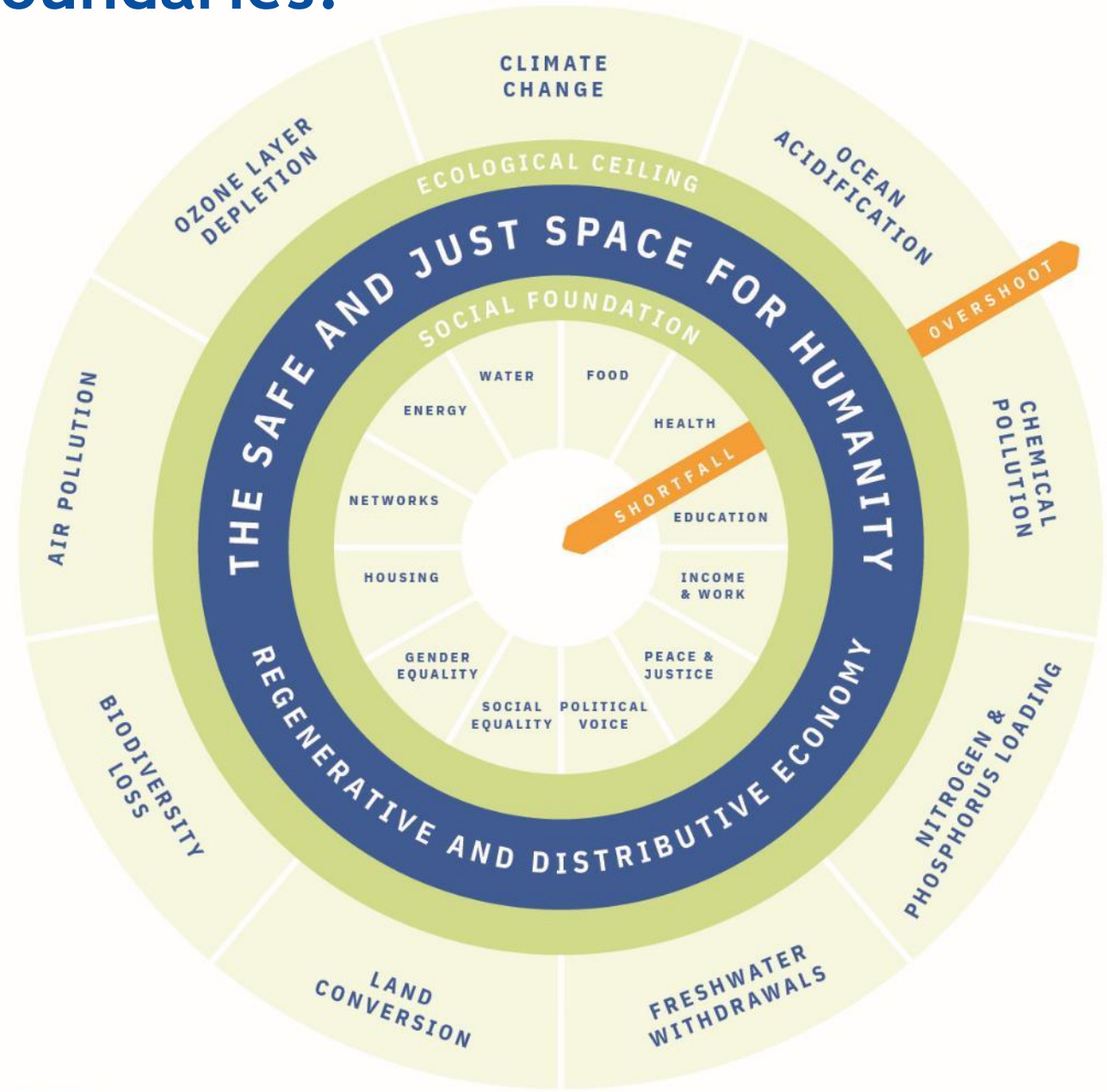
IEA Bioenergy
Technology Collaboration Programme

How Bioenergy Contributes to a Sustainable Future

Dina Bacovsky, former Chair IEA Bioenergy TCP

Bioenergy for the whole world, 22/01/2025, Copenhagen

Planetary boundaries!



Bioenergy …

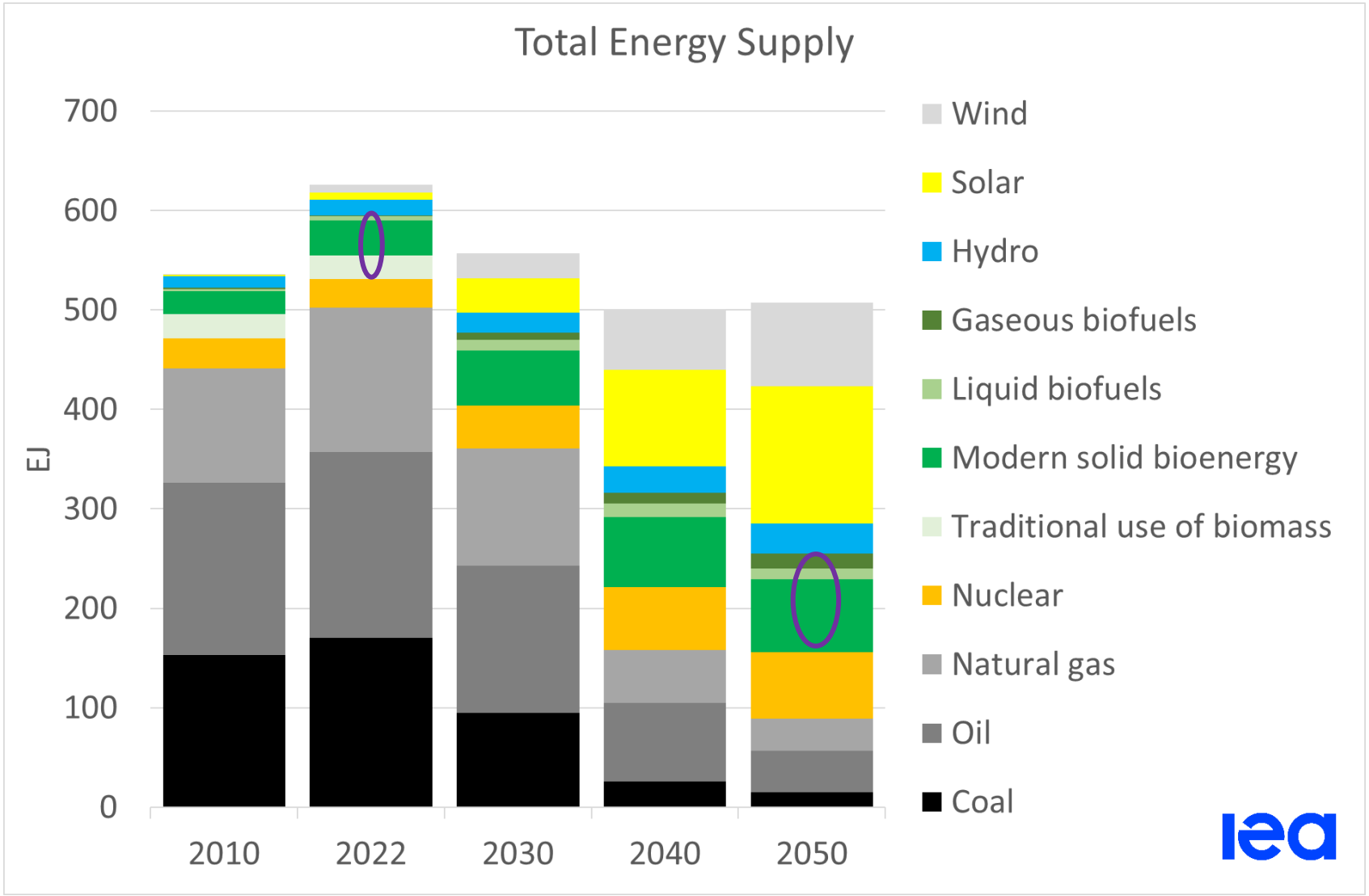
- is based on renewable, i.e. regrowing resources
- is the largest source of renewable energy today
- is **versatile**: heat, power, transport services
- provides substantial **GHG emission savings** if done responsibly
- diversifies energy sources and improves **energy supply security**
- provides **income** through regional biomass supply chains

