Biokraftstoffe – Machen BtL-Kraftstoffe das Rennen?

Produktionskosten und Investitionsmöglichkeiten

BIO-raffiniert IV "Öl-Wechsel - Wie managen wir die Rohstoffe der Zukunft"

Oberhausen, 23. November 2007

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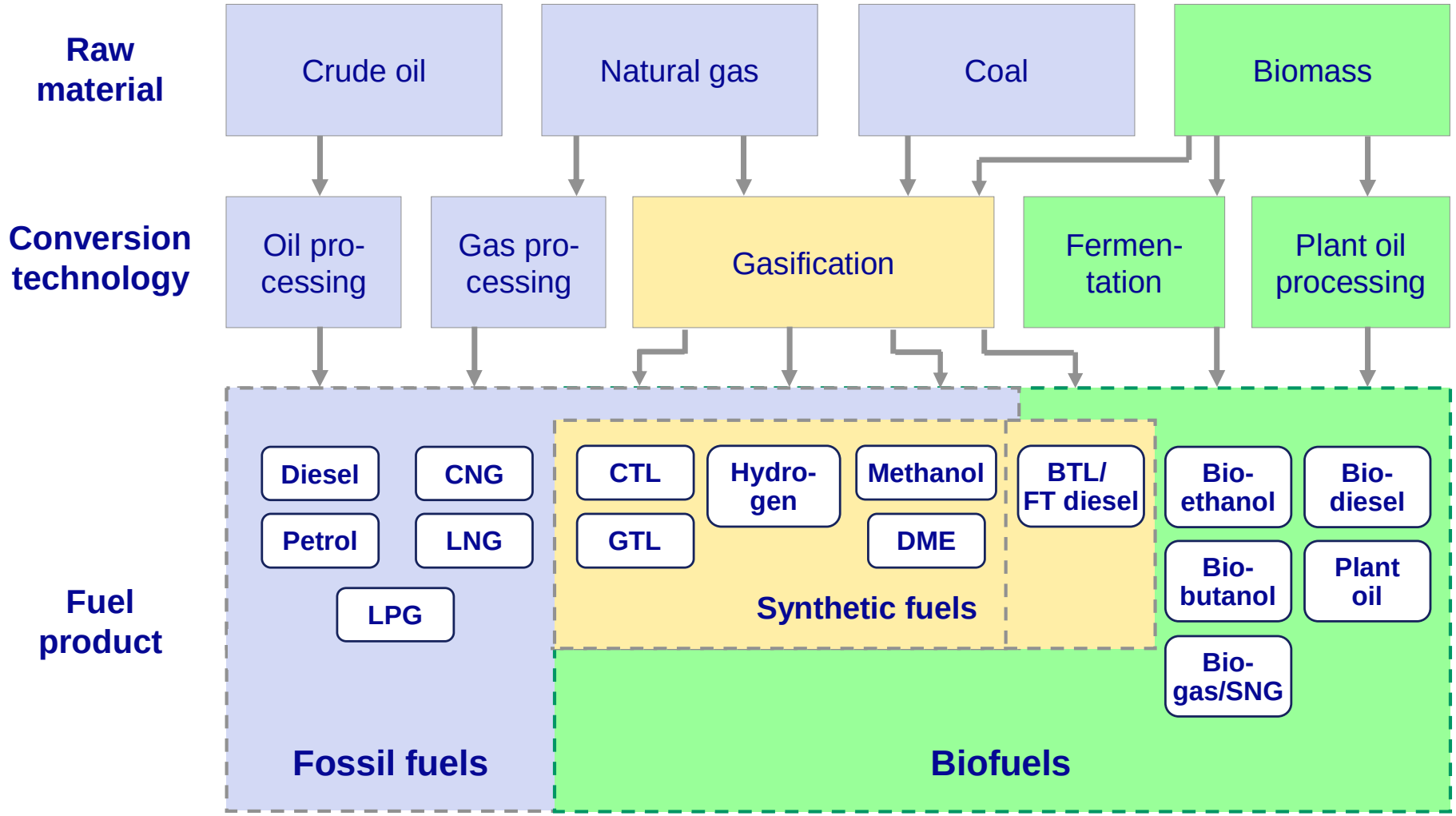
Fuel types can be categorized based on raw materials and main conversion technologies



