Crops2Industry

Niche markets for specialised crops

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Bio-refinery multi-product opportunities for industrial crops as feedstocks

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A petroleum refinery produces multi-products from each barrel of oil:

A bio-refinery processes biomass feedstocks into food, feed, chemicals, fibre-based materials, heat, power and biofuels – in various product combinations.

Industrial crops as feedstocks can lead to optimising biomass value chains aiming at selected market products.

Choose crop for market or market for crop?

Commercial crops
Speciality industry crops

Traditional markets
Niche product markets

New Bio-refinery processes

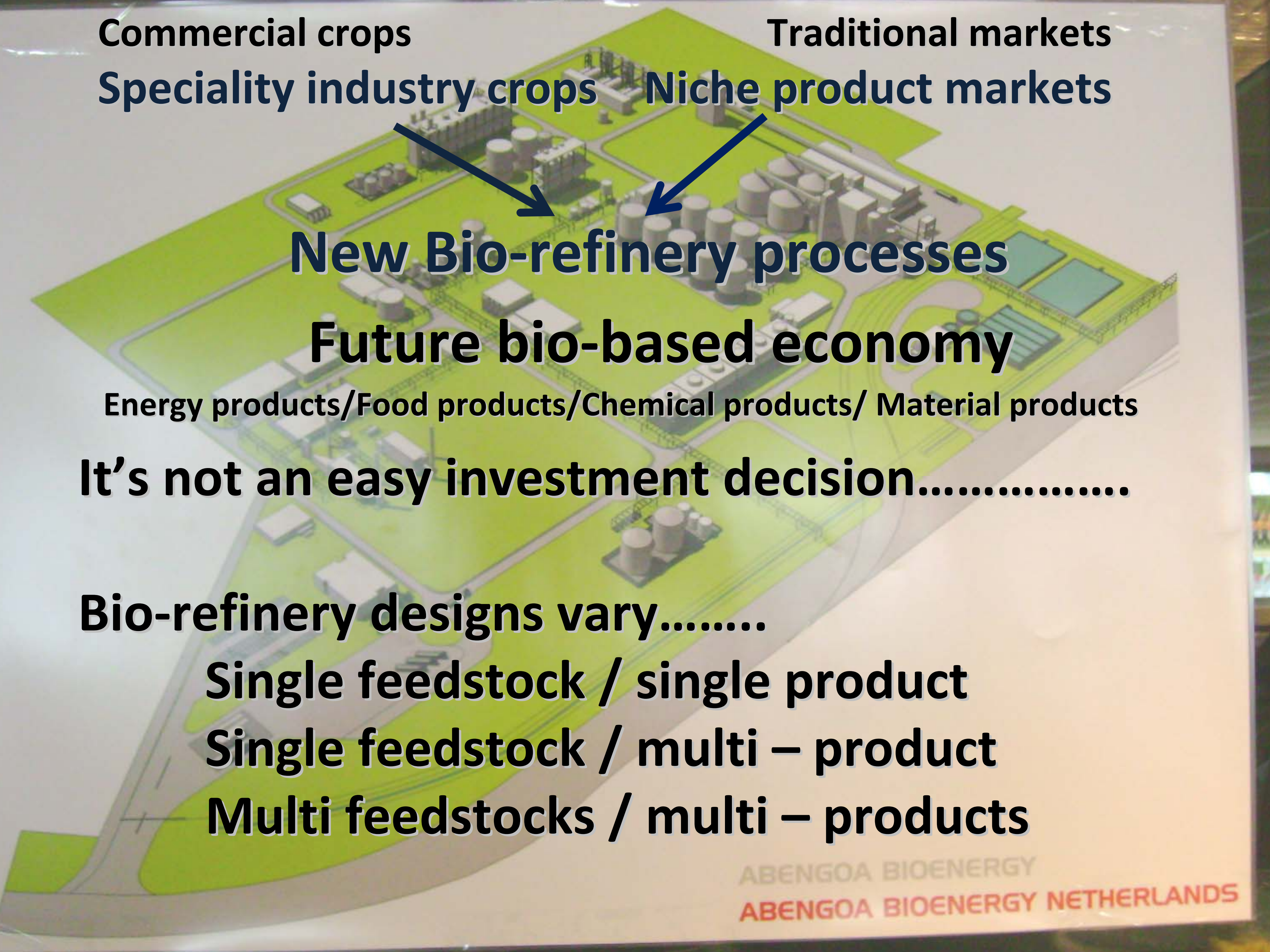
Future bio-based economy

Energy products/Food products/Chemical products/ Material products

It's not an easy investment decision…………….

