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WHAT IS THE BIOECONOMY?

A broad umbrella concept and funding scheme combining biotech, market creation and sustainability

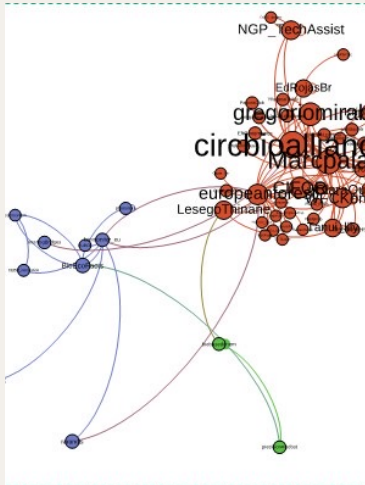
- **BMBF**
- **Vision of a biobased economy by 2030 in alignment with 2030 Agenda for Sustainable Development**
- **EU-Commission**
- **Create a bioeconomy, that is sustainable for “people, planet and profit”**
 - Food security
 - Climate-neutral production
 - Mitigate climate change by reducing pressure on ecosystems
 - Protect, maintain and use biodiversity
 - Protect sustainability of natural resources
 - Reduce dependence on non-renewable resources



Sustainable development goals form the umbrella for bioeconomy strategies

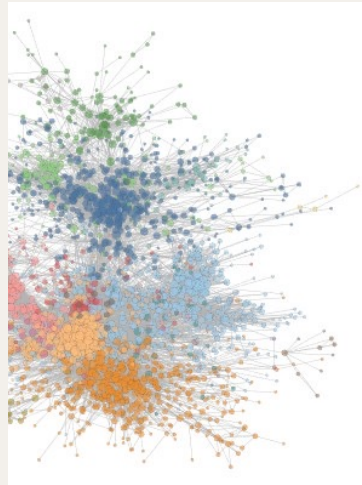
NETWORK PERSPECTIVES ON THE BIOECONOMY

Network from retweets



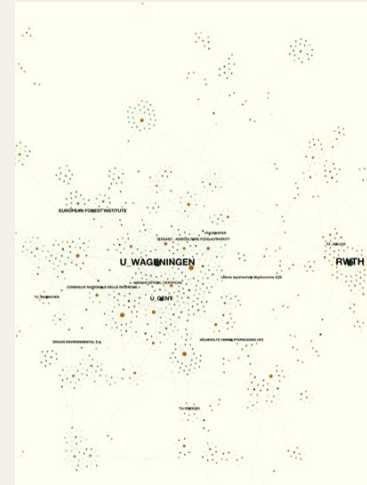
The Bioeconomy as a domain of communication on social media platforms (like Twitter)

Network from patents



The Bioeconomy as a technology development landscape/ technological field

Network from public funding data

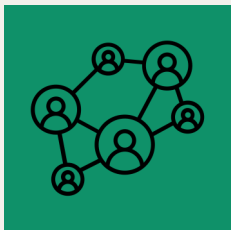


The Bioeconomy as a research collaboration landscape

THE BIOECONOMY AS A DOMAIN OF COMMUNICATION ON SOCIAL MEDIA PLATFORMS

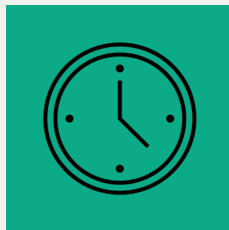
DATA TRACKING & ANALYSIS

- To analyze the bioeconomy discourse on Twitter, data from May 2021 and May 2022 was collected
- Keywords were collected for both timeframes such as "bioeconomy"
- The data was prepared and analyzed with a social network analysis using Gephi and topic modeling using R



PLATFORM

Twitter



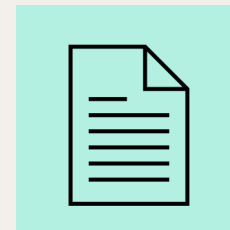
TIMEFRAME

01.05.2021 – 31.05.2021
01.05.2022 – 31.05.2022



TRACKING

- Keyword-based
- Bioeconomy
 - Bio-based economy
 - #bioeconomy
 - ...



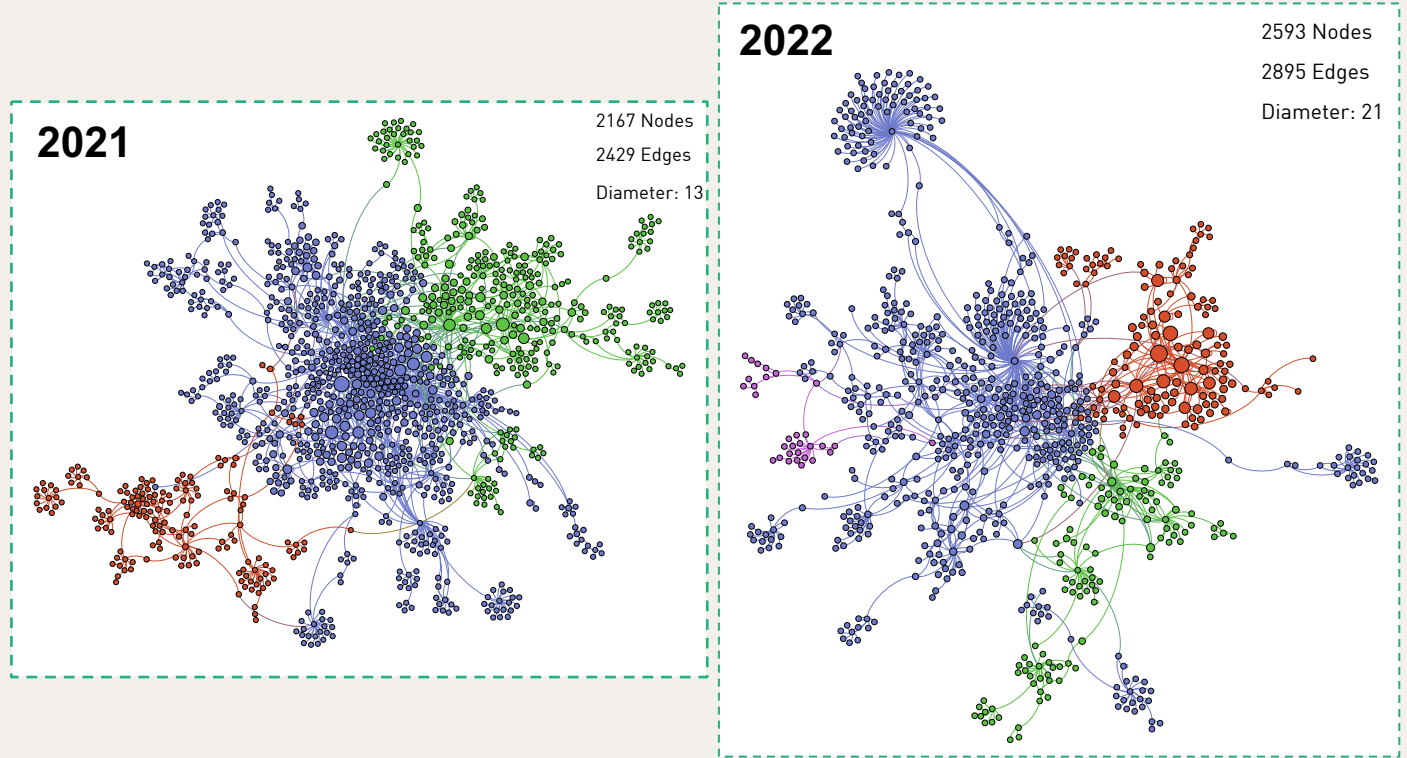
METHOD

Social Network Analysis
(*Gephi*)
Topic Modeling (*R*)