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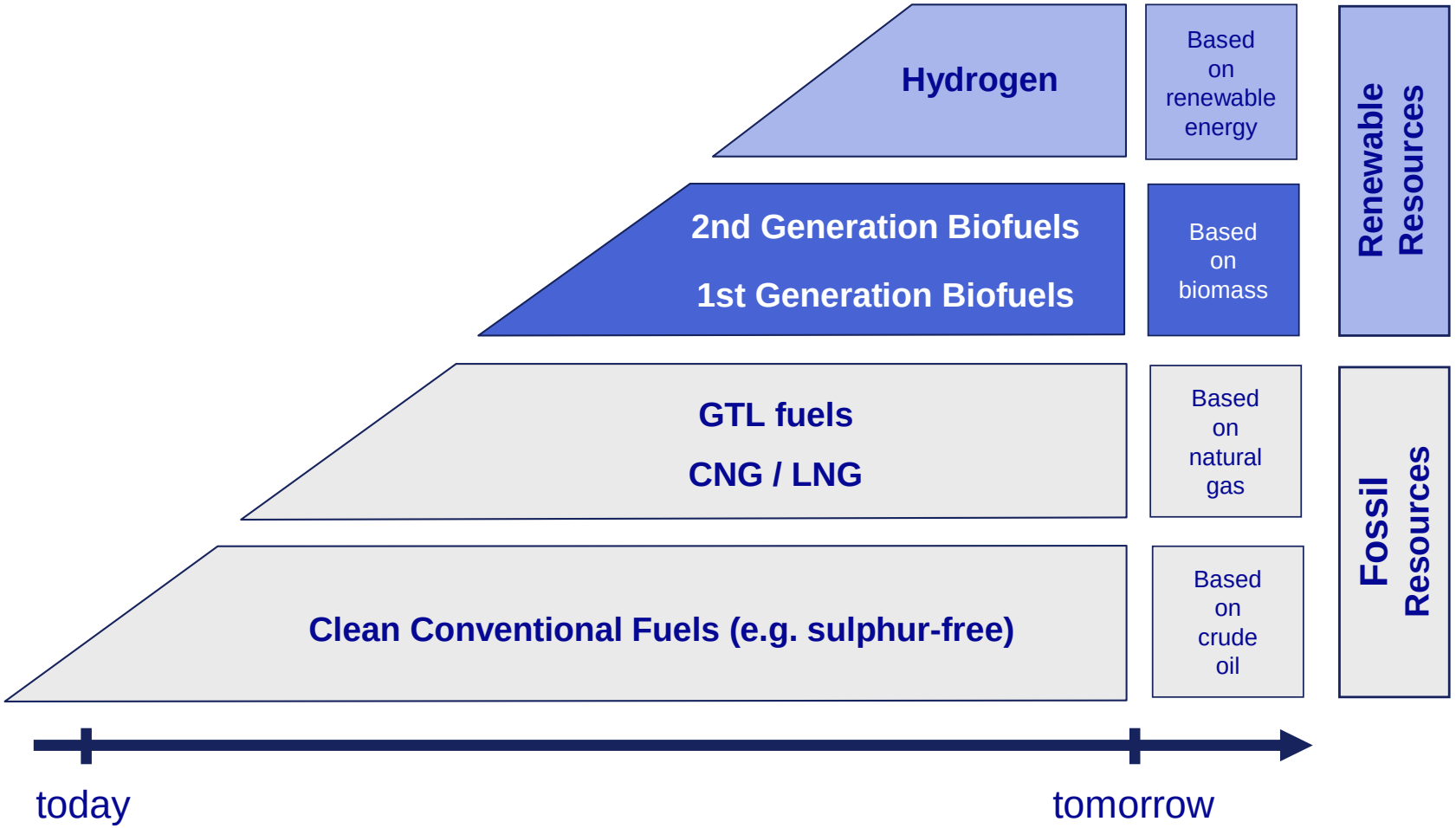
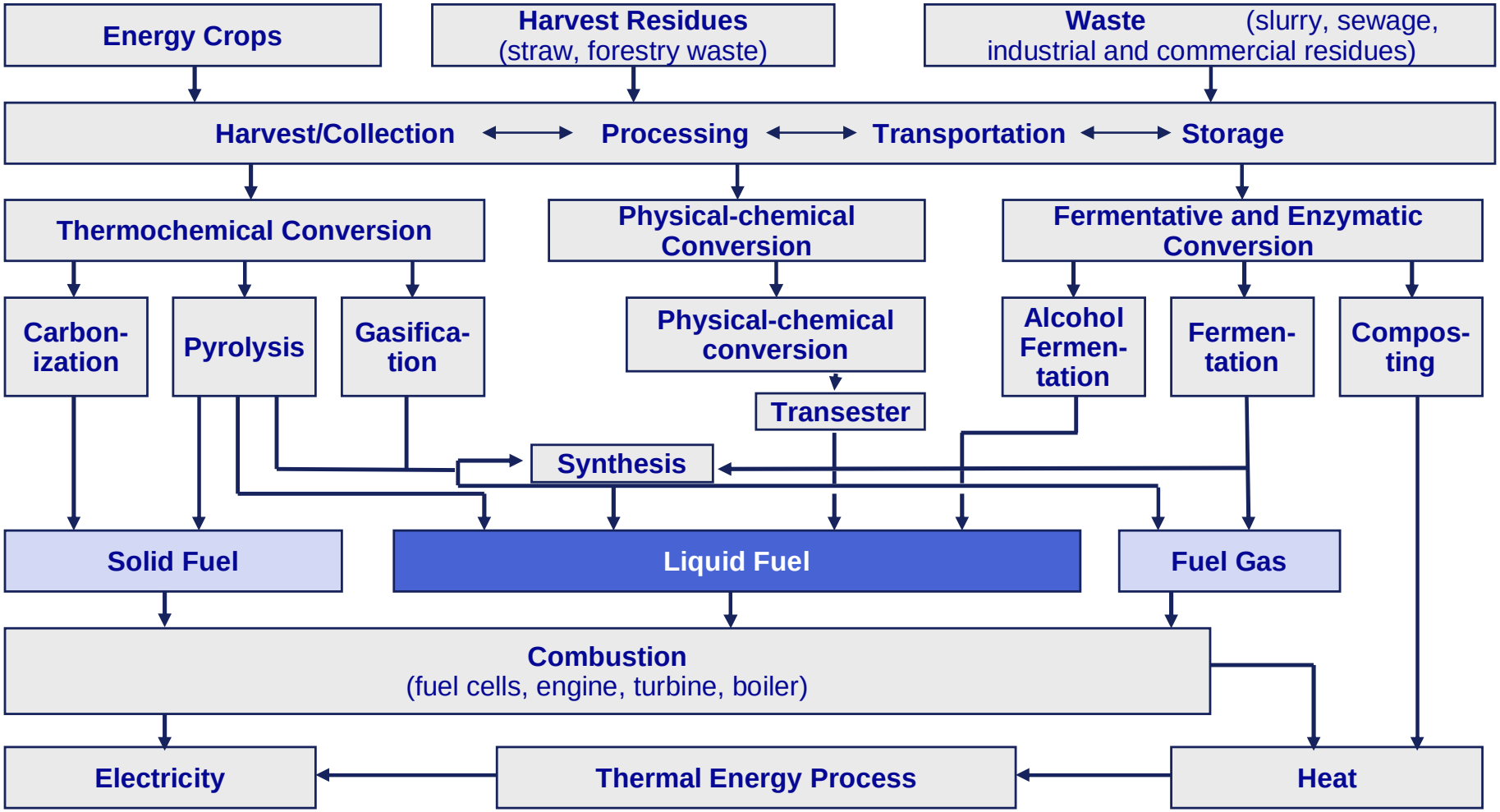
Different generations of modern fuels deriving from fossil and renewable resources exist



