Strategies for successful establishment of 4F Crops

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"Successful scenarios for the establishment of non-food crops in EU27"

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Research question:

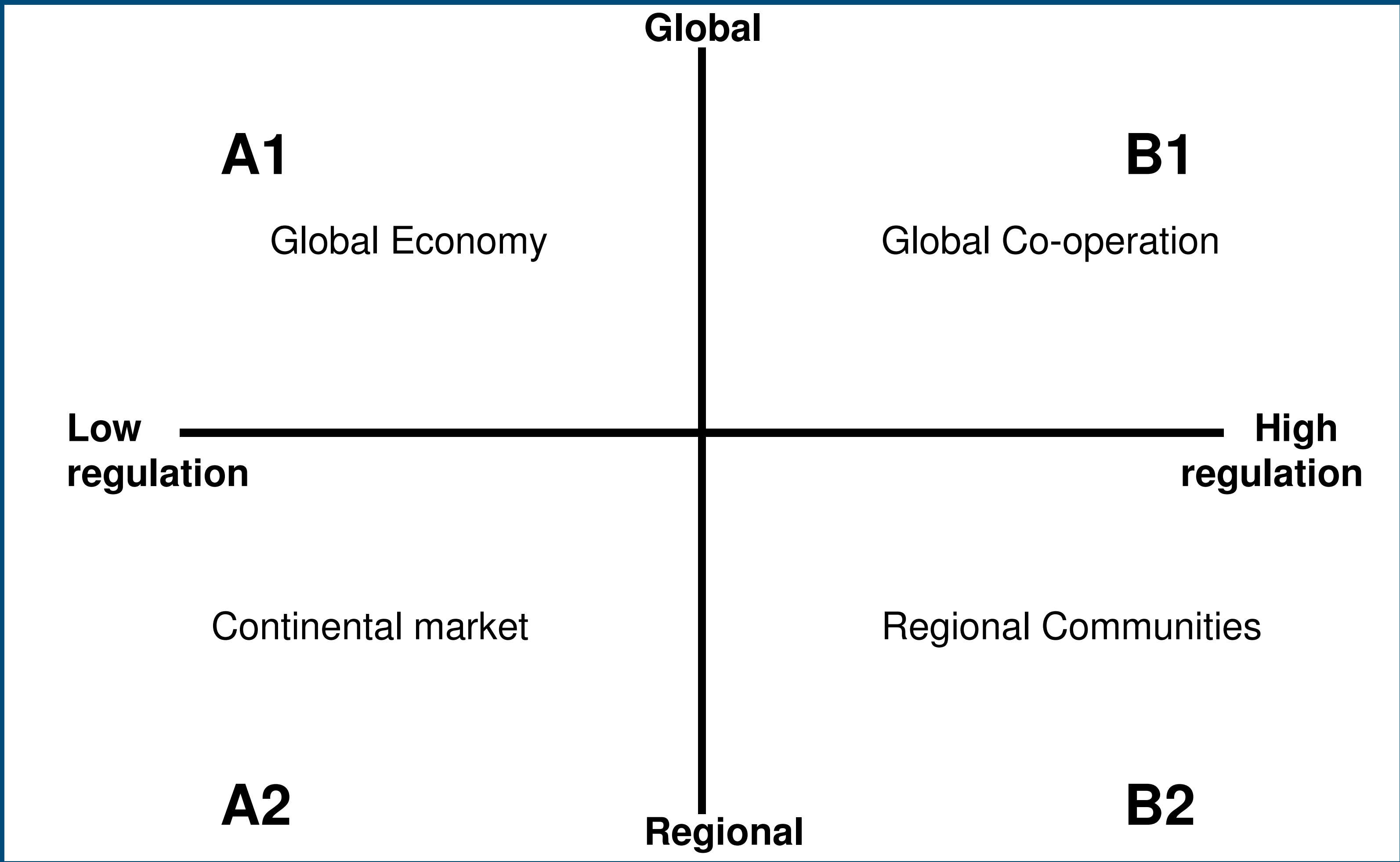
What role can/should new non-food crops play in (an uncertain) future?

- What is the demand for biomass from crops?
  - Volumes, quality
  - Sustainability
- What role can biomass crops play?
- What strategies are needed for successful introduction of (new) non-food crops in Europe?
  - What role can these crops play?
  - What should agriculture do?
  - What should what industry do?
  - What policies are needed?
  - What research is needed?

Outline

- How to look into the future?
  - → scenarios
- What is biomass for energy demand in 2020?
  - → NREAP
- What is biomass for chemical demand in 2020?
- How to fill in the biomass demand?
- What is the role of crops?
- What to do?

