IEA Bioenergy
Technology Collaboration Programme

Towards a Circular Bioeconomy



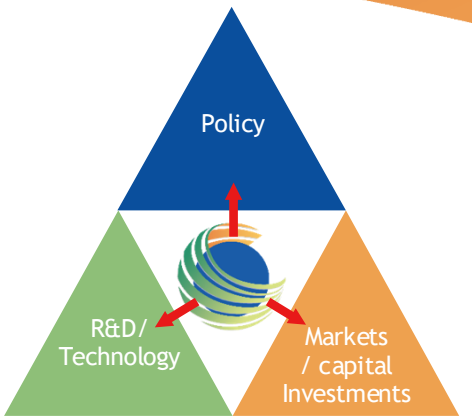
Bioenergy as a stepping stone towards a circular biobased economy

Eric van den Heuvel – Technical Coordinator

Workshop **Scaling Asia-Pacific Bioeconomies**
15 October 2026, Moreton Bay, Australia

The IEA Bioenergy Technology Collaboration Programme (TCP) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Bioenergy TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

IEA Bioenergy: Overview



Technology Collaboration Programme (TCP), functioning within a framework created by the International Energy Agency (IEA)

Goal:

- International **collaboration** and **info exchange** on bioenergy research, technology development, demonstration, markets, and policy analysis
- Facilitate the commercialization and market deployment of sustainable bioenergy systems = **climate positive**, **environmentally sound**, **socially acceptable** and **cost-competitive** (incl. external costs)

Members:

14 European countries + EC, USA, Canada, Brazil, India, China, Japan, Korea, Australia, New Zealand, South Africa

Work programme:

Carried out through **Tasks** and **Strategic Projects**, covering the full value chain from feedstock to final energy product
(~200 experts worldwide involved)



IEA Bioenergy

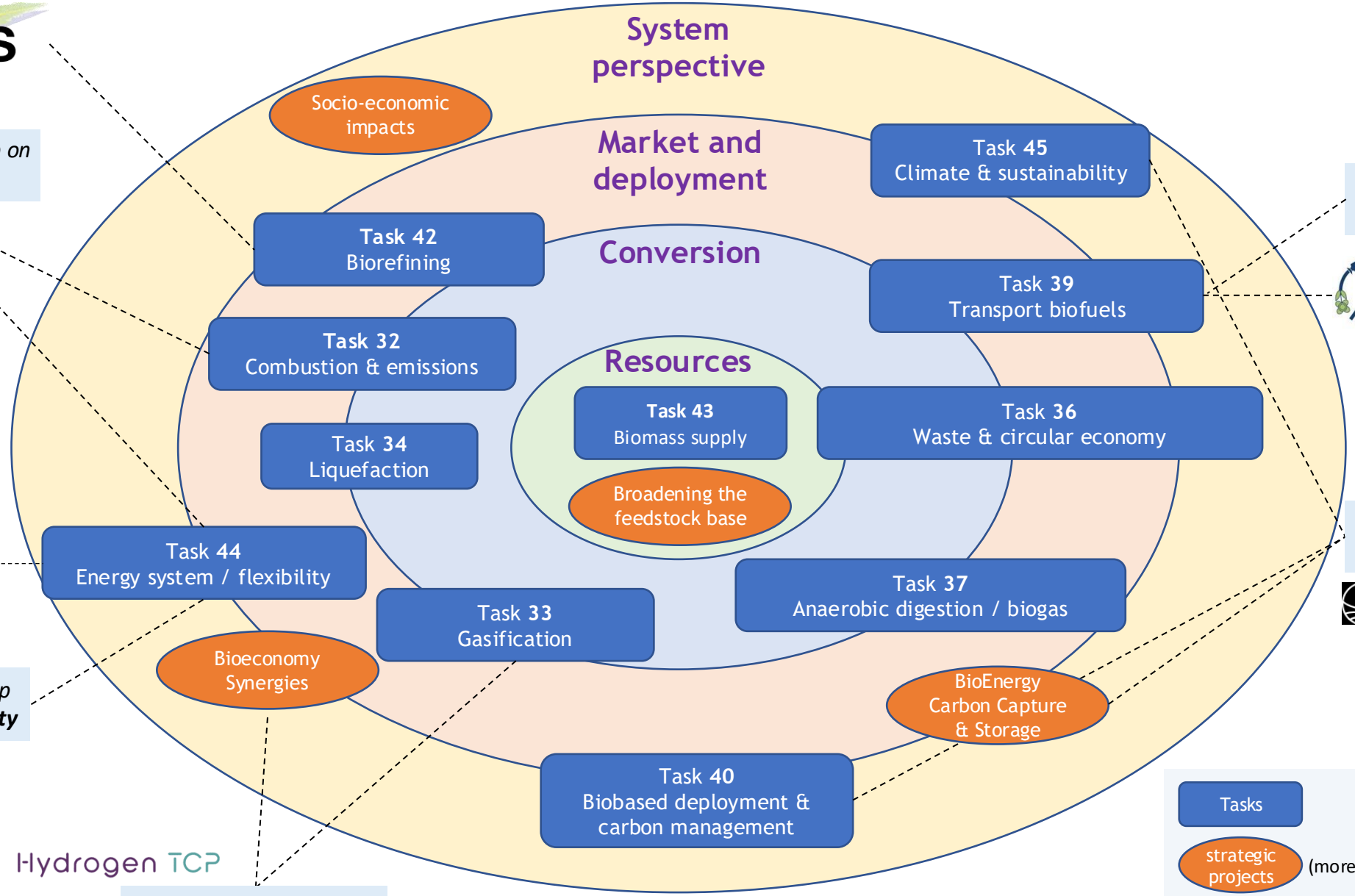
Want to join IEA Bioenergy TCP?

www.ieabioenergy.com

IEA Bioenergy: Vision

- Modern bioenergy is, and will continue to be, an **essential form of renewable energy**, making an important contribution to energy security and achieving international climate goals
- Bioenergy is an integral part of developments towards a **circular biobased economy**
- By accelerating the sustainable production and efficient use of biomass, the **contribution to the Sustainable Development Goals** will be optimized
- This will result in more cost-competitive bioenergy and other bio-based applications and in **reduced, or even net-negative, greenhouse gas emissions**, while **safeguarding ecosystems**

IEA Bioenergy: Activities



*TCP Coordination Group on **Thermal Networks***

*TCP **Transport** Coordination Group*

*TCP Coordination Group on **Carbon Management***

*TCP Coordination Group **Energy System Flexibility***

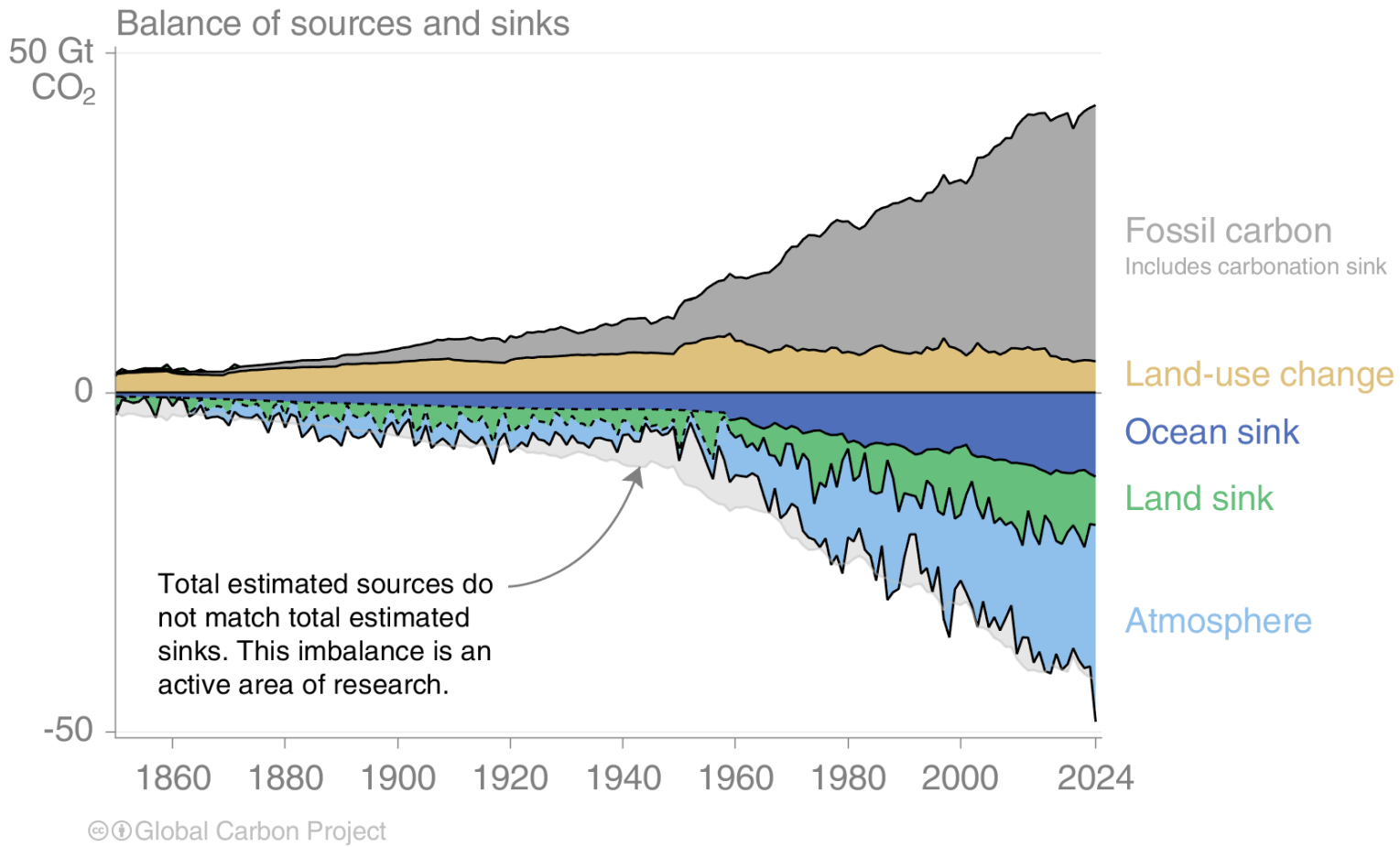
*TCP Coordination Group on **Hydrogen***