There are many pathways for the energetic utilisation of the different kinds of biomass



Source: Fraunhofer Institute for Environmental, Safety and Energy Technology

Biofuels are a complex topic due to the high number of different influencing factors

Biofuels influencing factors

Technical factors

- Raw material supply
- Conversion technologies
- Engine / powertrain technologies
- Infrastructure requirements / investments

Economical factors

- Fuel costs (incl. subsidy and tax aspects)
- Engine modification costs
- Infrastructure / availability costs
- Trade balance impact

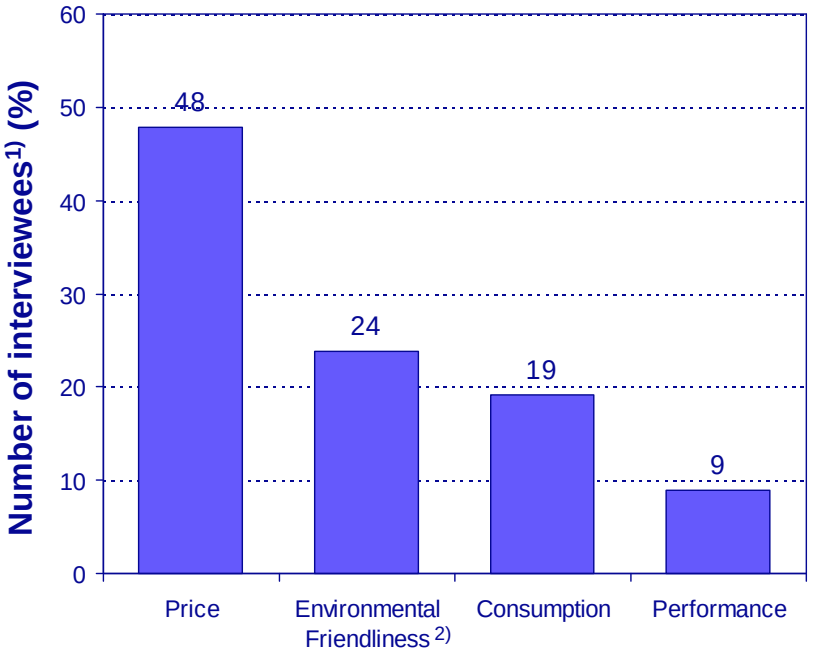
Ecological / political factors

- GHG emissions and reduction costs
- Support of local farmers
- Efficient land use / food vs. fuel usage
- Reduced dependency on crude oil

