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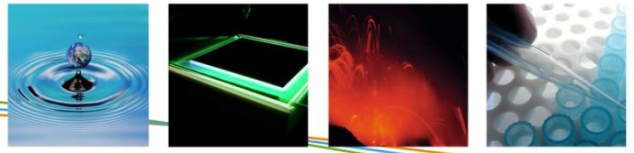


Road Map EU – India Collaboration on Biomass and Biowaste

Brussels, SAHYOG meeting
18 - 19 November 2014

SEVENTH FRAMEWORK PROGRAMME

Department of Biotechnology
Ministry of Science & Technology
Govt. of India

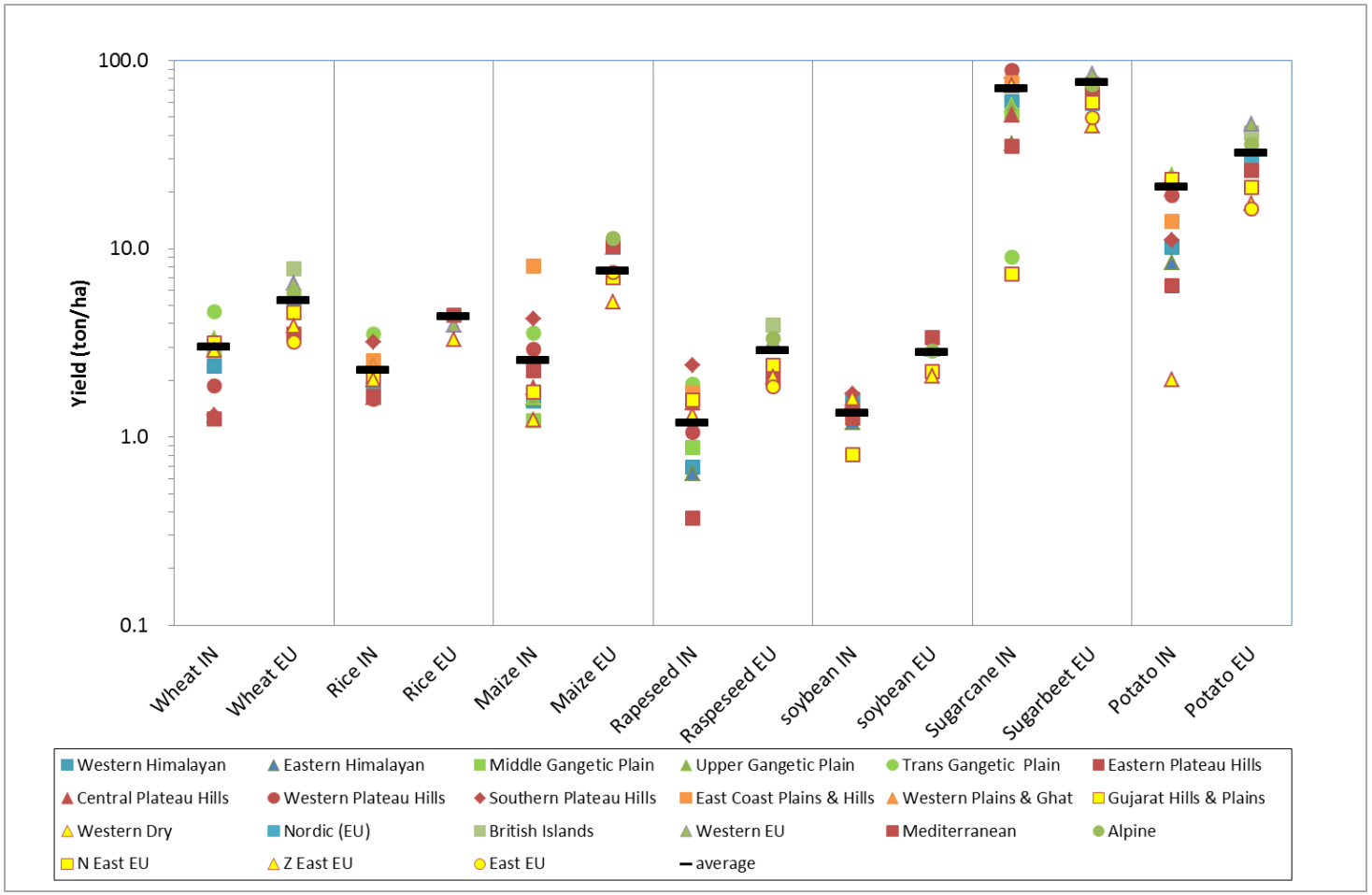
The process

- **State of the art** (Europe/India):
  - Biomass production/utilization and biorefineries
  - Biomass production/utilization for energy use
  - Identification of the gaps
- **Inventories** (Europe/India):
  - Biomass potential
  - (Large) R&D projects related to the bioeconomy
- **Stakeholders meetings** (Europe/India) and **twinning** (total 4)
- **List of R&D recommendations** in concensus by the partners
- **Survey** was made and sent out to a broad variety of stakeholders
- **Selection** of the most important R&D **recommendations for EU-IN collaboration**

Starting situation: state of the art

- General availability of biomass in Europe and India
  - Europe:
    - Agriculture and forestry have equal shares
    - Forestry is a very important biomass source for energy
    - Grassland/Forage important
    - Large coastline (~66000 km, ~half Mediterranean)
  - India:
    - Agriculture is dominating
    - Forests are largely protected, and not available for commercial wood supply. Fuel wood is mostly from TOF-areas.
    - Very high biodiversity (12.5% of world biodiversity, 2nd for bamboo)
    - Large coastline (7400 km)