Tasks

strategic projects (more Tasks/TCPs involved)

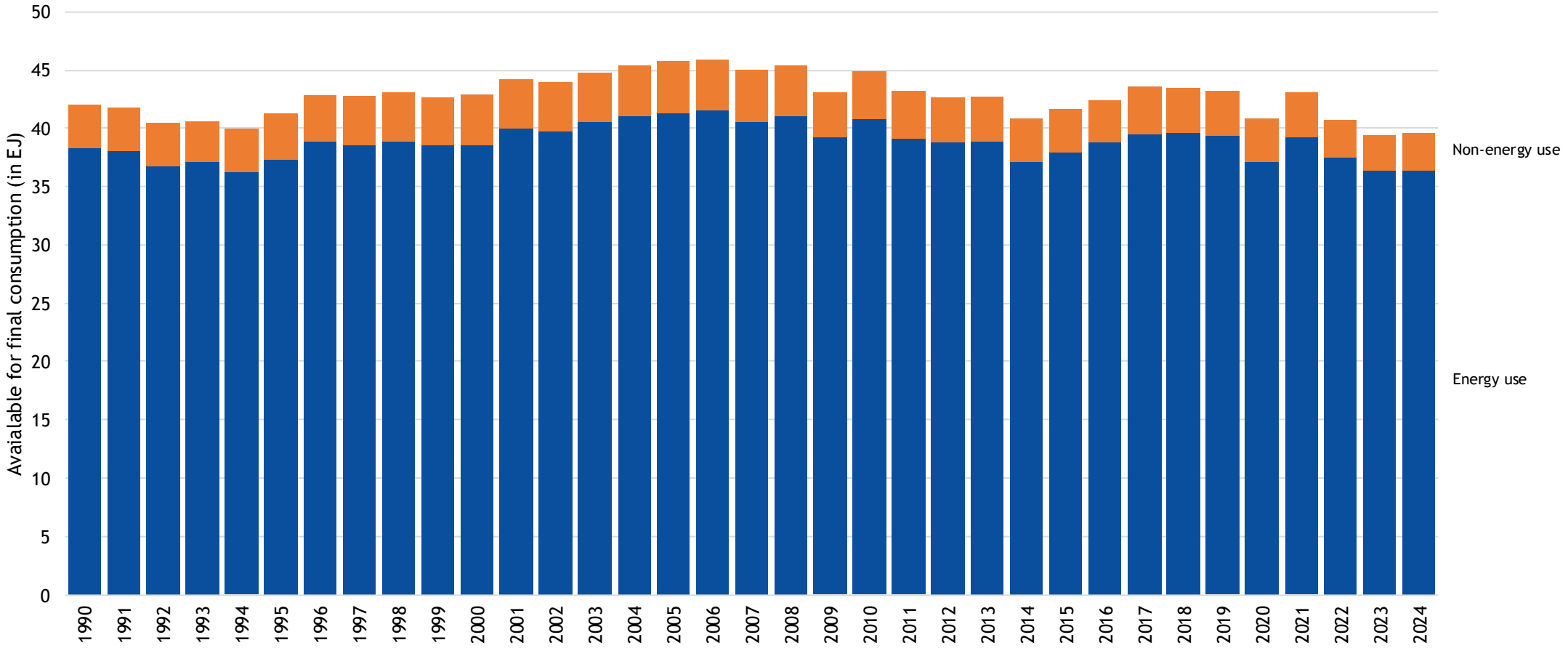
Link with other TCPs & TCP Coordination Groups

Climate policy is initially focused on mitigating fossil based carbon emissions



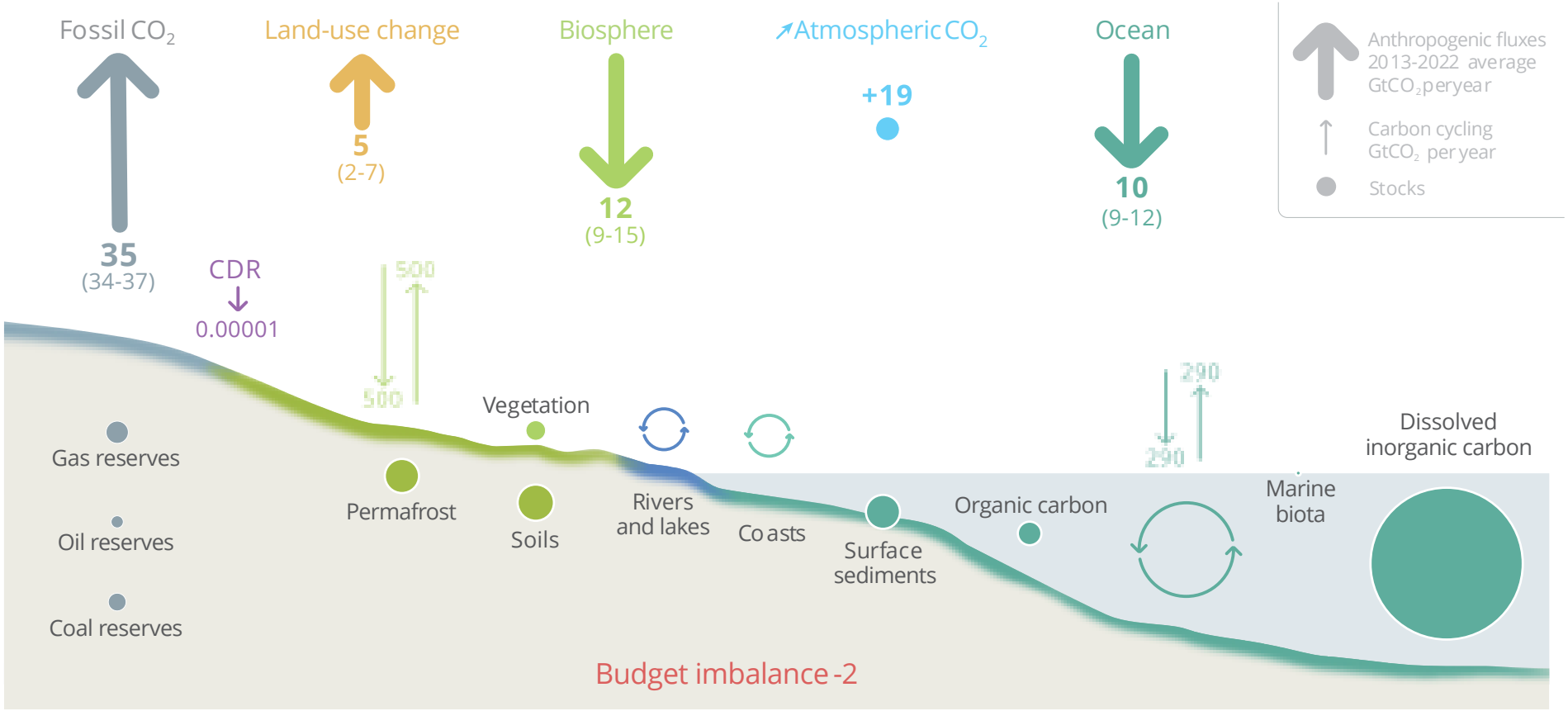
Source: Global Carbon Budget, 2025

And energy is a primary target as >90% of fossil resources are used for energy functions



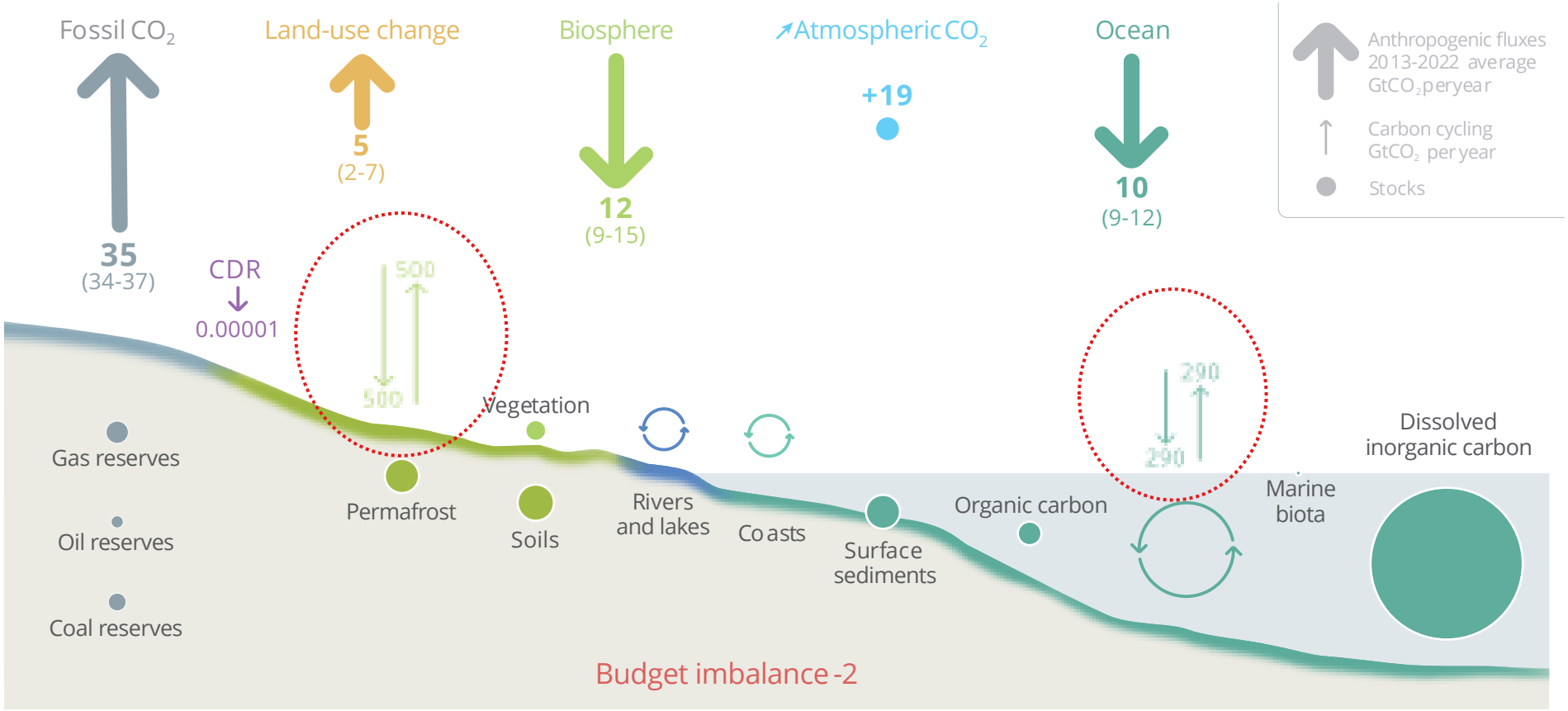
Source: EU, Eurostat, Complete Energy Balance database

