Discussion session – Group 2

Chemical products based on wood biomass

Chair: Prof. Dr. Paul Dyson and Enrico Bellini (KTT)

FNSNF
Swiss National Science Foundation

S-WIN
Swiss • Wood • Innovation • Network

Resource Wood
National Research Programme NRP 66

Schedule

- 02.30 pm: Introduction, key questions
- 02.45 pm: Participants' point of view: R&D gaps und industry needs
- 03.00 pm: Market and opportunities for Swiss industry for bio- or wood-based chemical products, next steps
- 03.30 pm: First conclusions
- 03.45 pm: Feedback of the group in plenary session

A vast array of studies and reports…

Universiteit Utrecht

Product overview and market projection of emerging bio-based plastics

PRO-BIP 2009

Final report

June 2009
Revised in November 2009

European Commission

From the Sugar Platform to biofuels and biochemicals

Final report for the European Commission
Directorate-General Energy

N° ENER/C2/423-2012/SI2.673791

April 2015

V1.4

A consortium led by

E4tech (UK) Ltd

with

Consorzio per la Ricerca e la Dimostrazione sulle Energie Rinnovabili (RE-CORD)

and

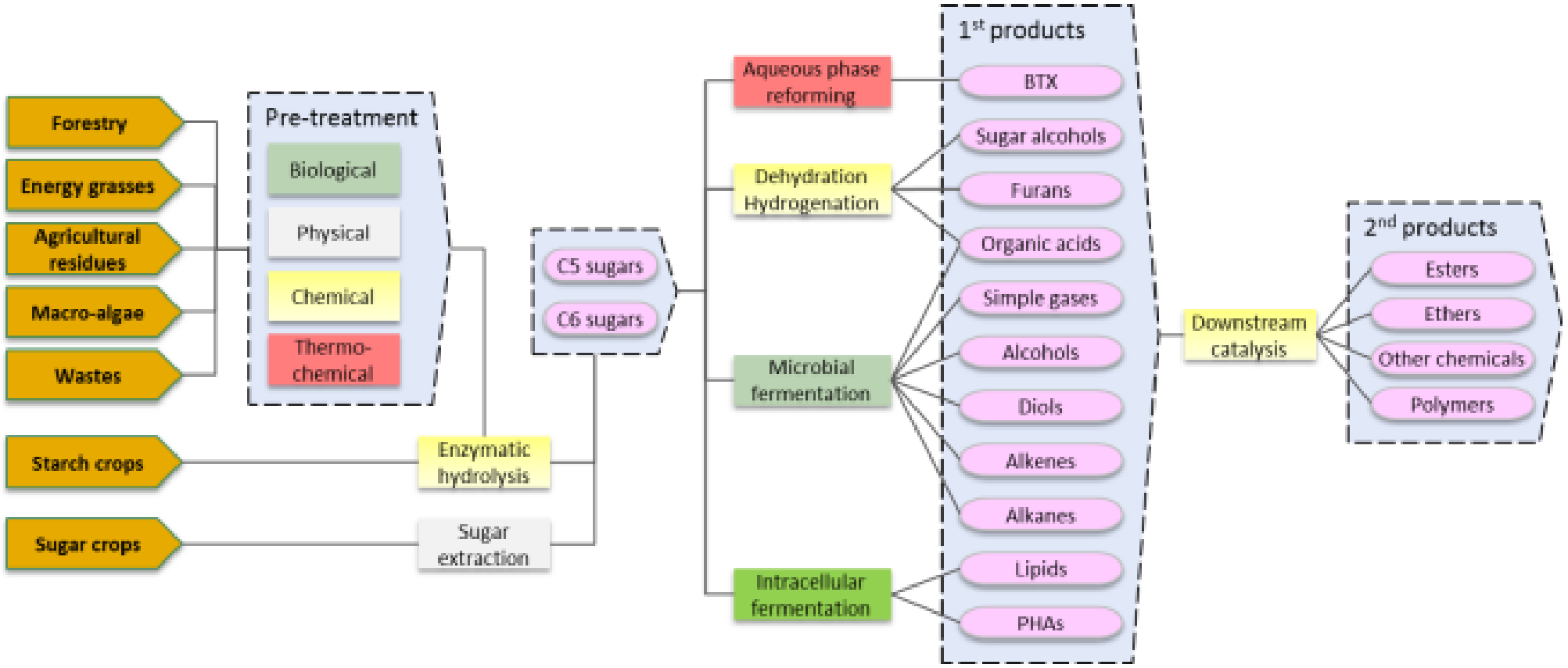
Stichting Dienst Landbouwkundig Onderzoek, Wageningen University and Research Centre (WUR)