State of the art: example yield



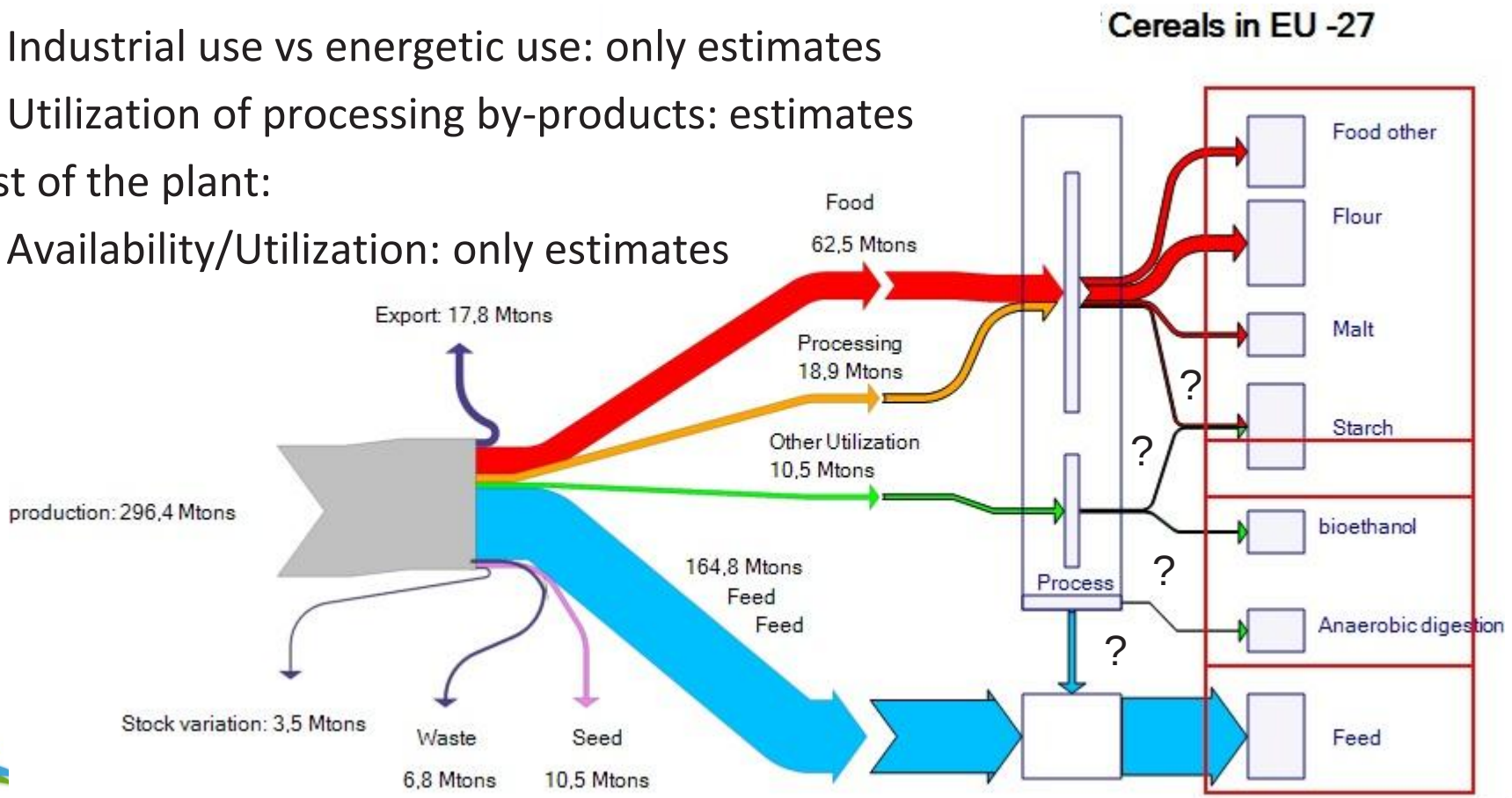
State of the art: example feedstock cereals (EU)

Product:

- Production data well documented in databases
- Food/Feed use well documented
- Industrial use vs energetic use: only estimates
- Utilization of processing by-products: estimates

Rest of the plant:

- Availability/Utilization: only estimates



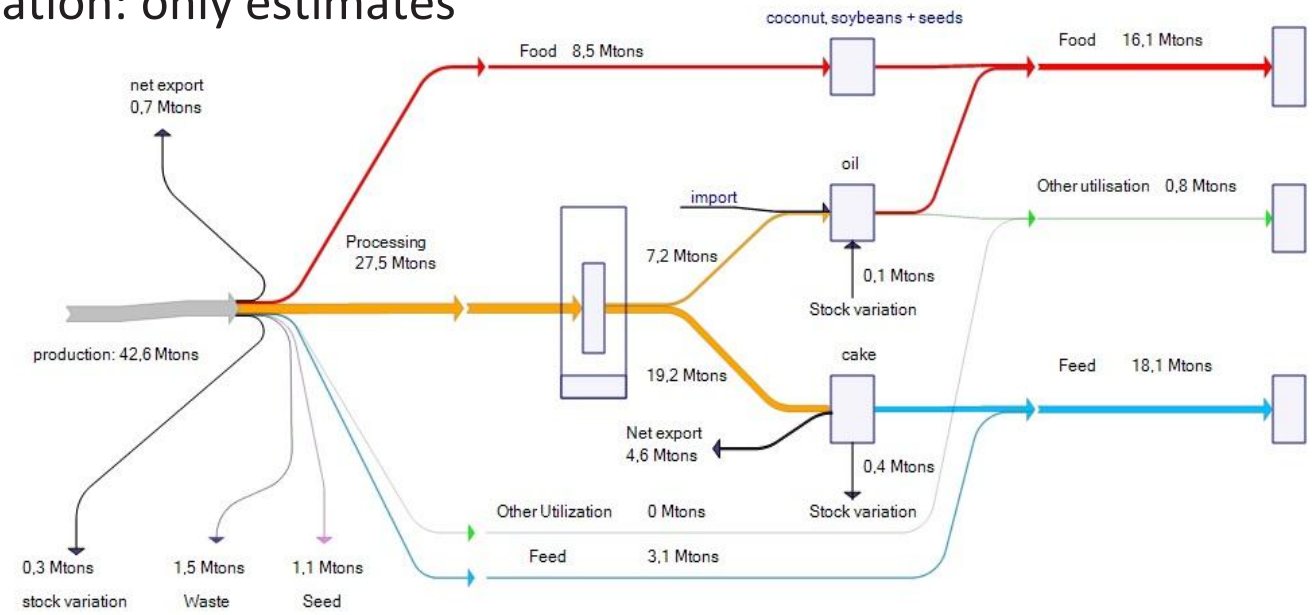
State of the art: example feedstock oils (India)