The global anthropogenic carbon fluxes



Source: Global Carbon Budget, 2025

The global anthropogenic carbon fluxes are relatively small compared to the system-carbon cycles



Source: Global Carbon Budget, 2025

The Circularity Gap report (2018) shows for which ‘societal needs’ the extracted resources are used and what the level of circularity is

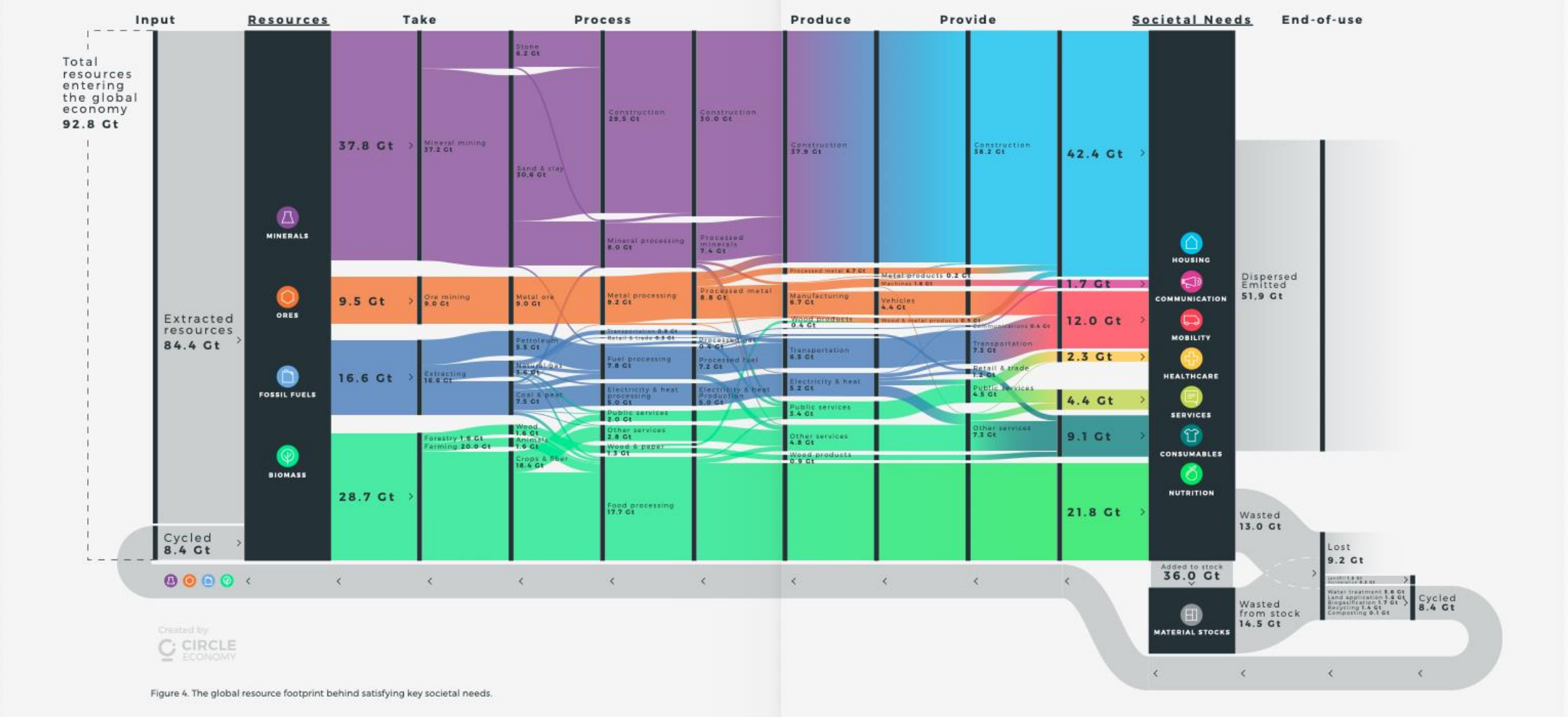


Figure 4. The global resource footprint behind satisfying key societal needs.

Source: Circle Economy, 2018_The circularity gap report

Unchanged trend of material extraction from fossil, ores, minerals and biomass might lead to further doubling by 2050 compared to 2015

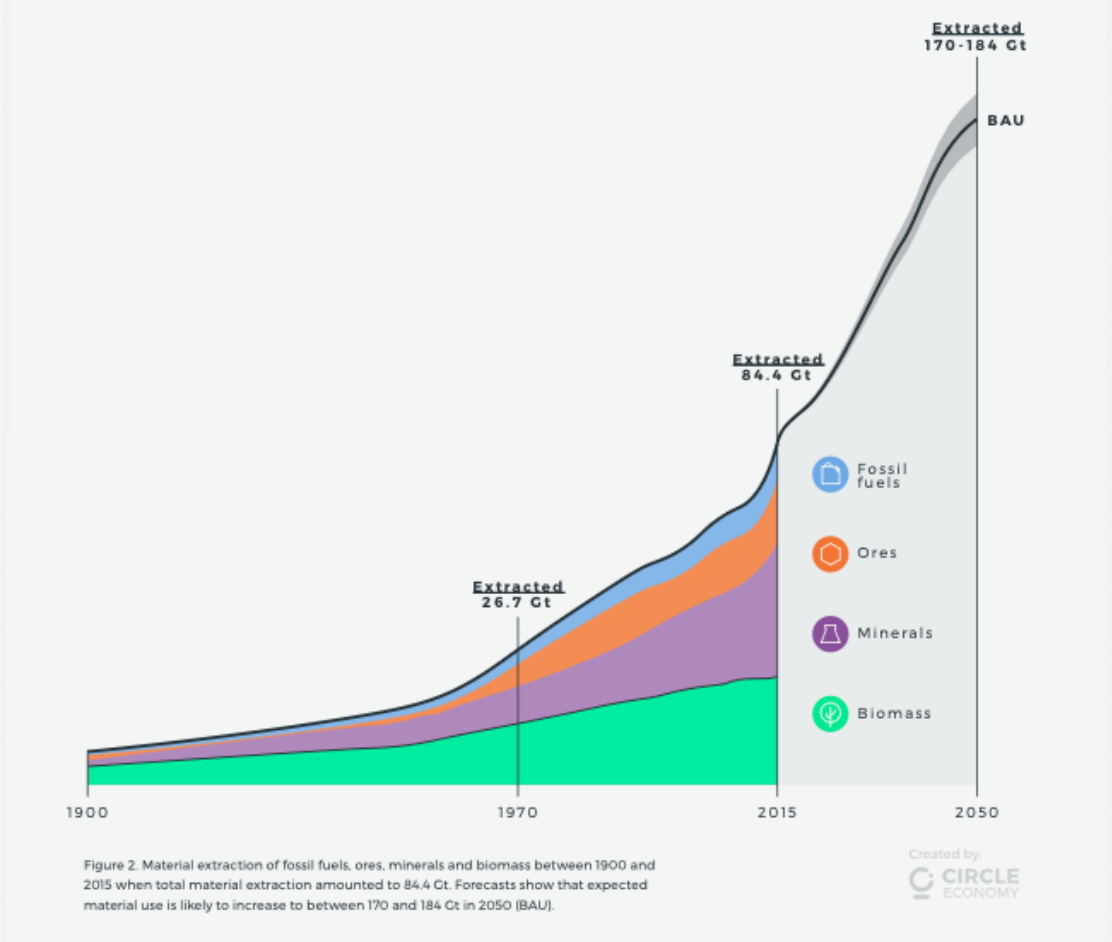


Figure 2. Material extraction of fossil fuels, ores, minerals and biomass between 1900 and 2015 when total material extraction amounted to 84.4 Gt. Forecasts show that expected material use is likely to increase to between 170 and 184 Gt in 2050 (BAU).

Source: Circle Economy, 2018_The circularity gap report

A drastic shift to recycled and regenerated resources is needed and that would require clear sustainability standards

