BIOSMART

Key cross-sectorial findings and a possible disruptor: synthetic animal protein

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Outline of presentation

1) The Biosmart project origin
2) Biosmart – Some findings on cross-sectorial issues
3) The «post-animal bioeconomy» a major disruptor?

Biosmart: managing the transition to a “smart” bioeconomy

Funded 2015

Premise of Biosmart

1) Current economy structured as an industrial economy
2) Location of industry is historically based
3) Industry is often seperated into sectors
4) Policy is also often sectorial

Factors limit the development of a circular economy

Need to plan a bioeconomy on the basis of ‘knowledge economy’ and renewable resources

What is a bio-economy?

“a world where biotechnology contributes to a significant share of economic input” using “renewable biomass and efficient bioprocesses to support sustainable production” (OECD, 2009: 8).

What is a "smart" bioeconomy

A "smart" bioeconomy

1) Optomizes technology and human capital
2) Is developed in a wise and judicious fashion

- individual bio-sectors merge to improve bio-technical knowledge flows
- improve utilisation of biomass feedstocks
- easy conversion of waste from one industry to a feedstock in another.

Biosmart – Some key findings on cross sectorial issues

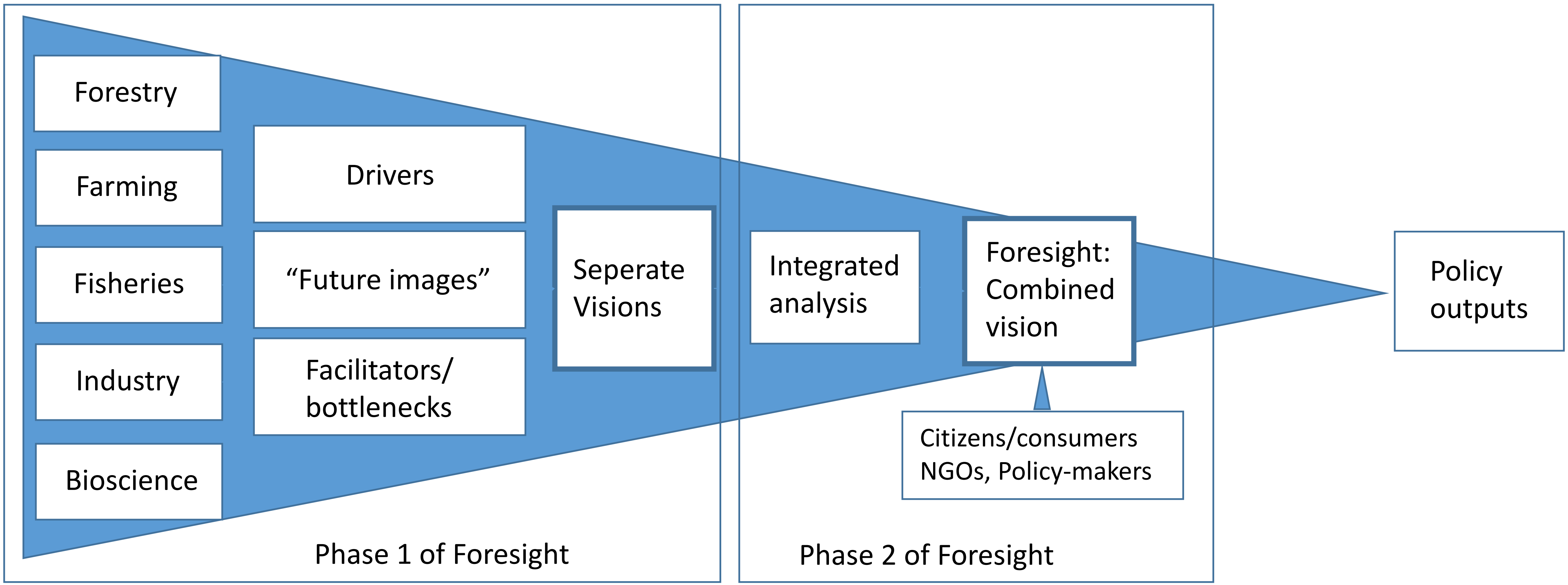
Foresighting ‘Smart’ Transition

Project designed around a «foresight analysis»

Private sector are key actors:

- What visions do they have?
- What are main barriers to development?