4 scenarios



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Eickhout, B. and A.G. Prins, 2008. Eururalis 2.0 Technical background and indicator documentation. Wageningen UR and Netherlands Environmental Assessment Agency (MNP) Bilthoven, The Netherlands

Biomass for energy and chemicals:

- Low regulation
  - This means Bioenergy / biofuels / biobased chemicals driven more by security of supply

- High regulation
  - This means bioenergy / biofuels / biobased chemicals driven more by sustainability demands = GHG mitigation

General assumptions under 4 scenarios

		Population	Solidarity	Economy	Technolgy	Globalization	Government regulation
A1	Global economy	↗	↘	↗	↗	↗	↘
B1	Global cooperation	↗	↗	↗	↗	↗	↗
A2	Continental markets	↘	↘	↗	↗	→	↘
B2	Regional Communities	↘	↗	↗	↗	↘	↗

Specific agri assumptions for 4 scenarios

	A1 GLOBAL ECONOMY	B1 GLOBAL CO-OPERATION	A2 CONTINENTAL MARKETS	B2 REGIONAL COMMUNITIES
CAP Expenditures, billion €	0	15	47	45
Export subsidies(2020)	no	No	yes	no
Self sufficiency	Lowest	Low	High	Highest
Organic agriculture	Lowest	Low	Low	Highest
Land available for non-food in 2020 (Million ha)	12.12	20.2	5.05	10.1
Land available for non-food in 2030 (Million ha)	14.76	24.6	6.15	12.3
Type of land released	low quality	Low quality	Average	Mainly low quality

Specific Bioenergy assumptions

	A1 GLOBAL ECONOMY	B1 GLOBAL CO-OPERATION	A2 CONTINENTAL MARKETS	B2 REGIONAL COMMUNITIES
Biomass price	low	high	high	Highest
CO_2 price	low	High	low	highest
Biomass efficiency	low	high	low	High
Biomass switch from E+H to transport and chemicals	Average	Fastest	Slow	Fast
Advanced biofuels introduced	Slow	Fastest	Slowest	Fast
Sustainability criteria	Not strict	strict and mainly focused on GHG	Not very strict	Very strict and broad
ILUC	Not relevant	Most relevant	Not relevant	Relevant
"Inertia of infrastructure"	high	low	high	Lowest
Biomass CHP	Low	High	Low	High
Biorefinery implementation	Large scale / price driven	High / larges scales	Low only traditional;	High/ also smaller scales

What is the Biomass demand for Energy and Chemicals?

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NREAP biomass demand in 2020 is basis

2020	EU-country	Primary Biomass Mtoe	Final energy consumption Mtoe	Biofuel all ktoe	total Biomass power ktoe	total biomass heat ktoe
NREAP	**Austria**	**5.46**	**4.63**	584	443	3607
PRIMES	**Belgium**	**6.95**	**2.90**	874	2021	
NREAP	**Bulgaria**	**1.48**	**1.35**	200	75	1073
NREAP	**Cyprus**	**0.10**	**0.08**	38	12	30
PRIMES	**Czech Republic**	**3.05**	**1.30**	597	705	
NREAP	**Denmark**	**5.64**	**3.67**	261	761	2643
PRIMES	**Estonia**	**0.81**	**0.32**	46	271	
NREAP	**Finland**	**9.95**	**8.28**	560	1110	6610
NREAP	**France**	**25.53**	**21.59**	3660	1476	16455
NREAP	**Germany**	**28.62**	**21.08**	5473	4253	11355
NREAP	**Greece**	**2.16**	**1.95**	617	108	1222
PRIMES	**Hungary**	**4.56**	**1.87**	386	1486	
NREAP	**Ireland**	**1.25**	**1.06**	482	87	486
NREAP	**Italy**	**13.70**	**9.82**	2530	1615	5670
PRIMES	**Latvia**	**1.32**	**0.48**	82	393	
NREAP	**Lithuania**	**1.53**	**1.30**	167	105	1023
NREAP	**Luxembourg**	**0.39**	**0.33**	216	29	83
NREAP	**Malta**	**0.04**	**0.01**		12	2
NREAP	**Netherlands**	**7.03**	**3.79**	834	1431	1520
PRIMES	**Poland**	**15.16**	**5.35**	1399	3952	
NREAP	**Portugal**	**3.58**	**3.10**	477	302	2322
PRIMES	**Romania**	**3.00**	**0.93**	248	677	
PRIMES	**Slovakia**	**2.56**	**0.99**	216	776	
NREAP	**Slovenia**	**0.88**	**0.78**	191	58	526
NREAP	**Spain**	**11.36**	**9.32**	3504	861	4950
NREAP	**Sweden**	**14.45**	**11.67**	810	1435	9426
NREAP	**United Kingdom**	**15.01**	**10.37**	4205	2249	3914
	total EU 27:		**173**	**28657**	**26703**	**117345**

Biomass requirements are estimated based in NREAP report and conversion efficiency estimates

Biomass use for power and heat is uncertain!