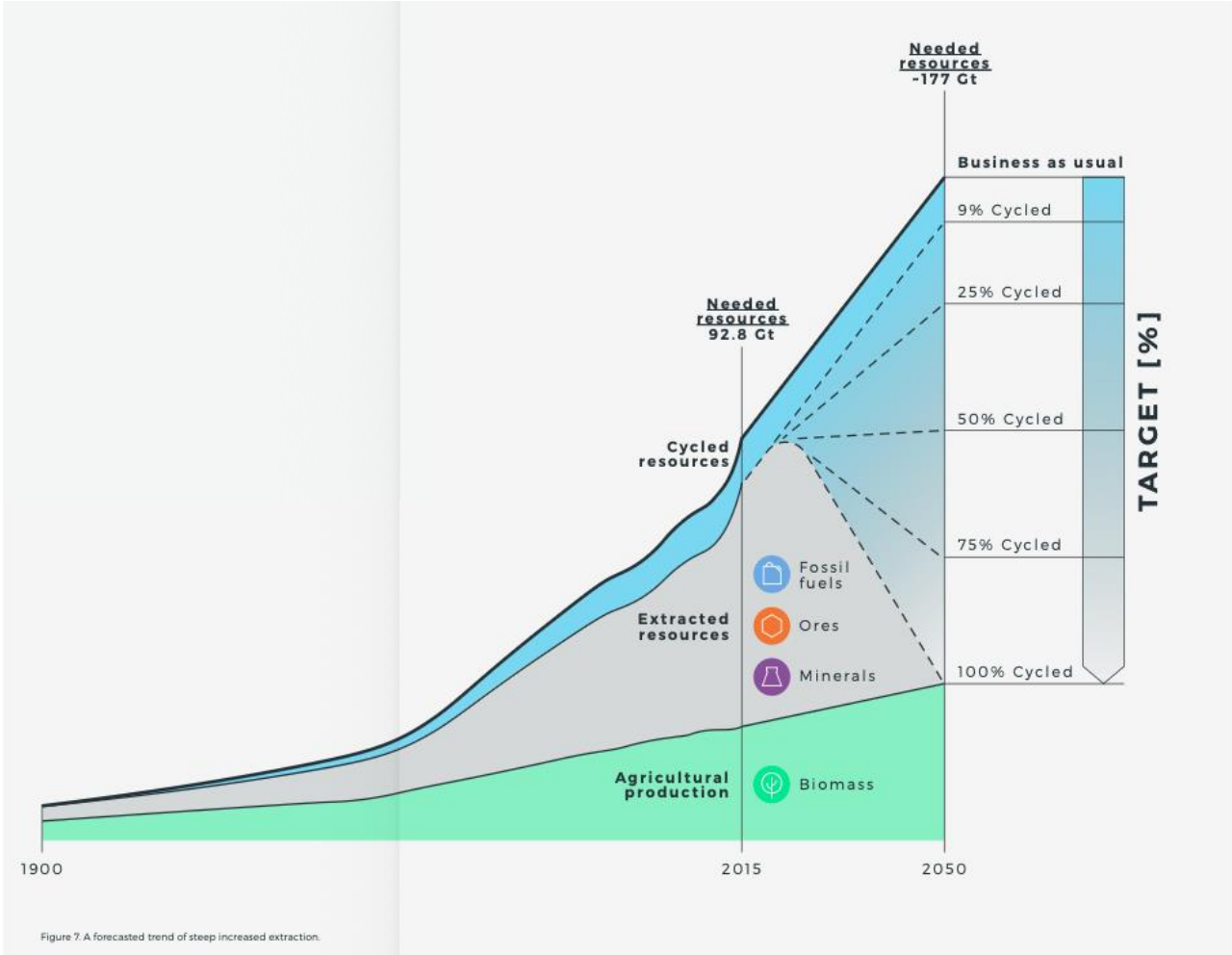
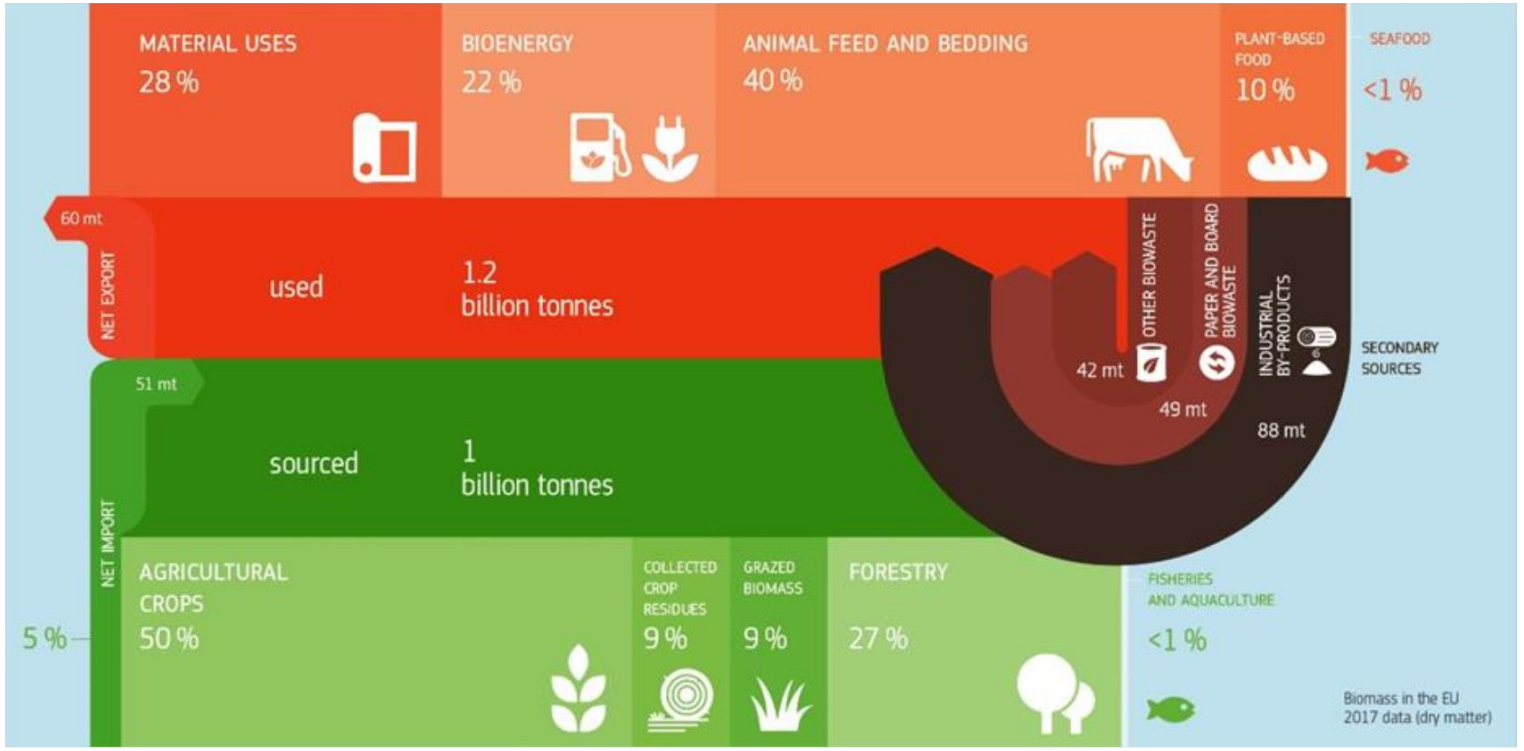


Figure 7: A forecasted trend of steep increased extraction.

Source: Circle Economy, 2018_The circularity gap report

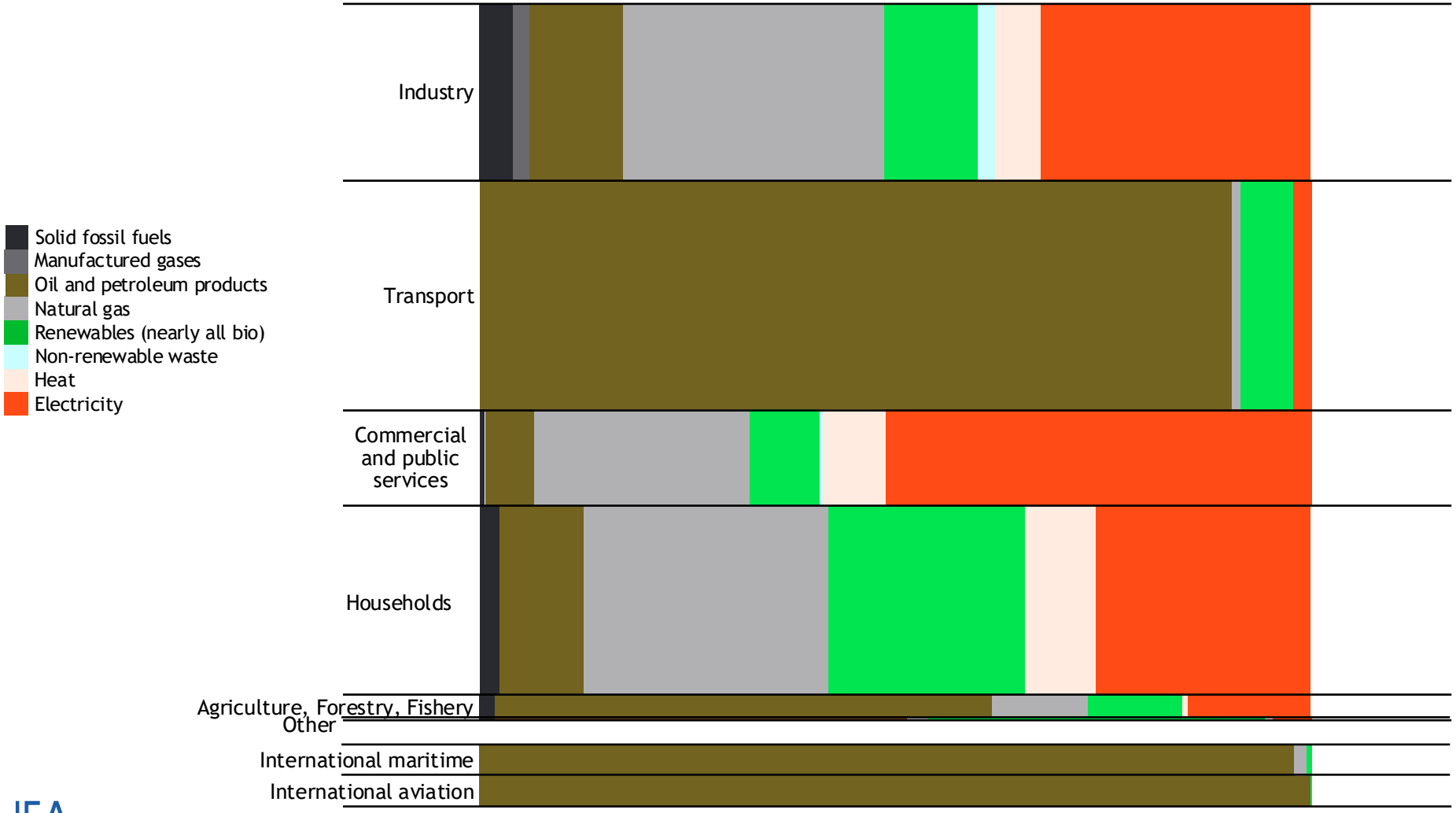
The EU is already a kind of bioeconomy, with deployment of biogenic sources in many sectors

- Total **sources** of biomass in the EU-27:
  - **±1 billion tonnes** of dry matter
  - includes domestic production and net imports
  - 70% origins from agricultural sector
- Total **uses** amounts to:
  - **±1.2 billion** tdm
  - Additional volume due to recovery of waste from industries and households



Source: JRC, 2023, Biomass production supply uses and flows in the European Union