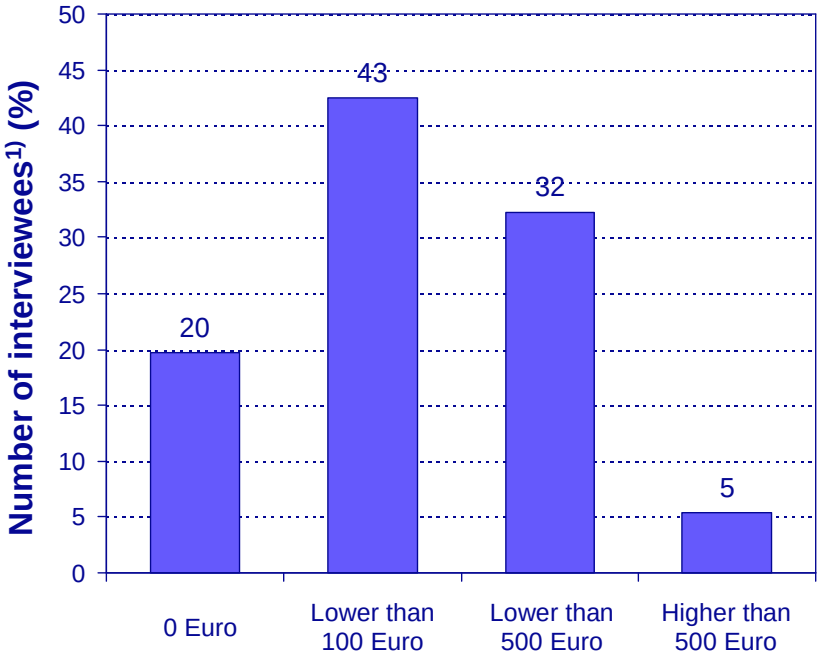
How can interesting technological opportunities be identified without getting lost in these details?

An analysis of the customer preferences shows clearly the importance of price and low modification costs

Buying criteria for car drivers



Acceptance of modification costs



1) Multiple answers were not possible
2) At the same fuel price
Source: Interviews with approx. 200 car drivers conducted by the Hochschule Reutlingen on behalf of FESTEL CAPITAL

Fundamental aspects of customer acceptance will define the requirements for short- to mid-term biofuel usage

Hypotheses regarding biofuel usage

Customer acceptance

- Lower prices compared to fossil fuels (without tax subsidy!)
- Normal usage of existing cars
  - No loss of power and range
  - No modification costs
- High availability and easy handling (similar to existing fuels)

Biofuel requirements

- Low raw material and production costs
- No additional distrubution / infrastructure costs
- Problem-free mixing with existing fuel types
- Same chemical/physical properties as existing fuels (e.g. energy content)

Important are economical factors and not ecological aspects - the deciding factor for market success are the costs for the car owner at the filling stations

Due to these requirements the high complexity of biofuels can be reduced significantly