E4tech Strategic thinking in sustainable energy

RE·CORD

WAGENINGEN UR For quality of life

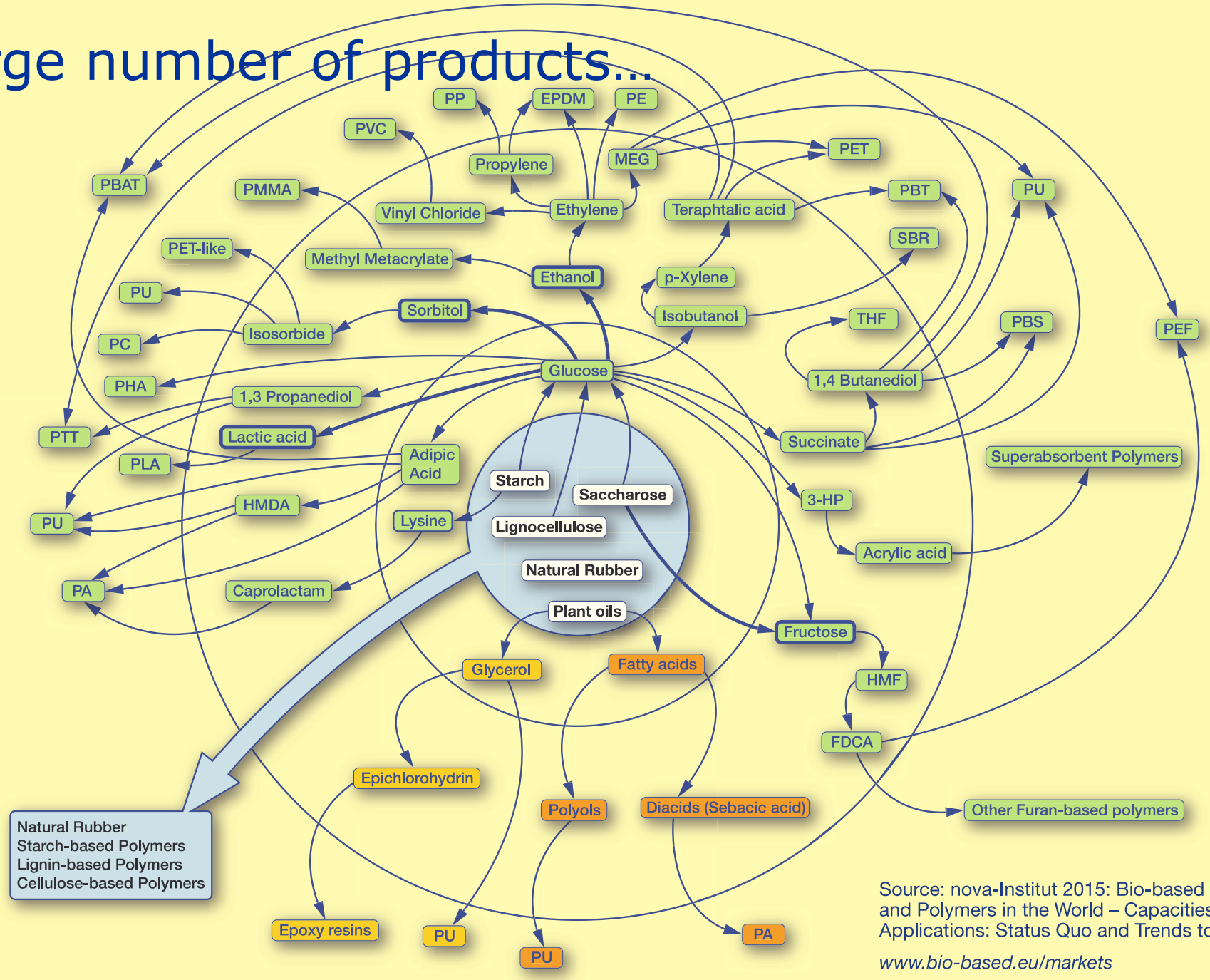
…many possible ways…



Source: E4tech, RE-CORD and WUR (2015) "From