Foresighting ‘Smart’ Transition



Foresight ‘Smart’ Transition – separate visions

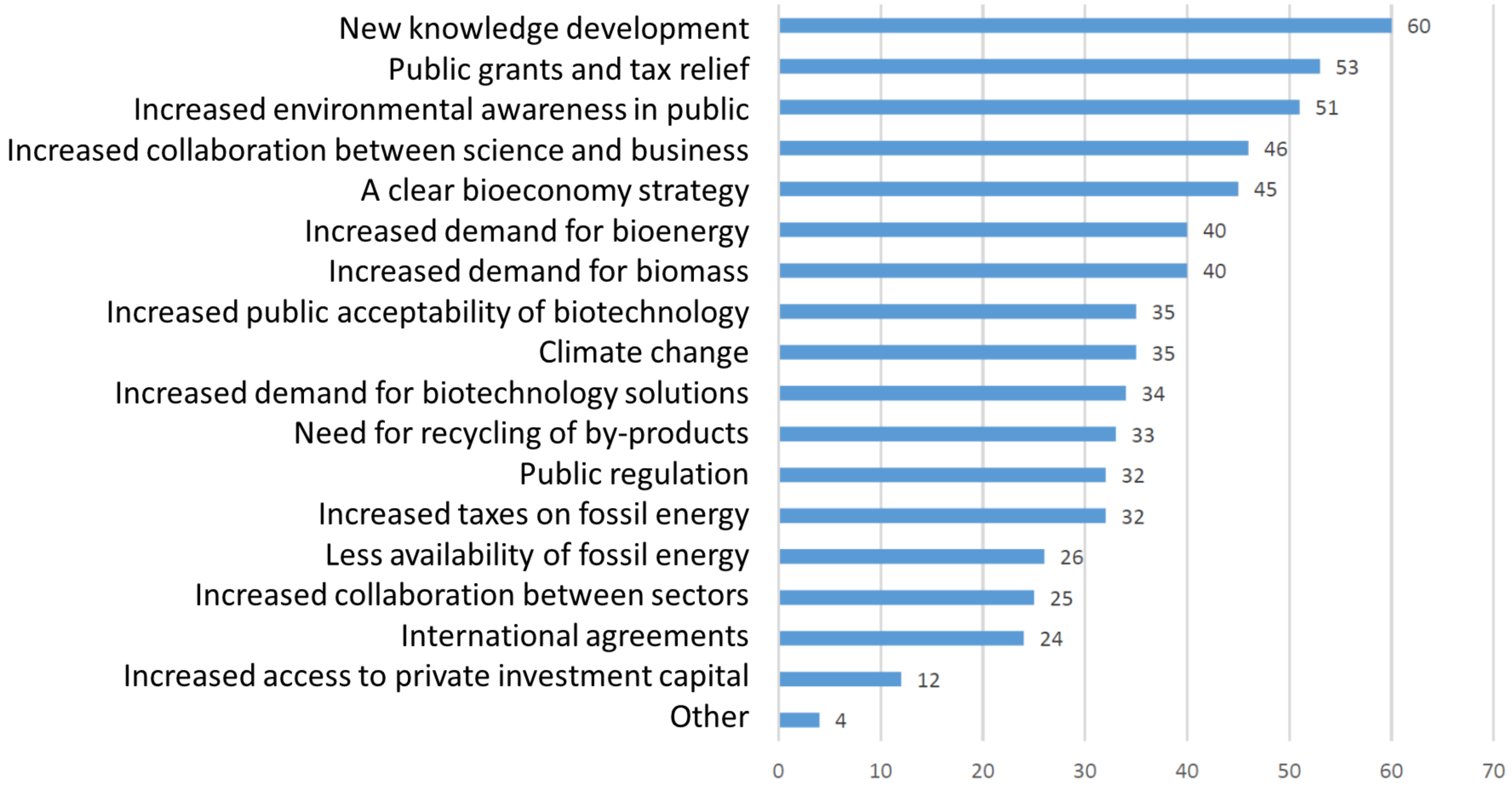
Representative survey undertaken of 1300 actors in the Bioeconomy

Sectors included:

- Agriculture
- Forestry
- Fisheries
- Aquaculture
- Industry
- R&D sector
- University sector

Foresight ‘Smart’ Transition - separate visions

Factors businesses think are important for facilitating a transition to a bioeconomy in Norway



Foresight 'Smart' Transition

Principal components analysis of previous table

Sectorial scenarios

Knowledge driven bioeconomy

Sektorer: Fiskeri- Akvakultur-Bioteknologi - FoU

Biomass demand driven bioeconomy

Sektorer: Jordbruk – Skogbruk-Akvakultur- Bioteknologi

Policy driven bioeconomy

Sektorer: Industri og foredling - transport

Public attitude driven bioeconomy

Sektorer: Jordbruk – transport – FoU - Offentlige tjenester

1. Knowledge driven bioeconomy

Sectors:

- Aquaculture, fisheries, biotechnologists
- Businesses with innovation plans support the knowledge-driven scenario

Main basis of change:

- New knowledge will be the basis for bioeconomy
- Increased collaboration with research and development
- Increased collaboartion between sectors

Barriers:

- Restrictive regulation
- Access to investment capital
- Lack of markets for produce

2. Biomass demand driven bioeconomy

Sectors:

- Forestry, agriculture, aquaculture, biotechnologists
- Younger businesses support this view

Main basis of change:

- Large demand for land and sea to produce biomass
- Based on biomass from forests and plants (including algae)

Barriers:

- Current lack of knowledge in transforming biomass

3. Policy driven bioeconomy

Sectors:

- Transport, industry, R & D (partly)

Main basis of change:

- Government sets up a policy and directs development
- Instruments for change include: tax breaks, subsidies, government regulations, carbon taxes, and international agreements

Barriers:

- Lack of coordinated policies
- Lack of concrete action plans
- Sectorial interests and governance can slow down integrated development

4. Public attitude driven bioeconomy

Sectors:

- Agriculture, transport, R&D, and public service

Main basis of change:

- Increased environmental awareness creates demand for sustainability
- Demand for dramatic cut in climate gas emissions
- Change in market demand for sustainably produced products

Barriers:

- Slow change in value chains
- Public resistance to higher costs

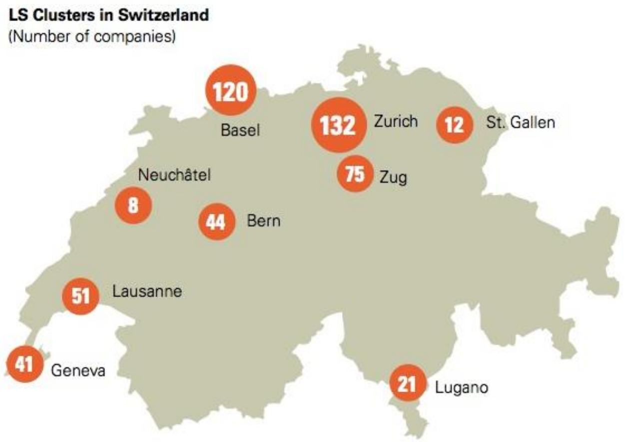
Stage 2: Foresight analysis

- Two foresight workshops
  - First earlier this year
  - Second undertaken on Friday (21st)