but

- cannot achieve decarbonisation of our energy system on its own

⇒ complements other renewable energy sources & increases in energy efficiency & reductions in energy demand

Role of Bioenergy in the IEA Net Zero by 2050 Roadmap



Contribution of bioenergy from 60 EJ → 100 EJ

Important to move away from traditional biomass use

Modern bioenergy would represent 15-20% of total energy supply
=> second largest source of energy supply (after solar) in 2050.

Data source: International Energy Agency (2023), Net Zero by 2050

Multiple sources of biomass - for energy & biobased economy

Forestry

- Harvests from natural & semi-natural forests
- Harvests from forest plantations

Agriculture

- Sugar, starch and oilseed crops
- Lignocellulosic crops and short rotation coppice
- Aquaculture (algae)

Organic residues and waste

- Industrial residues & waste
  - From agro-food processing
  - From wood processing
- Agriculture and forestry residues
  - Crop harvesting residues
  - Livestock residues
  - Wood harvesting residues
- Municipal waste (organic fraction)
  - Household waste & wastewaters
  - Material waste (e.g. post consumer wood)
  - Residues from landscape management

Source: IEA ETP 2017

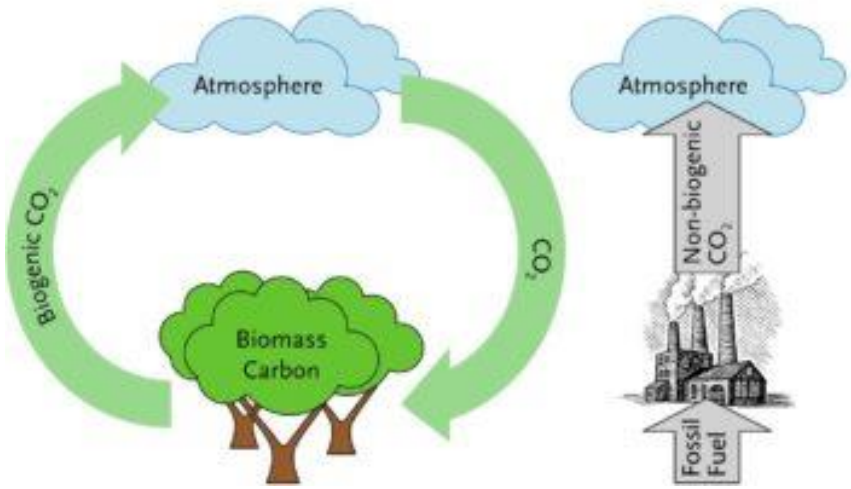
Sustainability is key

Bioenergy contributes to climate change mitigation when:

- Biomass is grown **sustainably** *(from sustainably managed landscapes)* and/or based on **waste/residues**
- **Converted** to energy products **efficiently** (often together with other biobased products)
- Used to **displace fossil fuels**