But at the same time the energy consumption in the EU27 (in 2023) is still very much fossil based: 950 Mtoe / 39,8 EJ (incl. int. aviation and maritime)



Source: Eurostat, Energy Balance, 2023 data. Data are excluding international aviation and maritime bunkering, graph created by studio Gear Up

The shifting focus in EU policy

- **Initially on energy security**
- Since COP in Kyoto (1990) gradual focus to Renewable Energy
- All instruments addressed reducing fossil fuel carbon dioxide emissions
  - E.g. the EU emission Trading Scheme, focusing on energy sector and energy use industry
  - Focus on Reduced energy consumption and energy efficiency
  - Attent for also Scope 3 emissions (e.g. in ETS2 for transport and built environment

- **Recently the focus shifted** to:
  - Strategic autonomy
  - Reducing dependency of import of resources, more focus on bioeconomy and recycling wastes
  - Shifting to Clean Industry, Innovation and Competitiveness

In that light the EC developed a strategic framework for a Competitive and Sustainable EU Bioeconomy in 2025

- Builds on earlier documents published 2011 and 2018
- The bioeconomy represent a **strategic opportunity** of the 21st century
- Definition of bioeconomy: activities that deliver sustainable solutions based on **biological resources to create added value**
- Responsible and efficient use of biomass remains key for **long-term competitiveness**, **supply stability** and **eco-system health**

Source: EC, A strategic. Framework for a Competitive and Sustainabel EU Bioeconomy (SWD(2025)895)

The Bioeconomy Strategy addresses efficient use of biomass

Directing it to higher-value applications and reducing pressures on ecosystems, while reflecting local conditions and market realities:

- **Food and nutrition security**
- **Higher-value products and materials, storing carbon longer, substituting fossil-based materials**
- **Residual and secondary streams can be used for energy,**

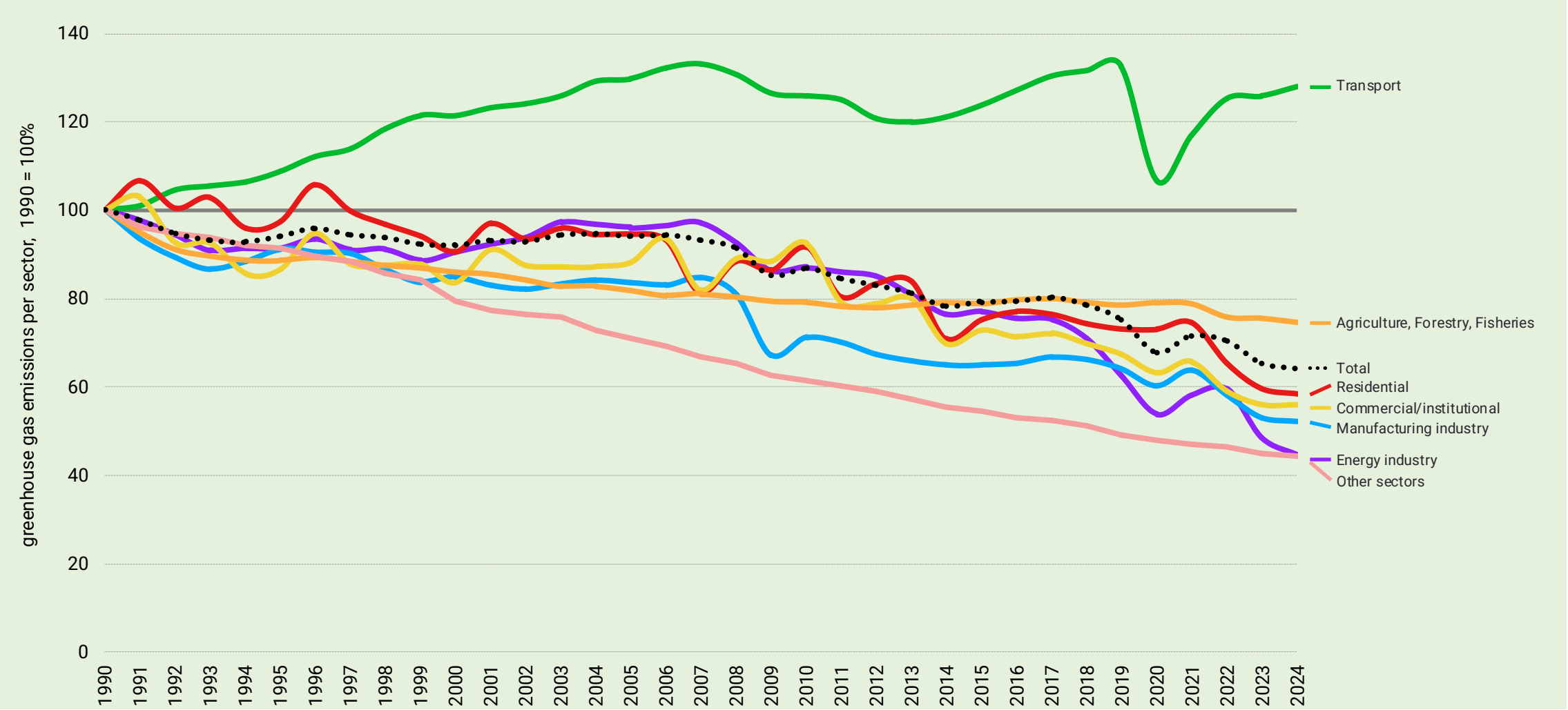
This is where the current experiences with **biomass for energy** can act as **stepping stone** and establish **enhanced synergies**

Source: EC, A strategic. Framework for a Competitive and Sustainabel EU Bioeconomy (SWD(2025)895)

The shifting focus in EU policy

- Initially on energy security
- Since COP in Kyoto (1990) gradual focus to Renewable Energy
- All instruments addressed reducing fossil fuel carbon dioxide emissions
  - E.g. the EU emission Trading Scheme, focusing on energy sector and energy use industry
  - Focus on Reduced energy consumption and energy efficiency

The greenhouse gas emissions in EU's economic sectors went down



Source: EC,2025, Transport in Figures - Pocketbook

The shifting focus in EU policy

- Initially on energy security
- Since COP in Kyoto (1990) gradual focus to Renewable Energy
- All instruments addressed reducing fossil fuel carbon dioxide emissions
  - E.g. the EU emission Trading Scheme, focusing on energy sector and energy use industry
  - Focus on Reduced energy consumption and energy efficiency
  - Attent for also Scope 3 emissions (e.g. in ETS2 for transport and built environment

- Recently the focus shifted to:
  - Strategic autonomy
  - Reducing dependency of import of resources, more focus on bioeconomy and recycling wastes
  - Shifting to Clean Industry, Innovation and Competitiveness

In that light the EC developed a strategic framework for a Competitive and Sustainable EU Bioeconomy in 2025

- Builds on earlier documents published 2011 and 2018
- The bioeconomy represent a **strategic opportunity** of the 21st century
- Definition of bioeconomy: activities that deliver sustainable solutions based on **biological resources to create added value**
- Responsible and efficient use of biomass remains key for **long-term competitiveness**, **supply stability** and **eco-system health**

Source: EC, A strategic. Framework for a Competitive and Sustainabel EU Bioeconomy (SWD(2025)895)

The strategy charts a way forward to buiold a sustainable ns a nature-positive bioeconomy by:

- Scaling innovation and investments
- Building new lead markets for bio-based materials and technologies
- Ensuring sustainable sustainable biomass supply across value chains
- Harnessing global opportunities

Source: EC, A strategic. Framework for a Competitive and Sustainabel EU Bioeconomy (SWD(2025)895)

The Bioeconomy Strategy addresses efficient use of biomass

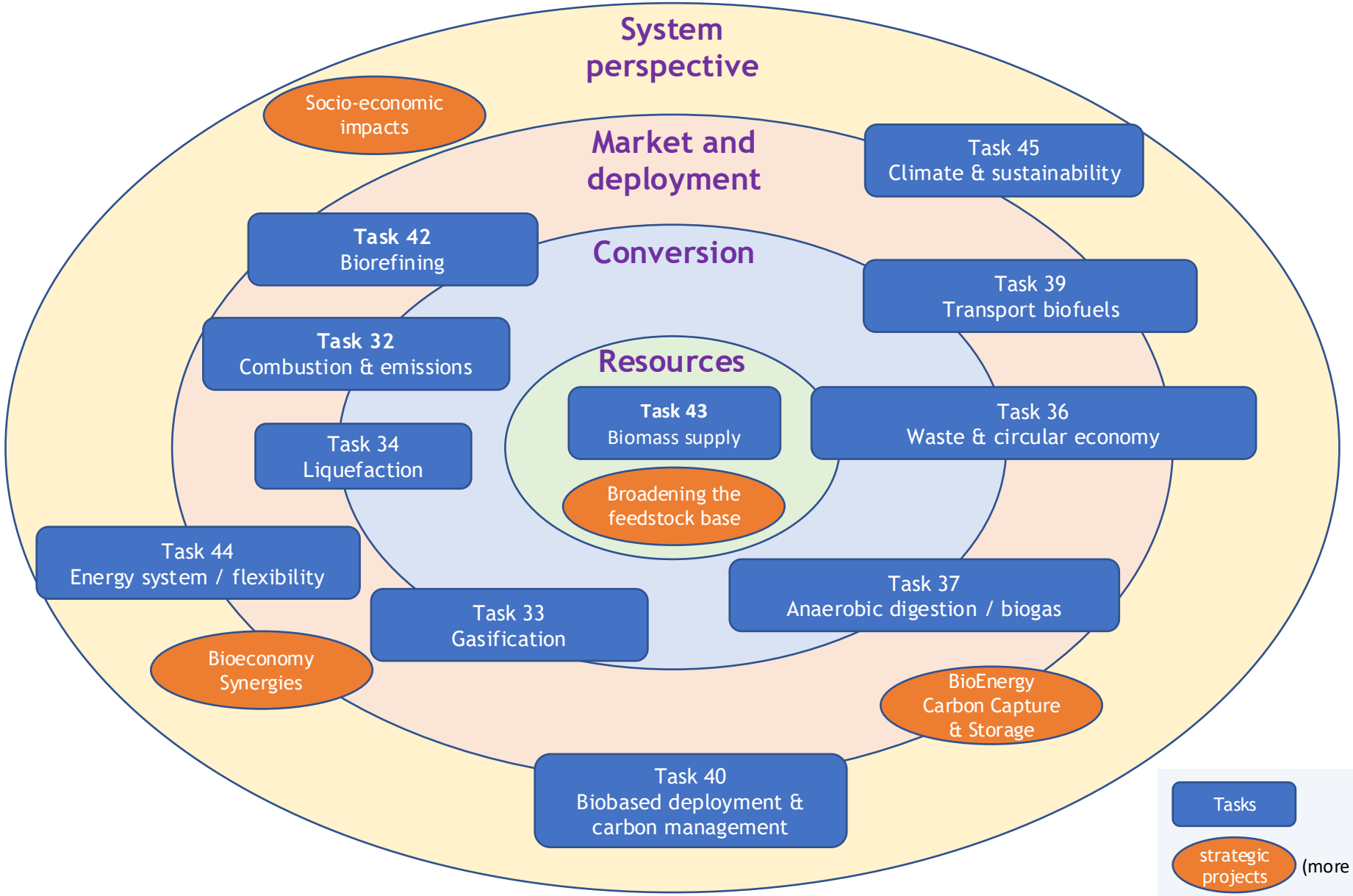
Directing it to higher-value applications and reducing pressures on ecosystems, while reflecting local conditions and market realities:

- **Food and nutrition security** while maintaining and improving ecosystem services
- Where feasible, biomass should be used for **higher-value products and materials**, that **store carbon longer** and **substitute fossil-based materials**
- **Residual and secondary streams can be used for energy**, particularly where not alternative decarbonisation solutions exists, or where it ensures energy security and energy affordability

This is where the current experiences with **biomass for energy** can act as **stepping stone** and establish **enhanced synergies**

Source: EC, A strategic. Framework for a Competitive and Sustainabel EU Bioeconomy (SWD(2025)895)

Let's see some connections



Tasks

strategic projects (more Tasks/TCPs involved)

Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Let's see some connections

Indigenous-led Circular Bioeconomies: Social and Economic Impacts and Social Percenptions



System perspective

Socio-economic impacts

Market and deployment

Task 45
Climate & sustainability

Task 42
Biorefining

Conversion

Task 39
Transport biofuels

Task 32
stion & emissions

Resources

Task 43
Biomass supply

Task 36
Waste & circular economy

Task 34
Liquefaction

Broadening the feedstock base

Task 37
Anaerobic digestion / biogas

Task 33
Gasification

BioEnergy
Carbon Capture
& Storage

Task 40
Biobased deployment & carbon management

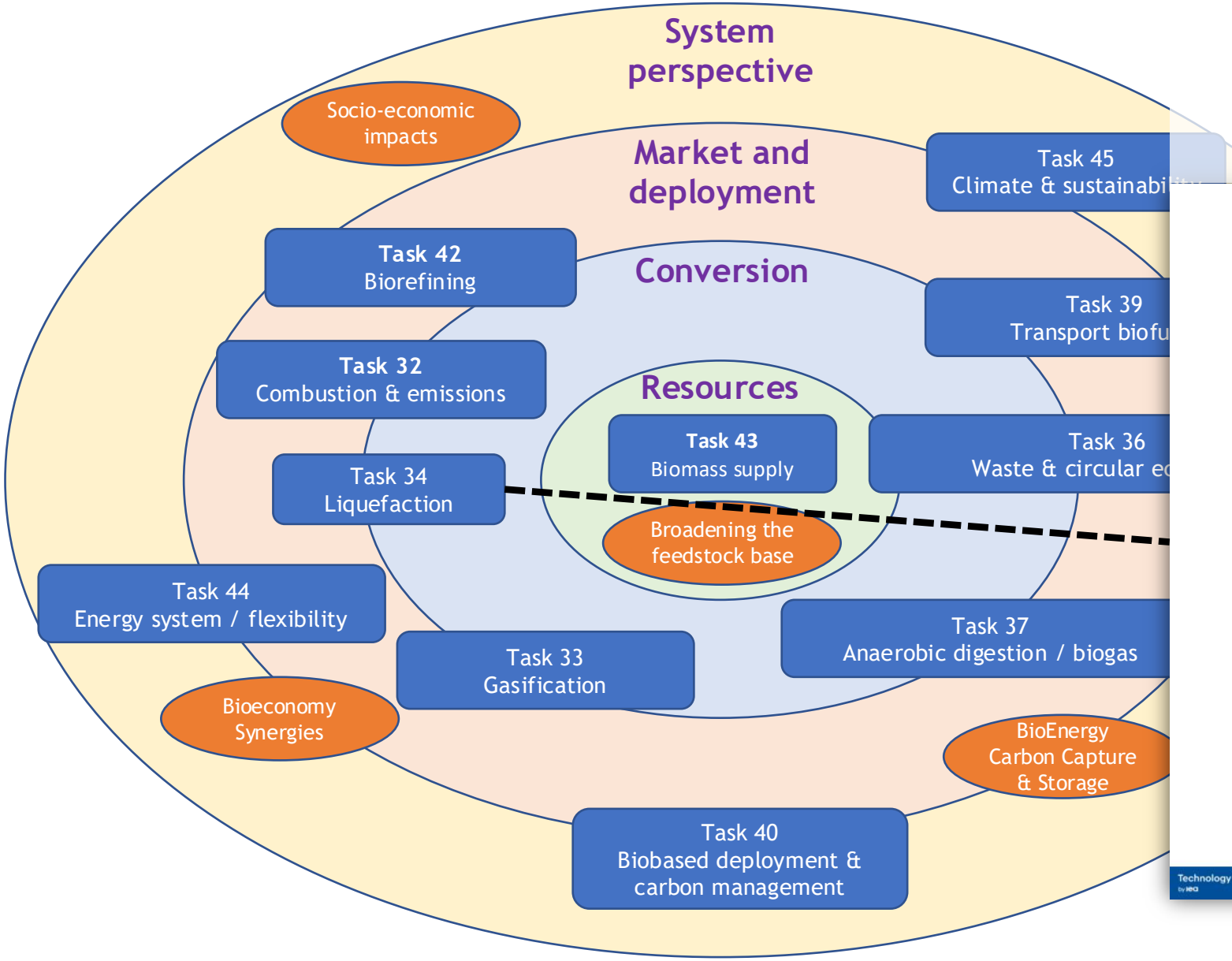
Tasks

strategic projects (more Tasks/TCPs involved)

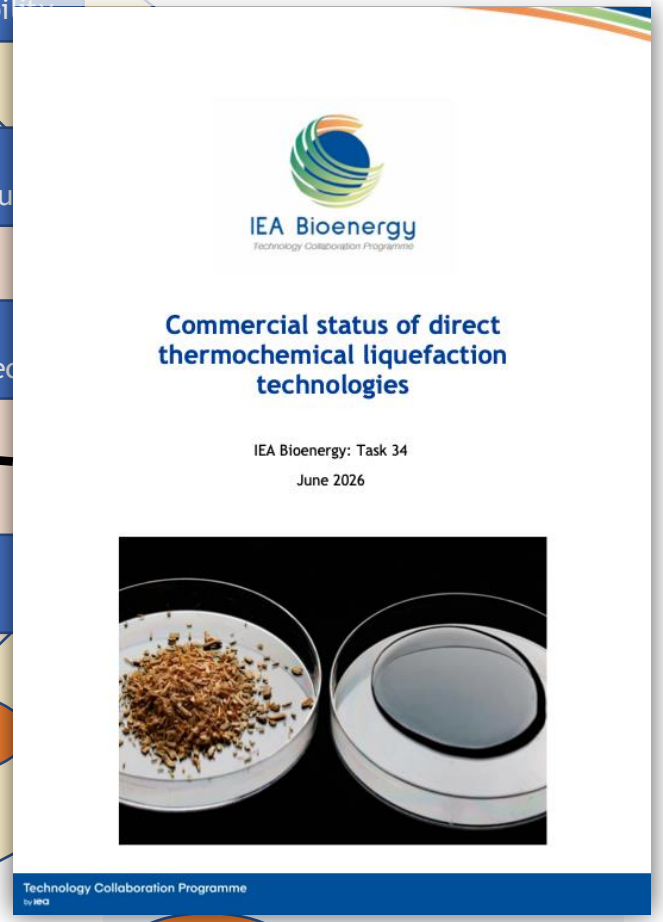
Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Let's see some connections



Commercial status of direct thermochemical liquefaction technologies



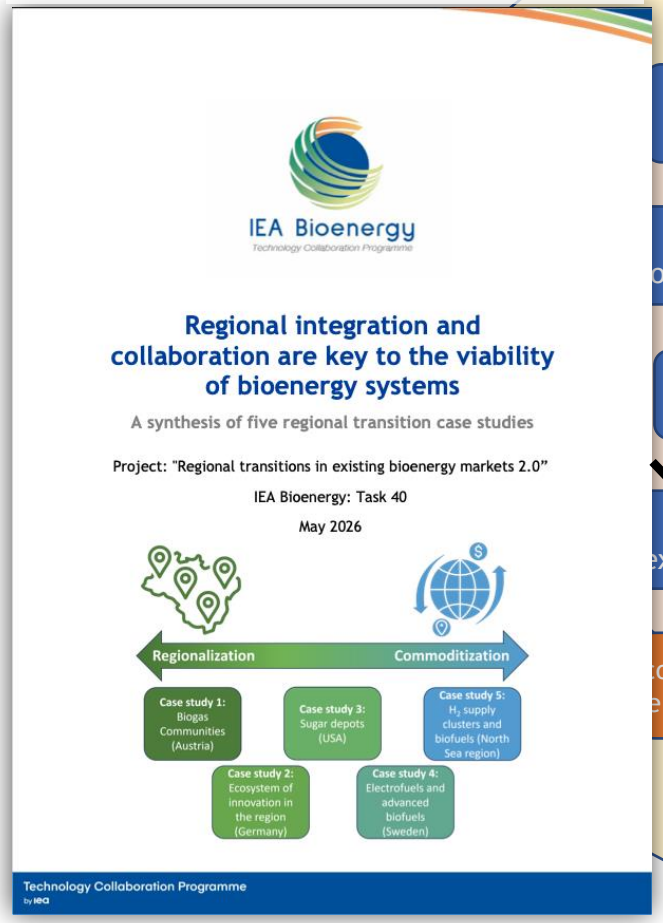
strategic projects (more Tasks/TCPs involved)