Bio-refinery designs vary……..

- **Single feedstock / single product**
- **Single feedstock / multi – product**
- **Multi feedstocks / multi – products**



Developing a biorefinery.

The Rocky Point sugar mill cogeneration and ethanol plant in Australia took 2 years of planning and needed 17 contracts and building consents before construction could begin!

All year round supply

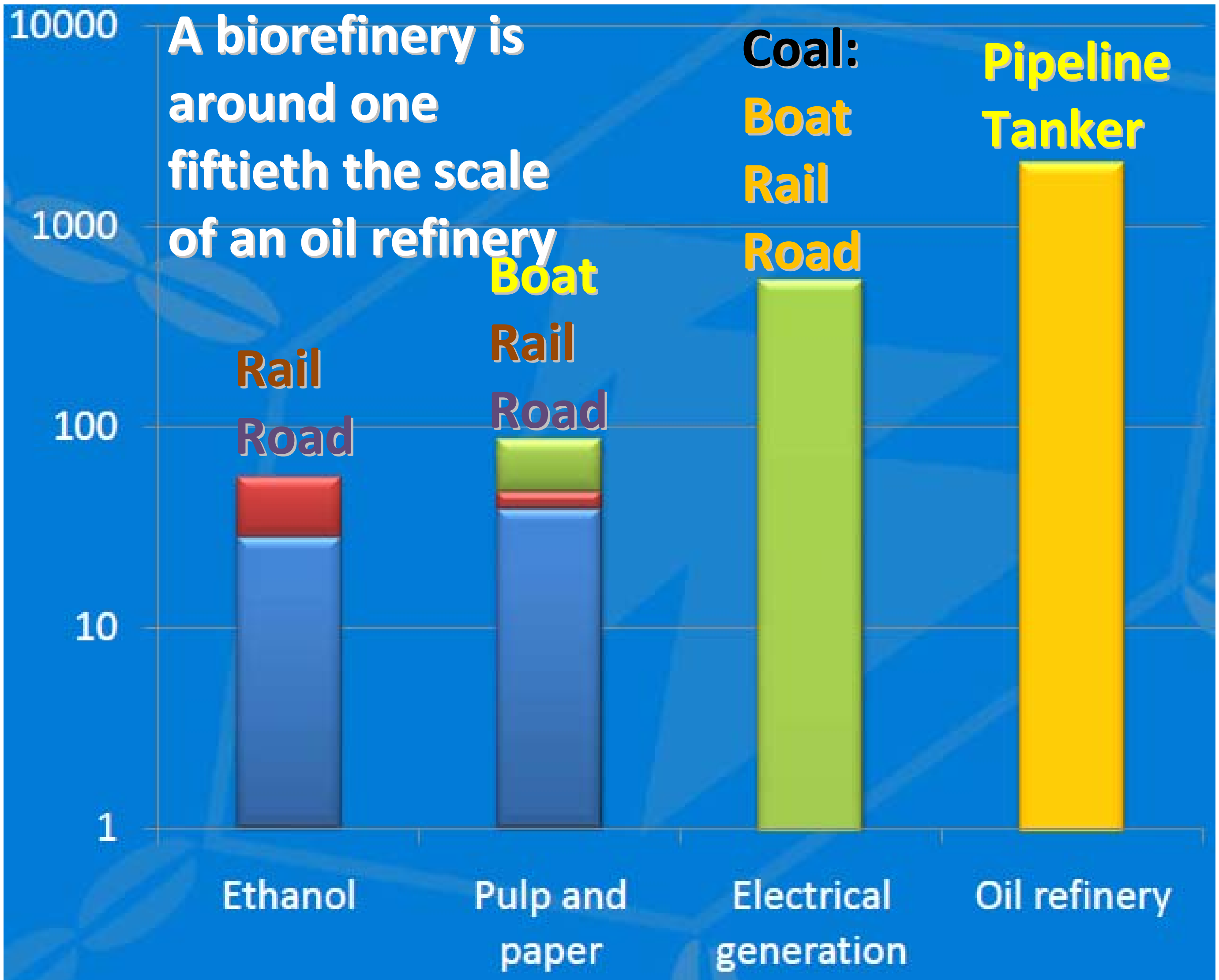
The challenge for bio-refineries is to provide sufficient feedstock all year round so as to spread capital investment costs over greater volumes of products.