Product:

- Production data of “food” crops well documented in databases, however energy crops such as Jatropha not.
- Food/Feed use well documented,
- Utilization of processing by-products other than feed: N/A-estimates

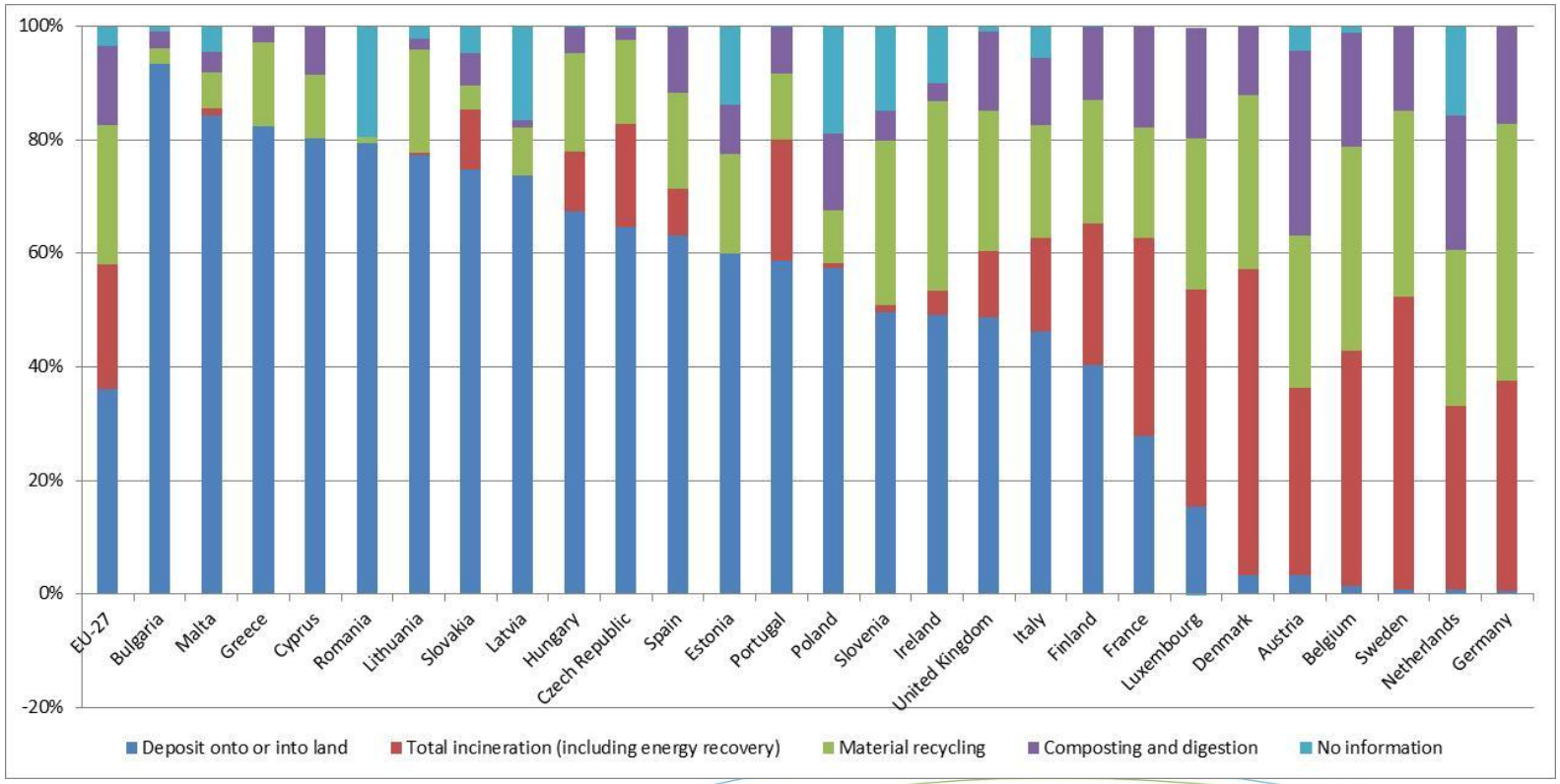
Rest of the plant:

- Availability/Utilization: only estimates



State of the art: generation & utilisation of MSW

- Municipal waste
  - EU: 500 kg/ capita – 38% biodegradable
  - India: 180 kg/capita – 50 % biodegradable



State of the art: examples new (bioenergy) feedstock (bamboo, perenials)

- India: bamboo
  - Second richest country in terms of bamboo genetic resources
  - ~14 Mha, 169 Mton of green culms
  - Interest as a potential feedstock as wood substitute, energy feedstock….
- Europe:

Species	Yield (ton DM /ha/yr)	Energy (GJ/ha)	Conditions	Extra
Giant Miscanthus (C4) *Miscanthus x giganteus*	10-30 5-15 (DK) 4-30 (DE) 10-15 (UK) 30-32 (IT)	170-528	Temperate climate central and S EU Sensitive to frost Water:700-800mm/y Soil similar maize	>30 y research Yield after 3y, Harvestable:15-20y Area: 0.018 Mha (UK, IE, FR, DE)
Giant reed (C3) *Arundo donax*	15-25 (GR,ES,IT)	245-570	Mediterranean Sufficient water	Feedstock M&G ethanol cellulosic plant in Crescentino (IT). Major energy crop US
Switchgrass (C4) *Panicum virgatum*	10-25 19 (FR)	174-435	Temperate climate central and S EU Sensitive to frost Water:450-750mm/y	Major energycrop in US. Low lignin strains Area: 0.050 Mha (RO)