NETWORK BIOECONOMY

Social Network Analysis

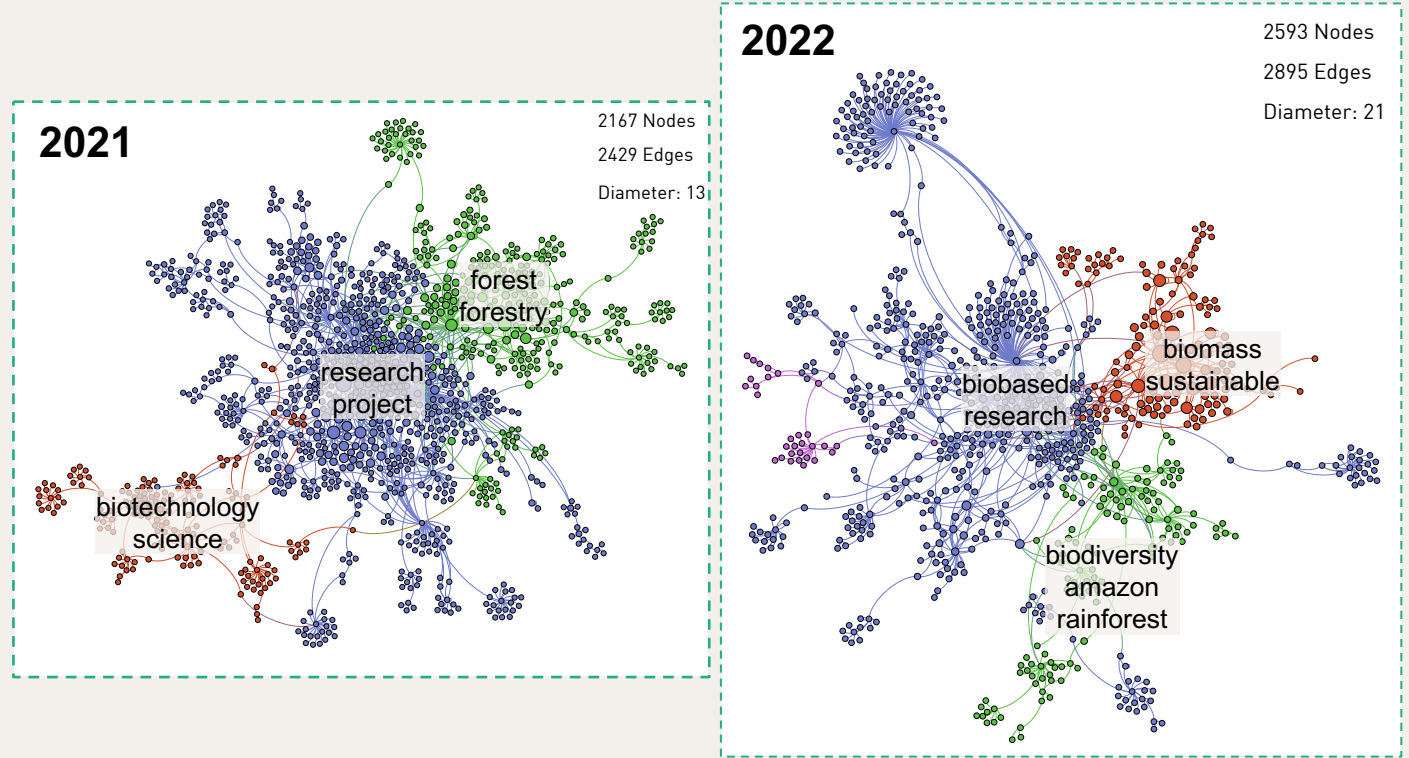
- Here, the social networks on Bioeconomy are shown for both years
- Three different clusters can be depicted (green, purple, red)
- Small changes between the years can be observed
 - Distribution of nodes & edges
 - Red cluster gained size in nodes, showing more relevant communication and interaction within the cluster



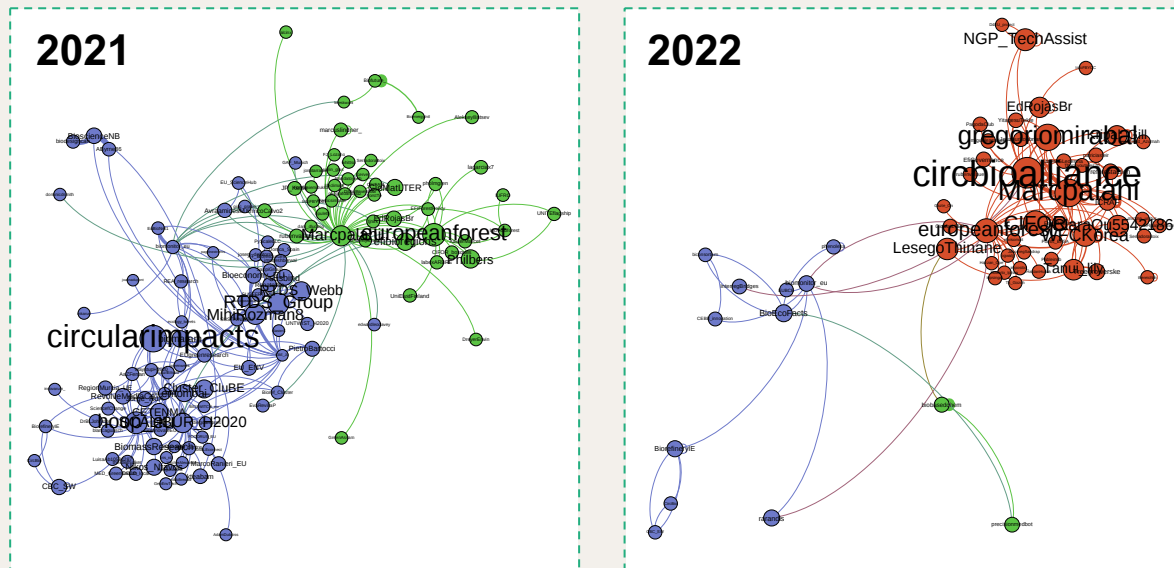
NETWORK BIOECONOMY

Social Network & Topic Modeling per Cluster

- To gain deeper insights in the bioeconomy discourse, it is analyzed what is said within the different clusters
 - Understanding which topics are relevant
 - Examining which topic gain importance
 - Observing changes in communication



KEY ACTORS ON BIOECONOMY

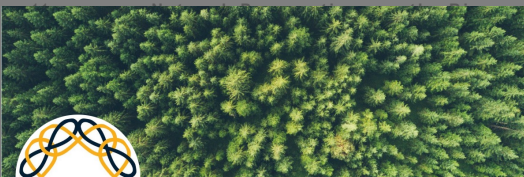


- Examining who the key actors are helps to understand who shapes and influences the network and communication around Bioeconomy
- In 2021, the main actors were located in the green and purple cluster
- A change can be observed in the key player of Bioeconomy since the red cluster gain importance (most key actors in 2022 can be found here)