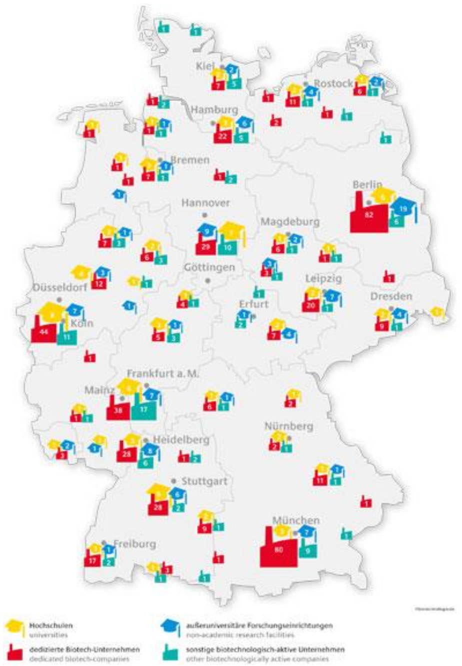
- Key stakeholders invovled
- Will develop an integrated vision for bieoconomy

Locational issues

Location of bioeconomic clusters ?



Switzerland



Germany

Norway?

Locational issues

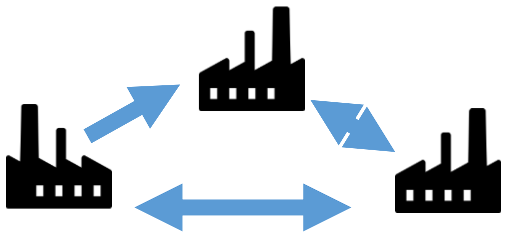
- Norwegian innovation clusters
- Launched in 2014 by *Innovation Norway* and the *Research Council*
- 25 immature clusters, 12 mature national clusters, 2 mature global clusters
- Goal: «Increased competitiveness in regional clusters through long-term internal and external collaboration between companies, R&D and educational institutions»

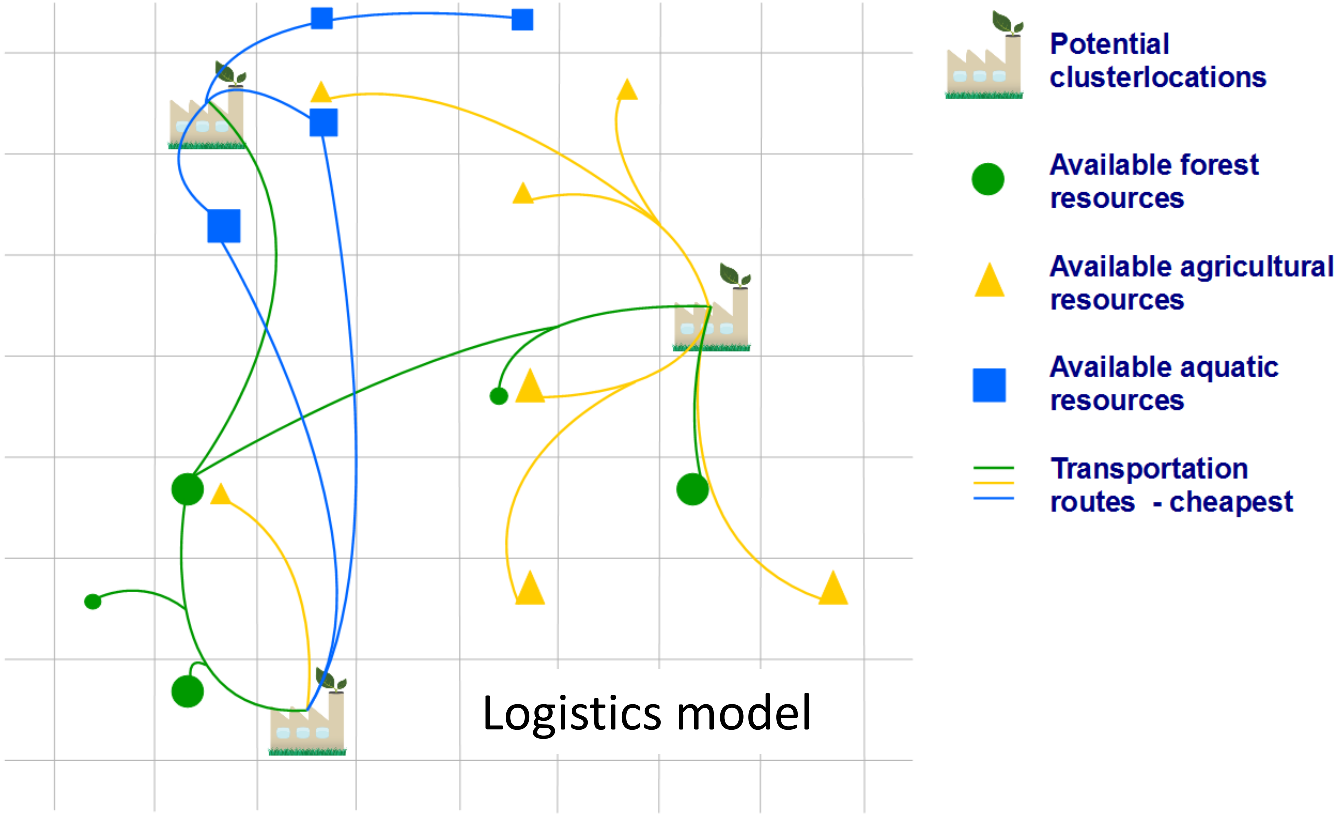
Biosmart observations:

- Initial within cluster links are expanding as between cluster links are being forged
- Concept of circular economy is becoming embedded in companies
- Possible problem with forming tight interdependent clusters creating a possible «lock-in» effect.