- Forest residues often available all year round
- Crop residues are seasonal
- Specialist industry crops are seasonal
- So need storage that adds to delivered costs.

Feedstock delivery modes vary for typical largest plant for each facility

Feedstock energy content

PJ/year



Review

Direct and indirect land-use competition issues for energy crops and their sustainable production – an overview

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Multi –products and co-benefits can give an economic solution to bridging the cost gap

Example: Planting strips of eucalyptus trees in cereal crops in Australia

– a Win / Win land use project

Saline soil remediation

Increased cereal yields

Biomass available for bio-refinery feedstocks – presently for heat and power via gasification

Electricity feed-in-tariff premiums and carbon credits.

Commercial Biorefineries

Bulk polymers: Polylactide (PLA), 3-hydroxypropionic acid, 1,3-propanediol, etc.		BIOLOGICAL	NatureWorks, DuPont, Cargill
Nutraceuticals: xylitol, arabitol, etc.			Codexis
Platform chemicals: Glycerol, furfural, levulinic acid, succinic acid, etc.			DuPont
Biofuels: ethanol, bio-hydrogen, etc.	THERMOCHEMICAL		Iogen, Abengoa
Biofuels: bio-oil, methanol, ethanol, Fischer-Tropsch, BTL, etc.			Choren
Bioenergy: electricity, steam, combined heat & power (cogen), district heating, wood pellets, etc.			Combined Heat&Power Scandinavia

