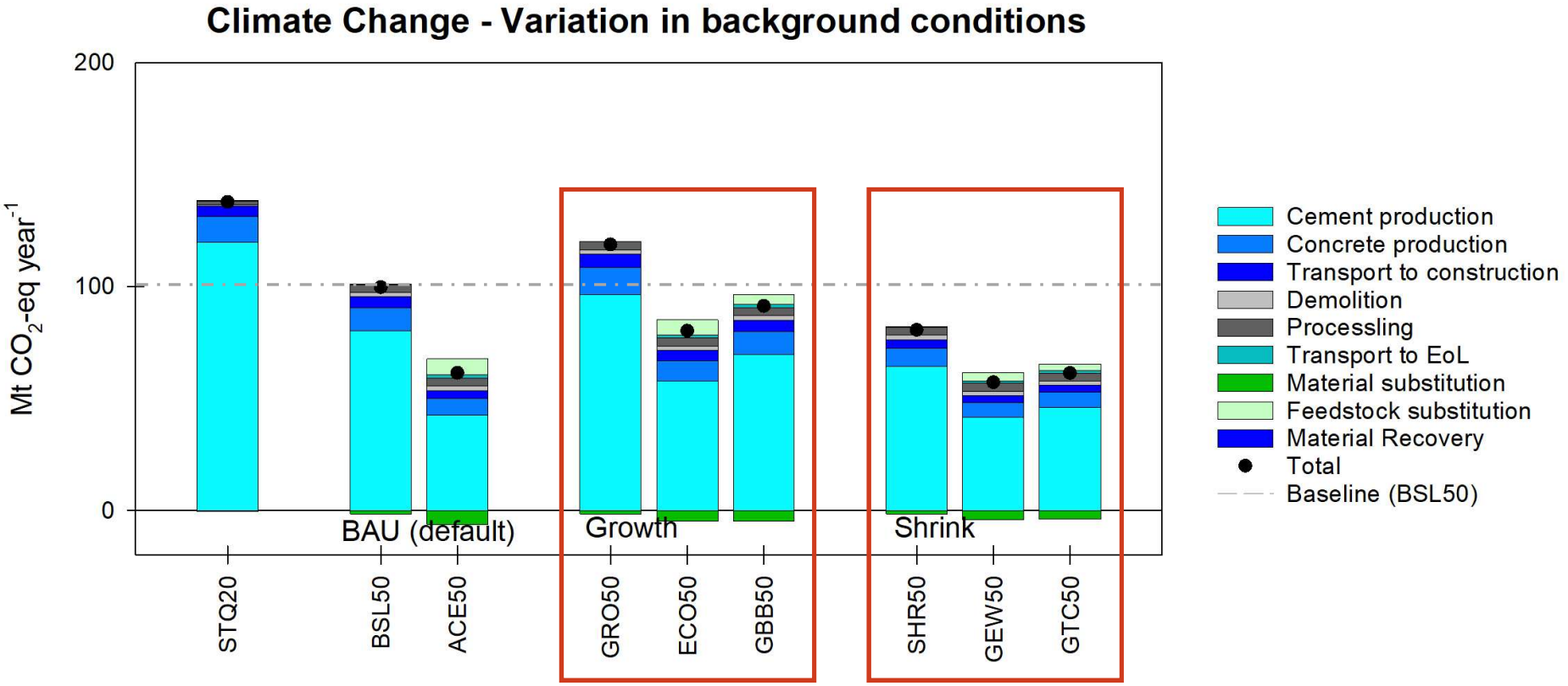
Sensitivity analysis on different socio-economic background



Implementation: different effectiveness of CE levers and change in demand based on stakeholder workshop

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Sensitivity analyses findings

- In case of a less cleaner energy mix, CE levers have even higher reduction potential
- In case of different socio-economic systems, demand change has biggest impact on overall result, as the effectiveness of the levers depends on the size of the system
- All future scenarios are below the Baseline, showing the robustness of CE levers, while desirability also depends on socio-economic indicators not captured in the analysis
- Highest reduction potential in scenario with high government control

If we had more time, we would…

- Compare GECO energy scenarios against SSP energy scenarios
- Look more at explorative scenarios
- Include future characterisation factors

Thank you very much for your attention! Any questions?

The views expressed in this presentation are solely the ones from the authors and cannot be regarded as the official position of the EU Commission.

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