Locational issues

Clustering of facilities enables resources to be exchanged and shared between industries thus providing optimal (economic and environmental) sustainability.





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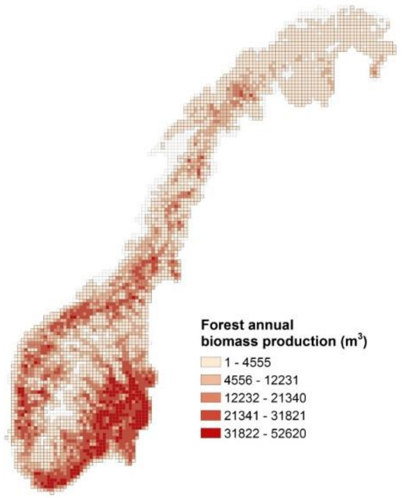
Locational issues



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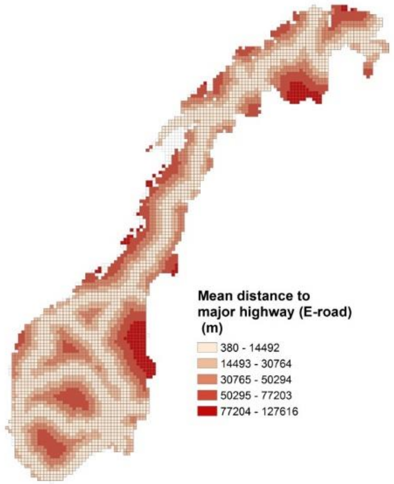

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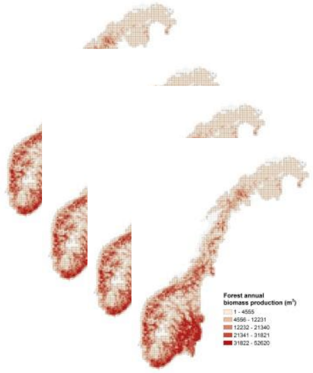

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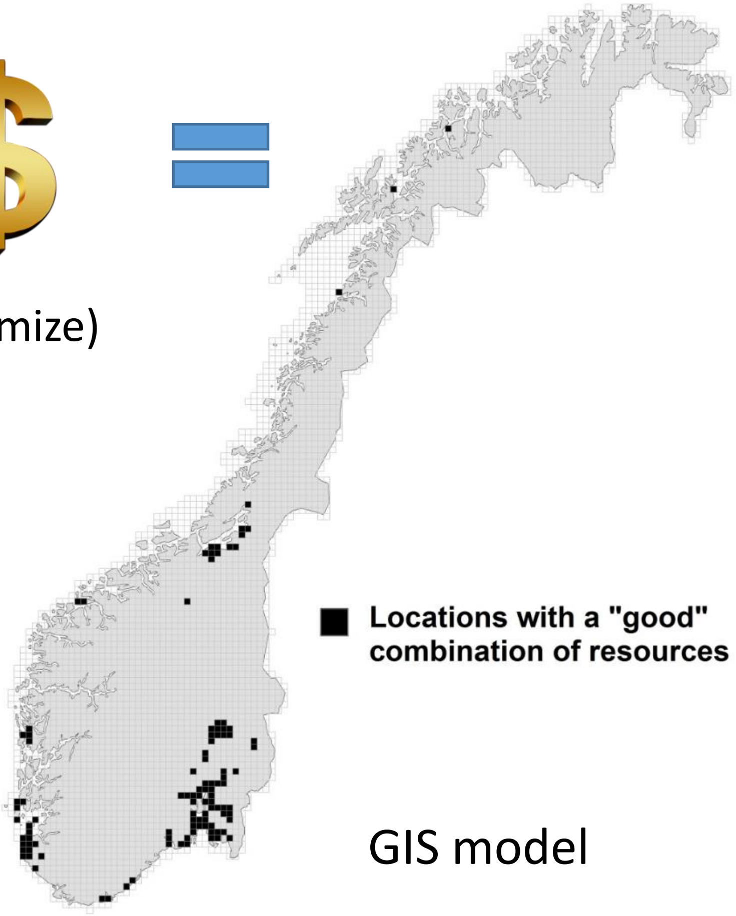