KEY ACTORS

Based on Eigenvektor Centrality

Year	Name	Background
2022	Marc Palah	Director of European Forest Institute Chair
2022	European Forest Institute (EFI)	Research & policy support on forest-related issues
2022	Eduardo Rojas Briales	Professor at Forestry Department
2021	European Forest Institute (EFI)	Research & policy support on forest-related issues
2021	Marc Palah	Director of European Forest Institute Chair
2021	RTDS Group	Research Group
2021	Mihaela Rozman	Researcher
2021	Stephen Webb	Researcher
2021	SCALIBUR project	EU funded research project on biowaste
2021	HOOP Project #UrbanBioeconomy	HOOP Project on urban circular bioeconomy
2022	Circular Bioeconomy Alliance	Governmental organizations, companies, investors, research organizations and NGOs
2022	CIFOR	Environmental Conservation Organization
2022	WFC Korea	Account of the XV World Forestry Congress
	New Generation Plantations	
2022	Technical Assistance	'ecosystem of collaboration'
2021	CluBE	Organization of local bioeconomy actors in Greece
2021	Circular Economy	The international network of #CircularEconomy professionals and organizations
2022	Gregorio Mirabal	Activist
2022	Lesego Thinane	Activist
2022	Environmentalist Lily Tanui	Director of Tree Growers Association of Kenya
2021	Philip Chambers	Forester



Circular Bioeconomy Alliance

@circbioalliance

We aim to accelerate the transition to a circular bioeconomy that is climate neutral, inclusive and prospers in harmony with nature.

circularbioeconomyalliance.org Joined December 2021

85 Following 473 Followers



Marc Palahí

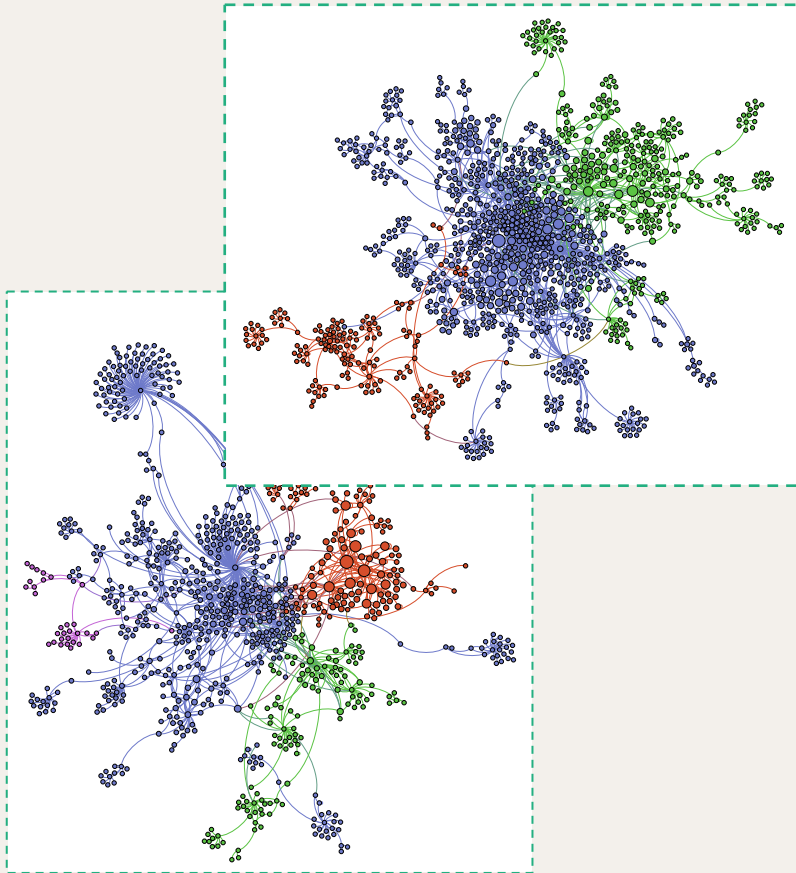
@Marcpalahi

Director, European Forest Institute Chair, Circular Bioeconomy Alliance
circularbioeconomyalliance.org #science #forests #bioeconomy #biodiversity
[Translate bio](#)

Joensuu, Finland efi.int Joined December 2011

1,095 Following 4,803 Followers

- Most key actors are researcher or research groups (shown by the green rows), indicating that the Bioeconomy discourse is mainly influenced by scientists
- Organizations on Bioeconomy can also be found frequently in the network



KEY LEARNINGS

Bioeconomy as a domain of communication on social media platforms

- The discourse is mainly influenced by researchers and research groups who have been found to communicate the most about bioeconomy
- Three main clusters can be found in the discourse of bioeconomy, each focusing on different topics
- The red cluster (focusing on biotechnology & biomass) gained importance over the year
- The main focus of the topics addressed remained the same over the year
- Only small shifts in the foci can be observed

THE BIOECONOMY AS A TECHNOLOGICAL FIELD

BIOECONOMY: A TECHNOLOGY LANDSCAPE

- Identify IPC patent technology classes associated with bioeconomy technologies based on ifo report and obtain a sample of ~830,000 patents from 2000 to 2020.
- Create the IPC co-classification network at the main group level, perform a cluster analysis to identify cohesive subgroups in the network, and analyze clusters in terms of growth, aggregate centrality and key actors.



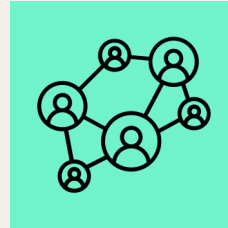
DATA

Lens.org
EPO PATSTAT



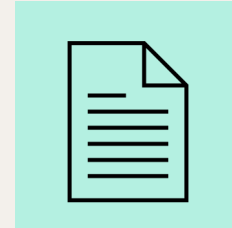
TIMEFRAME

01.01.2000 - 31.12.2020



NETWORKS

Co-classification linkages
between IPC classes from
ifo bioeconomy report



METHOD

Network clustering,
descriptive statistics

MAPPING THE BIOECONOMY

Patent data and technology classifications

ifo

104
2019

FORSCHUNGS-
BERICHTE

Ermittlung wirtschaftlicher
Kennzahlen und Indikatoren für ein
Monitoring des Voranschreitens der
Bioökonomie

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Wiebke Jander, Philipp Grundmann, Sven Wydra, Ulrich Schmoch*

ifo INSTITUT

ifo Zentrum für Energie, Klima
und Ressourcen

Lehrstuhl für Wirtschaftsinformatik
an der Universität München e.V.