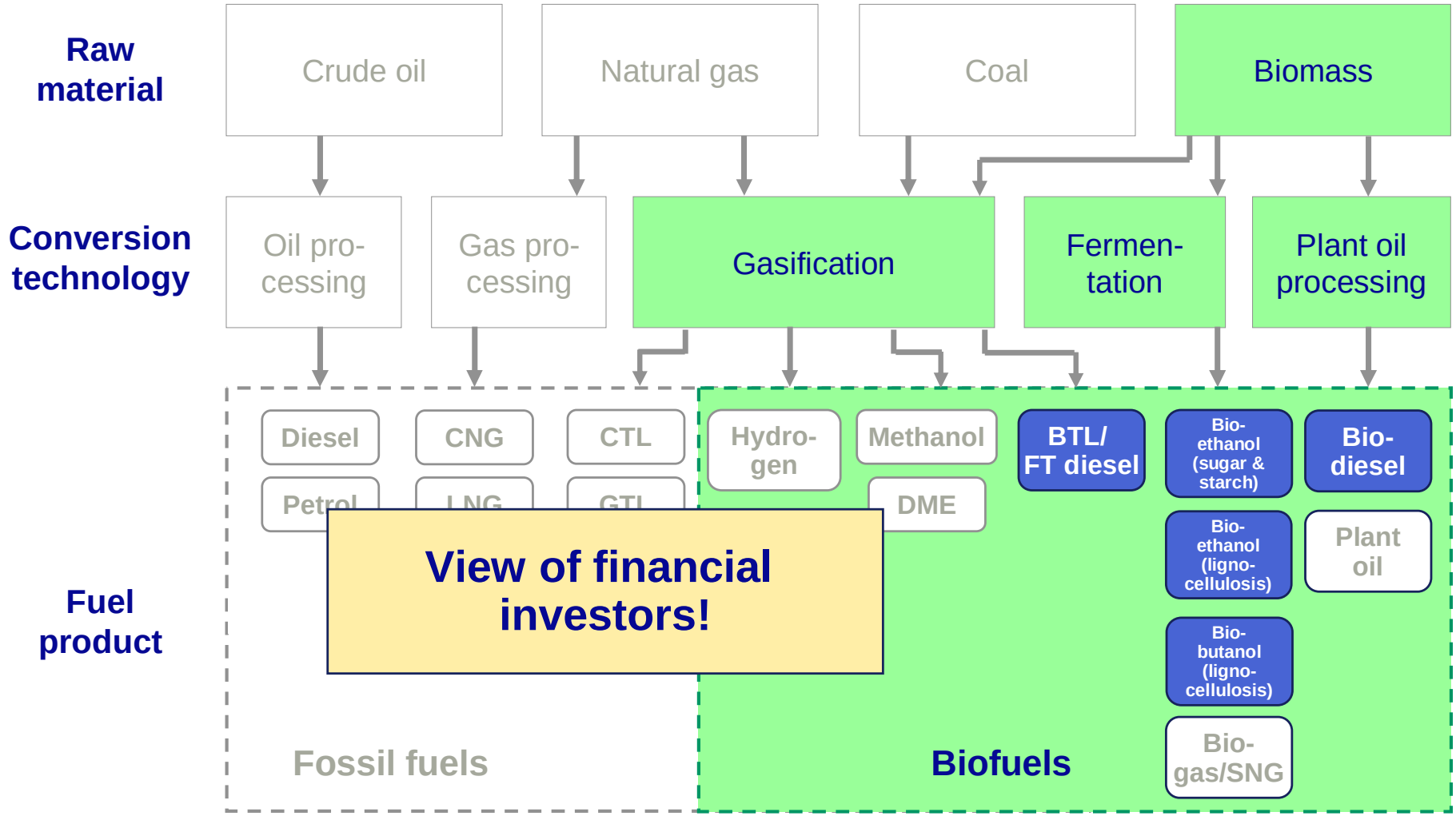
Biofuels influencing factors

Technical factors	Economical factors	Ecological / political factors
• **Raw material supply**	• **Fuel costs** (incl. subsidy and tax aspects)	• GHG emissions and reduction costs
• **Conversion technologies**	• Engine modification costs	• Support of local farmers
• Engine / powertrain technologies	• Infrastructur bility costs	se / food
• Infrastructure requirements / investments	• Trade balance impact	ndency on crude oil

View of financial investors!

Regarding success probability only fuel costs based on raw material supply and conversion technologies are of importance

Based on these requirements only BTL fuel, bioethanol, biobutanol and biodiesel were analysed in detail with regard to production costs