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Survey - organization

- 4 Sections:
  - Identification stakeholder
    - type, sector, involvement in EU-IN collaborations
  - Recommendations
    - Feedstock supply and issues
    - By-products and waste
    - Biorefineries
    - Policy, products and markets

- Each stakeholder could select at most 3 recommendations per section
- Extra space for suggestion and comments

General comments: examples

Good initiative to get opinion from multi-disciplinary research concepts such as Sustainability. It will help to guide funds to proper fields of research on a priority basis.

Interesting and chalenging

India provides big markets, agro-resources and potential resources in municipal waste. A partnership of EU and India in identifying resources, developing technologies and realizing business opportunities is for sure a great option to push the global bioeconomy.

There is need to fund more applied R&D in form of pure research grants which can generate accelerated technology and solutions that are required to sustain Indian and Europe social needs

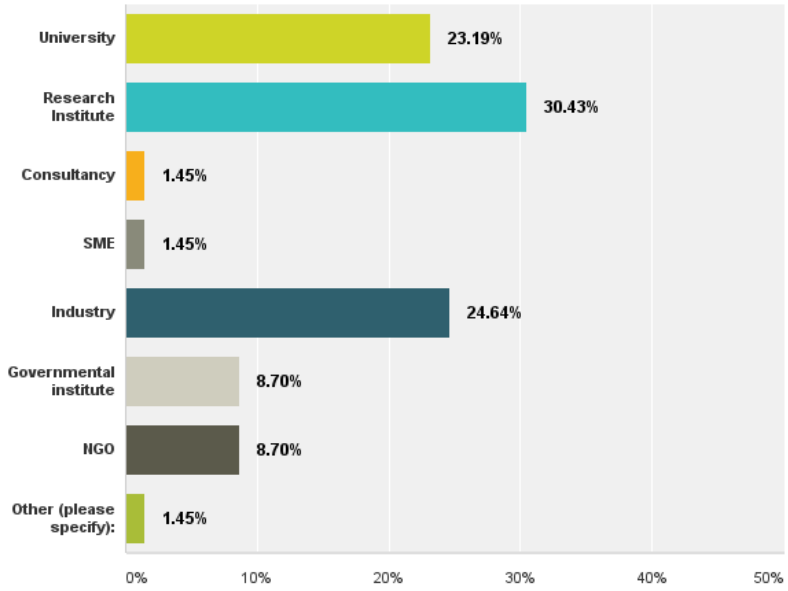
Example: by-products and waste

- Set up of a survey to assess the amount and type of waste dumped at landfills.
- Assessment of the composition and the generation of MSW and the development of new routes for the valorisation of the organic fraction.
- Set up of a survey of the generation and available agricultural and processing by-products and wastes available for energy and biochemicals production.
- Development of technologies/methods to harvest, collect and use agricultural by-products, including the assessment of the limits of biomass that can be removed from the fields.
- Development of technological routes to apply on existing agro-forestry waste, incl horticultural waste, for bioenergy or biobased products.
- Development of technological routes to apply on existing municipal waste as feedstock for bioenergy or biobased products.
- Development of technological routes to apply on existing industrial waste as feedstock for bioenergy or biobased products.
- Research on plants suitable for waste treatment and conversion.
- Development of new processes converting CO2 in bioenergy or biobased products.
- Research on bioremediation, including bioremediation in sewage systems,and phytoremediation of contaminated soils.
- Development of improved and safer conversion processes of wastes (incl. pretreatment and enzymatic hydrolysis).
- Development of new routes for waste valorisation biobased products through Volatile Fatty Acid platforms.
- Developing new routes for waste valorisation to biobased products and fuels using synthetic biology.
- Research to the better and maximum utilization of biowaste.

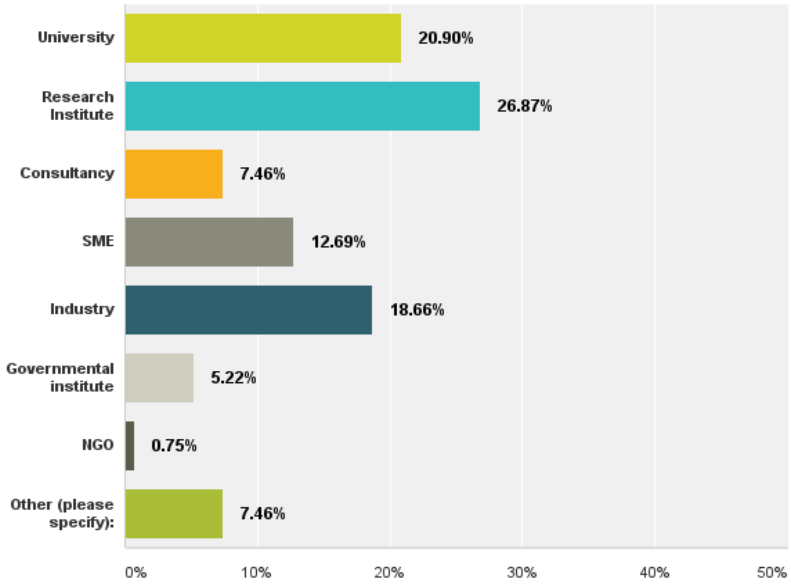
Survey - responses

- Survey was sent to a broad variety of stakeholders in Europe and India.
- ~240 answered, 207 complete responses