GIS model

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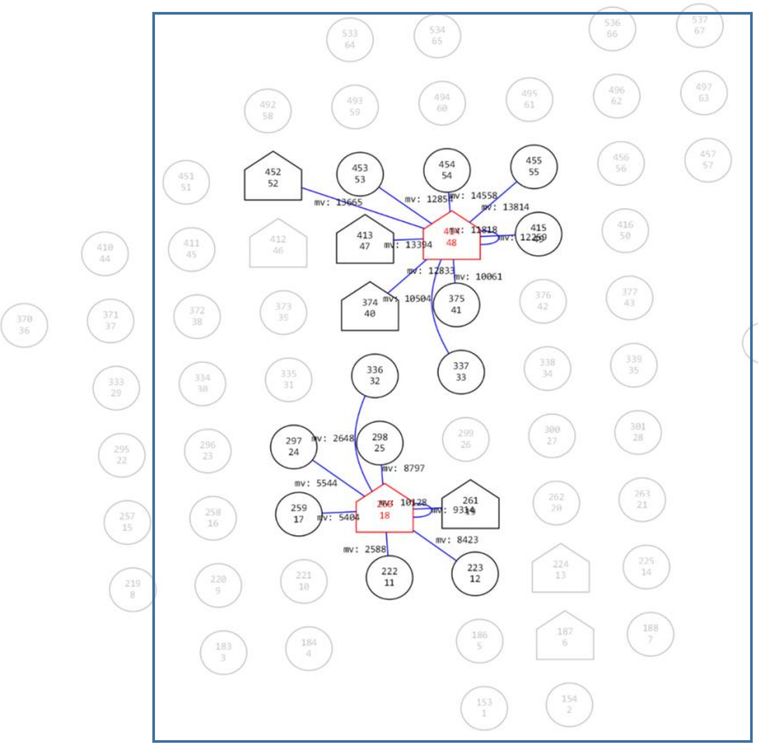
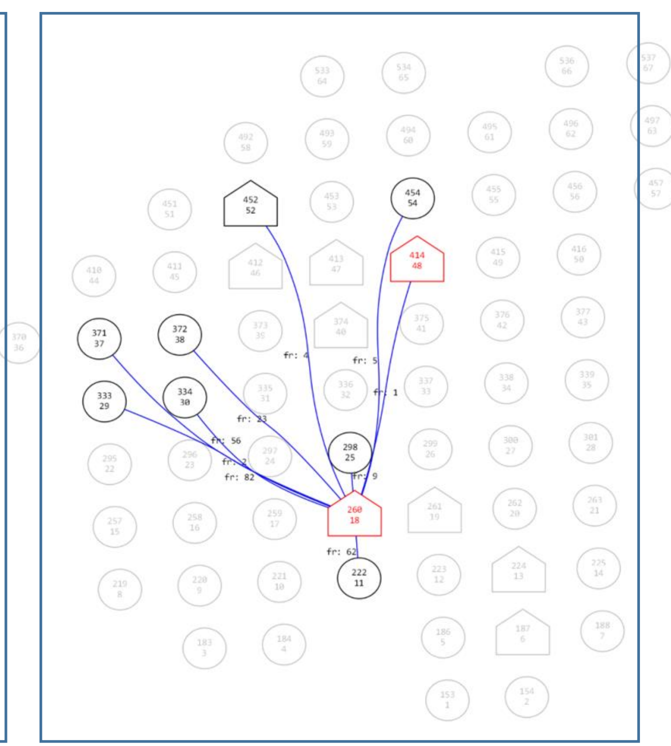
Locational issues

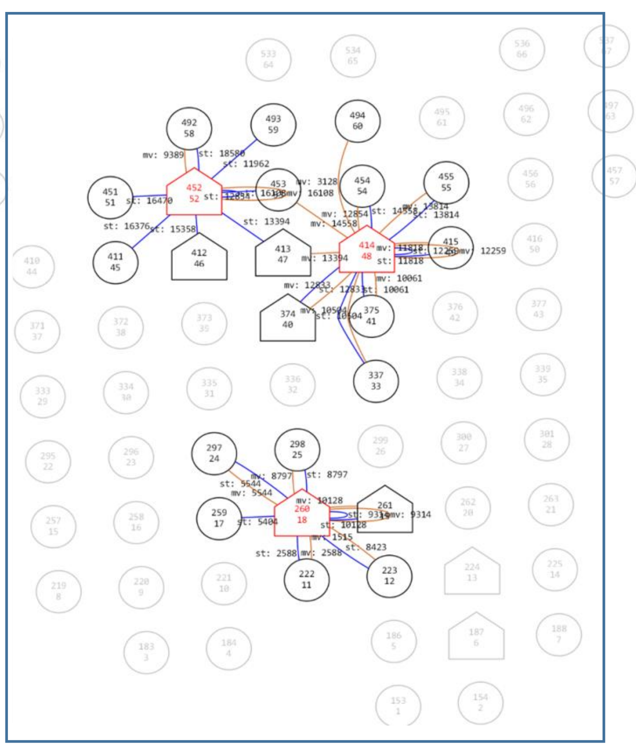
Using the Biosmart-developed linked model we can explore different scenarios of resource availability, type, quality, accessibility and their impacts on bioeconomic cluster site selection and sustainable resource use. Example of cluster location (red) and resources (black) in a region, for three scenarios:



Current



Higher price for a product

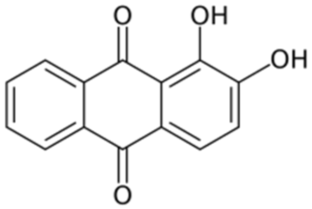


Higher transport cost

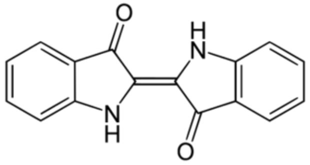
The «post-animal bioeconomy» a major disruptor?

Synthetic animal protein and the «post-animal bioeconomy»

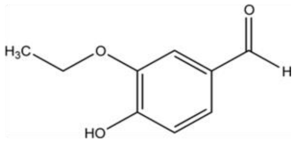
How disruptive can substitute technologies be?