the Sugar Platform to biofuels and biochemicals"

Figure 1: High-level representation of pathways via the sugar platform

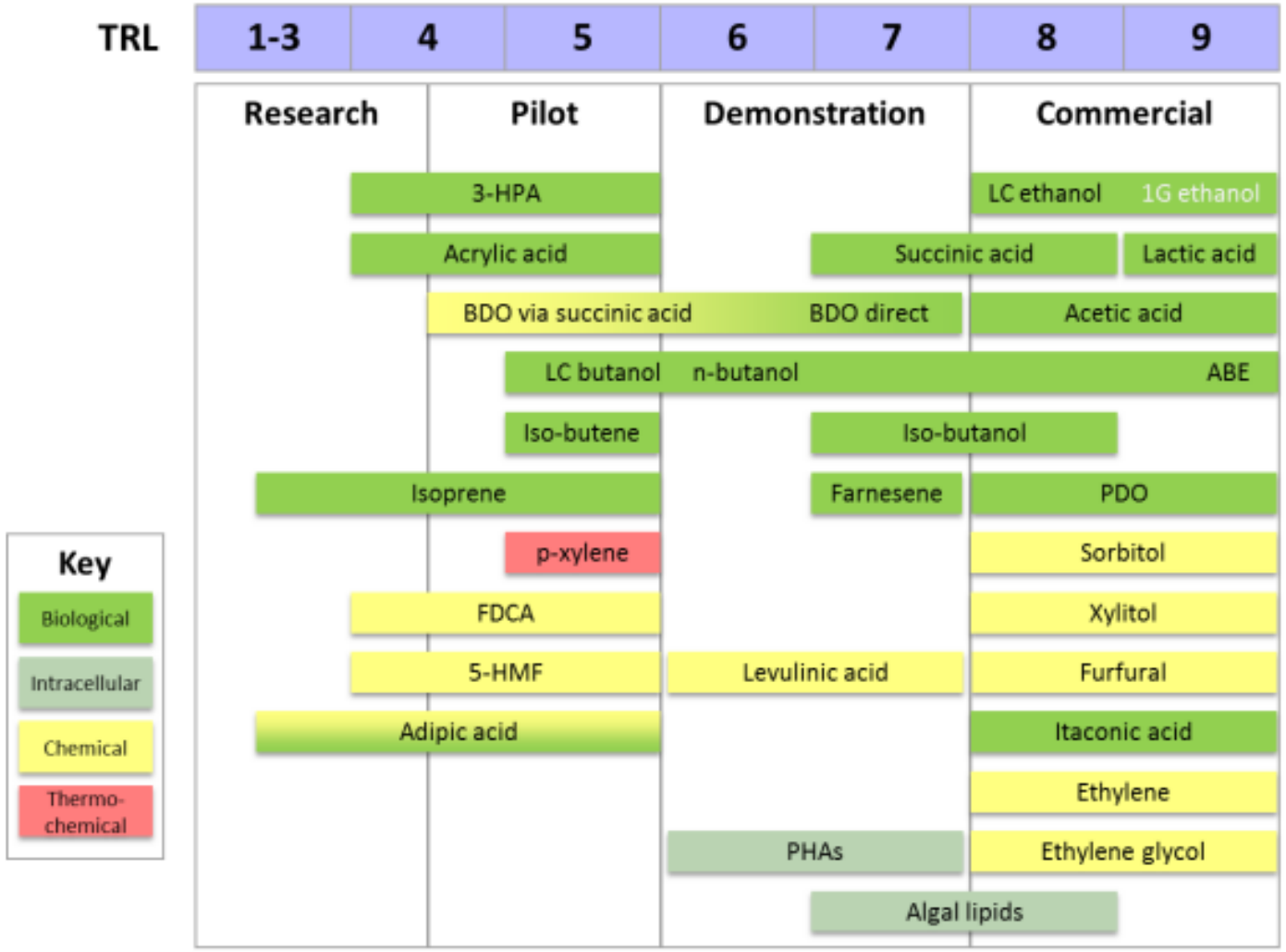
...a large number of products...