Choren, Germany

3-stage gasification process

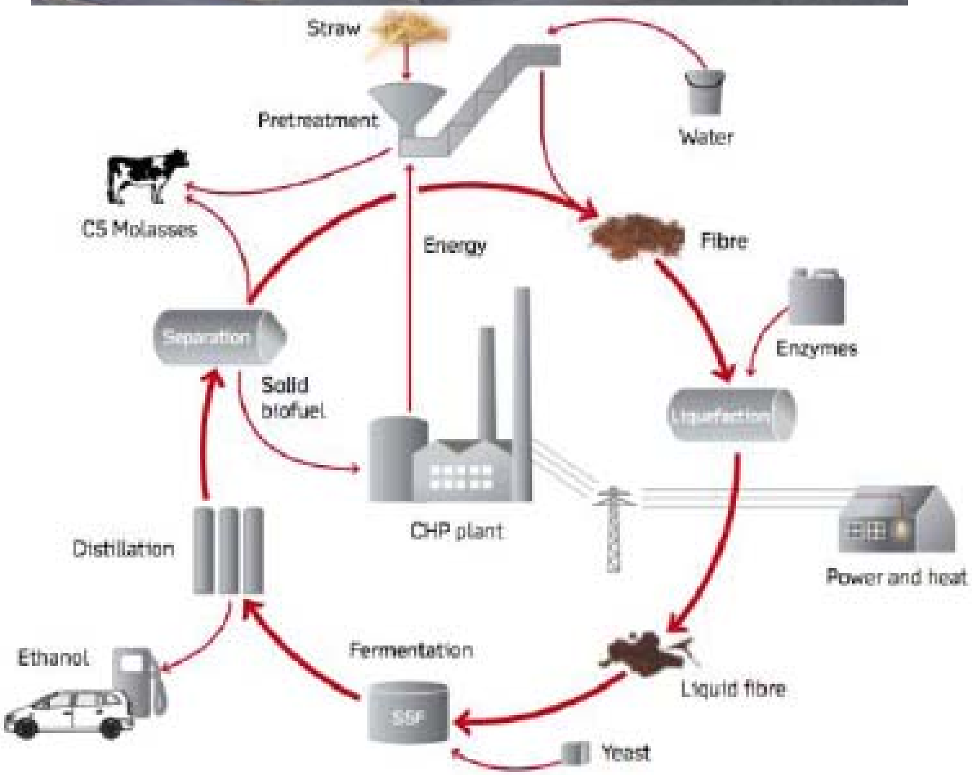
68,000 t /yr plant

50% crop residues / 50% wood chips

45 $MW_{electric}$

16.5 M l /yr synthetic diesel

Ibicon and Dong, Denmark



30,000 t/yr cereal straw