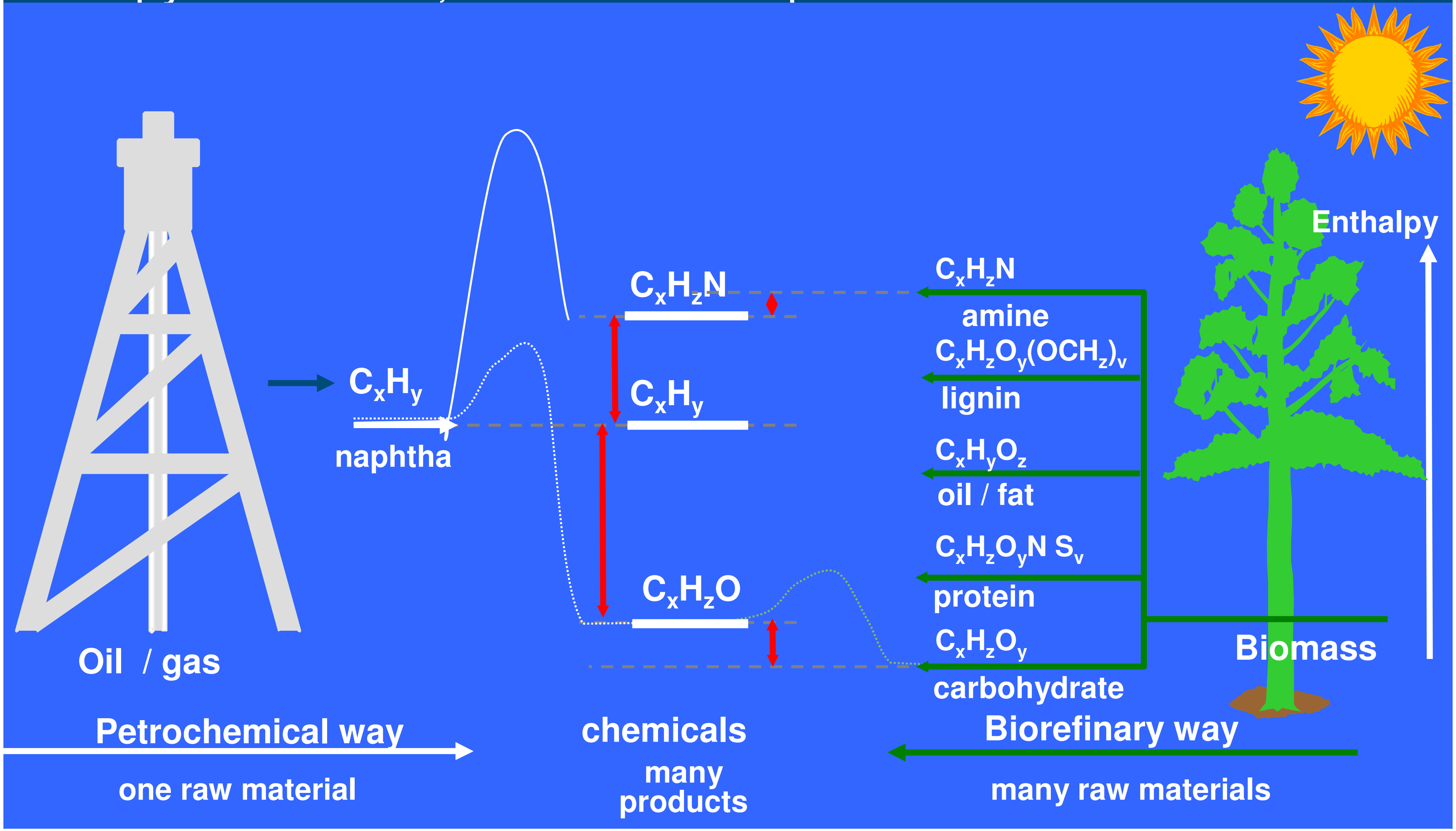
Biomass demand (Mton DM) in 2020 based on NREAP, PRIMES

		Total	Byproducts and waste	EU crops	Imports
Ethanol	Carbohydrates 1e generation	**17.73**	1.77	10.46	5.50
	Sugars from lignocellulse 2e gen	**1.55**	0.85	0.39	0.31
	oils and fats	**29.49**	1.47	19.17	8.85
Biogas	Biogas substrate: manure, crop, by-products	**125.94**	*88.16*	*36.52*	*1.26*
Lignocellulose	Solids for thermal conv: chips + pellets mainly	**469.76**	*258.37*	*117.44*	*93.95*
	Black liquor	**11.26**	*11.26*	*0.00*	*0.00*
	Total biomass demand	**655.74**	**361.89**	**183.98**	**109.87**

NB. Biomass demand for chemicals is not included

Biomass demand for Chemicals in the EU?

Functionalised chemicals can be made from Biomass without major enthalpy differences, but not from naphtha