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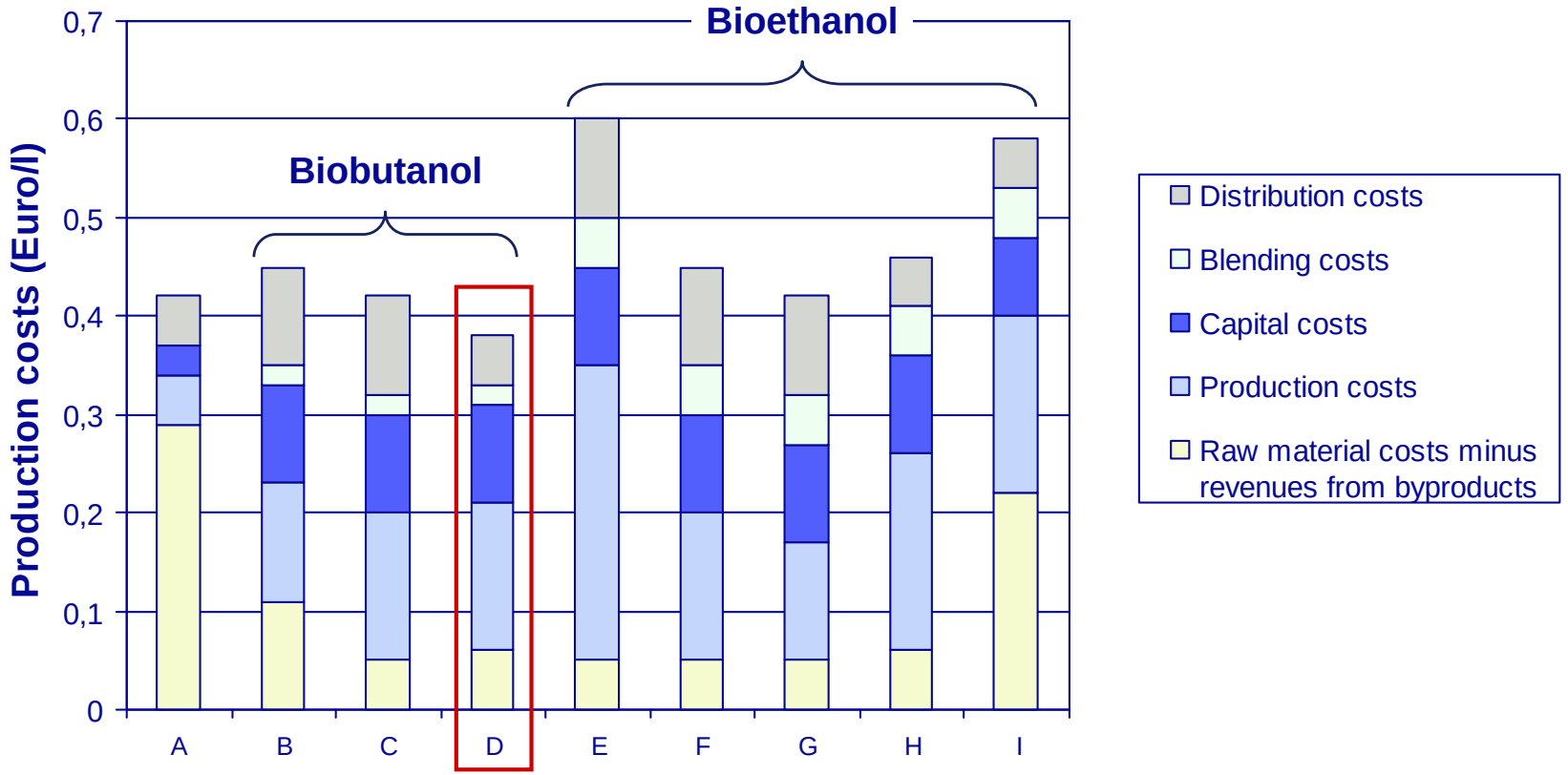
A model calculation for Germany shows the competitiveness of the different petrol substitutes (1/2)

Numbers are based on a "bottom-up" calculation model

Biofuel	Raw Material	Region	Scenario	Plant Size (kt/year)	Plant Investment (mn Euro)	Production Costs (Euro/l fuel)	Profit Margin (Euro/l)	Price at Filling Station (Euro/l)
Petrol	Crude oil	Europe	60 USD/barrel	10,000	2,600	0.37	**0.05**	1.30
Biobutanol	Corn	USA	Large scale mid-term	200	240	0.33	**0.02**	1.30
Biobutanol	Ligno-celluloses	USA	Large scale long-term	200	240	0.30	**0.05**	1.30
Biobutanol	Ligno-celluloses	Europe	Large scale long-term	200	240	0.35	**0.09**	1.30
Bioethanol	Ligno-celluloses	USA	Small scale mid-term	50	90	0.45	**-0.13**	1.30
Bioethanol	Ligno-celluloses	USA	Large scale mid-term	200	240	0.30	**0.02**	1.30
Bioethanol	Ligno-celluloses	USA	Large scale long-term	200	240	0.27	**0.05**	1.30
Bioethanol	Ligno-celluloses	Europe	Large scale long-term	200	240	0.36	**0.01**	1.30
Bioethanol	Wheat	Europe	Large scale actual with tax	200	200	0.48	**-0.11**	1.30
Bioethanol	Wheat	Europe	Large scale actual without tax	200	200	0.48	**0.54**	1.30

Source: FESTEL CAPITAL analysis

A model calculation for Germany shows the competitiveness of the different petrol substitutes (2/2)



A - Petrol (crude oil, 60 USD/barrel)

B - Biobutanol (corn, USA, large scale mid-term)
C - Biobutanol (straw, USA, large scale long-term)
D - Biobutanol (straw, Europe, large scale long-term)