India



EU

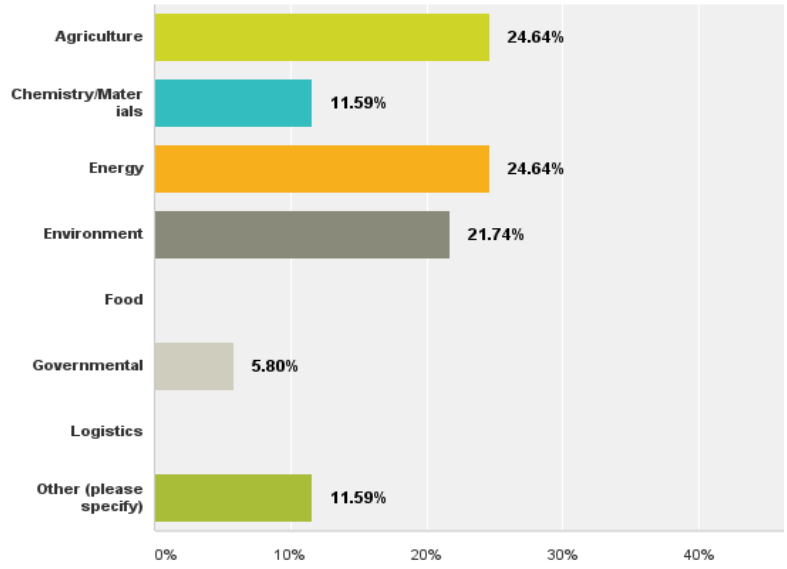


- University, Research Institute and Industry: equally distributed
- Industry: In EU large participation SMEs, in India mostly large enterprises

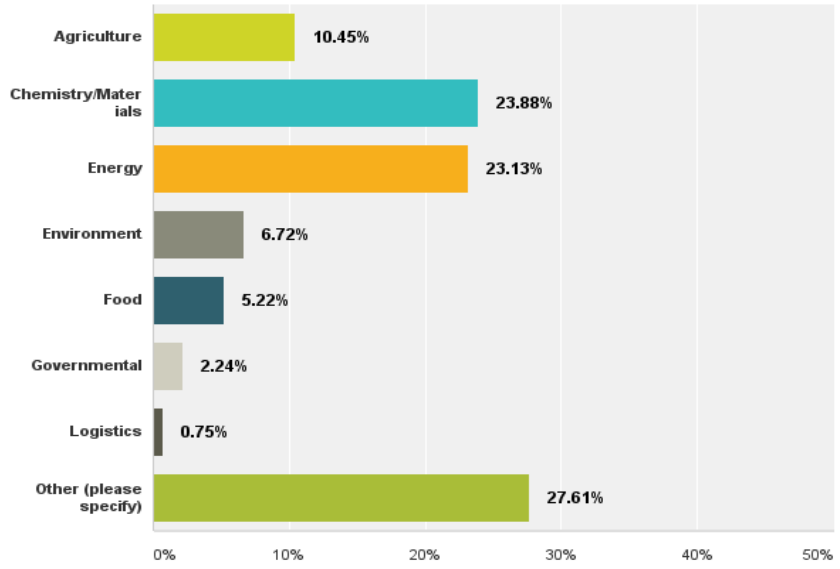
Survey - responses

- Answers were obtained from the diverse sectors of the bioeconomy

India



EU



- India: more answers from agriculture and environment
- EU: more answers from chemistry/materials and other (biotechnology)
- Food: under-represented

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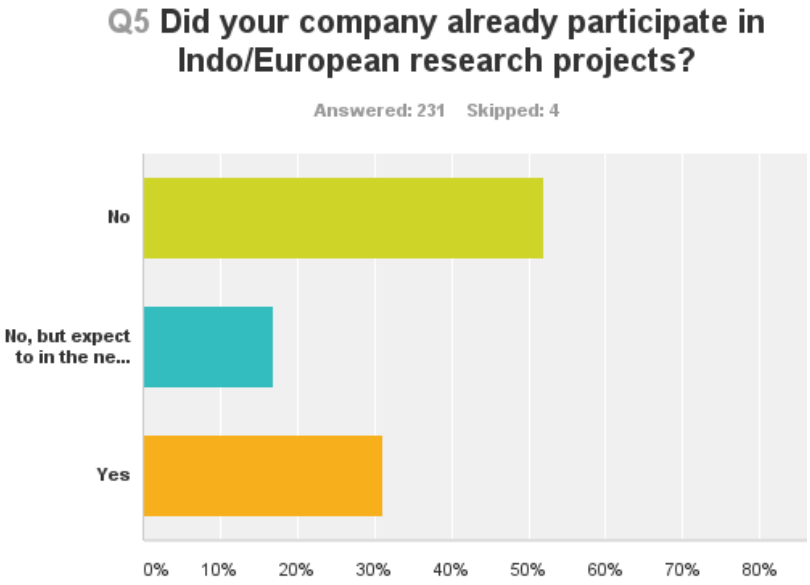
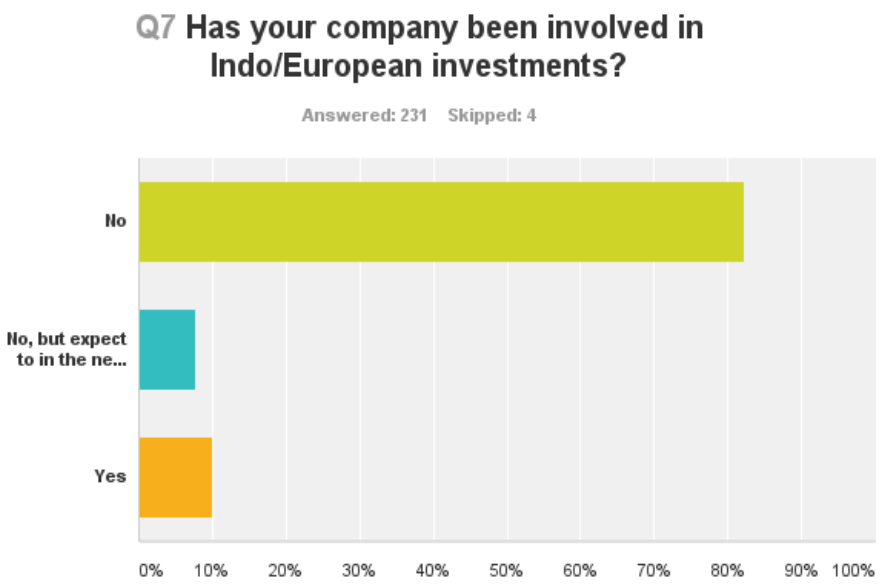
Survey – responses