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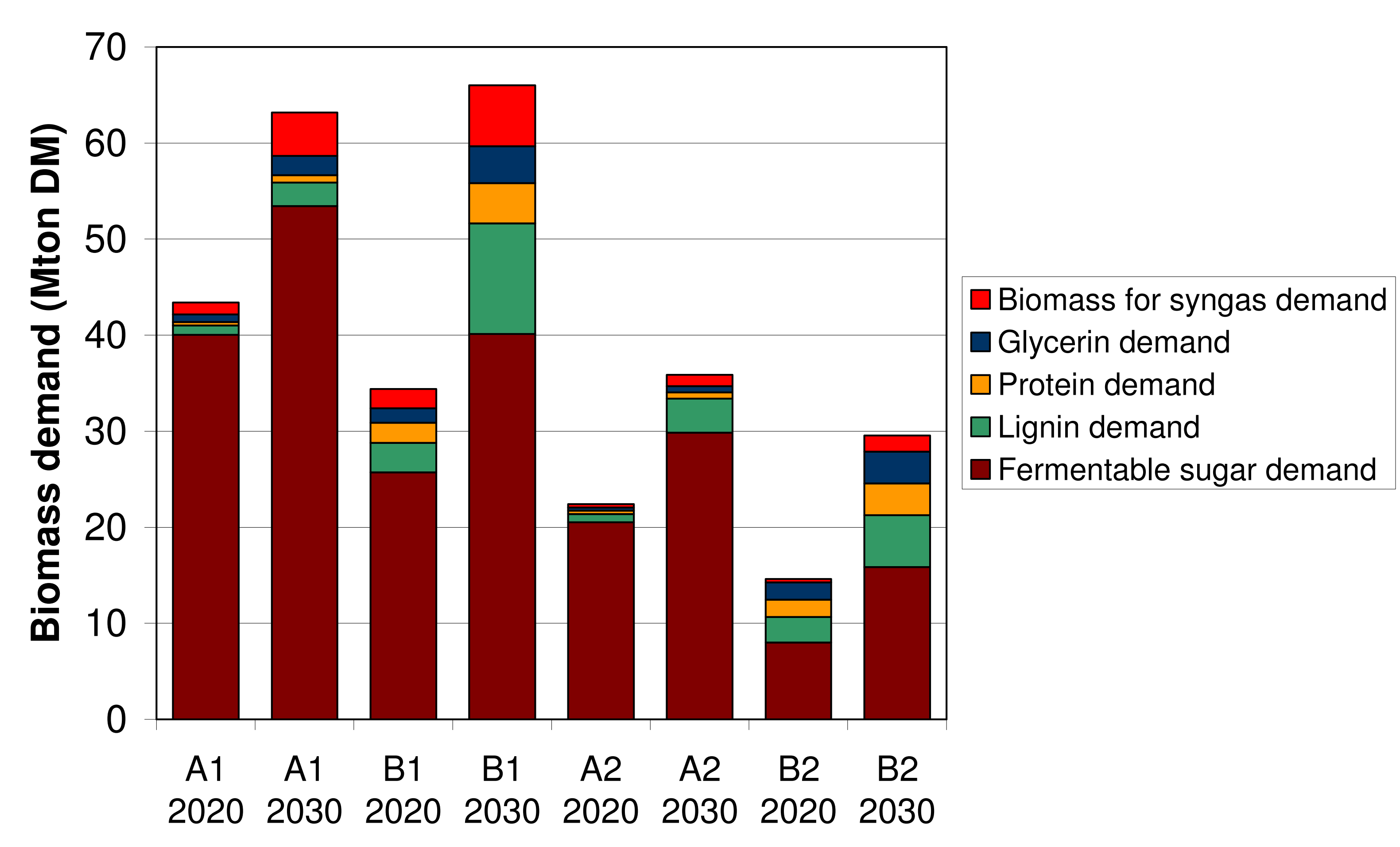
Scenarios affect demand from chem. ind.

- Chemical industry is adapted to biomass + sust requirements
  - Focus on functionalized molecules (polyesters, furanics)
- Without sust. requirements chemical industry will make unfunctionalized base chemicals (C2, C3): fitting current infrastructure
  - Chemical industry will demand biomass that fits the existing infrastructure → ethanol converted to ethylene replaces naphtha, syngas from biomass
- Chemical industry will follow energy: use glycerin from biodiesel industry, FT chemicals from BTL industry,

Biomass for EU chemicals under 4 scenarios



Example:

Biomass demand for E & C (Mton DM) - Scenario A1 in 2020

	Total energy	Total Chemicals	Total E+C	Byproducts and waste	EU crops	Imports
Carbohydrates 1e generation	14.93	35.88	50.81	4.06	23.12	23.63
Sugars from lignocellulse 2e gen.	1.73	4.15	5.88	2.59	1.53	1.76
oils and fats	23.61		23.61	0.94	12.04	10.62
Glycerin for chemicals		0.80	0.80	0.03	0.41	0.36
Proteins for chemicals		0.36	0.36	0.01	0.18	0.16
Biogas substrate: manure, crop, by-products	106.47		106.47	59.62	45.25	1.60
Solids for thermal conv: chips + pellets mainly	398.37	1.23	399.60	175.82	103.90	119.88
Black liquor = lignin	9.48	0.96	10.44	10.44	0.00	0.00
Total biomass demand	554.58	43.38	597.96	253.53	186.42	158.01