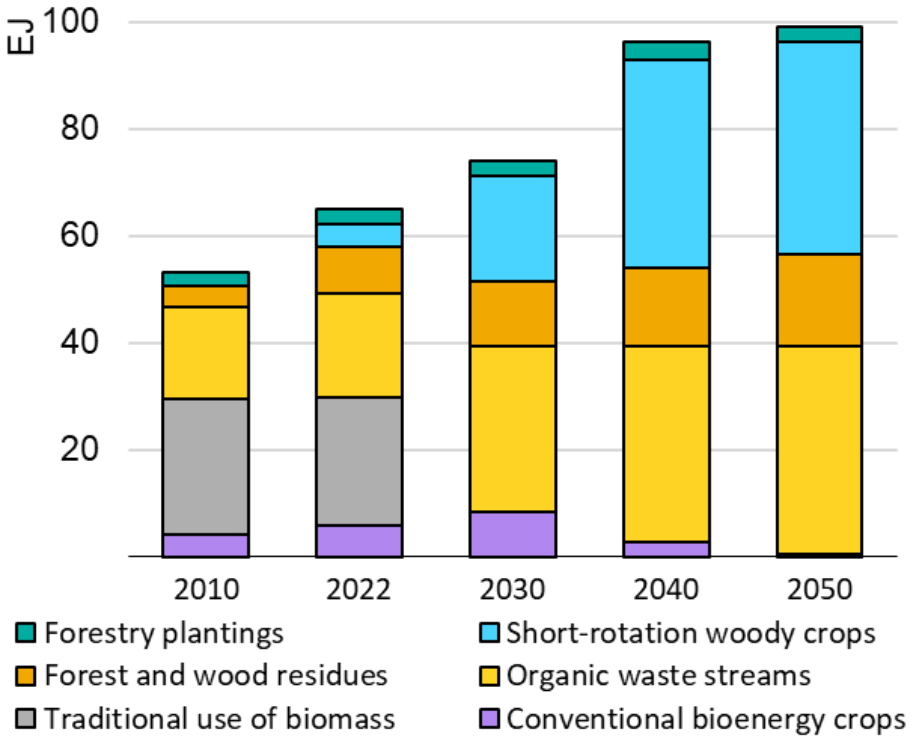
- **Bio-CCS/CCU** can add to that

- Biodiversity safeguards
- Attention for carbon sinks, preservation of carbon stocks
- Healthy soils (nutrients & organic matter)
- Social opportunities



Sustainable feedstock supply

- Improve **waste and residue** collection: industrial waste, municipal waste, forestry & agricultural residues
- Enhance **land productivity**: Intercropping, cover crops, growing crops on marginal land, improving crop yields
- Deploy (advanced) **technologies** that can process various feedstocks
- Importance of **decentral hubs** for storage and pre-processing
- Performance-based **sustainability** frameworks, incl. carbon assessment methodologies



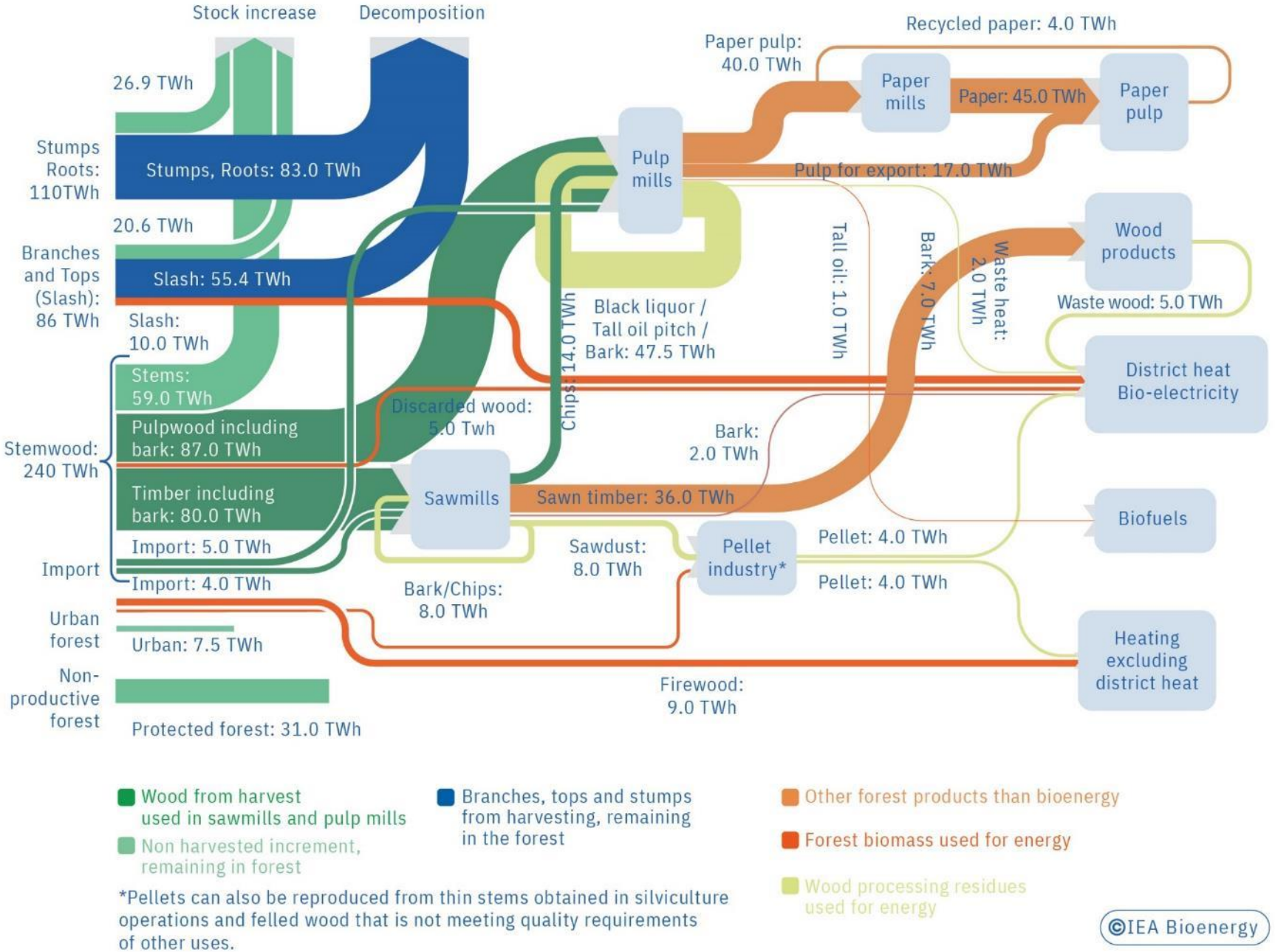
Data source: International Energy Agency (2023), Net Zero by 2050

Biomass from agricultural land

- Crops on arable land
  - Primarily for food/feed production
  - ➢ Either reduce pressure on land through increased yields & reduced food losses
  - ➢ Or use multi-cropping combinations
- Residues from crops on arable land

  => no additional land needed
  - Leave part of the residues behind to maintain soil quality
- Crops on abandoned, degraded or marginal land
  - Can restore or improve soil quality, enhance carbon sequestration
  - More costly to produce / lower yields

Biomass & energy flows from Swedish forests (2015)