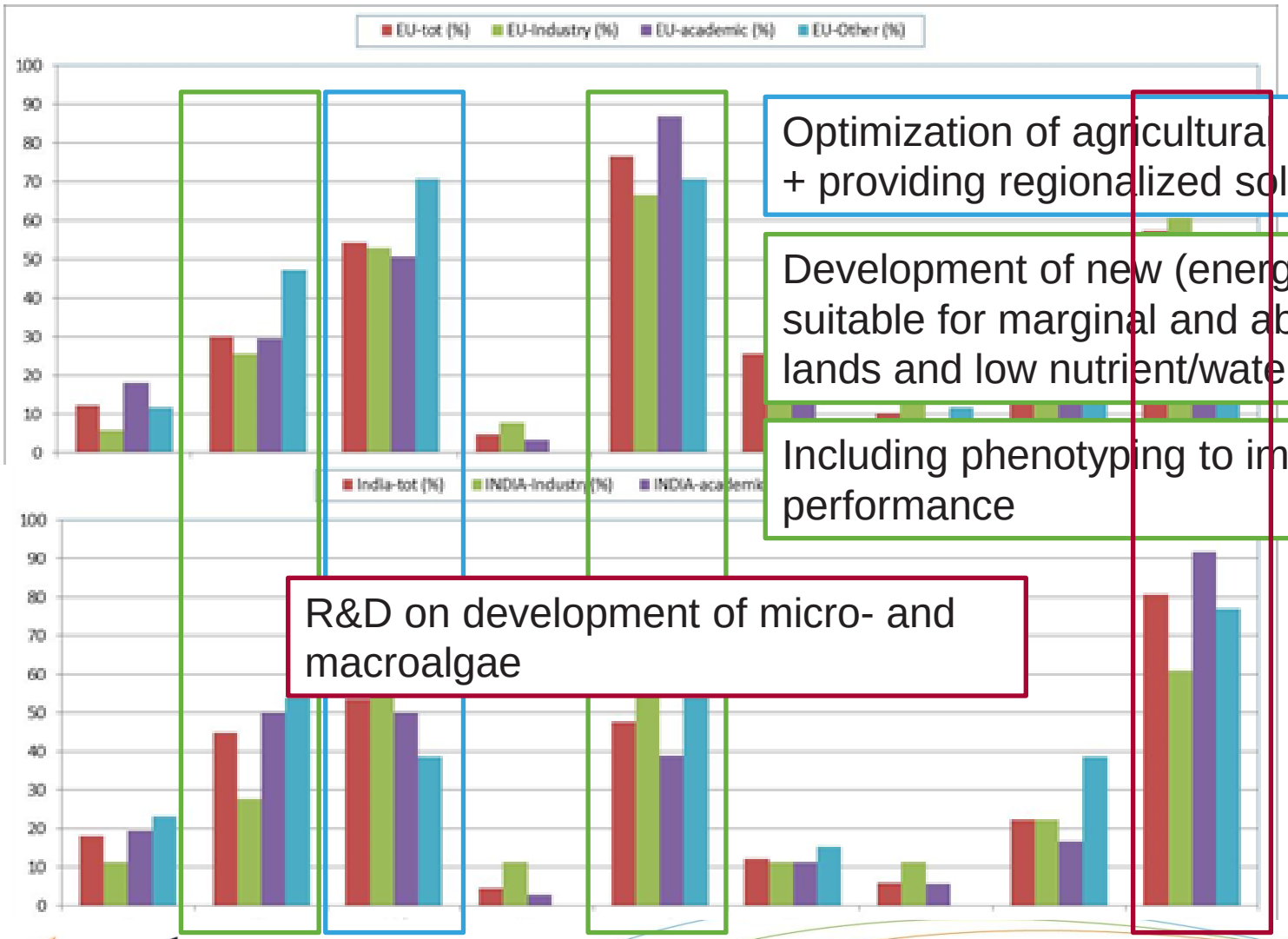




Survey Results: Example

By-products/Waste			
Answer Options	**India**	**EU**	**average**
Monitoring the amounts and composition of waste	45.6%	60.2%	52.9%
Set up of a survey to assess the amount and type of waste dumped at	1.8%	9.3%	5.5%
Assessment of the composition and the generation of MSW and the	14.0%	18.6%	16.3%
Set up of a survey of the generation and available agricultural and processing	29.8%	32.2%	31.0%
Improve collection and utilization of wastes	66.7%	69.5%	68.1%
Development of technologies/methods to harvest, collect and use agricultural	42.1%	40.7%	41.4%
Research to the better and maximum utilization of biowaste.	24.6%	28.8%	26.7%
Development of new Technologies to convert existing (solid) waste	77.2%	70.3%	73.8%
Development of technological routes to apply on existing agro-forestry waste,	29.8%	31.4%	30.6%
Development of technological routes to apply on existing municipal waste as	28.1%	20.3%	24.2%
Development of technological routes to apply on existing industrial waste as	19.3%	18.6%	19.0%
Research on wastewater treatment / bioremediation	36.9%	16.1%	26.5%
Research on plants suitable for waste treatment and conversion.	14.0%	8.5%	11.3%
Research on bioremediation, including bioremediation in sewage	22.8%	7.6%	15.2%
Conversion of CO2	28.1%	27.1%	27.6%
Development of new processes converting CO2 in bioenergy or biobased	28.1%	27.1%	27.6%
Development of routes to convert wastes to a platform system for bioenergy	26.3%	43.2%	34.8%
Development of improved and safer conversion processes of wastes	10.5%	22.0%	16.3%
Development of new routes for waste valorisation biobased products through	7.0%	6.8%	6.9%
Developing new routes for waste valorisation to biobased products and fuels	8.8%	14.4%	11.6%
answered question	***57***	**118**	***175***
skipped question	***11***	***19***	***30***