Enzyme hydrolysis and fermentation

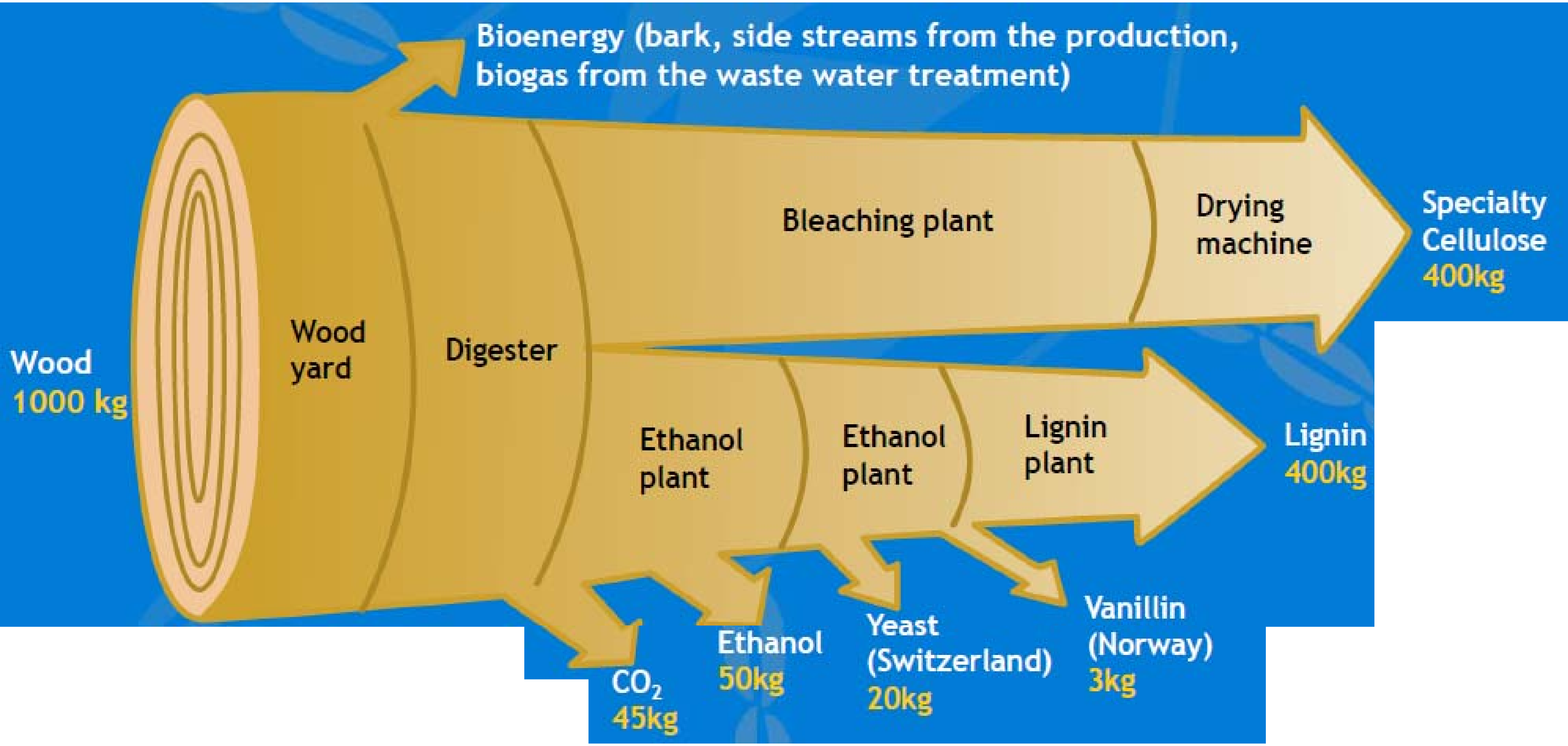
5.4 Ml /yr ethanol

8 000 t/yr solid residues for CHP

11 000 t/yr molasses animal feed

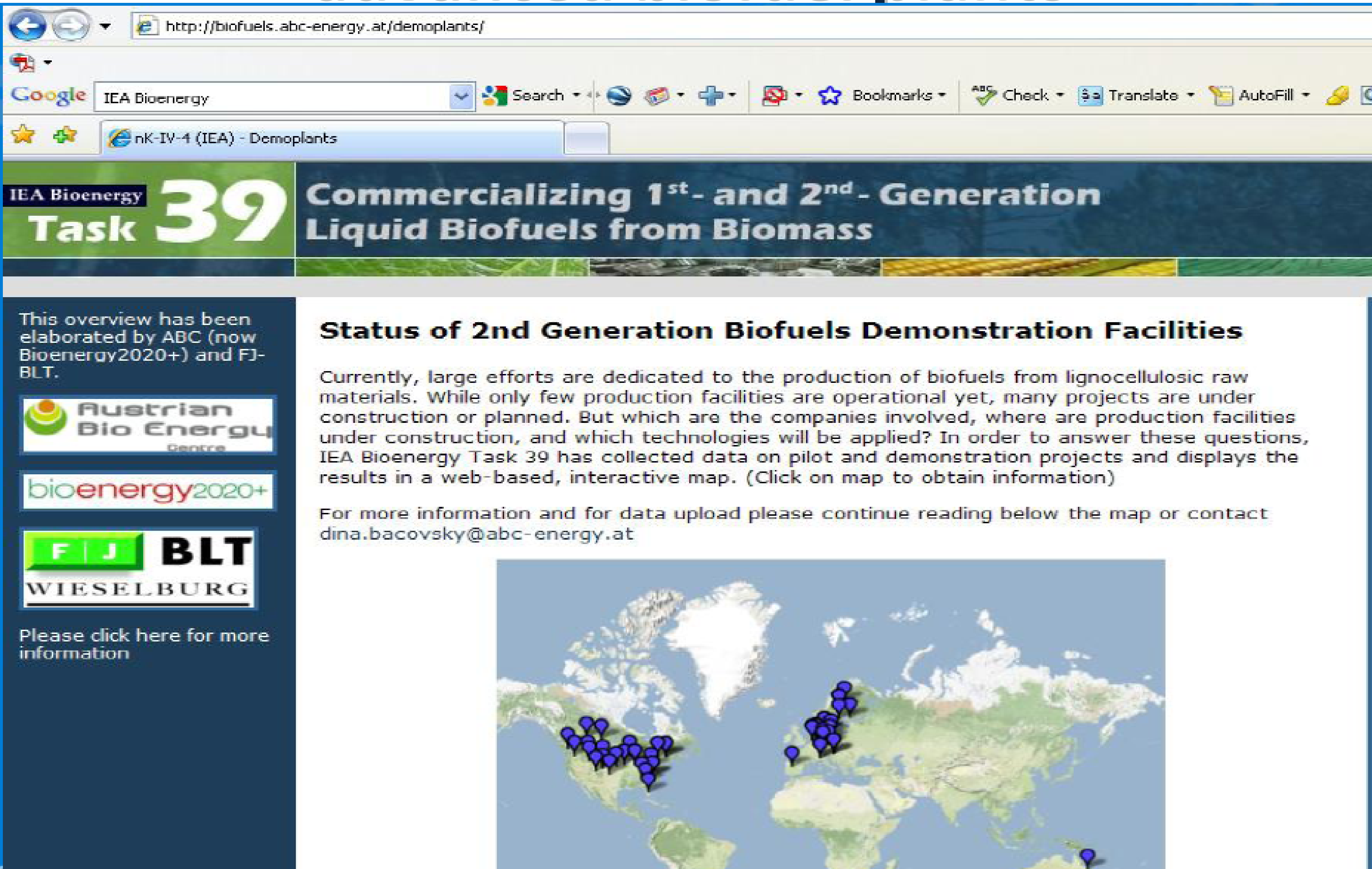
Borregaard, Norway and Switzerland