Alizerin – 1868
Coal tar based
Destroyed natural madder industry in 15-20 years



Indigotin – 1869
Coal tar based
Destroyed natural indigo industry in 30-40 years



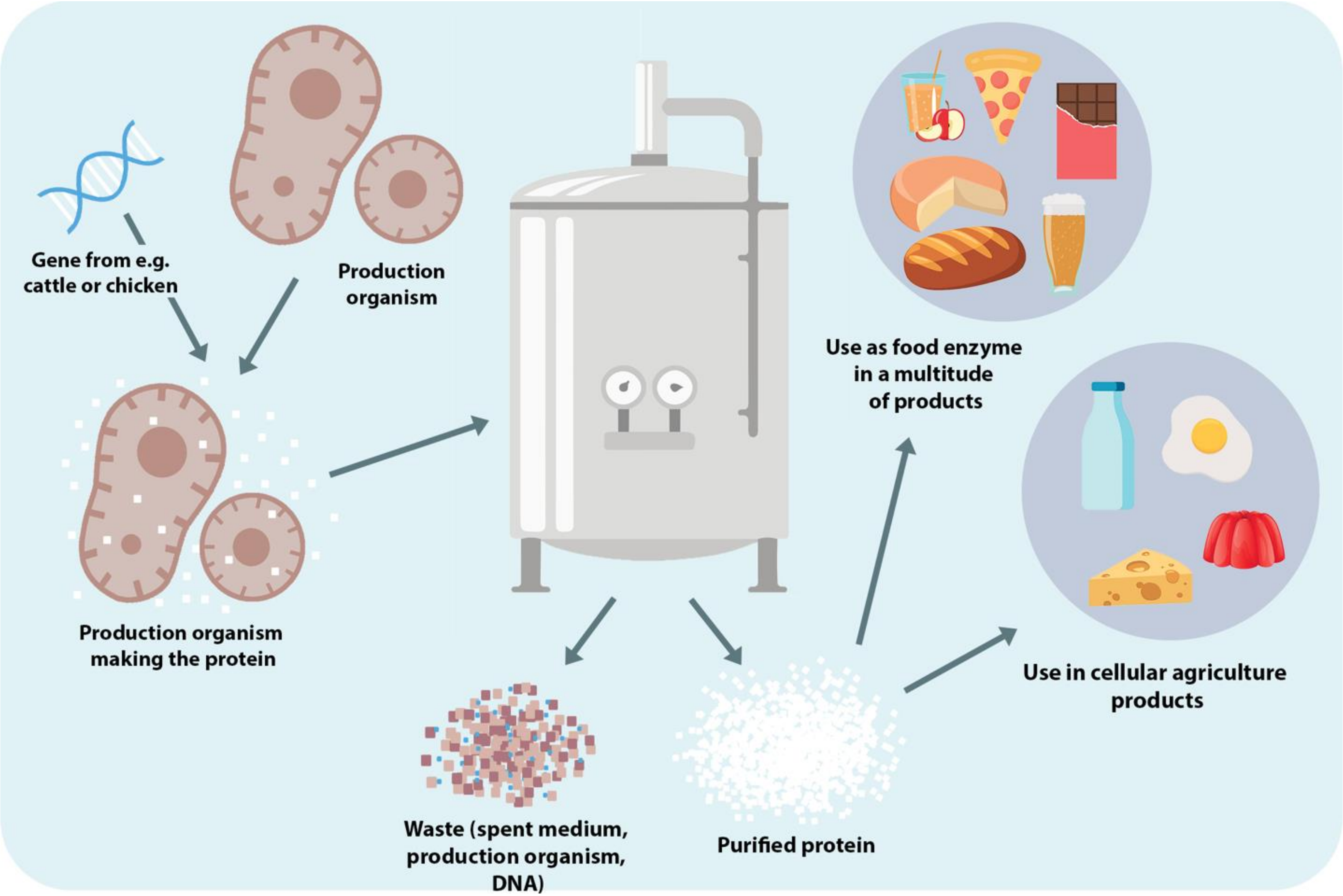
Vanillin – 1874
Timber by-product based
Bifurcated vanilla industry in 25 years

Synthetic animal protein and the «post-animal bioeconomy»

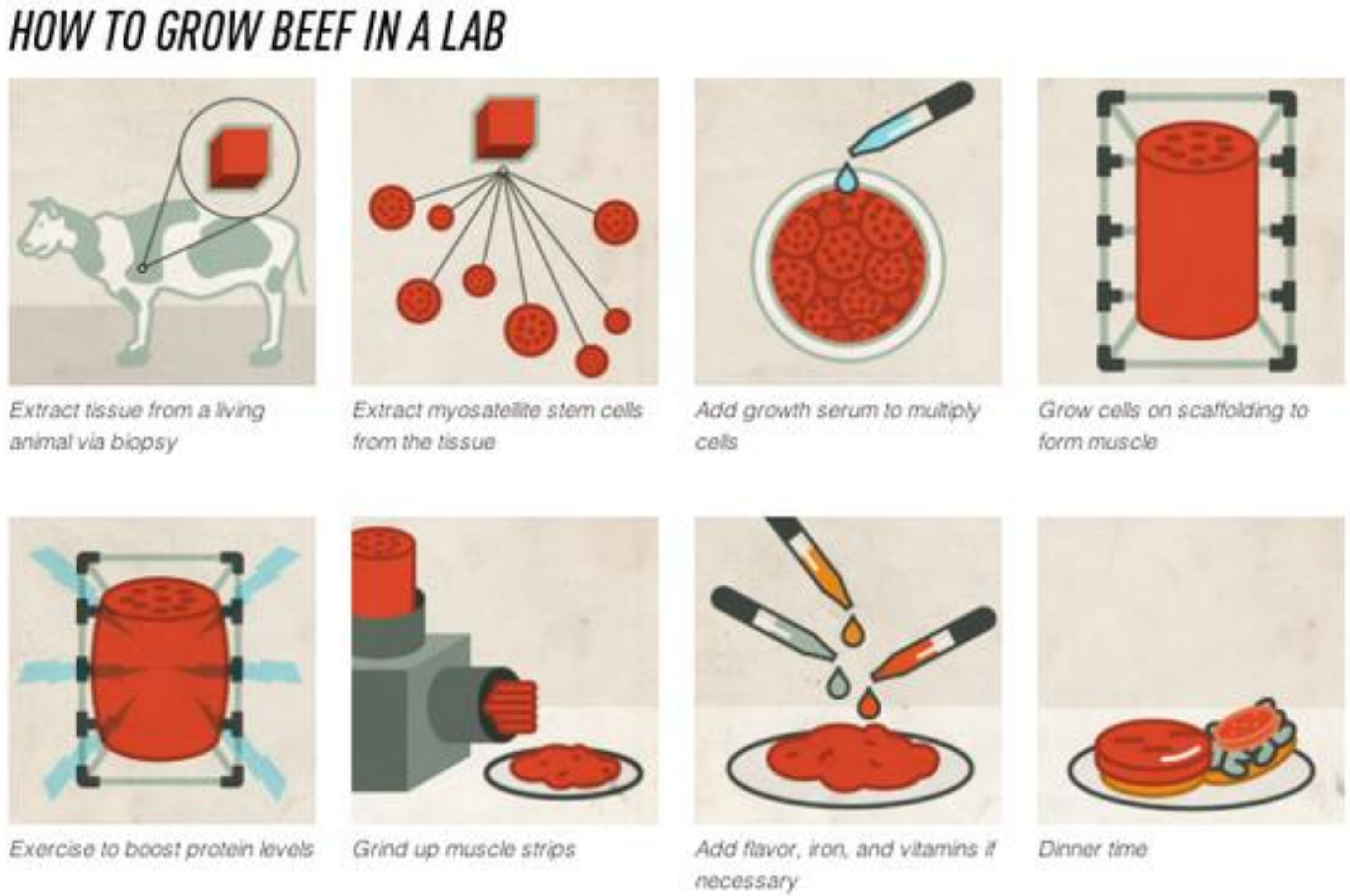
- 2013 – Mark Post creates a «synthetic buger» (for US $250,000)
- 2018 – 18 companies developing synthetic animal proteins