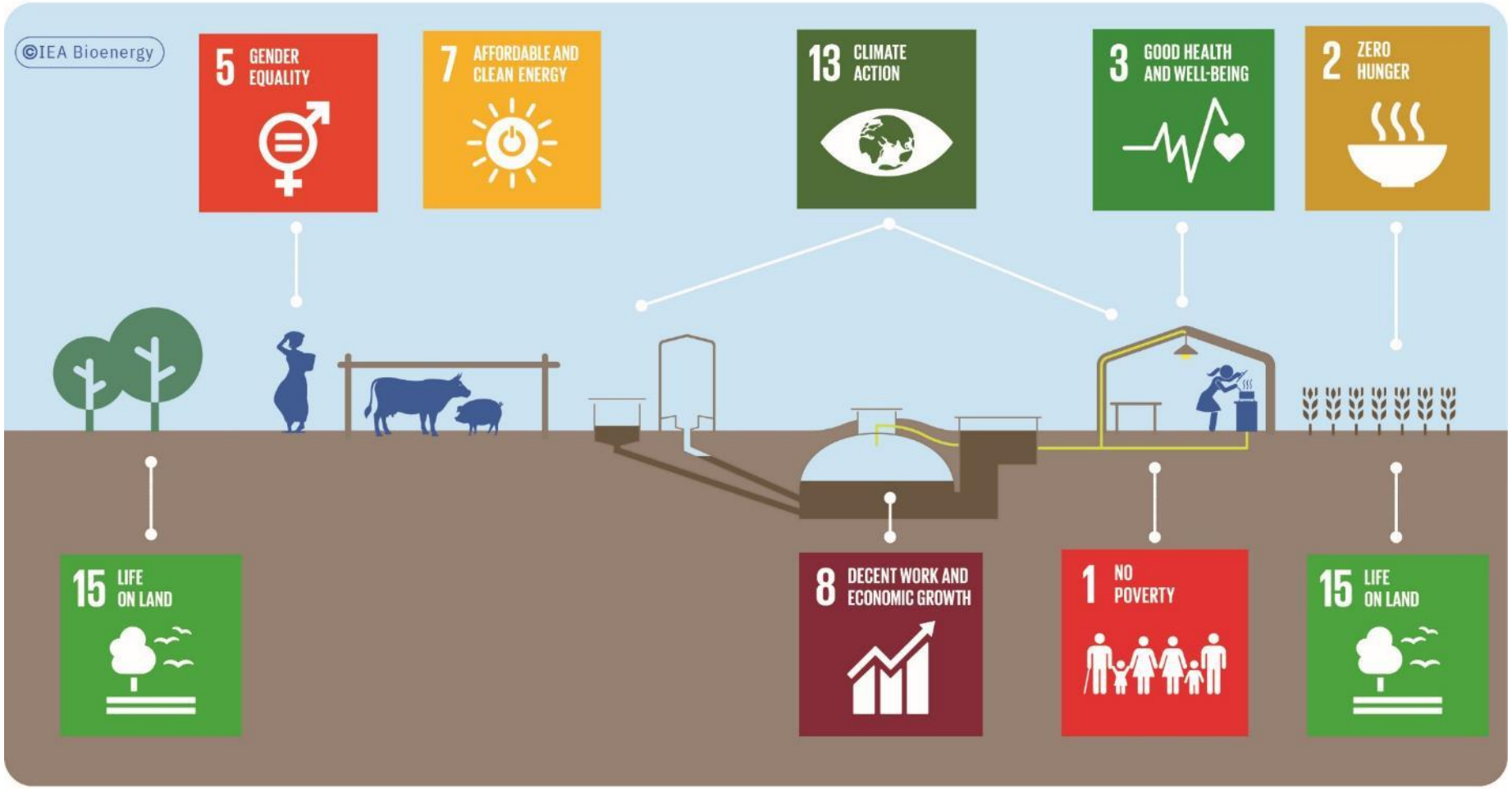


Annual biomass and energy flows from Swedish forest in 2015. Source: IRENA, 2019

Forest bioenergy is integrated in forestry and forest industry processes, providing different outputs as well as sustaining growth of the forest.

Forest bioenergy is not an isolated activity!

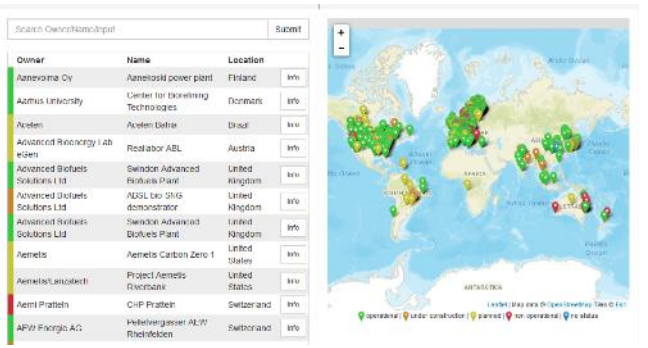
Biodigester



Bioenergy & Sustainable Development Goals

- 15 of the 17 SDGs are directly or indirectly linked to the production and use of biomass
- 37 case studies from around the world show how bioenergy production can positively contribute to the SDGs

Efficient conversion



Mature technologies:

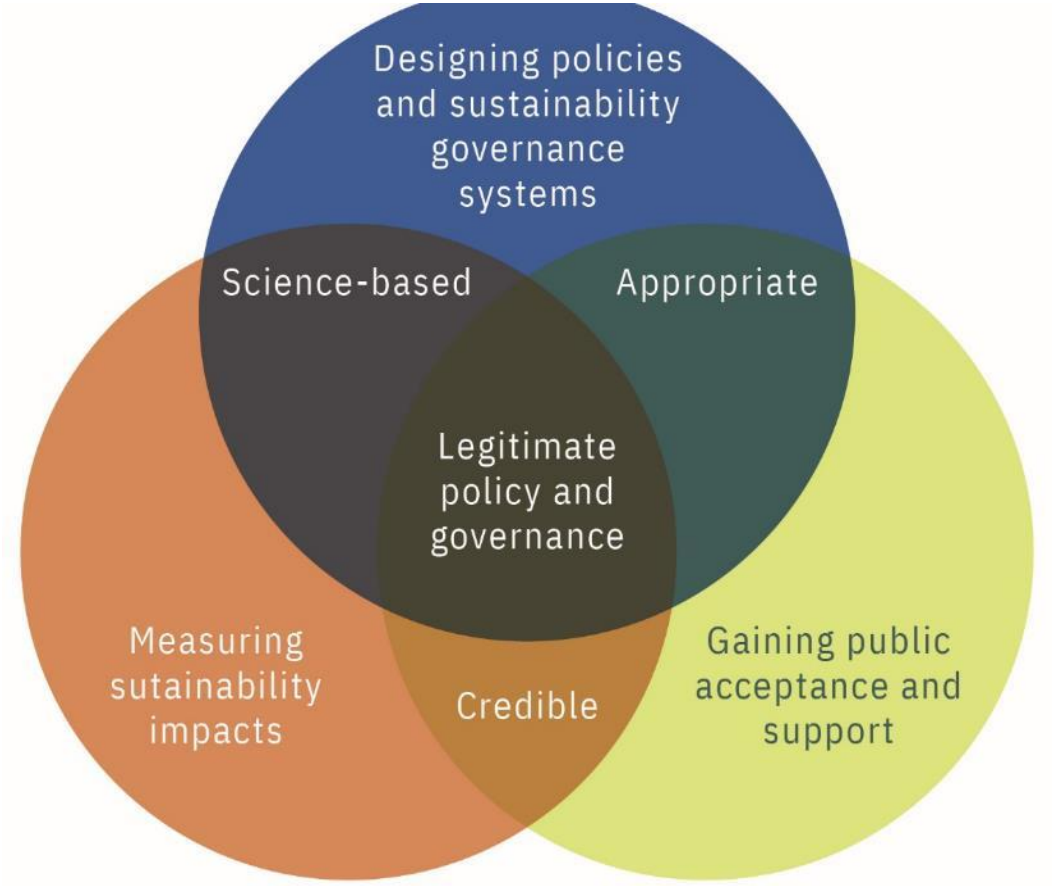
- Combustion for combined heat and power
- Gasification for combined heat and power
- Pyrolysis for combined heat and power
- Anaerobic digestion to produce biogas
- Oils, sugar and starch crops to biofuels (biodiesel, HVO, ethanol)
- Corresponding biorefineries

Under development:

- Gasification + synthesis to biofuels
- Pyrolysis + upgrading to biofuels
- Lignocellulose / residues to biofuels
- Corresponding biorefineries
- Carbon capture and utilisation or storage at bioenergy facilities

https://www.ieabioenergy.com/installations/

Displace fossil fuels



Wider deployment depends on:

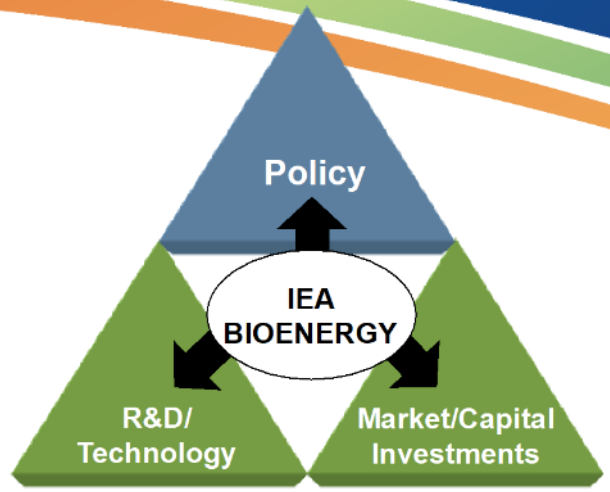
- Suitable regulatory frameworks that create market demand
- Further R&D to bring technologies that can use a wider range of feedstocks to maturity
- Trust in the governance system

Key take-aways

- Bioenergy can provide heat, electricity and transport fuels.
- Substitution of fossil fuels through sustainable bioenergy leads to substantial GHG emission savings. Combination with CCS can provide negative emissions.
- Further benefits are diversification of energy supply, balancing of variable renewable energy, provision of regional income, access to energy.
- If done right, biomass production for bioenergy can also improve or maintain biodiversity, carbon sinks, and species abundance.
- As to reach net zero by 2050, one fifth of 2050 energy demand could and should be met by sustainable bioenergy.
- Sustainable bioenergy is based on sustainable feedstock provision, efficient conversion technologies, and replaces fossil fuels.

IEA Bioenergy

www.ieabioenergy.com



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

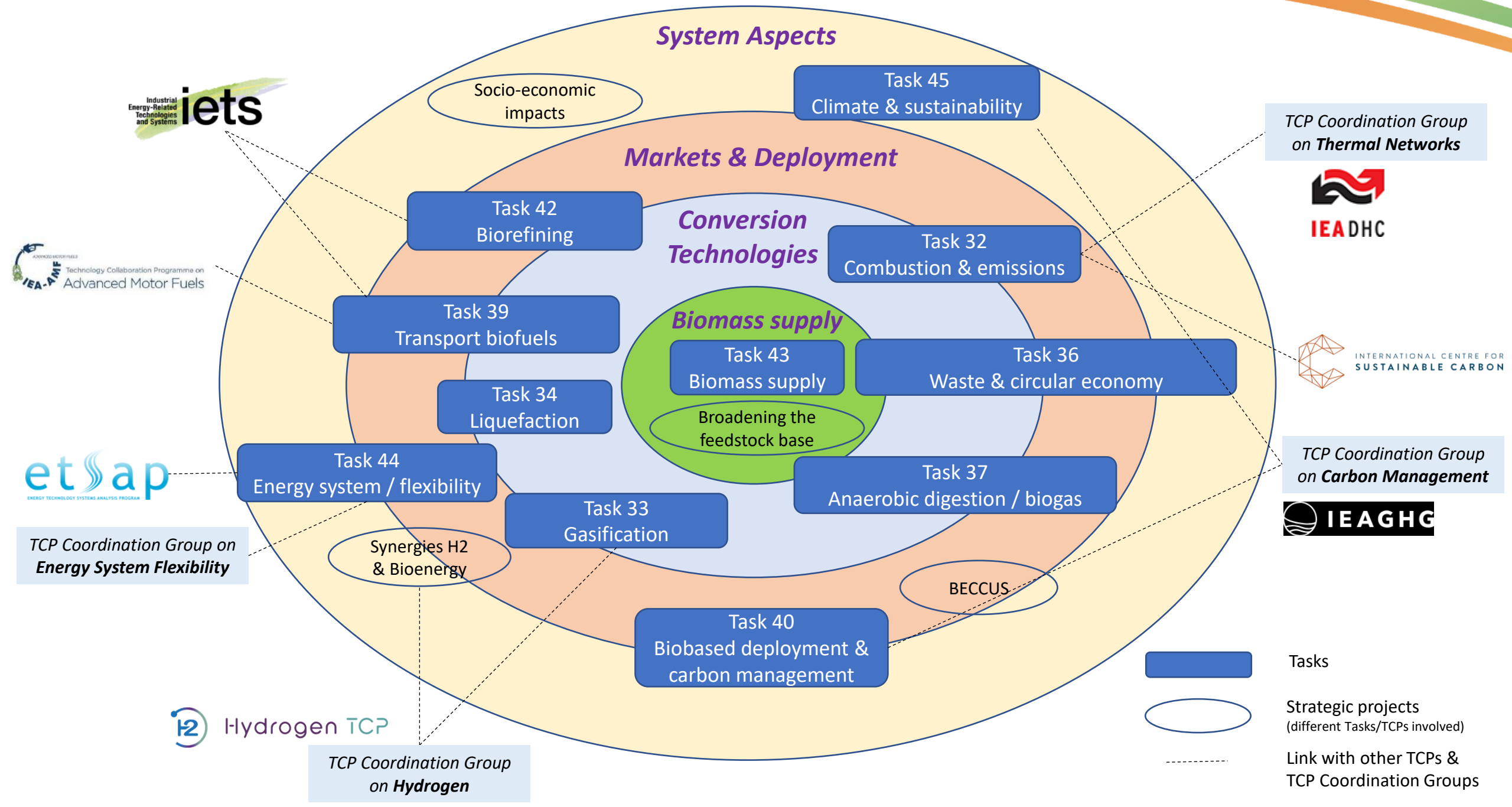
Goal:

- 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)

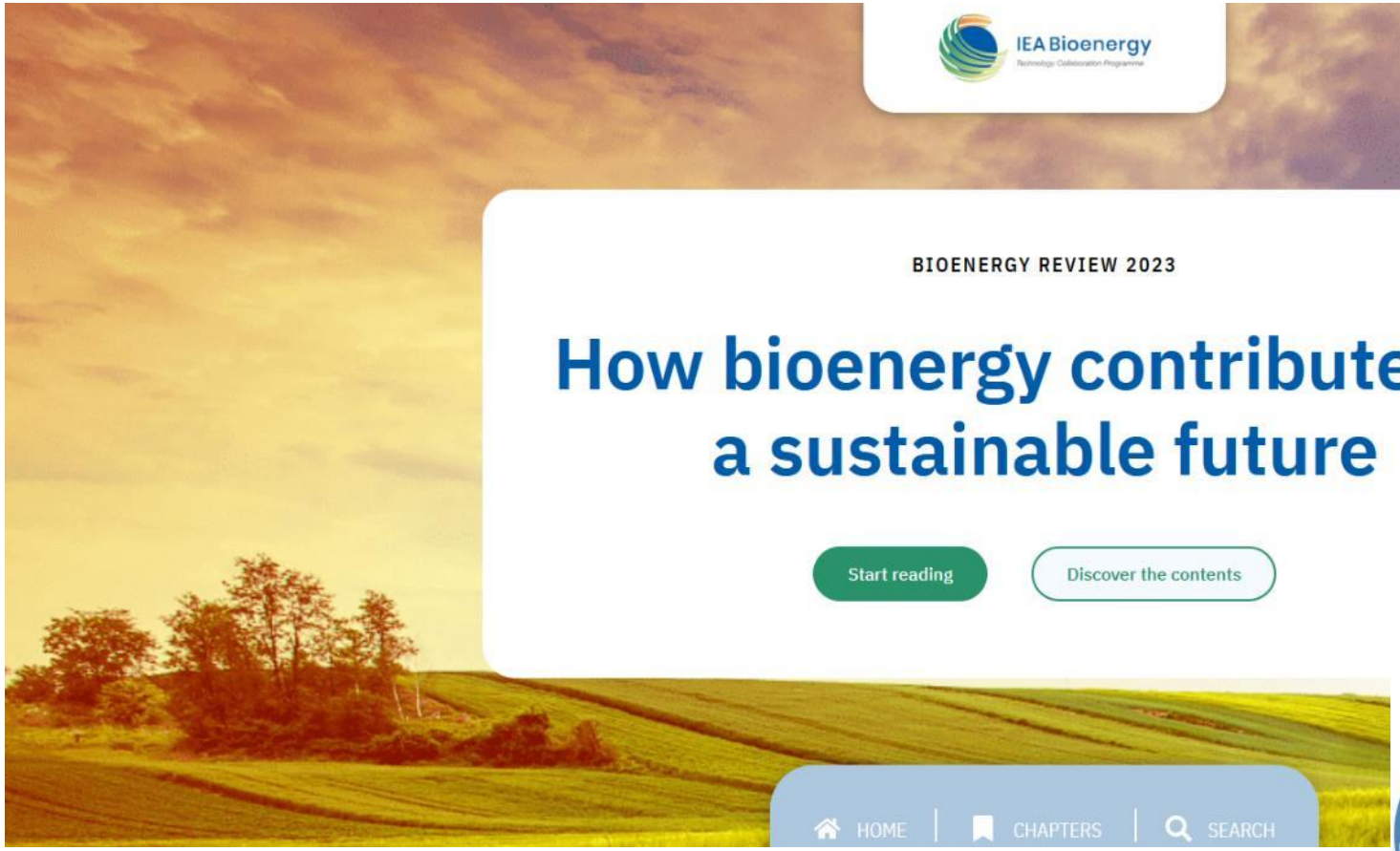
24 members: *13 European countries (including Norway) + EC, USA, Canada, Brazil, India, China, Japan, Korea, Australia, New Zealand, South Africa*

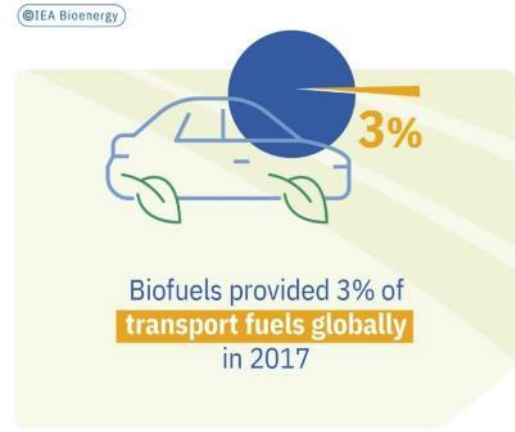
Work programme carried out through **Tasks** and **Special Projects**, covering the full value chain from feedstock to final energy product