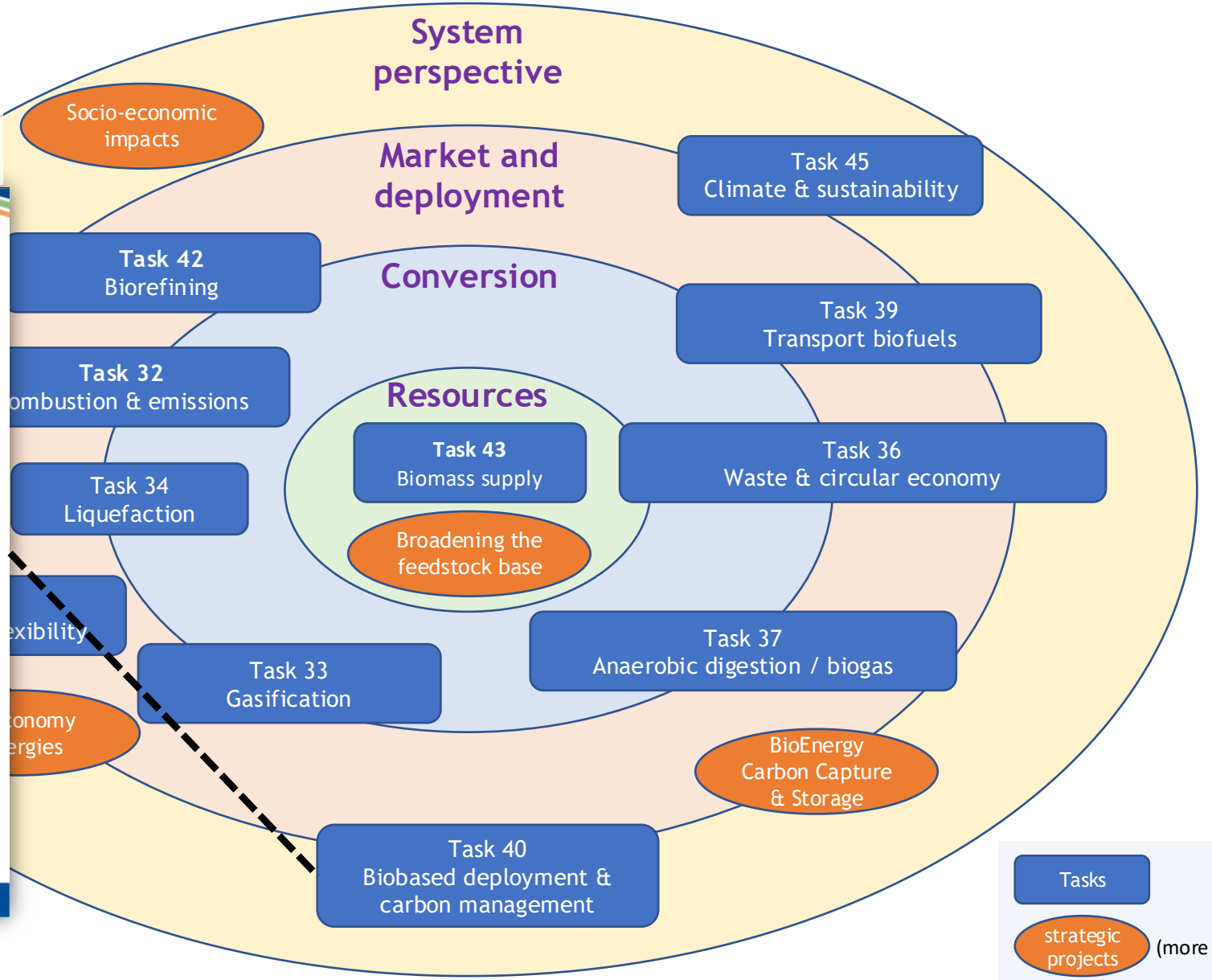
---------- Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Let's see some connections

Regional integration and collaboration are key to replace centralised fossil systems





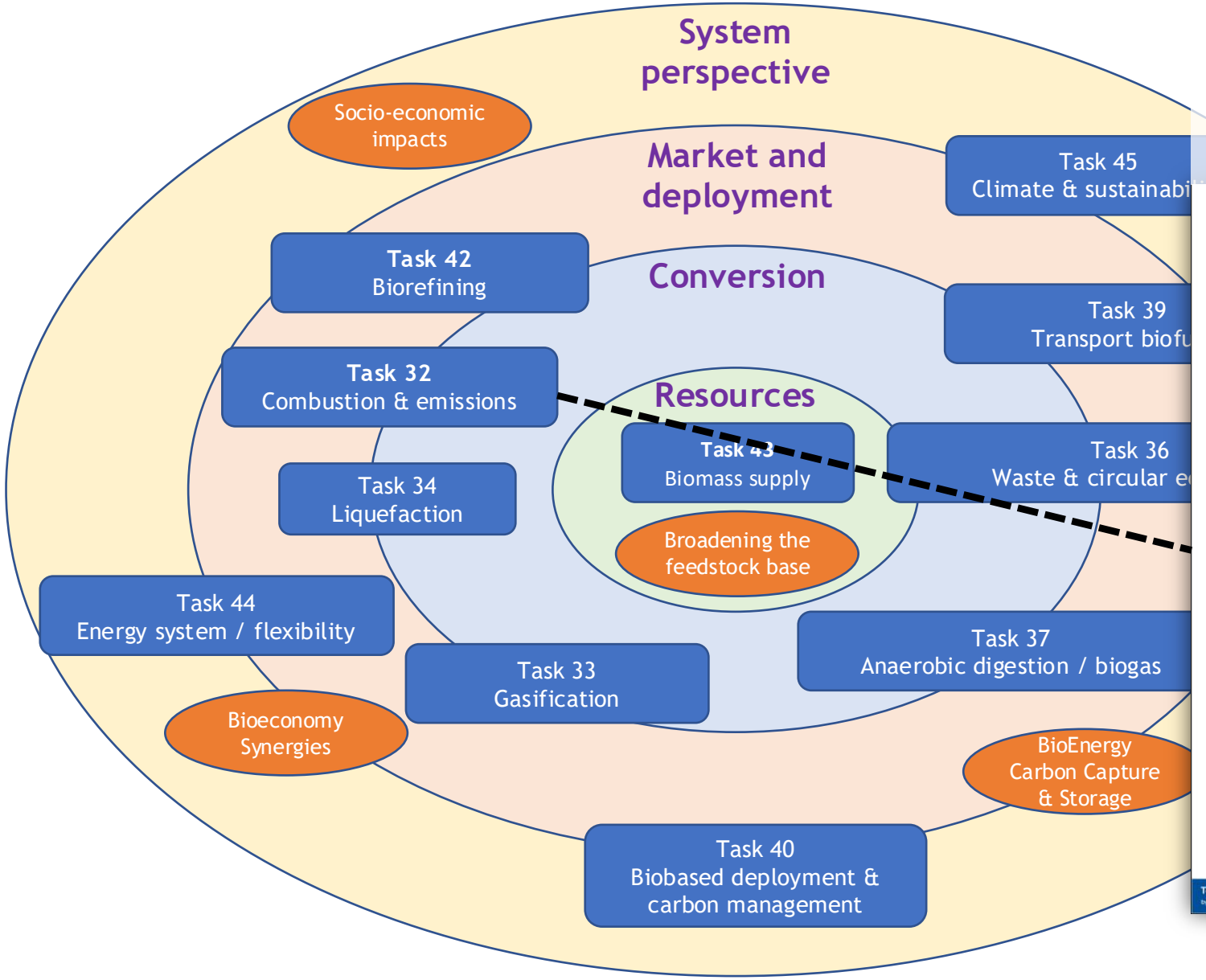
Tasks

strategic projects (more Tasks/TCPs involved)

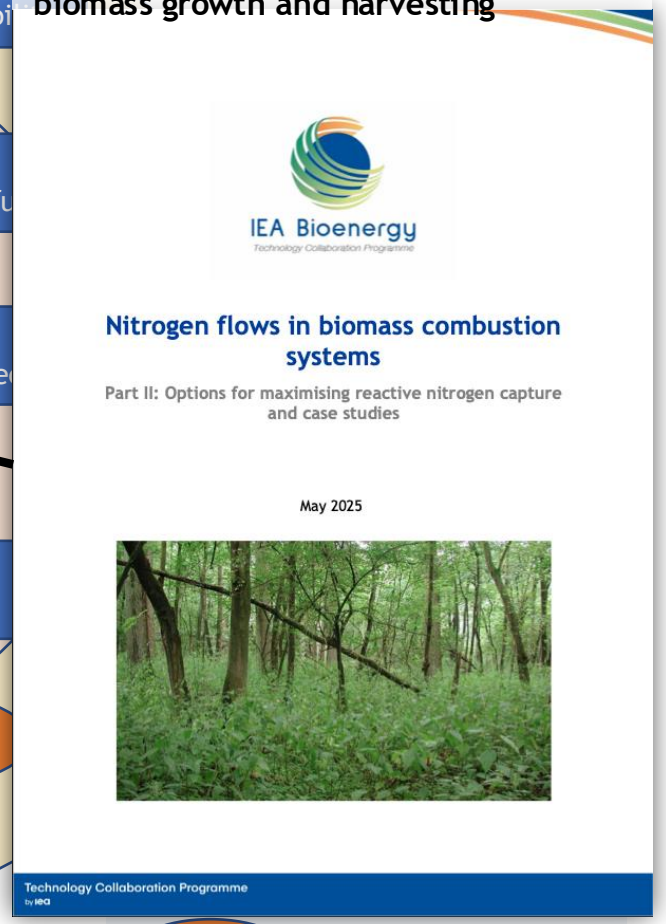
Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Let's see some connections



research on the quantification of reactive nitrogen flows along the whole biomass combustion cycle, including biomass growth and harvesting