E - Bioethanol (straw, USA, small scale mid-term)
F - Bioethanol (straw, USA, large scale mid-term)
G - Bioethanol (straw, USA, large scale long-term)
H - Bioethanol (straw, Europe, large scale long-term)
I - Bioethanol (wheat, Europe, large scale actual)

Source: FESTEL CAPITAL analysis

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A model calculation for Germany shows the competitiveness of the different diesel substitutes (1/2)

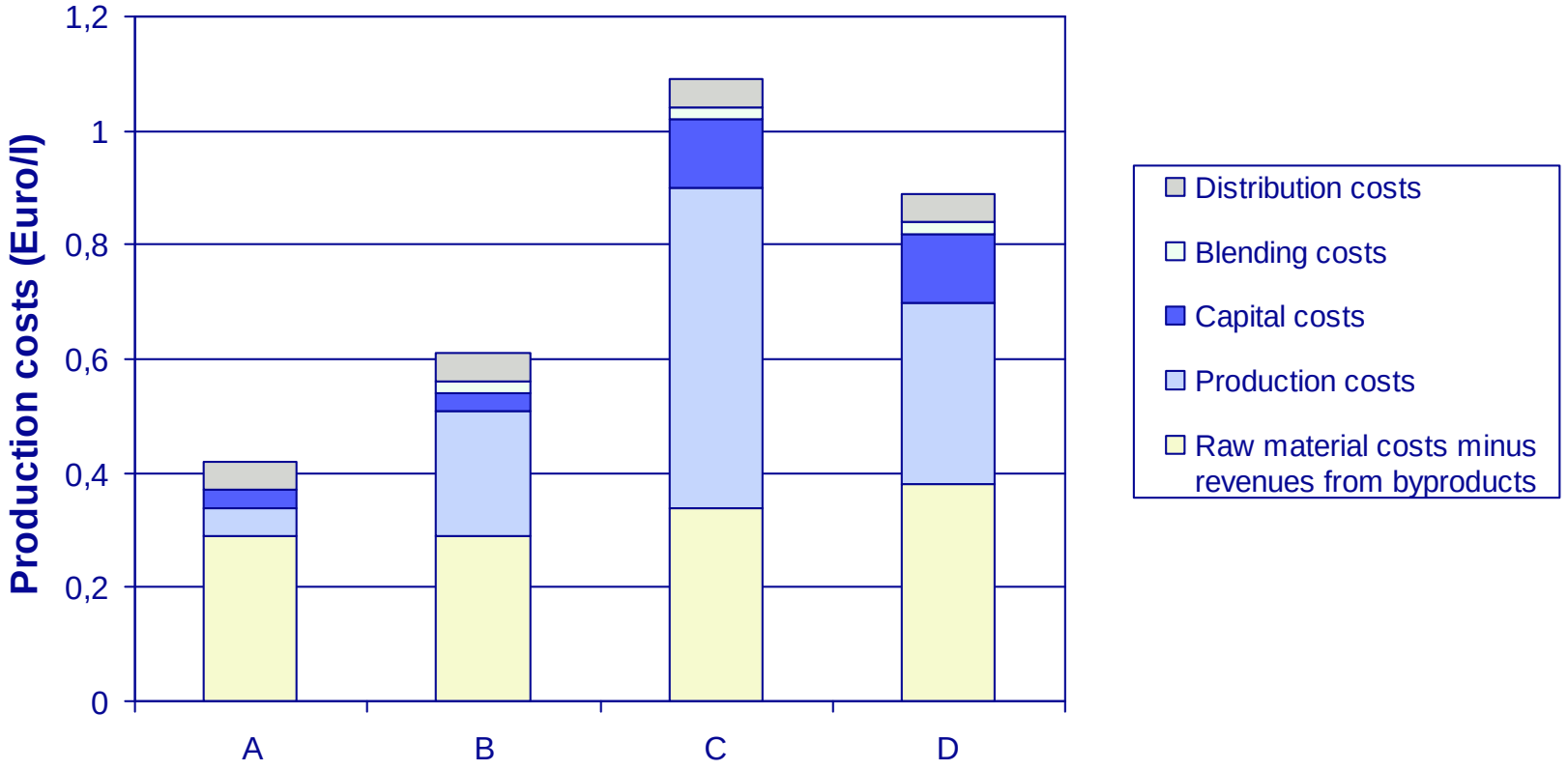
Numbers are based on a "bottom-up" calculation model