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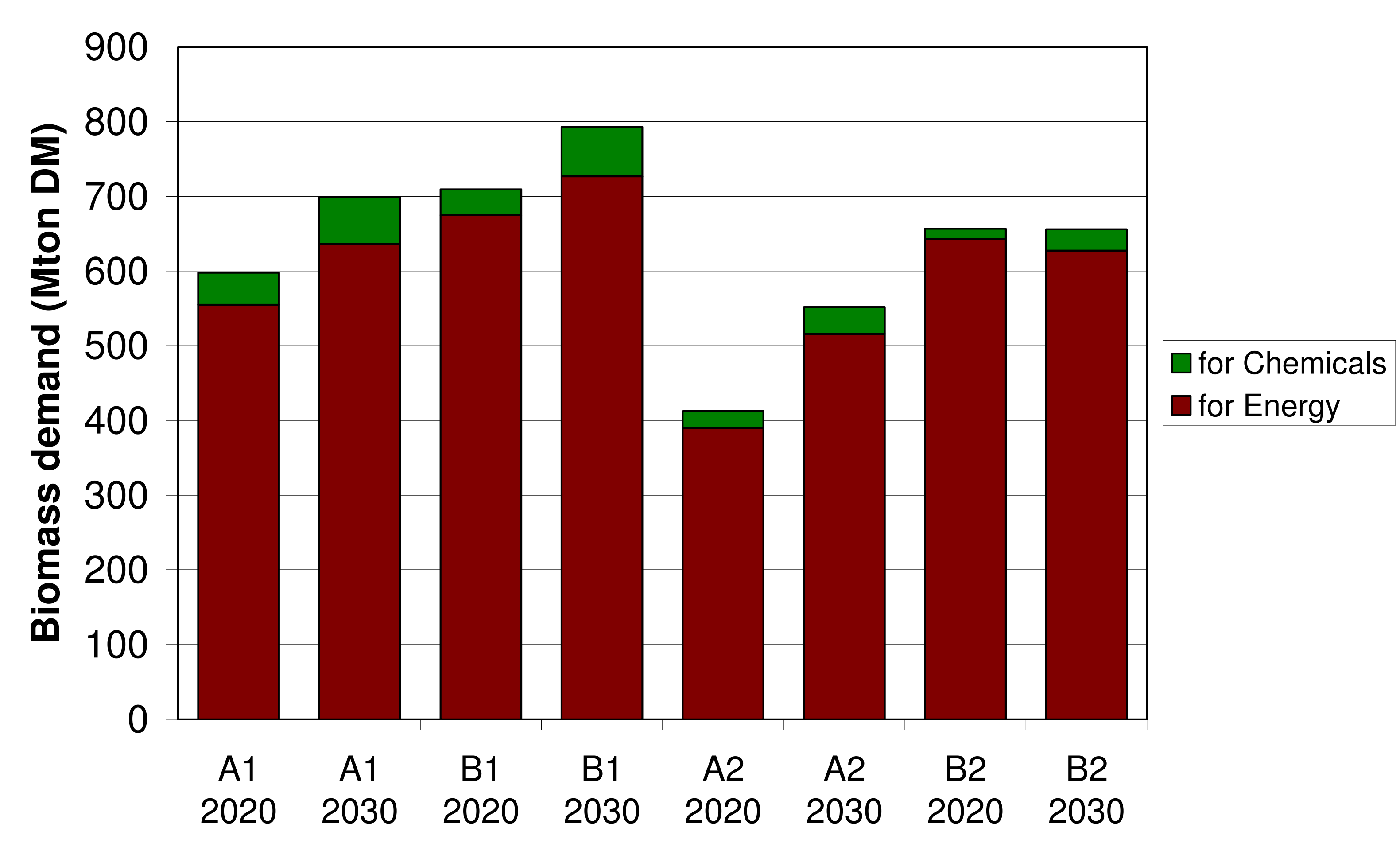
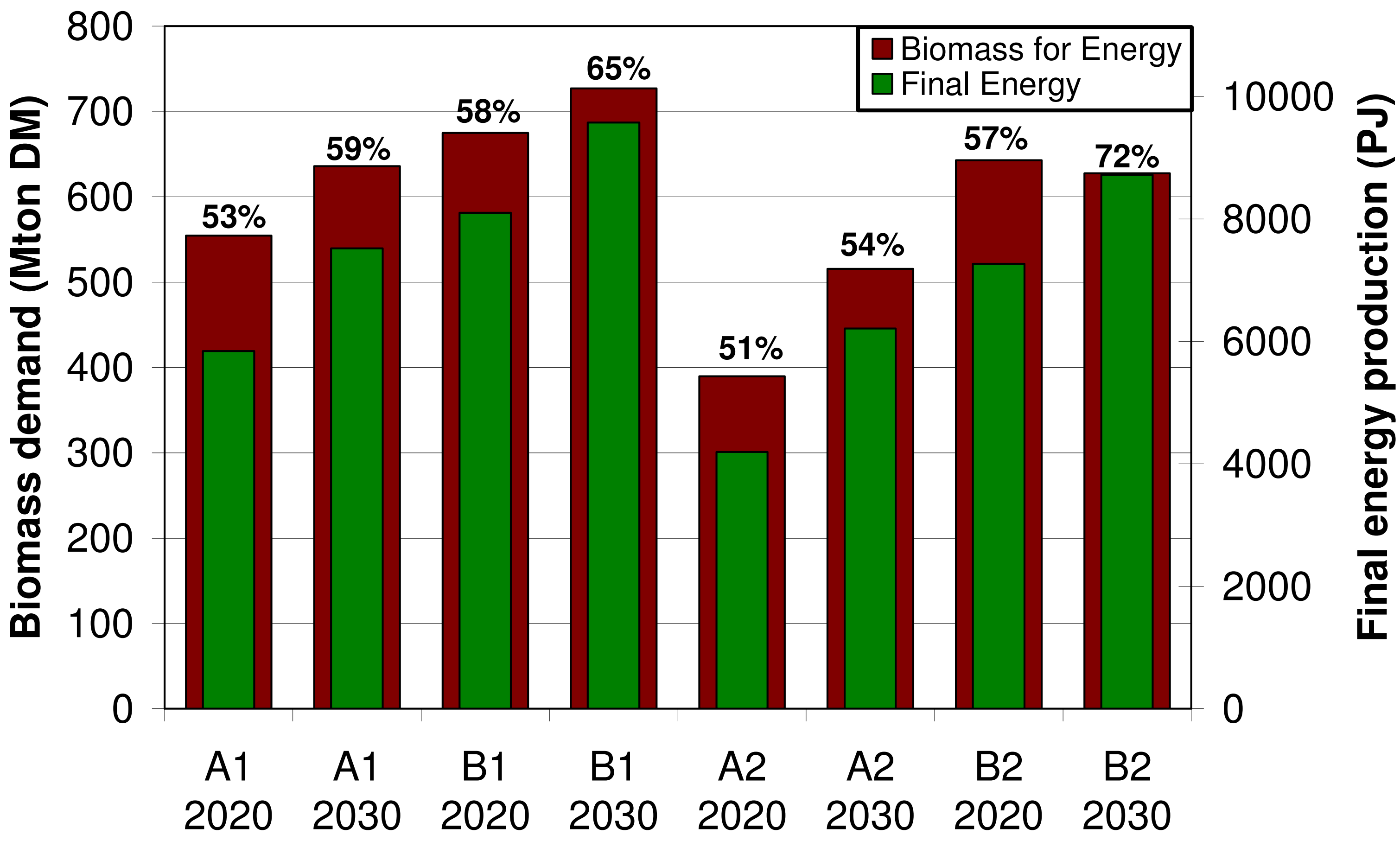
Biomass demand for Energy and Chemicals