Source: nova-Institut 2015: Bio-based Building Blocks and Polymers in the World – Capacities, Production and Applications: Status Quo and Trends towards 2020

www.bio-based.eu/markets

…at various development stages…



Source: E4tech, RE-CORD and WUR (2015) "From the Sugar Platform to biofuels and biochemicals"

Figure 2: Commercialisation status of the 25 selected sugar platform products

… and of various market potential.

Table 1: Summary of case study actors, markets, costs and emissions

Bio-based product	Actors	Key markets and value proposition	Cost relative to fossil alternative	GHG saved vs. fossil alternative
Acrylic acid	BASF-Cargill-Novozymes (EU) OPXBio-Dow (USA). Focus for both partnerships is on 3-HPA route	Drop-in replacement for a widely used chemical intermediate	20 - 48% better than the fossil-based when commercial	>70%
Adipic acid (ADA)	Biochemtex and DSM (EU) Some US projects have reached pilot scale (Rennovia, Verdezyne).	Drop-in replacement meeting demand for nylon 6,6 and polyurethanes	Expected to be cost competitive (lower capex and utilities)	70-95%, depending on N2O intensity of fossil process
1,4 – Butanediol (BDO)	Genomatica (USA) main actor. BASF, Novamont, DSM, Biochemtex making BDO and PBT based on Genomatica technology. JM-Davy BDO is via Myriant's succinic acid	Drop-in replacement for fossil BDO. BDO is used to make GBL, THF and PBT	15-30% lower than fossil and competitive at an oil price of 45 $/barrel	70-117% depending on the process and electricity co-product substitution
Farnesene	Only one market player, US-based Amyris. There are no major European players.	Moisturiser emollients, durable easy-cast tyres, and jet fuel properties consistent with C15 iso-paraffin	Already attractive in emollients; close to market in tyres; high compared to jet	Up to 80% compared with fossil jet
2,5 furan-dicarboxylic acid (FDCA)	Development led by Avantium in the EU. Corbion Purac, AVA Biochem and Novozymes also active in this space in Europe	Substitute for TPA to make new class of polyethylene furanoate (PEF) polymers. Application in drinks bottles as superior gas barrier vs PET	High since at small scale, yet to be commercialised	45-68%
Isobutene	Small number of players, only Global Bioenergies and Lanxess in EU. *Gevo and Butamax are the main developers of isobutanol*	Rubber for automotive, and as a precursor for fuel & lubricant additives and biofuels. Might be used as food antioxidant	Could be profitable under high oil price market conditions	20-80%
Poly-hydroxy-alkanoates (PHAs)	Modest EU activity compared with China and the Americas. Biomer and Bio-on are the key EU players. Metabolix the largest US player	Fully biodegradable, niche use in sutures. Tuneable properties means could be used in most aspects of plastics industry	High costs. May fall via integration with sugar mills	20% with starch feedstocks, 80% with sugarcane and 90% with LC feedstocks
Poly-ethylene (PE)	Braskem in Brazil is the only commercial scale producer	Drop-in replacement for fossil PE, the most commonly produced plastic globally – main application in packaging	Sold at 30-60% above to fossil PE. Higher volumes may see price differential fall	>50% using sugarcane. Higher savings with LC feedstocks
Polylactic acid (PLA)	A few large industry participants; NatureWorks (USA) and Corbion Purac (NL) dominate PLA and LA production respectively. ~9 other EU producers of PLA and LA.	Bio routes preferred to fossil. PLA suitable for packaging, insulation, automotive and fibres. Durable, degradable, easily composted, low toxicity	Costs unconfirmed, but improved at scale. Slightly higher market price than fossil PS, PP and PET.	30-70% vs fossil PP, PS and PET. Could rise to 80% with improved conversion
Succinic acid	2 main actors in Europe (Reverdia, Succinity) and a further 2 globally (BioAmber, Myriant)	Drop-in replacement for fossil, and near-drop-in for adipic acid in resins, plasticisers, and polyester polyols	Equal to fossil costs since 2013. Fossil succinic acid now only niche	75-100+%, depending on feedstock production and grid intensity