Softwood feedstock (spruce) to multi-products for 30 years



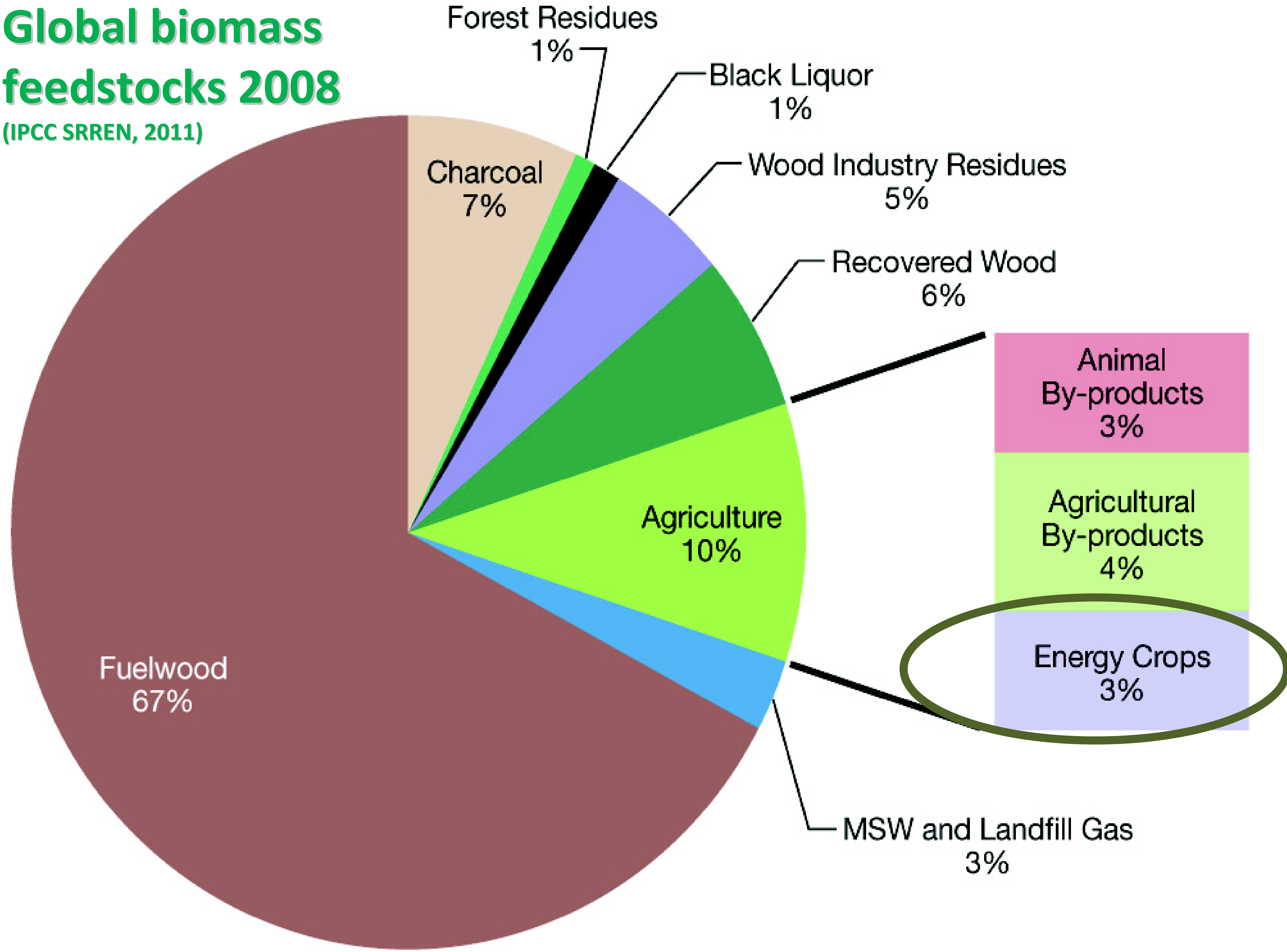
Global dominance of some niche, low volume / high value products.
N.B. Biorefinery product mix changes over time as markets fluctuate.