Startup Year	Company	Location	Animal	Manufacturing process	In production	High profile funders	Funding raised
2011	JUST	San Francisco	Poultry (initially), foie gras	Cell cultures	2018	Jerry Yang (Yahoo founder)	$220 million*
2011	Modern Meadow	New Jersey	Leather (collagen) (eventually meat)	Fermentation	2018	Evonik	$53 million
2012	Calysta	California	Fish feed	Fermentation	2019	Cargill, Temasek, DuPont	$400 million
2013	Mosa Meat	Netherlands	Minced beef, chicken and pork	Cell cultures	2021	Sergey Brin (Google founder)	$8.8 million
2014	Clara Foods	San Francisco	Egg whites	Fermentation	Not specified	Gary Hirshberg	$1.7 million
2014	Perfect Day	Cork	Milk and milk products	Fermentation	2018	Temasek	$24.7 Million
2015	Memphis Meats	San Francisco	meat (not yet specified)	Cell cultures	2021	Cargill and Tyson Foods	$22 million
2015	SuperMeat	Tel Aviv	minced chicken	Cell cultures	Not specified	PHW Group	$3.3 million * *
2015	Integriculture	Tokyo	Foie gras	Cell cultures	2020	Dr. Hiroaki Kitano	$2.7 million
2015	Geltor	San Francisco	Collagen and gelatin	Fermentation	2020	None	$2.5 million
2017	Finless foods	San Francisco	Bluefin Tuna	Cell cultures	2019	None	$3.5 million
2017	Aleph Farms	Isreal	Beef (3D printed)	Cell cultures	2018	The Strauss Group	$1.8 million* *
2017	Vitro Labs	San Francisco	Biofur (3D printed) and leather	Cell cultures	Not specified	None	No data available
2017	Wild Type	San Francisco	Salmon (initially)	Cell cultures	Not specified	None	$3.5 million
2018	Mission Barns	Delaware	Meat (not yet specified)	Cell cultures	Not specified	None	No data available
2018	Future Meat Technologies	Jerusalem	Meat (not yet specified)	Cell cultures	2020	Tyson Foods	$2.2 million **
2018	Blue Naulu	San Diego	Fish (not yet specified)	Cell cultures	Not specified	None	Undisclosed

Fermentation

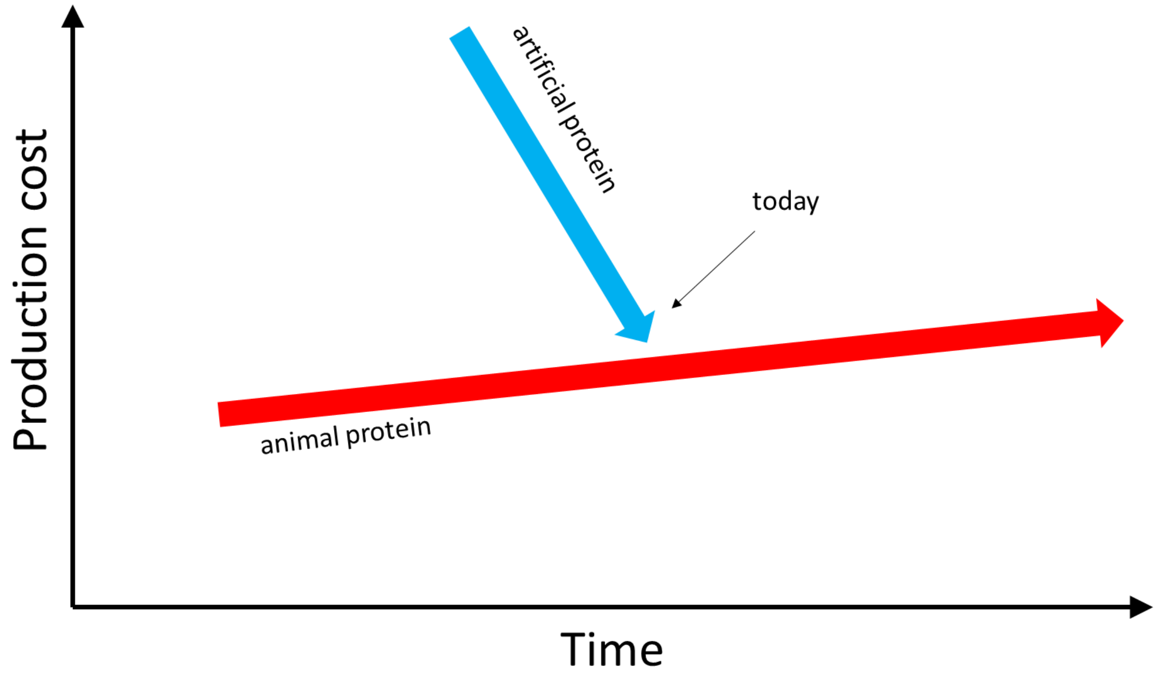


Cellular reproduction



Synthetic animal protein and the «post-animal bioeconomy»

- 2021 – Date Mosa Meats predicts it will make burgers for US $1
- 2026 - Date Integriculture predicts it will make 200g burgers for US $2



Three reasons synthetic animal protein is likely to lead to a «post-animal bioeconomy»

Why will synthetic animal proteins change the world?