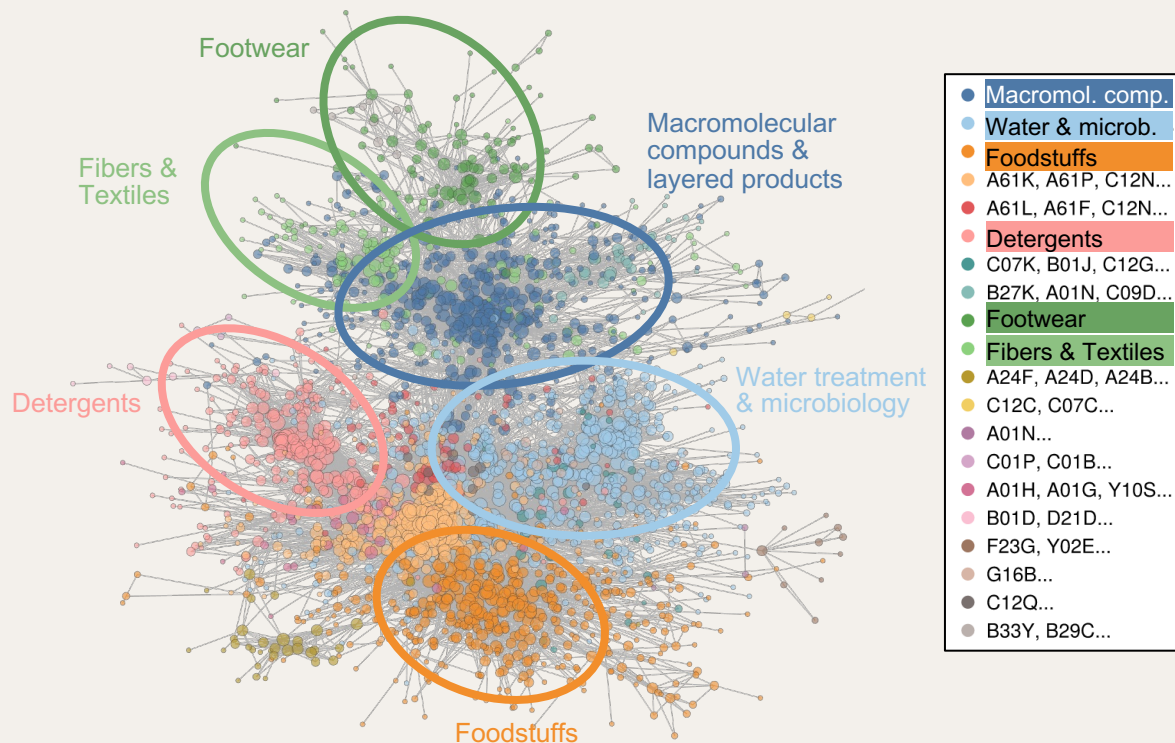
Tabelle 3: Symbole der IPC, die sich in einer engen Definition auf die Bioökonomie beziehen

IPC-Klassifikation	Inhalt
Landwirtschaft, Lebensmittel	
A01H	Neue Pflanzen
A01P	Chemische Mittel zur Regulierung des Pflanzenwachstums
A21D	Konservieren von Mehl oder Teig zum Backen
A23 außer N, P	Lebensmittel
A24B	Tabak
A43B, C	Schuhwerk
C05F	Organische Düngemittel
C13	Zuckerindustrie
F23G 7/02, 10	Verbrennen von organischen Stoffen
Medizin	
A61K 38	Medikamente mit Peptiden
A61K 39	Medikamente mit Antigenen oder Antikörpern
A61K 48	Medikamente mit genetischem Material
G01N 33/44-98	Analysieren von biologischen Stoffen
Holz, Papier, Textilien	
B27K	Behandeln von Holz
B27N	Herstellen von Gegenständen aus Holzspänen oder -fasern
D21B, C, D	Cellulose zur Papierherstellung
C14	Häute, Felle, Leder
D01B, C, D	Behandlung von natürlichen Fasern und Fäden
D01F 02, 04	Fäden aus natürlichen Stoffen
Chemie	
C02F 3, C02F 11/02, 04	Biologische Behandlung von Wasser und Schlamm
C07G 11-15	Antibiotika, Vitamine, Hormone unbekannter Zusammensetzung
C07K	Peptide
C08C	Behandlung von Kautschuken
C08H	Derivate von natürlichen makromolekularen Verbindungen
C08B	Polysaccharide
C08L 01, 03, 05, 07, 13, 15, 17, 19, 21, 87, 89, 91, 93, 97, 99	Massen auf der Basis von natürlichen makromolekularen Verbindungen
C09D 11/04, 06, 08	Tinten auf der Basis von natürlichen Stoffen
C09D 103, 105, 107, 113, 115, 117, 119, 121, 189, 191, 193, 197, 199	Überzugsmittel auf der Basis von natürlichen Stoffen
C09F	Naturharze
C09H 01	Natürliche Stoffe zur Herstellung von Leim
C09J 101, 103, 105, 107, 113, 115, 117, 119, 121, 189, 191, 193, 197, 199	Farbstoffe auf natürlicher Basis
C11B, C, D	Natürliche Fette, Wachse, Reinigungsmittel
C12	Biochemie
G01N 33/2-14, 44, 46	Analysieren von natürlichen Stoffen

- The bioeconomy contains a broad range of technological fields and disciplines.
- Step 1: Obtain IPC technology classification codes for bioeconomy technologies from ifo report (left).
- Step 2: Based on IPC codes, collect 835,075 patents.
- Step 3: Generate co-classification network.

THE BIOECONOMY TECH NETWORK

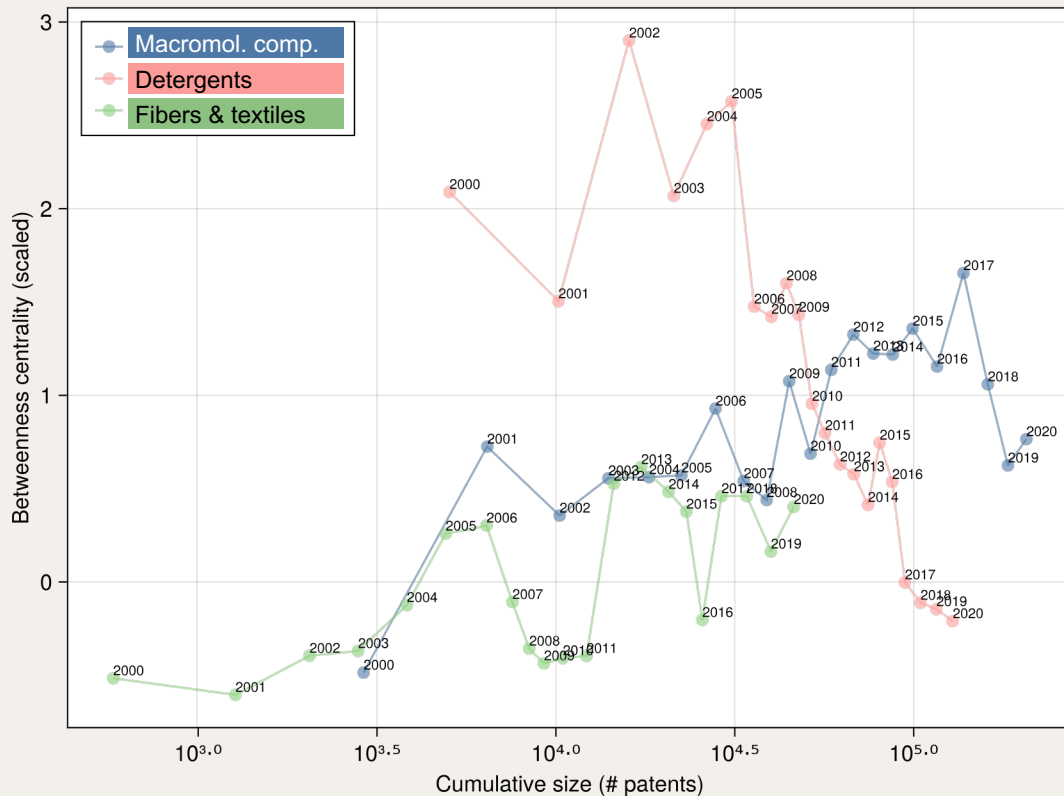
Co-classification of patents connects IPC technology classes



- Each node represents a technology domain as indicated by a IPC main group.
- Linkages are a result of co-classification (there are patents which are classified under both the connected IPC labels).
- Colors refer to network clusters (Louvain algorithm), i.e., sets of technologies that are closely connected through co-classification linkages.
- Clusters represent specific applications (e.g. foods, detergents, textiles) and cross-sector technologies (e.g. microbiology, macromolecular chemistry).