Survey Results – Feedstock

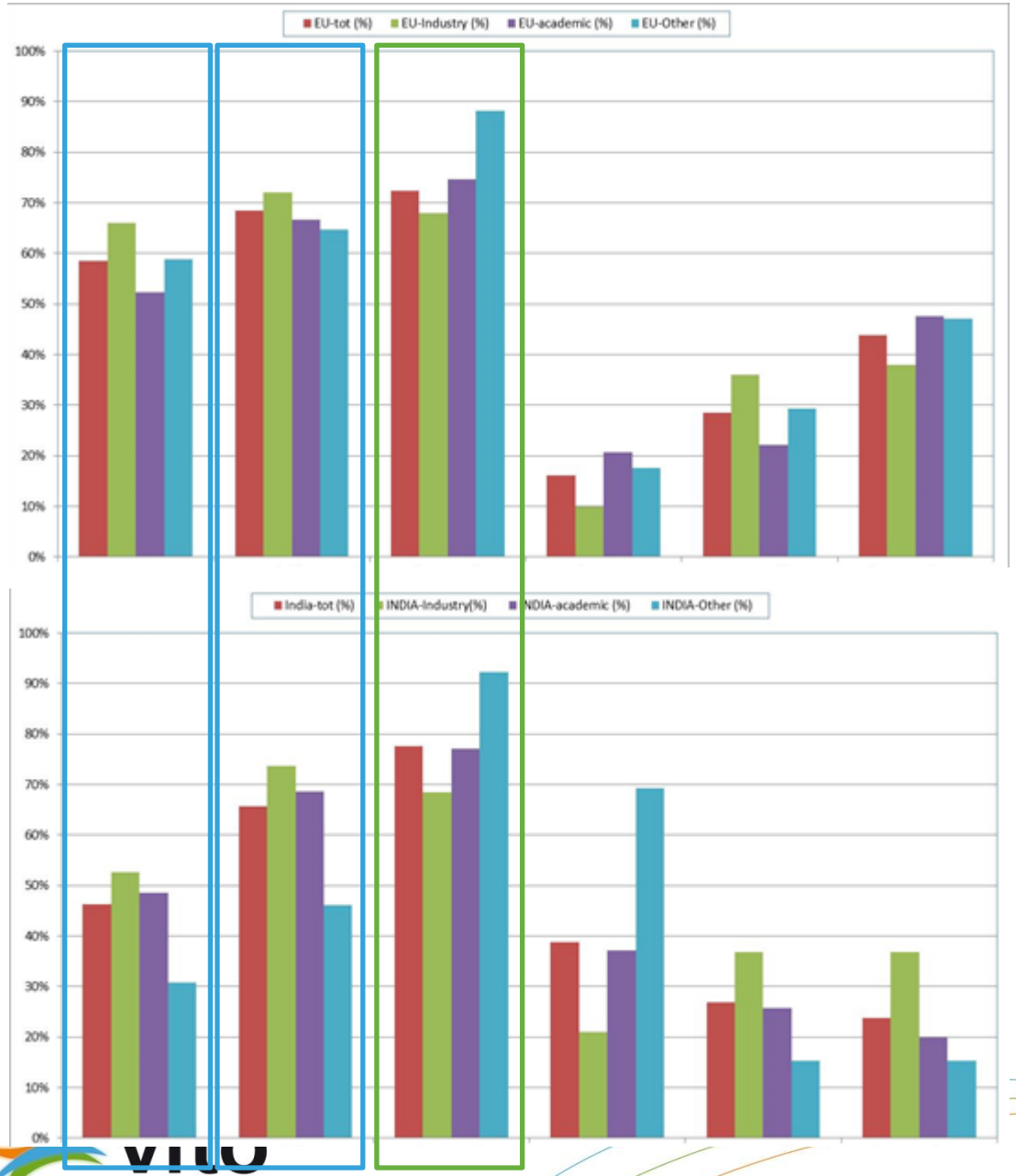


Optimization of agricultural practices + providing regionalized solutions

Development of new (energy) crops suitable for marginal and abandoned lands and low nutrient/water supply