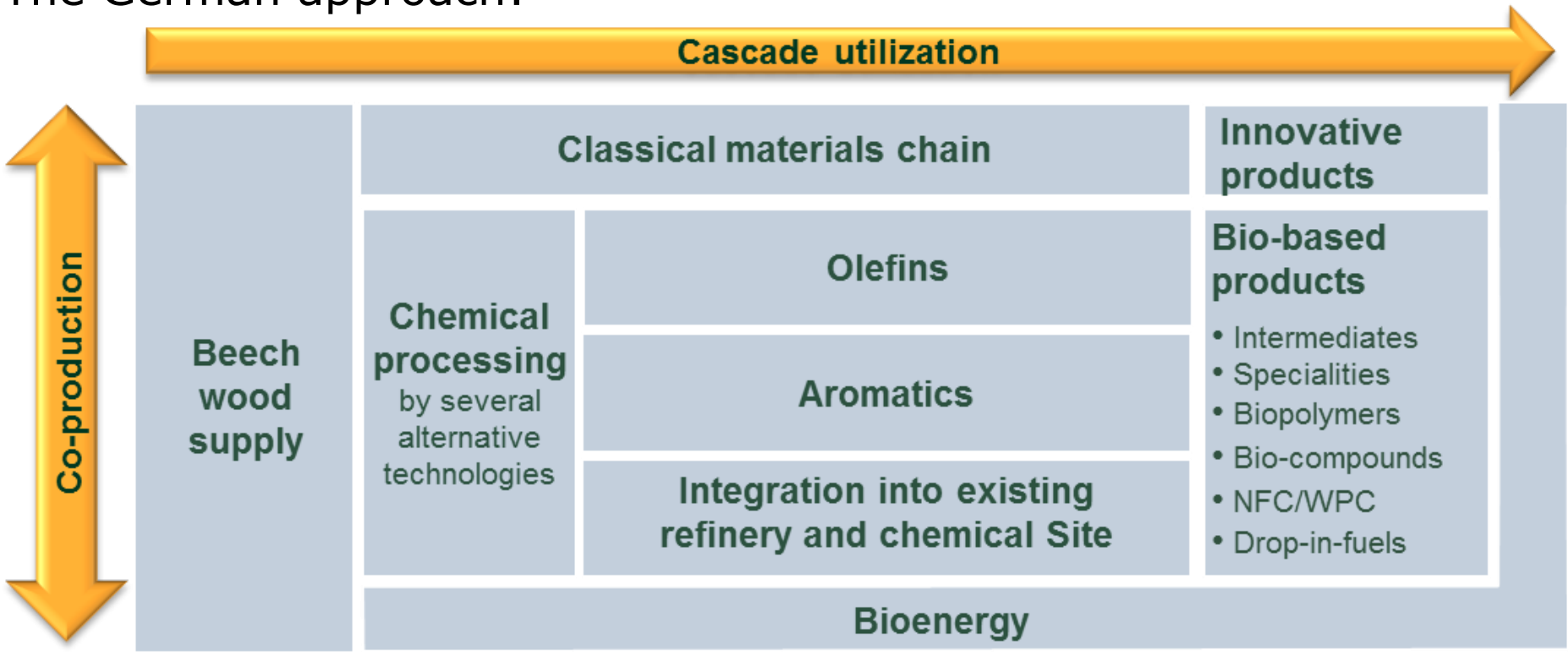
Source: E4tech, RE-CORD and WUR (2015) "From the Sugar Platform to biofuels and biochemicals"

Questions:

- Technical gaps in research? (R&D gaps)
- Industry needs?
- Is there a market and opportunities for Swiss industry for chemical products derived from wood biomass in general and in Switzerland in particular?
- How should Switzerland position itself in the global market of bio-refining?
- Which approach should we develop?