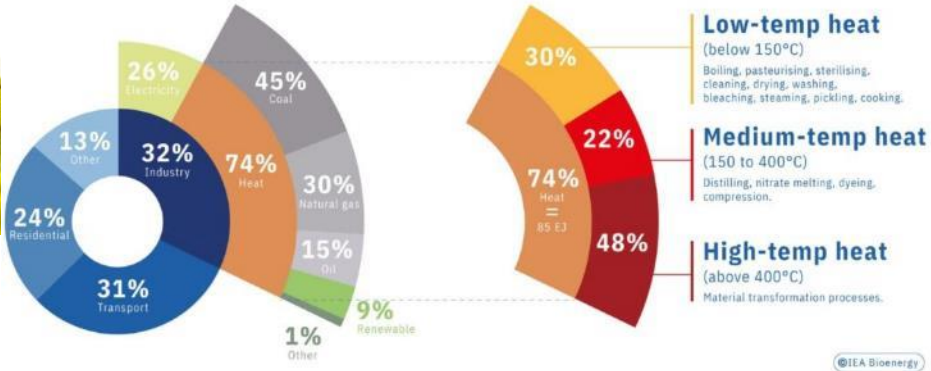
Members of IEA Bioenergy TCP


System Aspects
Socio-economic impacts
Task 45
Climate & sustainability
Markets & Deployment
Task 42
Biorefining
Conversion Technologies
Task 32
Combustion & emissions
Task 39
Transport biofuels
Biomass supply
Task 43
Biomass supply
Task 36
Waste & circular economy
Task 34
Liquefaction
Broadening the feedstock base
Task 44
Energy system / flexibility
Task 37
Anaerobic digestion / biogas
Task 33
Gasification
Synergies H2 & Bioenergy
BECCUS
Task 40
Biobased deployment & carbon management
TCP Coordination Group on Thermal Networks
TCP Coordination Group on Carbon Management
TCP Coordination Group on Energy System Flexibility
TCP Coordination Group on Hydrogen
Tasks
Strategic projects
(different Tasks/TCPs involved)
Link with other TCPs & TCP Coordination Groups

www.ieabioenergyreview.org







Thanks for your attention

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www.ieabioenergy.com

Extra slides

IEA Bioenergy's 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.

Mission of IEA Bioenergy

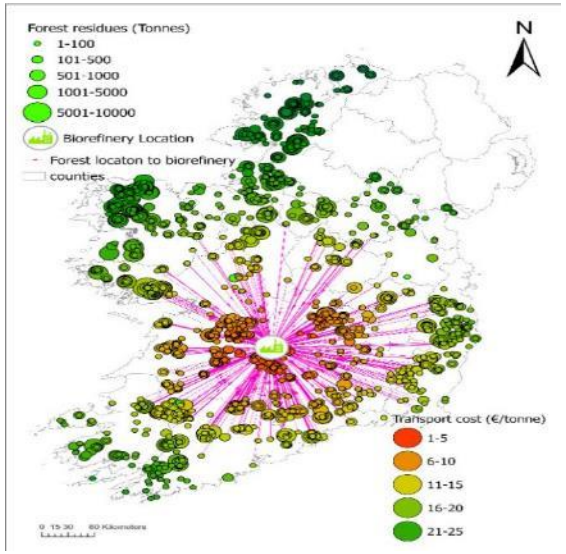
- to increase knowledge and understanding of bioenergy systems
- in order to facilitate the commercialisation and market deployment of […] bioenergy systems and technologies,
- and to advise policy and industrial decision makers accordingly.

The IEA Bioenergy TCP realises the mission by providing platforms for

- international collaboration in bioenergy RD&D
- information exchange in bioenergy RD&D
- policy analysis

Priority Research Area 1: Biomass supply

- Sustainable biomass availability
- Connected to sustainable landscape management (incl. restoration of degraded lands)
- Biomass mobilisation
- Recovery of wastes and residues
- Setting up supply chains.

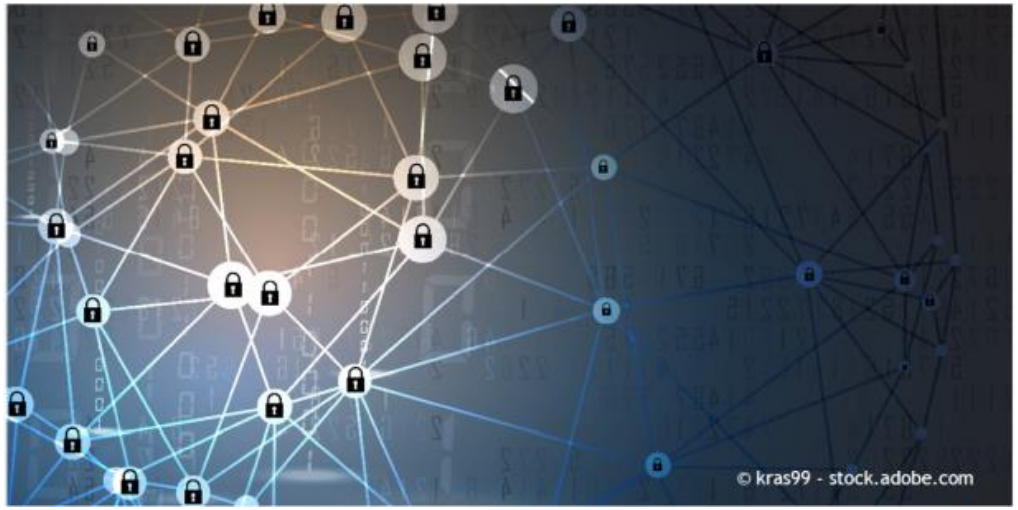


Priority Research Area 2: conversion technologies

- Advanced technologies => broader range of feedstocks
- Focus on difficult to abate sectors
- Bioenergy along with other products
- Further reduction of carbon footprint and costs through
  - efficiency improvements
  - biorefining technologies
  - carbon capture and storage or utilisation (BECCUS)
  - integration with renewable hydrogen and electricity