IEA Bioenergy for updates of advanced biofuel plants



Global biomass feedstocks 2008

(IPCC SRREN, 2011)



UNEP draft report "*ASSESSING GLOBAL LAND USE AND SOIL MANAGEMENT FOR SUSTAINABLE RESOURCE POLICIES*" due for publication mid 2012

The chemical industry uses around 5% of petroleum products for feedstocks.
In EU, the economic value of the sector is equal to the food sector value.
This makes the use of biomass as a feedstock source both likely and lucrative.

In the USA an 8% share of feedstock in the chemical industry comes from biomass.
Currently 8% to 10% of feedstocks used in the E U for organic chemical production are bio-based.

Current markets for bio-products

Traditional products (paper, pulp, detergents, and lubricants);
Modern biomaterials (pharmaceuticals, industrial oils, biopolymers and fibres); and
Innovative products (wood-plastic-composites, bio-based plastics, etc.)

Globally bio-plastics are 1.4% share of total plastic production.
The EU market doubled in size between 2005 and 2008 to reach 0.4% of total plastic production.

This could rise to 1.1% by 2020.

The chemical industry is the third largest user of non-food biomass (after wood-based industries) .

2.27 Mha cropland were cultivated for material use in Europe in 2005 (compared to 2.8 Mha for biofuels).

Excluding wood, the EU chemical industry uses 70% of the total biomass produced for materials.

About 64% of the biomass used for material purposes in Germany is currently imported.

The production and material use within Germany may reach 11% of the country’s global cropland requirements in 2030.

Biomaterials and biochemicals are generally thought to be more ‘environmentally friendly’ than for example transport biofuels,
but little work has been done.

Land deals and acquisitions

World Bank analysis of 464 projects between October 2008 and August 2009-

203 of the projects included area information - totalling 56.6 Mha;

The median project size was 40,000 ha; 37% focused on food crops,

21% on biofuels, and

21% on industrial cash crops.

Concerns of land grabbing remain.

A Vision for Biorefineries

- But first- recall the world in 2000:
  - Food / fibre commodities cheap.
  - Low oil and gas prices.
  - Kyoto Protocol not ratified.
  - No carbon trading in place.
  - US had not invaded Iraq etc.
  - Greece was wealthy………………..!!
  - Bankers were the good guys……!!
  - No Wifi, MP3, Ipods, SMS, GPS.
  - Liquid biofuels were “good”.
  - Few electric, hybrid or flex-vehicles.
  - Little, if any, trade in biomass.

A Vision for Biorefineries

- The world in 2020 ???? Who knows?
  - Oil / gas reserves low =higher prices?
  - Climate change clearly evident?
  - Carbon traded throughout OECD?
  - IT and communication advances?
  - New world order?
  - Smart grids growing?
  - Investors very risk averse?
  - Credit availability scarce?
  - Drought tolerant GM crops grown?
  - Biotechnology/bioenergy advances?
  - Industrial crops grown widely

Key messages from IPCC SRREN Bioenergy chapter

Drivers for bioenergy systems include rapidly changing policies, recent market based activities and increasing support for advanced biorefinery and ligno-cellulosic biofuel options.

The sustainability of bioenergy, in particular in terms of life cycle GHG emissions, is influenced by land and biomass resource management practices.

It is not the availability of the biomass resource, but the public policies that will either expand or constrain bioenergy development over the coming decades.

Opportunities

UN FAO project:

The Relativity of Food and Energy

***E*nergy = *m*eals * *c*limate *c*hange**

The agri-food chain depends on energy.

World needs 75% more food by 2050.

But we waste one third of food produced.

Avoid waste means more land available.

Then can have integration of food and industrial crops with bio-refinery processing.

So what future for Bio-refineries and Industrial Crop feedstocks?

Have to look at the whole system – not just growing crops.

- The biorefinery process
- Treatment of wastes and environmental impacts
- Reliable and sustainable feedstock supply
- Markets for the main products
- Uses for the by-products
- "Best mix of products" measured in $s or carbon value or jobs or soil condition or what?
- Product certification and labelling
- Co-benefits – soil fertility, water use efficiency, employment, rural development
- Government incentives to encourage high up-front capital investments
- Regulations and safety issues.
- End-of-life of products – life cycle analysis

Moving towards a Bio-based economy is imperative

However….

we are running out of time so need answers quickly


fuelled with LOW CO_2
CELLULOSE
ETHANOL
IOGEN
CORPORATION