How should Switzerland position itself in the global market of bio-refining? Which approach should we develop?

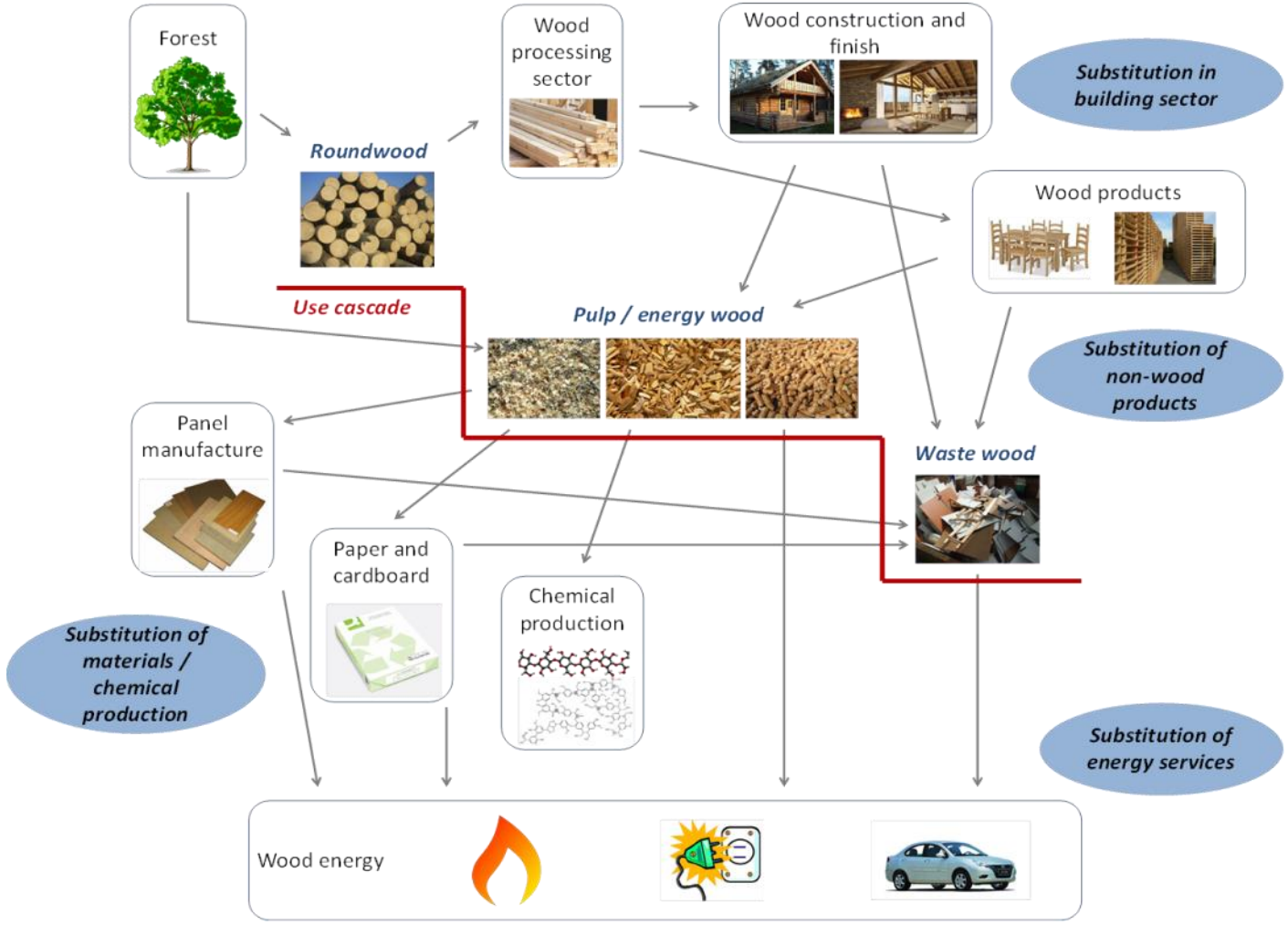
The German approach:



Source: Dr. Rainer Busch
German BioEconomy Cluster

Backup slides

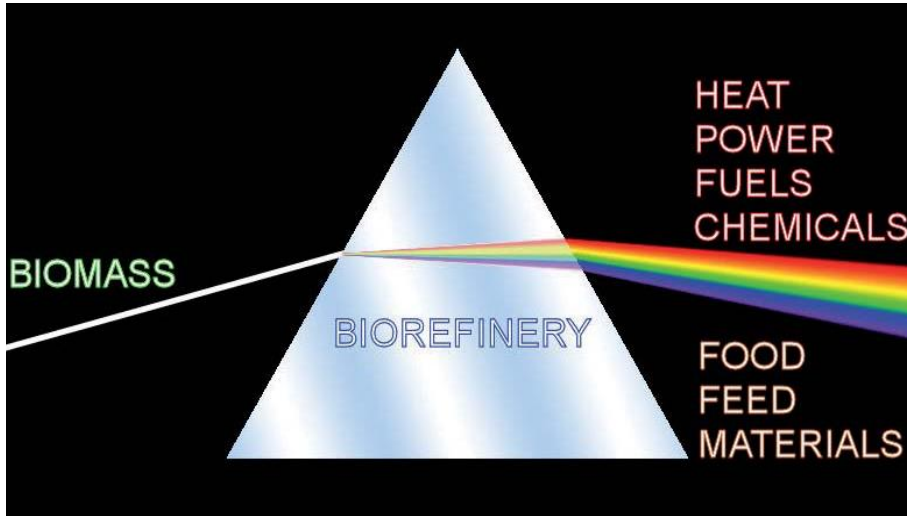
“Cascade use”: the buzzword for recovering useable materials and/or energy from wood in the future