Biomass demand for E versus Final energy production



% Efficiencies refer to HHV efficiencies for Power and Heat conversion only

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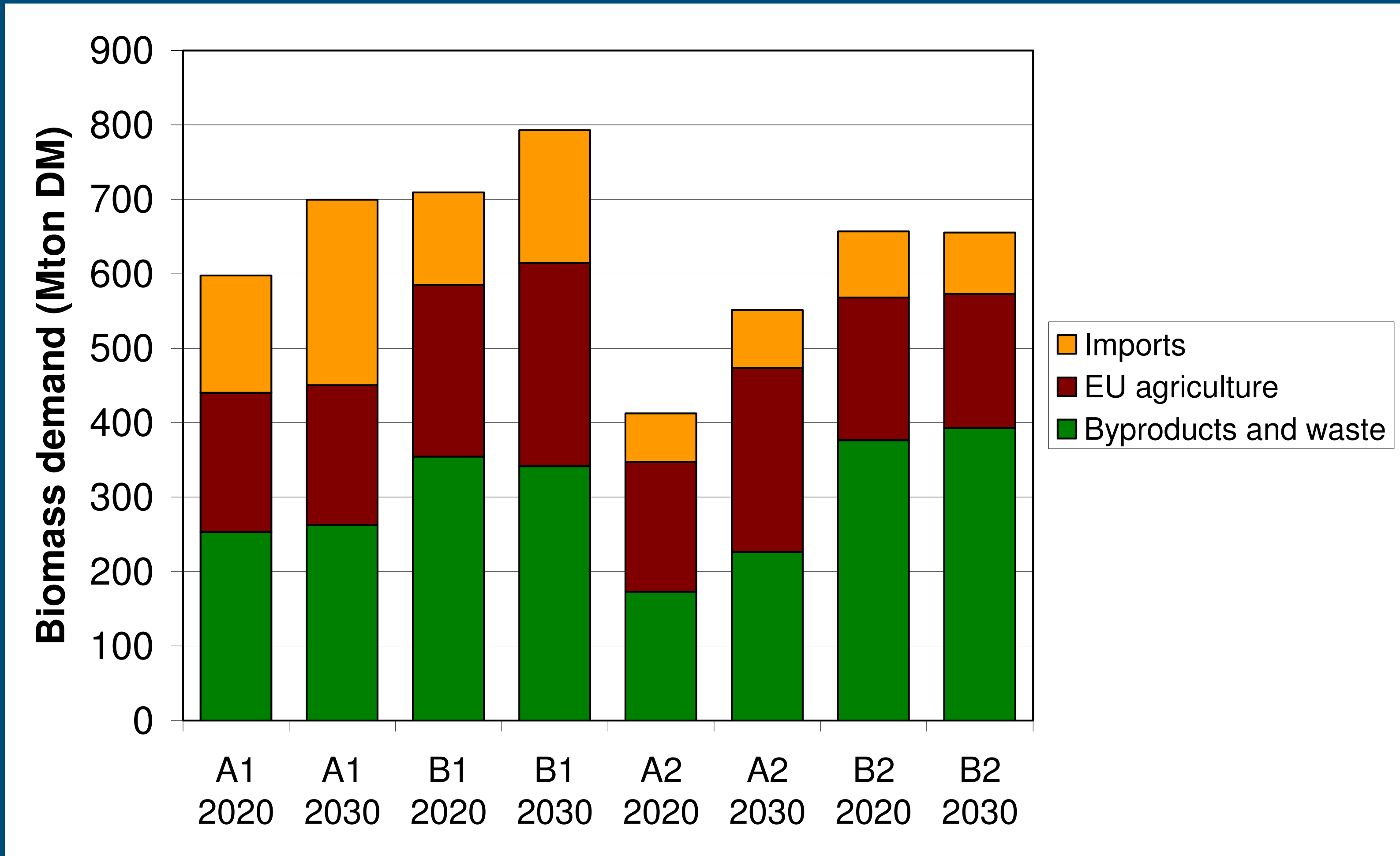
Sourcing of the total biomass demand