Biofuel	Raw Material	Region	Scenario	Plant Size (kt/year)	Plant Investment (mn Euro)	Production Costs (Euro/l fuel)	Profit Margin (Euro/l)	Price at Filling Station (Euro/l)
Diesel	Crude oil	Europe	60 USD/barrel	10,000	2,600	0.37	**0.06**	1.10
Biodiesel	Rape seed	Europe	Large scale actual with tax	200	40[1)]	0.54	**-0.13**	1.10
Biodiesel	Rape seed	Europe	Large scale actual without tax	200	40[1)]	0.54	**0.34**	1.10
BTL	Wood	Europe	Small scale mid-term with tax	120	200	1.02	**-0.61**	1.10
BTL	Wood	Europe	Large scale long-term with tax	1,200	1,600	0.82	**-0.41**	1.10
BTL	Wood	Europe	Large scale long-term without tax	1,200	1,600	0.82	**0.06**	1.10

1) Including oil mill

Source: FESTEL CAPITAL analysis

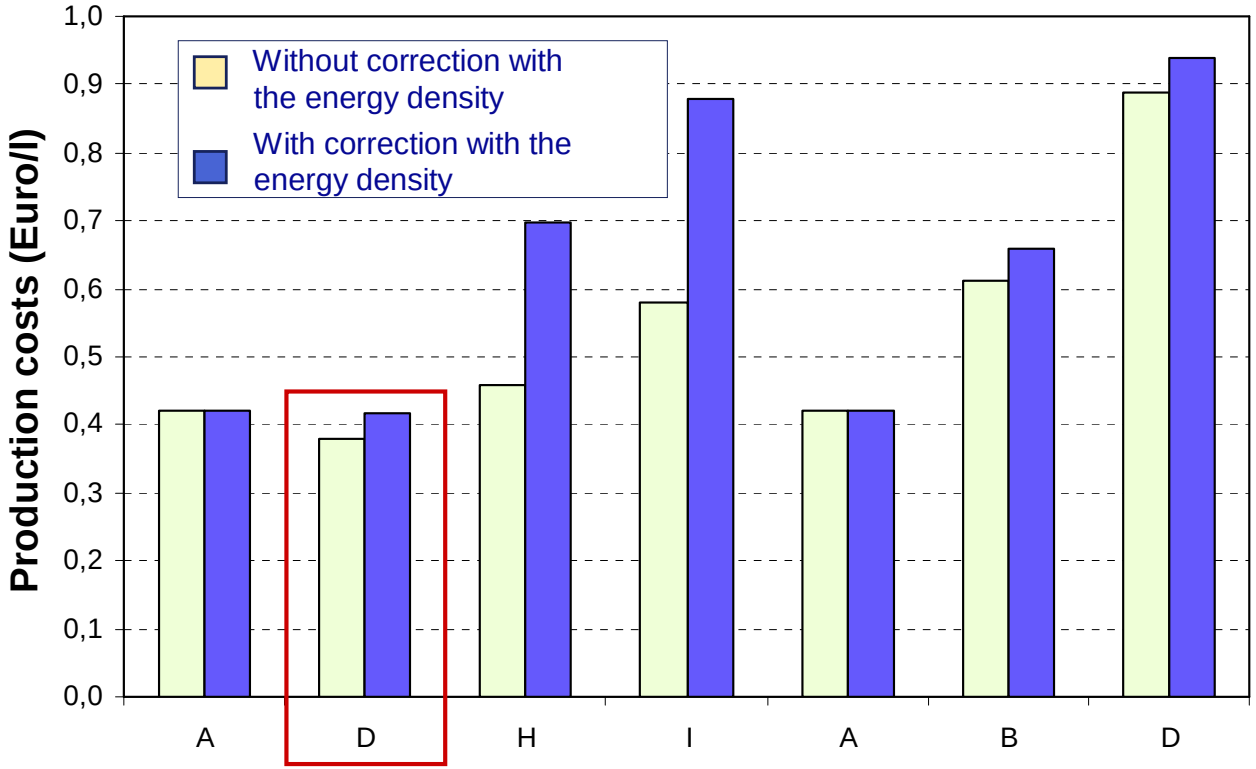
A model calculation for Germany shows the competitiveness of the different diesel substitutes (2/2)



A - Diesel (crude oil, 60 USD/barrel)
B - Biodiesel (rape seed, Europe, large scale actual)
C - BTL (wood, Europe small scale mid-term)
D - BTL (wood, Europe large scale long-term)

Source: FESTEL CAPITAL analysis

The most competitive biofuel type for the German market is European bio-butanol made from straw



A: Petrol (crude oil, 60 USD/barrel)

D: Biobutanol (straw, Europe, large scale long-term)

H: Bioethanol (straw, Europe, large scale long-term)

I: Bioethanol (corn, Europe, large scale actual)

A: Diesel (crude oil, 60 USD/Barrel)

B: Biodiesel (rape seed, Europe, large-scale actual)

D: BTL (wood, Europe, large scale long-term)

Source: FESTEL CAPITAL analysis