TECHNOLOGY EVOLUTION IN THE BIOECONOMY

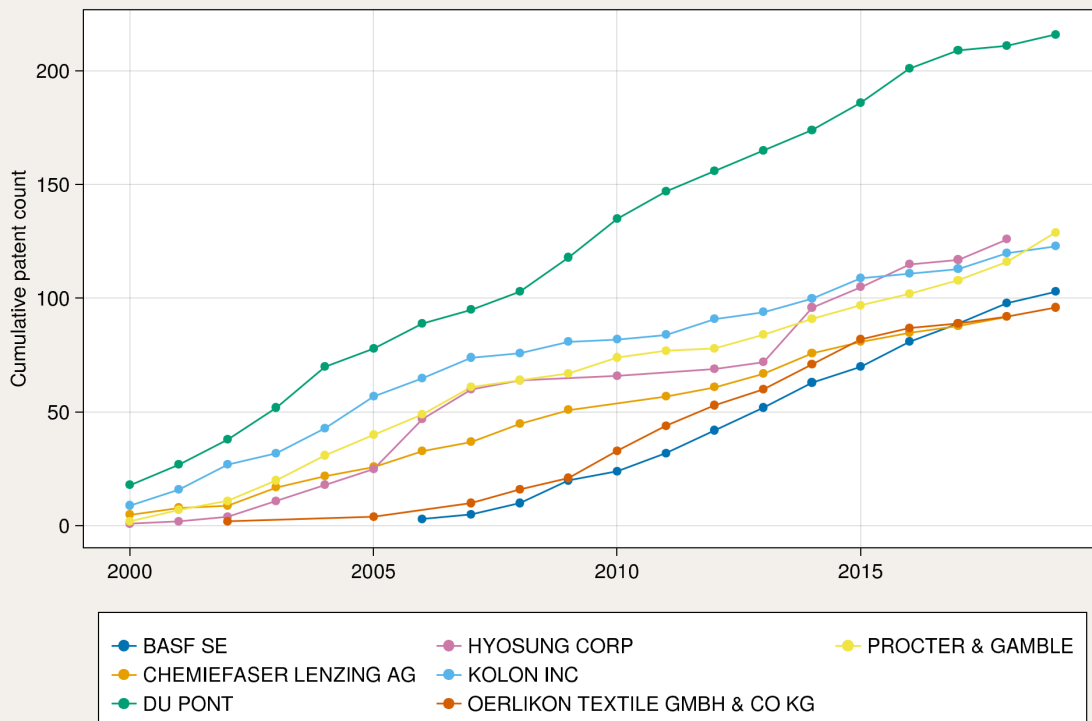
Growth and centrality in selected technologies



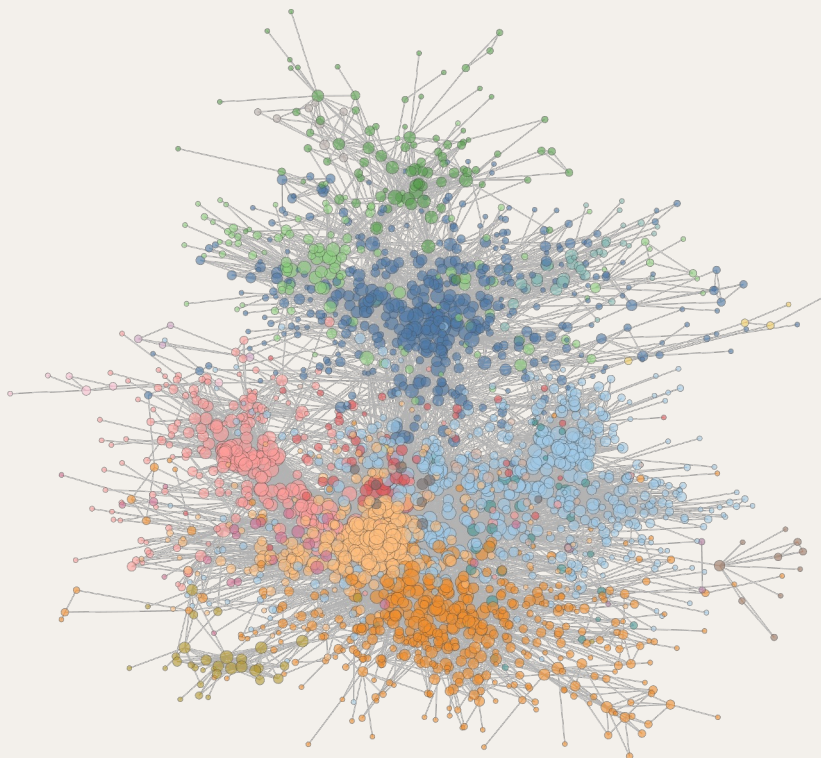
- Technology clusters evolve in terms of both their size (number of patents) and position (betweenness centrality) in the bioeconomy tech network.
- Technologies related to detergents development were highly central in the early 2000s but have recently become more peripheral, while still exhibiting strong growth (niche creation).
- While starting out small and peripheral, fiber and textile technologies have also shown exponential growth and are now above average in centrality.

GLOBAL BIOECONOMY INNOVATORS

Key patent applicants in the fibers & textiles bioeconomy cluster



- Strong patent applicants for the textile cluster include large American, Korean and Japanese chemical corporations (e.g. DuPont, P&G, Hyosung or Kolon).
- European specialist firms, such as Lenzing or Oerlikon also feature strongly.
- BASF has entered the domain late but shows strong portfolio buildup over the last 10 years.



KEY LEARNINGS

Bioeconomy as a technological field

- Bioeconomy innovation trajectories differ between application fields in terms of growth and overall network position.
- E.g., development of detergents starts out as a large and central field but moves to its own niche over time. Fibers & textile development starts out small and peripheral but becomes more central over the observation period.
- Key actors in the textiles & fibers bioeconomy cluster are especially large American & East Asian chemical corporations but European specialist firms, such as Oerlikon or Lenzing, are also increasingly visible due to their portfolios.

THE BIOECONOMY AS A RESEARCH COLLABORATION LANDSCAPE

BIOECONOMY: A RESEARCH COLLABORATION LANDSCAPE

- This network perspective is based on public funding databases with data from the years 2010 to 2022.
- The following social network analysis is based on a keyword search in project descriptions.
- Only projects and organizations that explicitly use the keywords in their descriptions appear in the networks.
- The Networks will represent three timeframes to show the development of the bioeconomy on the European level and of the German textile bioeconomy.