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(conventional) biomass availability

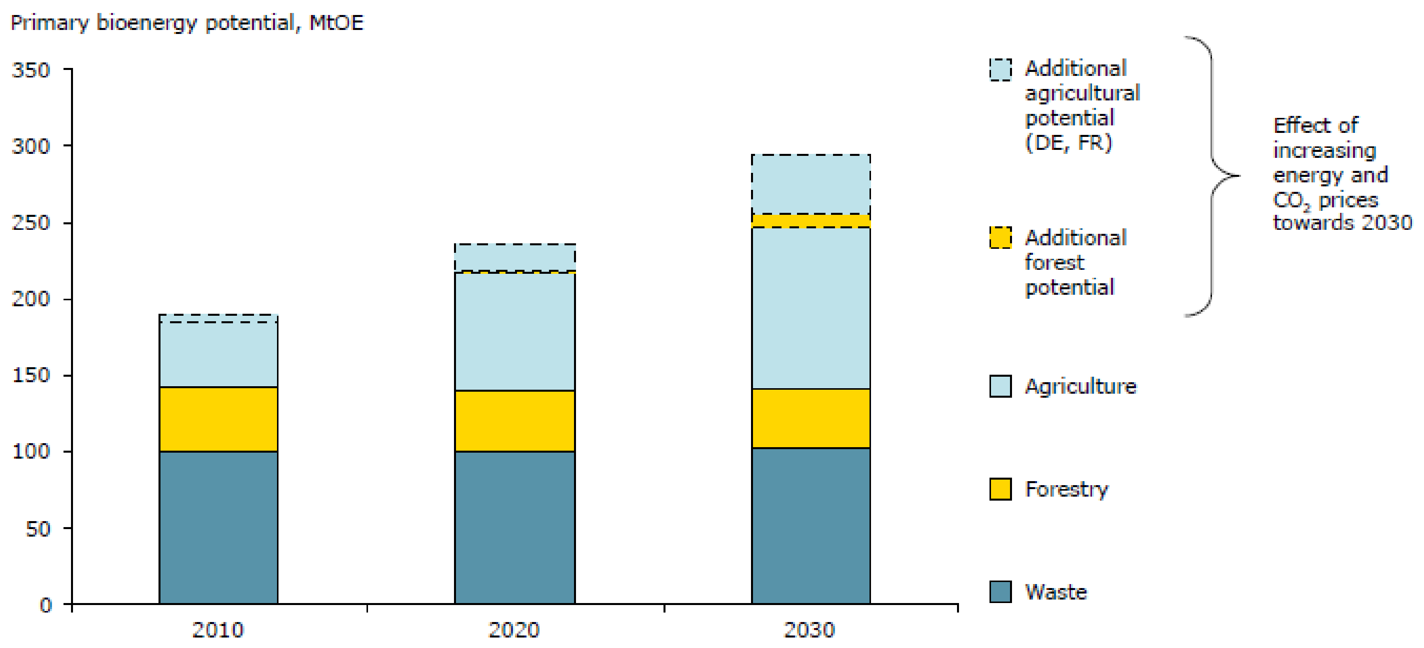
	2020	2030	
By-products and Waste	370	370	EEA, 2006
Non-food crops	184 to 230	250 - 390	EEA, 2006 ; Ganko and Kopczynski, 2010
Total:	554 - 600	620 - 760	

2020: 20. 2 million ha @ 10 ton/ha est. = 202 Mton DM

2030: 24,6 million ha @12 ton/ha est. = 295 Mton DM

Unconventional options

not included



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How to fulfill the demand for non-food biomass?

- Factsheet per crop type
- SWOT per crop type
- Role of crop type in de different scenarios
- Priorities and suggested actions per crop type

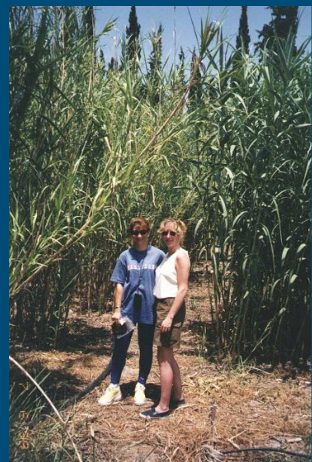
Selected crop types

- Perennial Biomass crops (wood and herbaceous)
- Oil Crops (i.e. oil/protein crops)
- Sugar Crops

- (Fibre crops)
- (Biobased chemicals crops)