Including phenotyping to improve crop performance

R&D on development of micro- and macroalgae

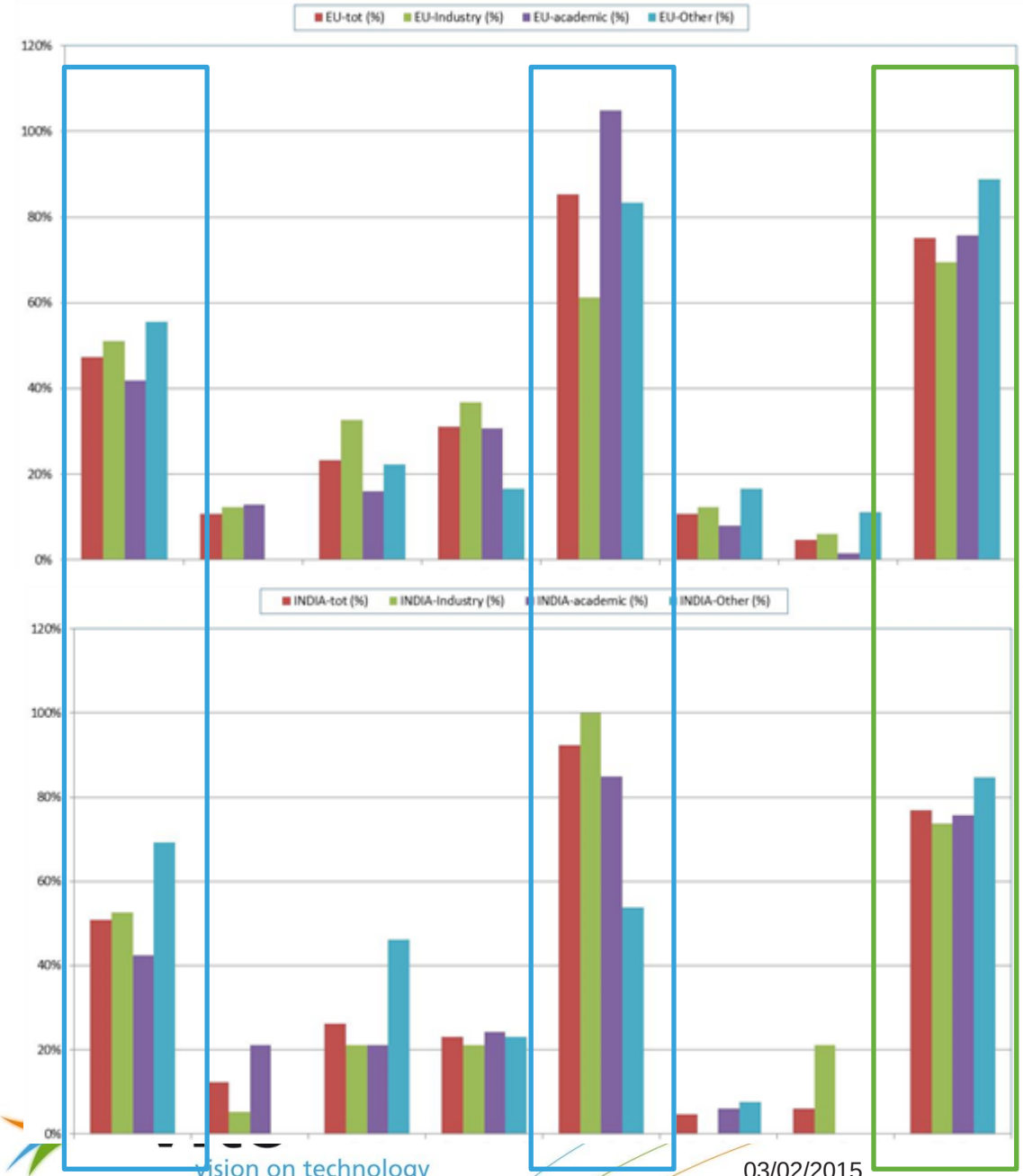


Waste and byproducts

Survey of wastes
(agro-forest, MSW, industrial)

Improved
collection/harvesting

Technologies to convert
“solid” wastes
(agro-forest, industrial, MSW)



Biorefineries

Lignocellulosic biorefinery for fuels and biomaterials

+ demonstration

Anaerobic digestion
(Low cost, mutifeedstock, digestate use, gas upgrading)

Feedstock – steps in time

- Refinement of agricultural practices
  - Improved yields of crops by improving water/nutrient, regionalized solutions
  - Plants phenotyping to improve crop performance to grow on marginal land (low water and nutrients demands)
  - New high yielding dedicated (energy) crops especially suited for marginal and abandoned lands or non food areas.
- Algae as a future biomass
  - Demonstration of algae production sites under EU-India conditions
  - Improved efficiency of algae harvesting
  - Process intensification of algae disruption and fractionation towards added value compounds
  - Algae as a feedstock for biofuels and biochemicals

Waste – steps in time

- Waste management and logistics
  - Harmonized survey on different types of residues and wastes (link to policy) and their technical potential + future estimates
  - Improved segregation/sustainable harvesting and logistics of residues/wastes
- Upgrading MSW, agro-forestry residues, industrial waste
  - Increased efficiency of thermal treatment processes considering environmental obstacles
  - Powerful anaerobic digestion systems for conversion of organic waste
    - Pretreatment and improved anaerobic digestion (including gas processing, muti-feedstock, low cost for rural areas)
    - Cascading: waste pretreatment with chemical extraction of high value compounds (e.g. food additives)
    - Set up of carboxylate platform to make fuels and chemicals

Biorefinery – steps in time

- Demonstrating and implementing ligno-cellulosic biorefineries
  - Demonstration plants for lignocellulose biorefineries
  - Consolidation and improvement of 2G biofuels production (improved lignocellulose disruption and fractionation)
- Development of future ligno-cellulosic biorefineries
  - Improved valorisation of hemicellulose and lignin side products
  - Integration of waste and water treatment
  - Based on new crops
    - Miscanthus, giant reed..-based for Europe
    - Bamboo-based for India

Cooperation framework to realise the SRA and roadmap

- Financial structure for joint (R&D) projects
- Production side:
  - capacity building for farmers of improved agricultural practises.
- Conversion side:
  - joint industrial cooperation and demonstration
  - increased production of biobased products
- Consumer side:
  - increased public awareness and societal support for biobased products
- Policy:
  - creating an enabling environment for the bioeconomy (higher CO_2-price…..)
  - support by LCA studies to indicate the sustainability improvement of a biomass-based circular economy

THANK YOU!!

Kathy Elst Ludo Diels Deepak Pant

thanks to all SRA partners
Kees Kwant, Rebecca Van Leeuwen, Neeta Sharma, Silvia Tabacchioni, Priyangshu Sarma, Piyush Joshi, Reeta Goel, Neera Sarin, Rob Bakker.