1. Main technological developments are independent of food sector

Heavily funded medical and pharmaceutical sectors are working on:

- Serum formulation
- 3D protein printers
- 3D scaffolds
- Continuous processing
- Building larger bio-reactors
- etc

Technologies are directly transferable to food production

Why will synthetic animal proteins change the world?

2. Public is more accepting than of GMOs

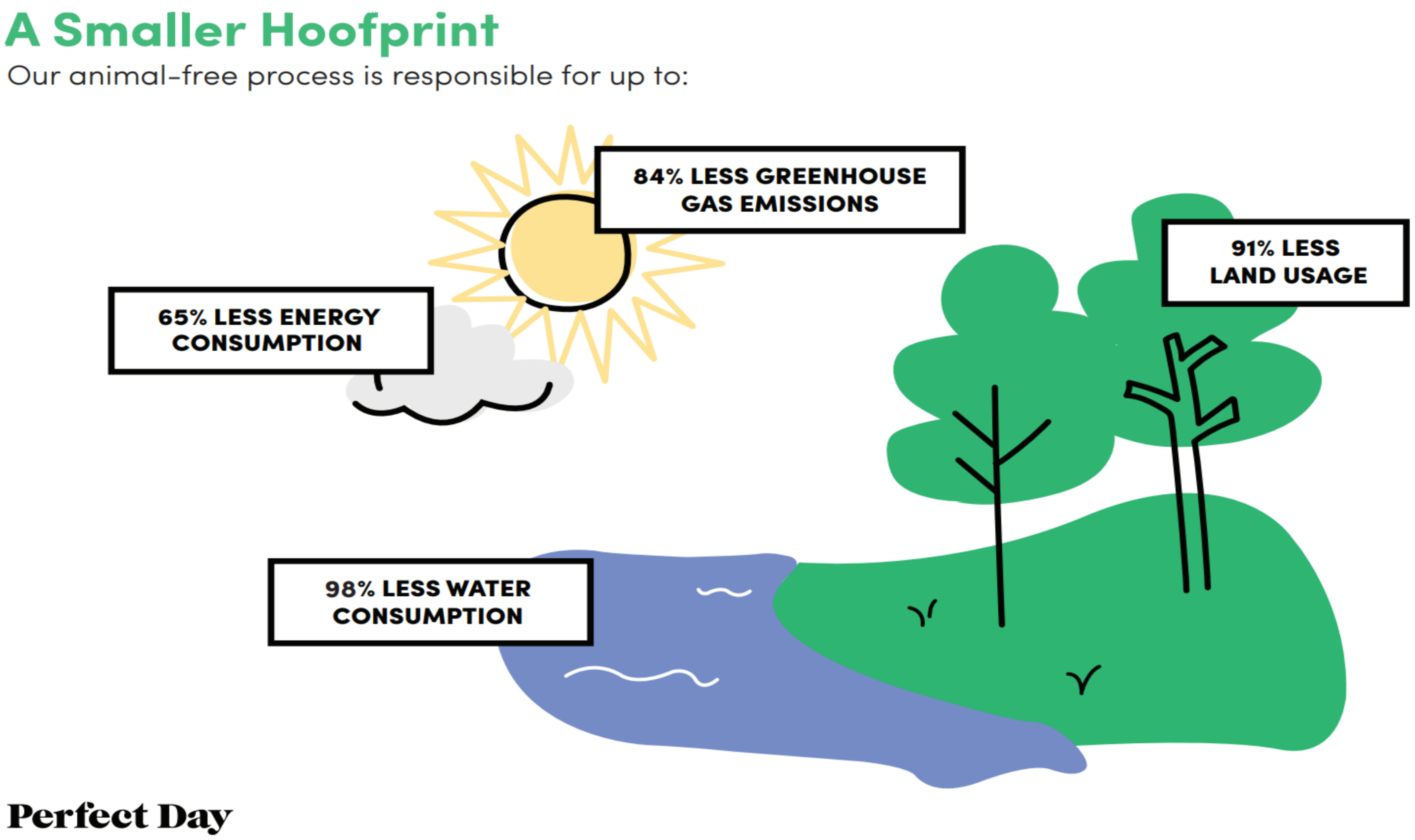
United States study:	9% rejected the idea of trying cultured meat
	31% would try it
Belgium study:	9% rejected the idea of trying cultured meat
	24% would try it

In a choice experiment, 11% of respondents preferred the cultured meat burger above the natural burger or vegetable burger options (Slade, 2018).

The “Impossible Burger” a vegetable burger with an added GM fermentation-based “heme” has met considerable market success.

Why will synthetic animal proteins change the world?

3. Early studies suggest could be <u>much</u> more sustainable



The «post animal bioeconomy»

- Likely demise of intensive livestock production
- Quality “natural” protein products remain
- Bifurcated market – “natural” and “synthetic” product
- Grazing land used for growing biomass
- Animal protein production integrated into bio-refineries

- Much lower resource use
- Much lower climate gas emissions

Thank you!