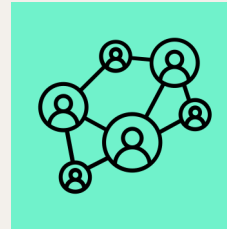
DATA

Förderkatalog (BUND)
Gepris (DFG)
Cordis (EU)



TIMEFRAME

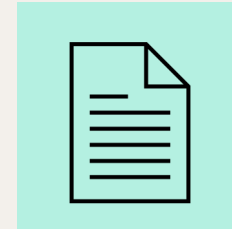
01.01.2010 – 30.04.2022



NETWORKS

Based on the keywords:

- Bioeconomy, Bio-based economy
- textile, yarn, clothing, sportswear, fabric, fibre, filament

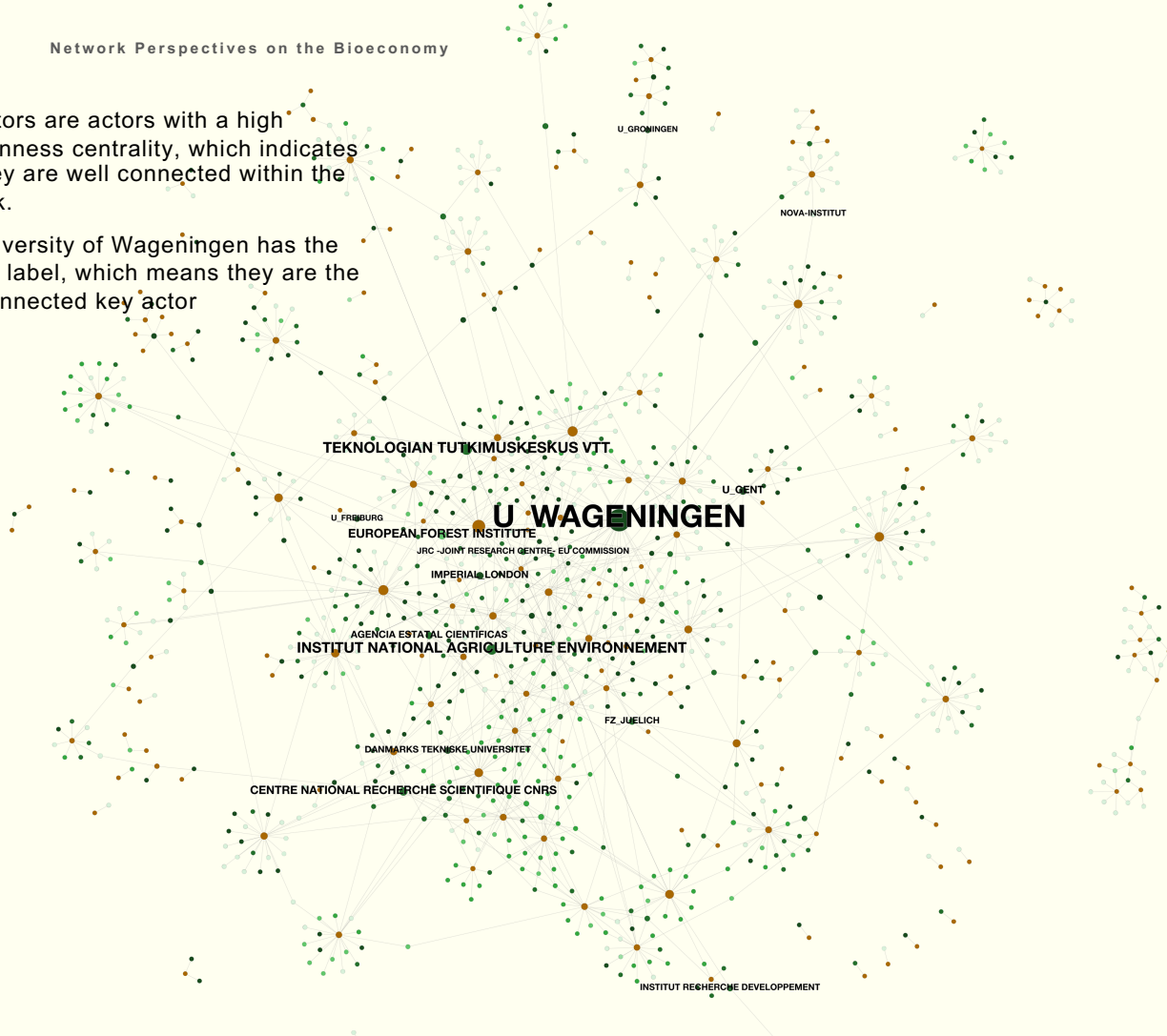


METHOD

Social Network Analysis
(*Gephi*)

Key actors are actors with a high betweenness centrality, which indicates that they are well connected within the network.

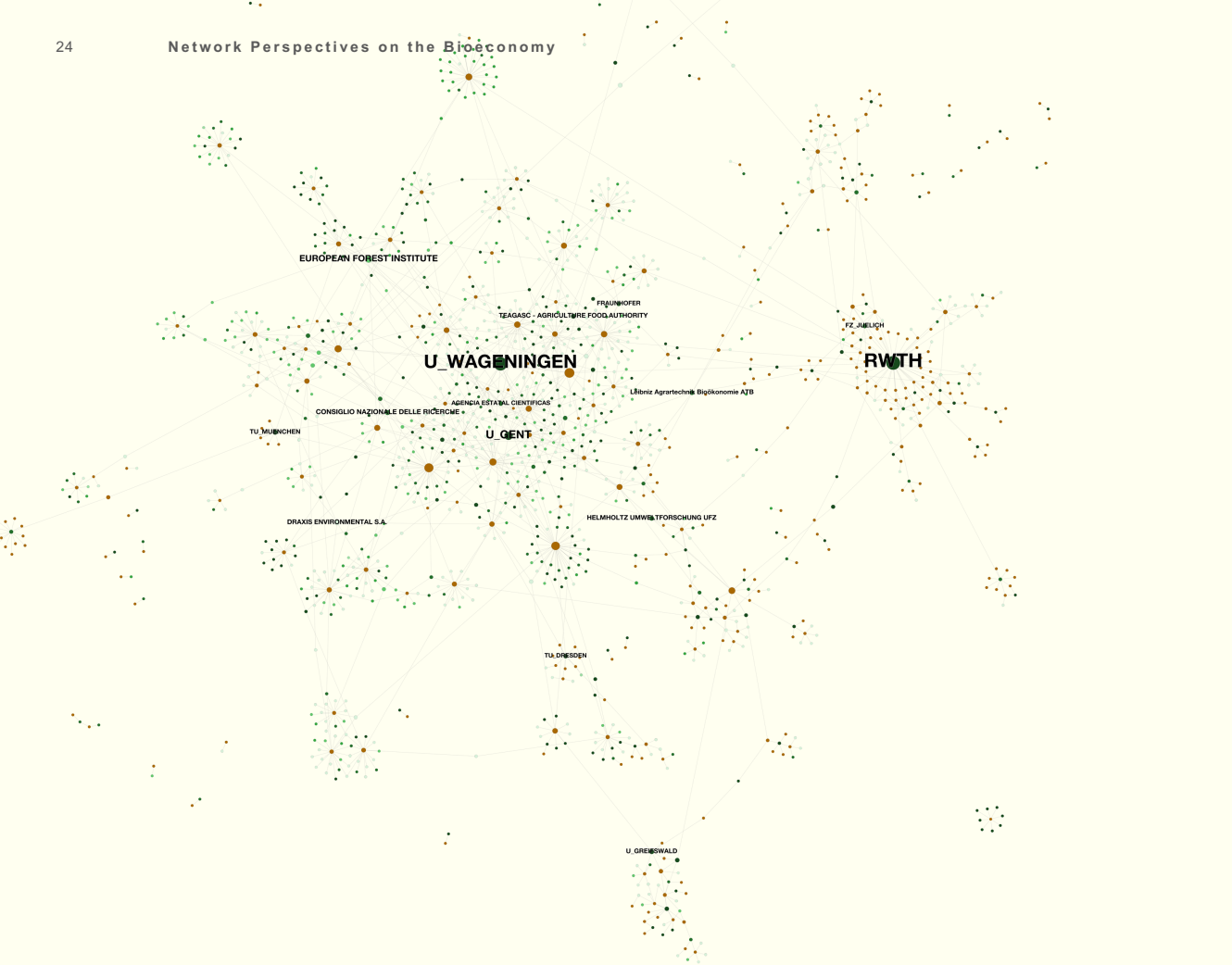
The university of Wageningen has the biggest label, which means they are the best connected key actor