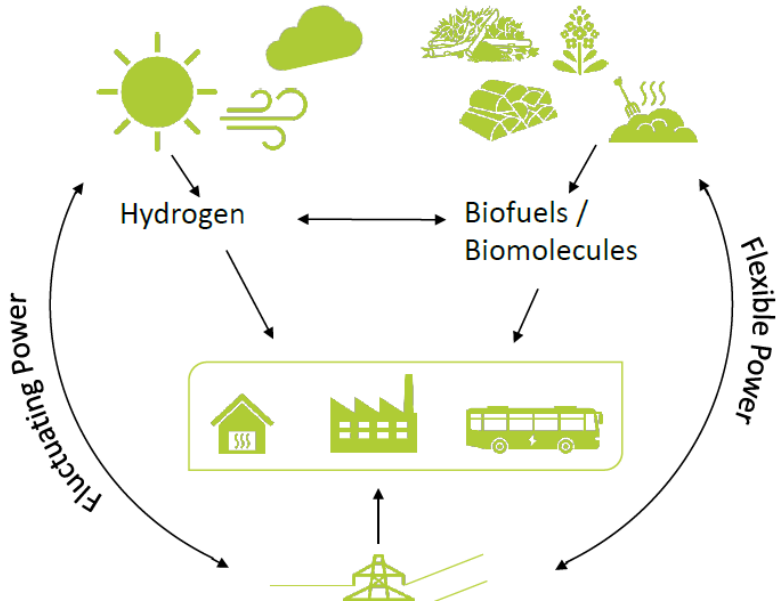
Priority Research Area 3: Markets and deployment of sustainable bioenergy

- Opportunities of bioenergy/biomass in different markets
- Barriers and challenges of industrial actors in setting up biobased value chains
- How can deployment of sustainable bioenergy be accelerated through appropriate policy, governance and market mechanisms.



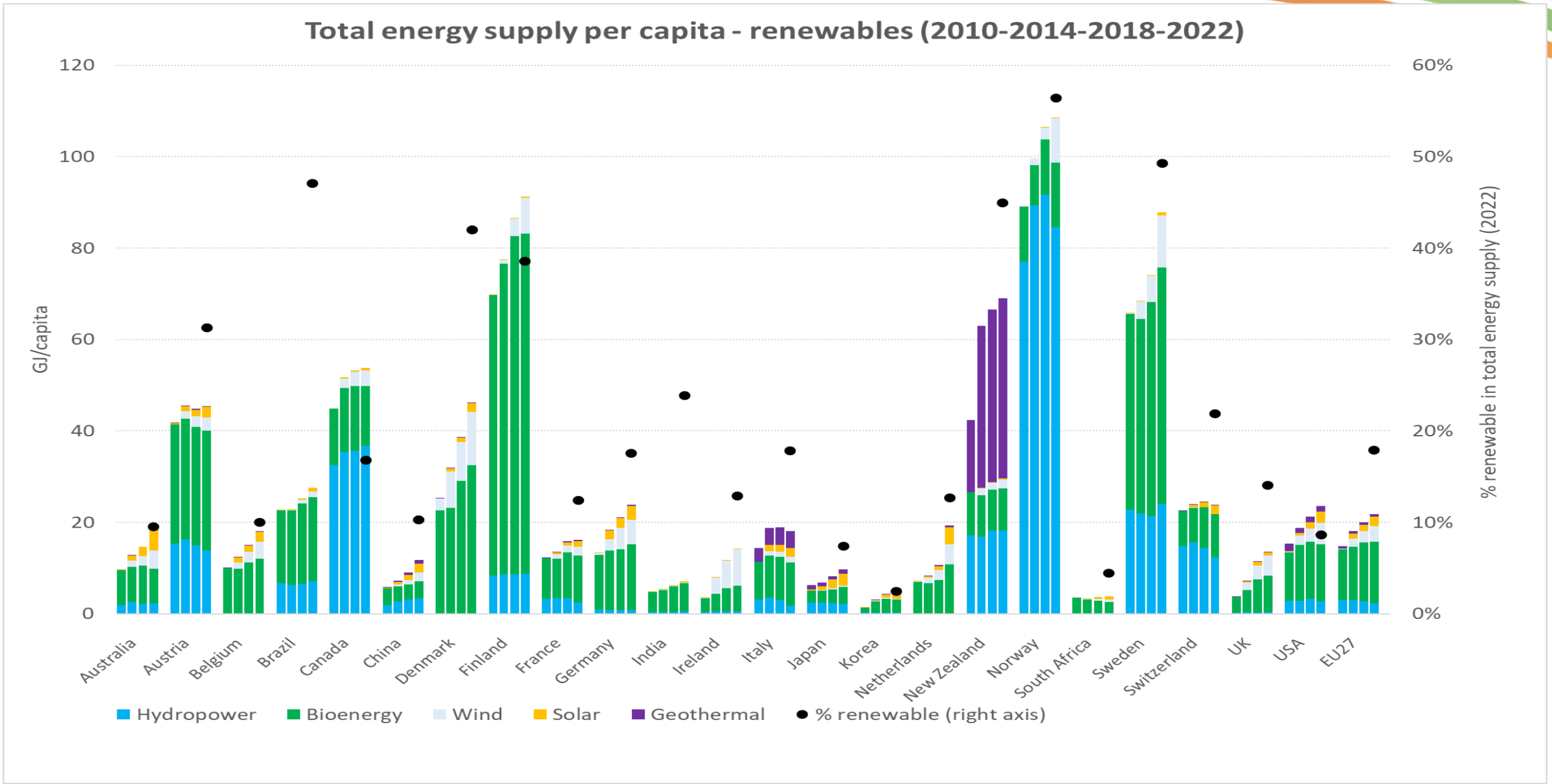
Priority Research Area 4: system aspects

Assess system-wide impacts of bioenergy



- Bioenergy in the clean energy transition
  - Provide flexibility and contribute to resilience of the energy system
  - Priority applications, e.g. difficult to abate sectors, negative emissions
  - Integration in energy and industry systems
- Bioenergy within a circular bioeconomy
  - Circular carbon, management of waste and residues, nutrient cycles
- Contribution to climate change mitigation and other Sustainable Development Goals
  - climate impact, land and water use, biodiversity, social and socio-economic conditions

=> conditions for bioenergy to provide sustainable solutions within the circular bioeconomy and the clean energy transition & maximize positive impacts.



IEA Bioenergy: Countries' Report – update 2024, Figure 5: evolution of renewable in total energy supply per capita in the IEA Bioenergy member countries (Data source: IEA (2024) World Energy Balances and Renewables Information)