Source: S. Hellweg

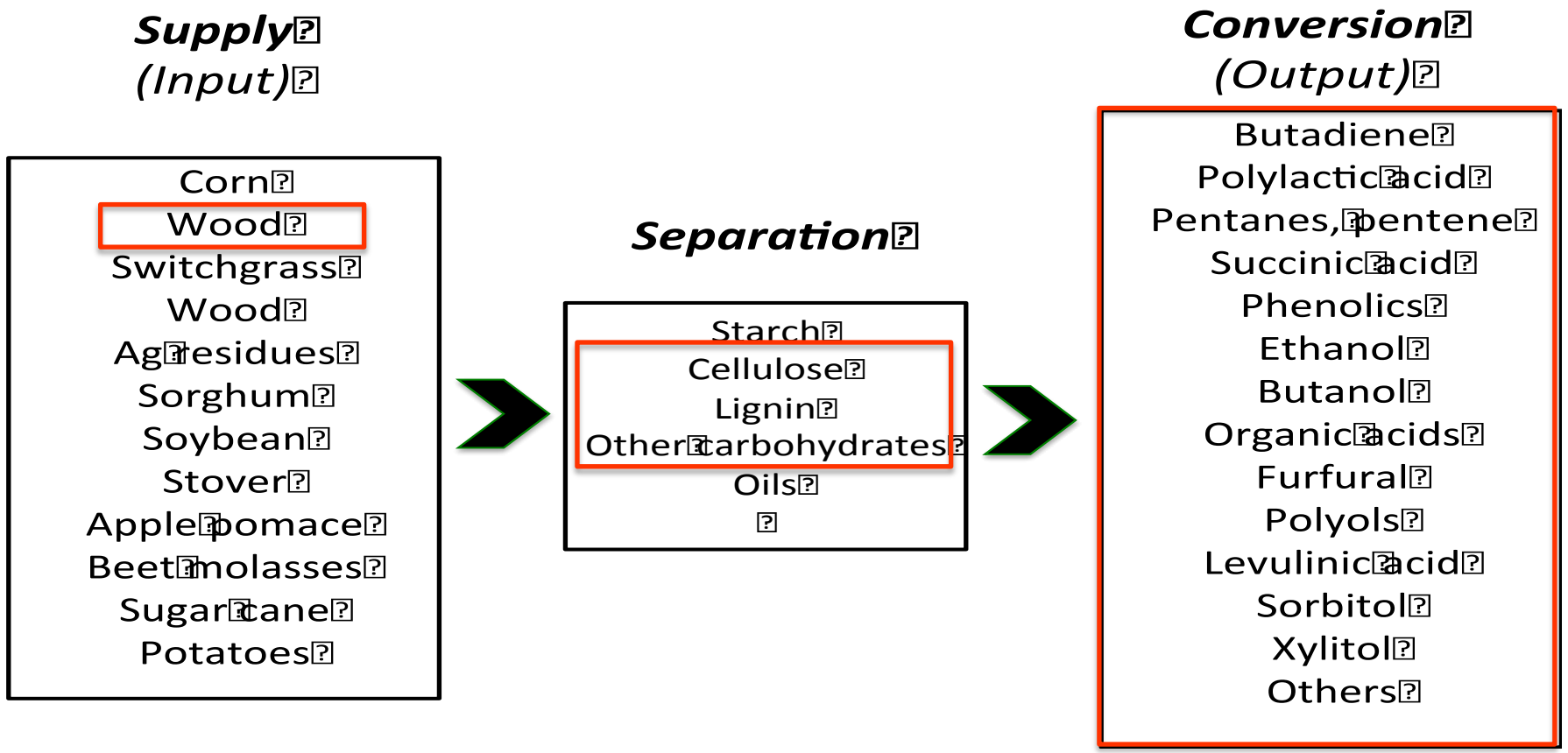
Biorefinery concept

- The sustainable processing of biomass into a spectrum of marketable products and energy.
- A facility that integrates biomass conversion processes and equipment to produce fuels, power, heat, and value-added chemicals from biomass



Source: IEA: Biorefineries: adding value to the sustainable utilisation of biomass

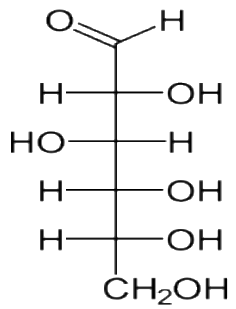
Biorefinery, a biomass conversion machine



Source: Dr. Rainer Busch
German BioEconomy Cluster

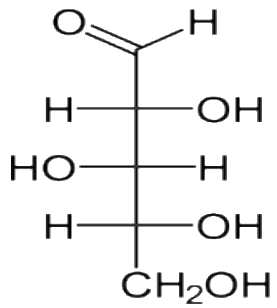
Cellulose, Hemicellulose....

- ...are hydrolysed to sugars:
- Cellulose → Glucose (C6-sugar) Fermentation

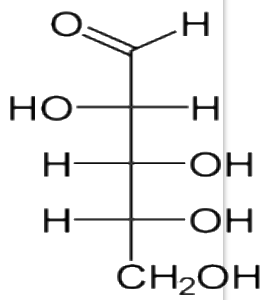


D-Glucose

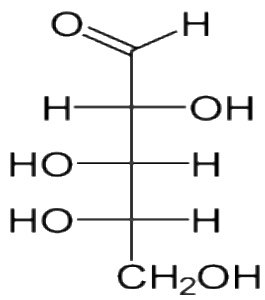
- Hemicellulose → Xylose and Arabinose (C5-sugars)



D-Xylose



D-Arabinose



L-Arabinose

Source: Dr. Rainer Busch
German BioEconomy Cluster