2010-14 Bioeconomy EU Network

- Early stages of funding programs
- Key actors from the Netherlands, France, Scandinavia, Spain and Germany

- 194 projects started between 2010-2014
 - 117 EU
 - 75 BMBF
 - 2 DFG
- 908 organisations
 - 314 company
 - 206 higher education
 - 192 research organization
 - 127 public bodies
 - 69 others
 - 178 German Organizations



2019-22

Bioeconomy EU Network

- **Significant decline in EU funding**
 - Shift to circular economy
- **Diversification of funding agencies**
- **RWTH new as a key actor in the bioeconomy**
- **„Innovation Space effect“ visible**
- 352 projects
 - 244 BMBF
 - 98 EU
 - 7 DFG
 - 1 BMEL, 1 BMU, 1 BMWi
- 1068 organizations
 - 400 company
 - 246 higher education
 - 196 research organization
 - 143 others
 - 83 public bodies
 - 285 German Organizations

2010-2022

Bioeconomy research collaboration landscape over the entire time period

- **The Bioeconomy is concentrated on agriculture and forestry**
- **As well as biotechnology approaches**
- **Germany and the BMBF are major drivers**
- **Only a minor part of the bioeconomy is focused on textile applications**
- **Percentage of Projects focused on:**
 - 50,79% Agriculture
 - 41,43% Forestry
 - 28,56% Biotechnology
 - 9,22% Biopolymers (incl. Cellulose)
 - **4,44% Textiles**
- **1216 projects**
 - **600 EU**
 - **597 BMBF**
 - 11 DFG
 - 6 BMEL
 - 1 BMWi
 - 1 BMU
- **3534 organizations**
 - 96 Countries
 - 671 Germany (**318 EU**)
 - 365 Spain
 - 307 UK
 - 274 Italy
 - 240 France
 - 207 Scandinavia
 - 172 Netherlands
 - 167 Belgium

Degree centrality is a measure of the total connections a node has.

The bigger the label, the more collaborations the organization has in this time frame.



2010-2014 TEXTILE BIOECONOMY in Germany

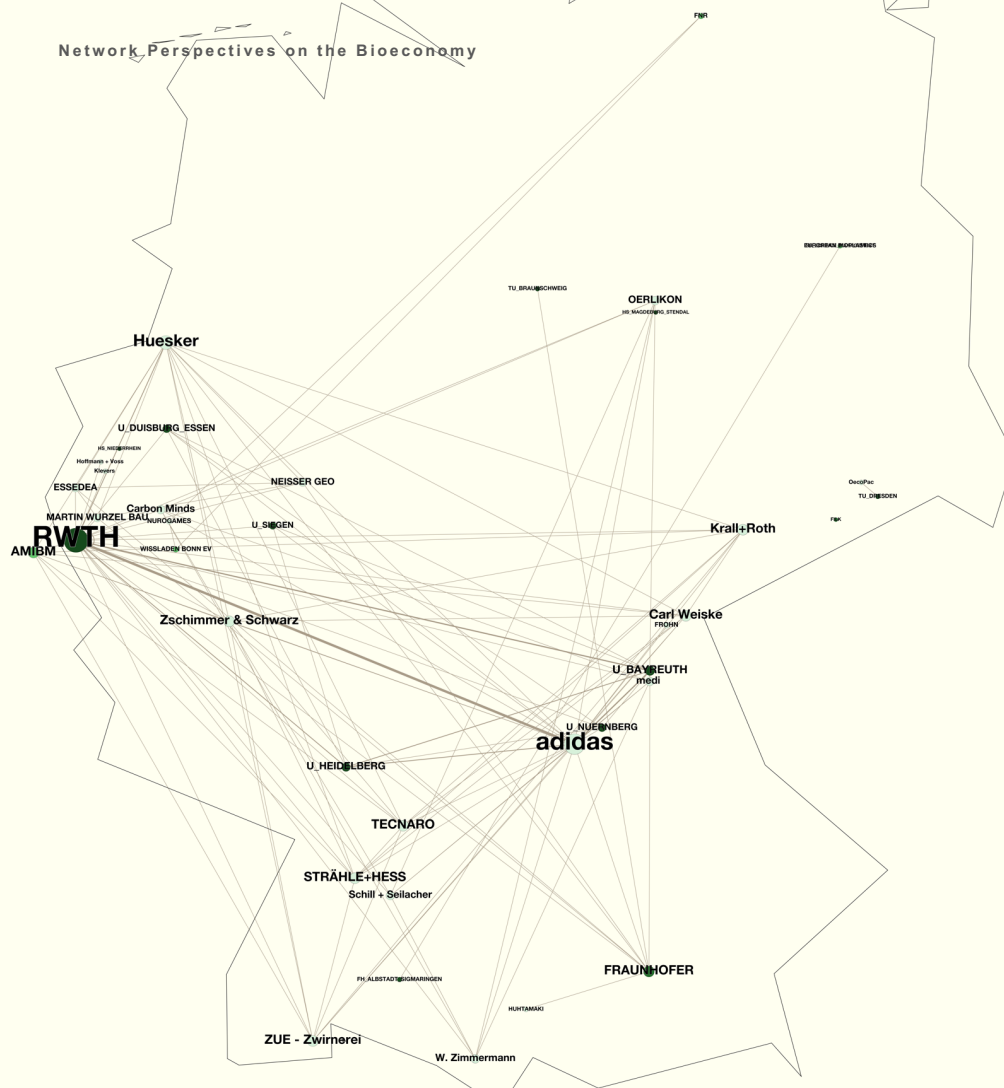
- 13 organizations
- 7 company
- 3 higher education
- 3 research organization



2015-2018

TEXTILE BIOECONOMY in Germany

- Despite being small, the German textile bioeconomy is constantly growing
- 19 organizations
 - 10 company
 - 5 higher education
 - 4 research organization