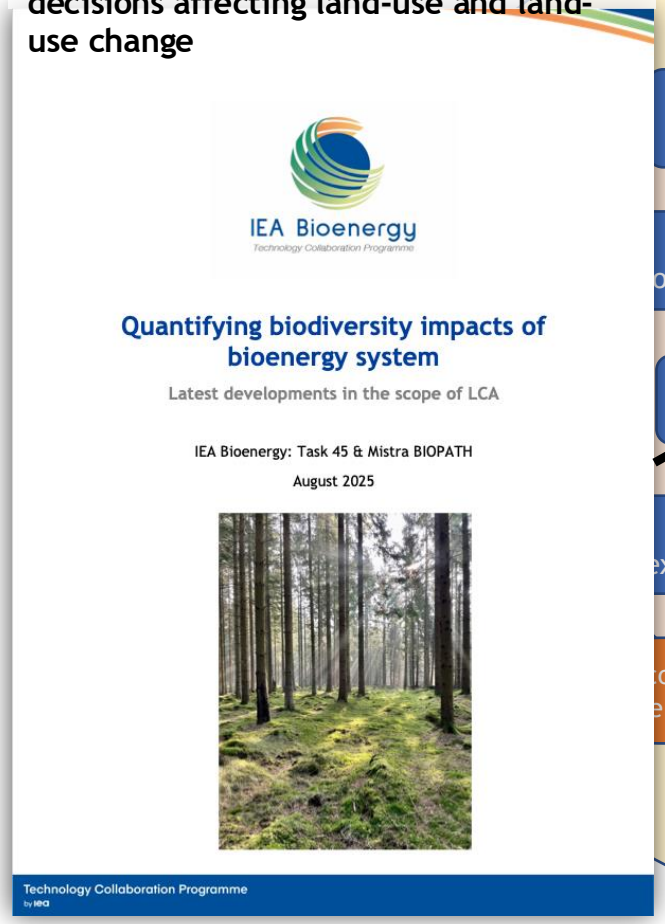
strategic projects (more Tasks/TCPs involved)

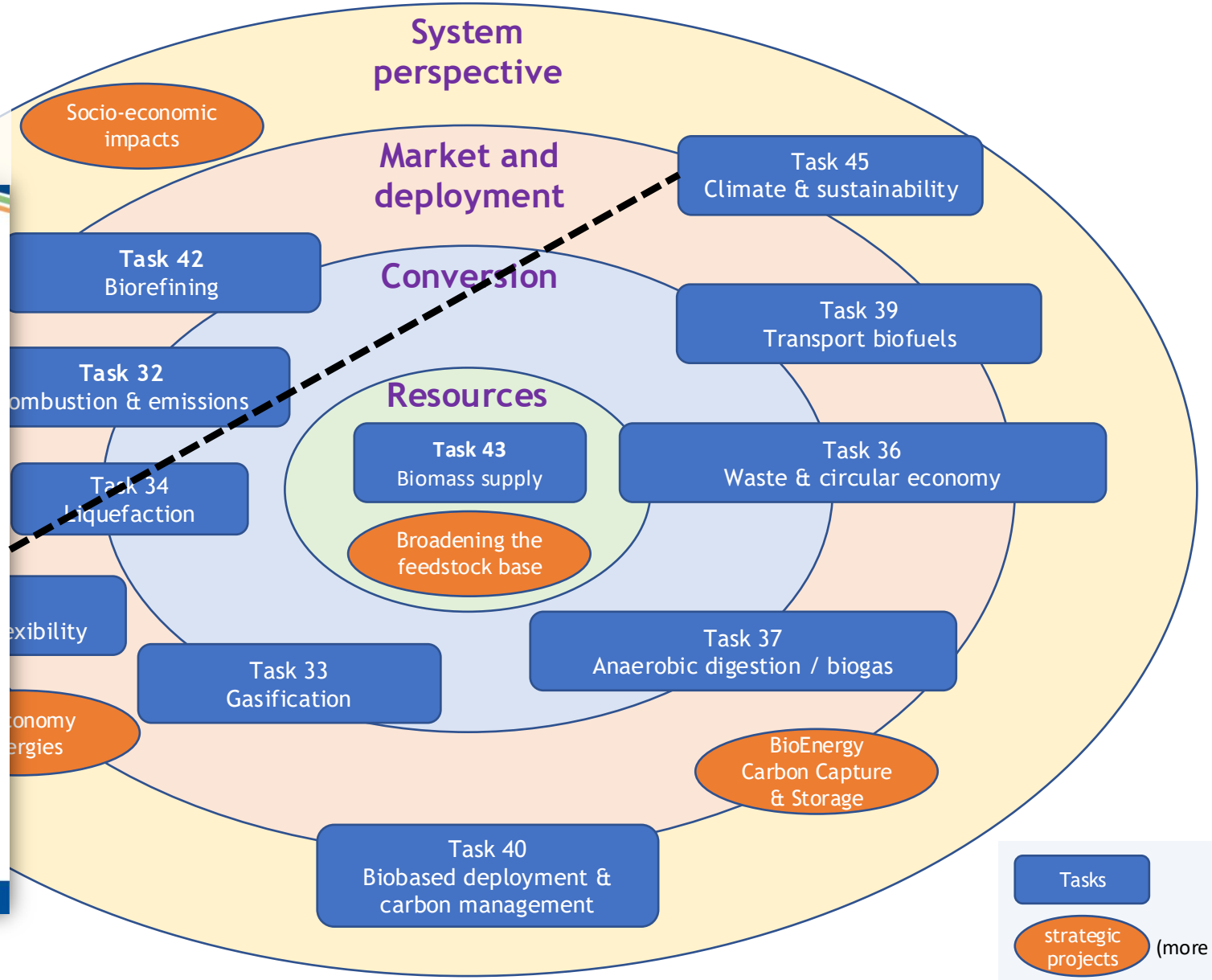
Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Let's see some connections

Overview of current progress in assessing biodiversity impacts and using assessment outcomes to inform decisions affecting land-use and land-use change





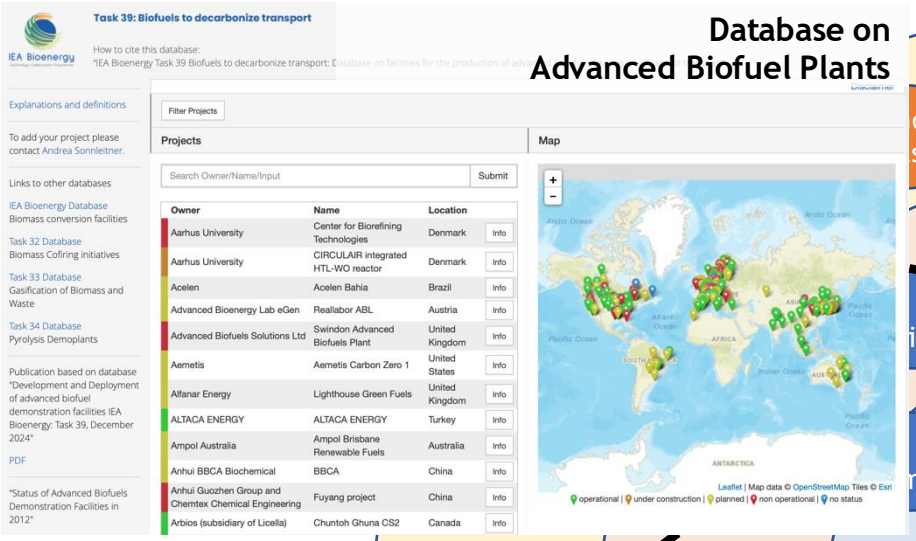
Tasks

strategic projects (more Tasks/TCPs involved)

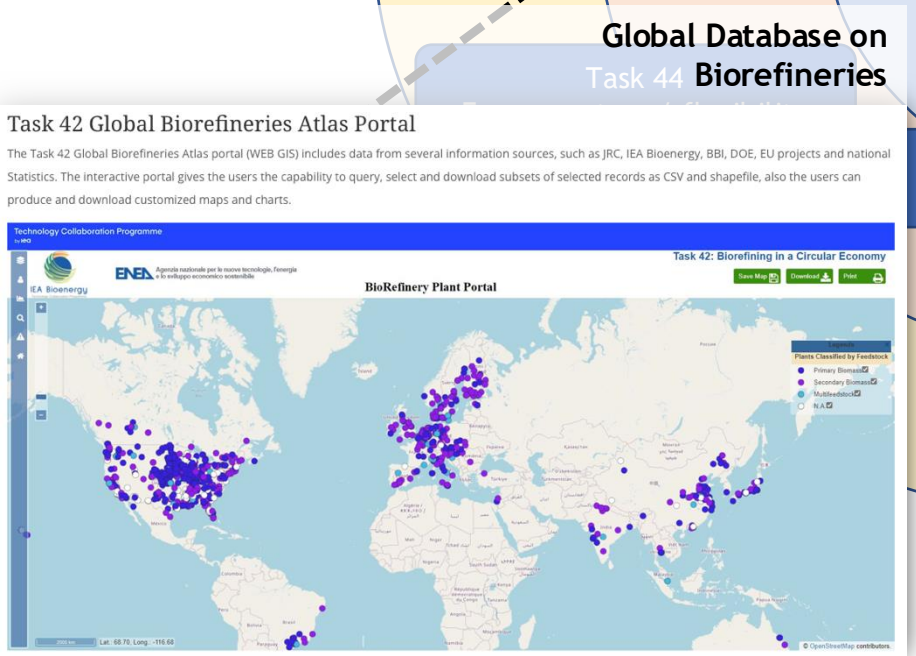
Link with other TCPs & TCP Coordination Groups

IEA Bioenergy

Some related work by our Tasks



Database on Advanced Biofuel Plants



Global Database on Biorefineries

Database on Gasification facilities

Some final reflections

- The volumes of biomass resources currently deployed for energy can be shifted in near future to biorefineries for chemicals and product
- The biobased value-added pyramid of lower-to-higher value improves in feasibility when establishing optimal value added when the total portfolio of products serves several end-use markets
- The design parameters for a circular biobased economy are different -and probably not yet fully discovered - than those parameters that have shaped the linear fossil economy
- Collective intelligence and collaboration in different networks and ecosystems might accelerate developing these parameters
- Avoid competition among the biobased resources

Thank you

Eric van den Heuvel
Eric.tc.ieabioenergy@studiogearup.com

IEA Bioenergy
Technology Collaboration Programme

Watch the IEA Bioenergy video:

www.ieabioenergy.com