Perennial herbaceous crops

- Reed canary grass
- Miscanthus
- Switchgrass
- Giant Reed
- Cardoon

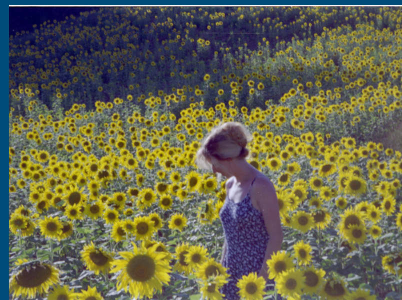


SWOT: Perennial herbaceous crops

STRENGTH	**WEAKNESS**
Low inputs Cheap biomass (value?) Low nutrient use High nutrient efficiency	Does not fit in rotation system Low nutrient demand No high value by-products Low price of product Low labor need per ha Yield level not necessarily higher than arable crops Biomass quality lower that wood
OPPORTUNITY	**THREAT**
High productivity on low quality soils Low risk of erosion High nutrient efficiency Higher biodiversity than arable crops Good crops for (lignocellulosic based) carbohydrates (fuels + chemicals) Soil C improvement	No fitting policies Not native (Miscanthus, switchgrass) Knowledge limited (in EU) Second generation fuels delayed Low impact is not (yet) appreciated By-products and imports are cheap

Oil seed crops

- Oilseed rape
- Sunflower
- Ethiopian mustard

SWOT: Oil seed crops

STRENGTH	WEAKNESS
■ There is a ready market for oil crops ■ Protein co-product is valuable, lowers impact ■ Crops fit in rotation system ■ Quality of rape is excellent for (N) Europe ■ Europe has strong knowledge basis in oil crops (rape)	■ GHG efficiency is limited ■ Cost of production is high (compared to imports) ■ Oil is subsidizing protein
OPPORTUNITY	**THREAT**
■ Imported oil seeds (soy) and oils (palm) appear to have larger ILUC problem ■ Significant yield increased seem possible ■ More value in specialty proteins possible ■ Proteins for chemicals are an opportunity ■ Glycerin is feedstock for chemical industry ■ Oil industry has diesel shortage and prefers biodiesel to bioethanol ■ As a food/fuel crop less impact and risk	■ Open markets may make production unprofitable ■ Hydrogenated biodiesel will make the use of cheaper imported oils possible ■ ILUC is high influencing GHG balances negatively → hard to fix ■ Second generation (FT) diesel ■ GTL (FT) diesel is cheaper and has ■ GTL may bring BTL closer sooner

Sugar crops

- Sugar beet
- Sweet sorghum

SWOT: Sugar crops

STRENGTH	WEAKNESS
▪ Crops are very productive ▪ Strong knowledge base (sugar beet) ▪ Sugar beet and Sweet sorghum have good water use efficiency and salt / heat tolerance ▪ High yields may compensate ILUC	▪ Cost is high compared to imports (Brazil) ▪ ILUC is hard to avoid ▪ Short harvest campaign makes processing expensive
OPPORTUNITY	**THREAT**
▪ Co-products are an option (proteins?) ▪ Open markets will lower sugar price such that chemical industry will be stimulated to use sugars ▪ Potential as a feedstock for fermentation industry and feedstock for chemical industry is huge! ▪ Not just ethanol! ▪ As a food/fuel crop less impact and risk	▪ Open markets will reduce markets for sugar crops ▪ Second generation has better impact especially if ILUC is also considered ▪ Starch is also an alternative for most applications (energy and chemicals)

Role of crops in Scenarios

A1 GLOBAL ECONOMY **Lignocellulosic perennials:** Limited potential on lower quality/released land. **Oil crops:** Only is they can compete with imports **Sugar Crops:** Large market though competition from imports is a challenge	**B1 GLOBAL CO-OPERATION** **Lignocellulosic perennials:** Good potential on lower quality/released land – 15 year cycle is possible – designated areas **Oil crops:** Have to be competitive and sustainable - 2e generation is an alternative **Sugar Crops:** Efficient sugar crops will be able to compete with sustainable imports
A2 CONTINENTAL MARKETS **Lignocellulosic perennials:** Limited potential – 15 year cycle is problematic – no designated areas **Oil crops:** EU oil crops fit well in the agri system and fuel industry - oil crops will stay competitive longer against 2nd generation **Sugar Crops:** Total market is smaller but more profitable	**B2 REGIONAL COMMUNITIES** **Lignocellulosic perennials:** Good potential on lower quality/released land. Competition from ecological agrculture **Oil crops:** Fit well in local small scale production systems – protein is valuable **Sugar Crops:** Have a role to play in smaller scale bio-refineries

Research and development:

Perennial Herbaceous Crops:

- Focus on yields, low quality soils, low impacts

Oil Crops:

- Increase yield – increase value through processing –

Sugar crops:

- Yields! Develop more efficient processing – look at other pathways → ABE, Chemicals

Policies

Perennial Herbaceous Crops:

- "Laissez faire" will not do – If you like low impact these crops deliver you need to introduce policies to assign "logical niche" > 15 years.

Oil Crops:

- Integrate oil and protein vision – provide a level playing for energy and chemicals

Sugar crops:

- Level playing field fuels and chemicals → how to make use of synergy between fuels and chemicals instead of competition?

Observations

- Chemical industry demand is not on the radar yet
  - Sugar market for chemicals may be huge soon
- ILUC is hanging over the market:
  - Be efficient with land = be efficient with biomass!

End

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