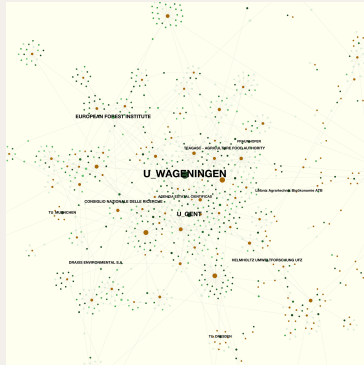
2019-2022

TEXTILE BIOECONOMY in Germany

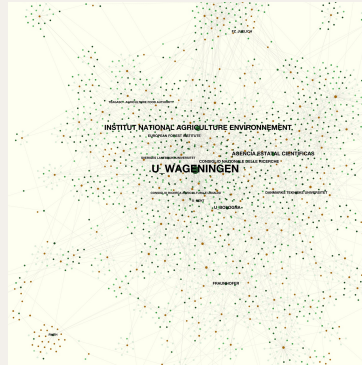
- There is a **BIOTEXFUTURE** effect visible
 - **BIOTEXFUTURE** integrates the textile Bioeconomy in Germany
-
- 40 organizations
 - 23 company
 - 11 higher education
 - 3 research organization
 - 3 others

KEY LEARNINGS

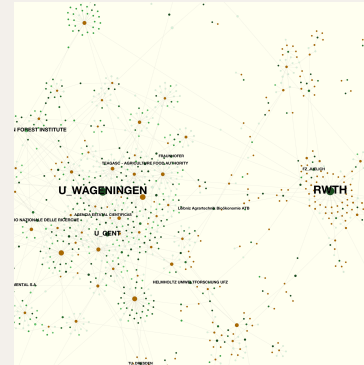
Bioeconomy as a research collaboration landscape



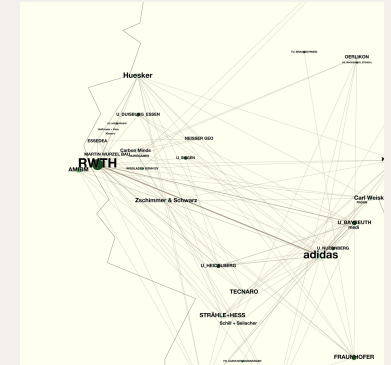
Funding for the bioeconomy is declining in recent years, shift to the circular economy noticeable.



Bioeconomy in general is concentrated on agriculture, forestry and biotechnology. Germany and the BMBF are major drivers.



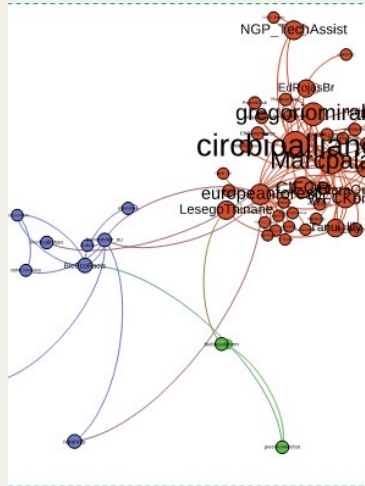
„Innovation space effect“ in bioeconomy with several organisations appearing to be central due to their involvement in the innovation space funding scheme of the BMBF.



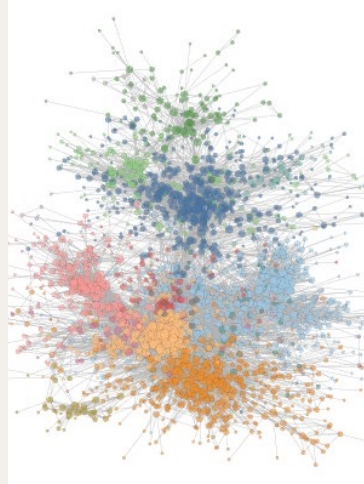
„BIOTEXFUTURE effect“ in German textile bioeconomy with key actors being adidas and RWTH and the majority of organisations in the network being project members of BTF.

KEY TAKEAWAYS

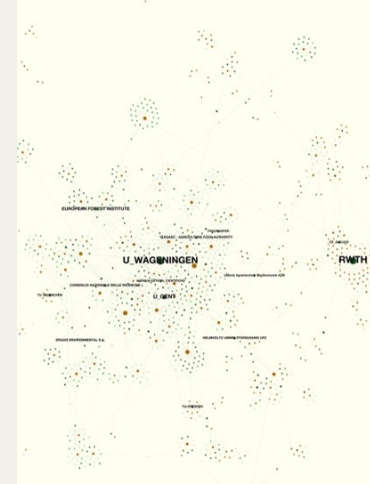
What each perspective has to offer



- Identify important multipliers
- See trending topics
- See changing focal points of communication
- Get a grasp at public attention



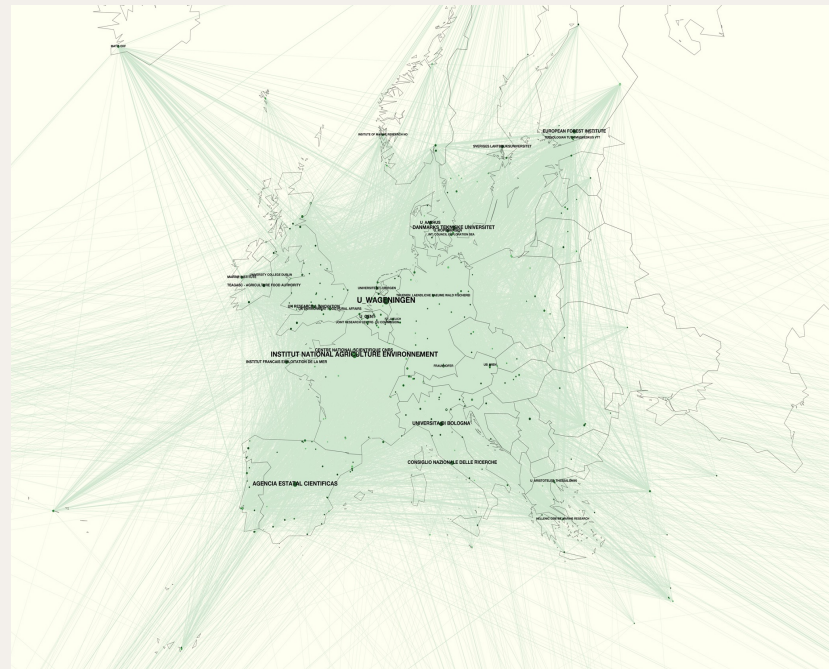
- Identify important knowledge-holders
- See trends in technological categories
- See the interrelatedness of technologies
- See where a lot of development happens



- Identify important research hubs
- See emerging new hubs
- See trends in funding allocation and research topics
- See who is collaborating with whom

NETWORKS ARE IMPORTANT

- DIFFERENT PERSPECTIVES HELP TO IDENTIFY A BROAD SPECTRUM OF IMPORTANT STAKEHOLDERS
- SCENARIOS NEED MULTIPLE DATA SOURCES
- NETWORK DATA IS ESPECIALLY USEFUL TO GRASP HOW ACTORS, CONCEPTS AND MATERIALS/TECHNOLOGIES ARE RELATED
- NETWORK VISUALIZATIONS ARE BEST SUITED TO SHOW HUBS AND DEVELOPMENT OF CENTERS



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