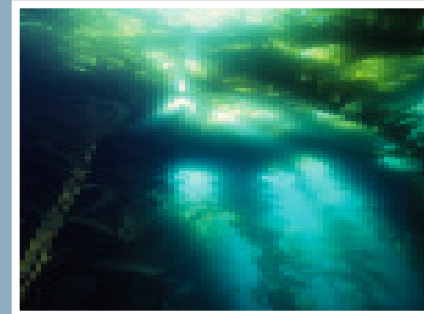




Micro-algae to biofuel

Profit or loss?

Insights and outlines
with AlgaeValue™

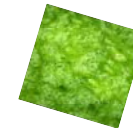


Index

01 KEMA in 1 minute

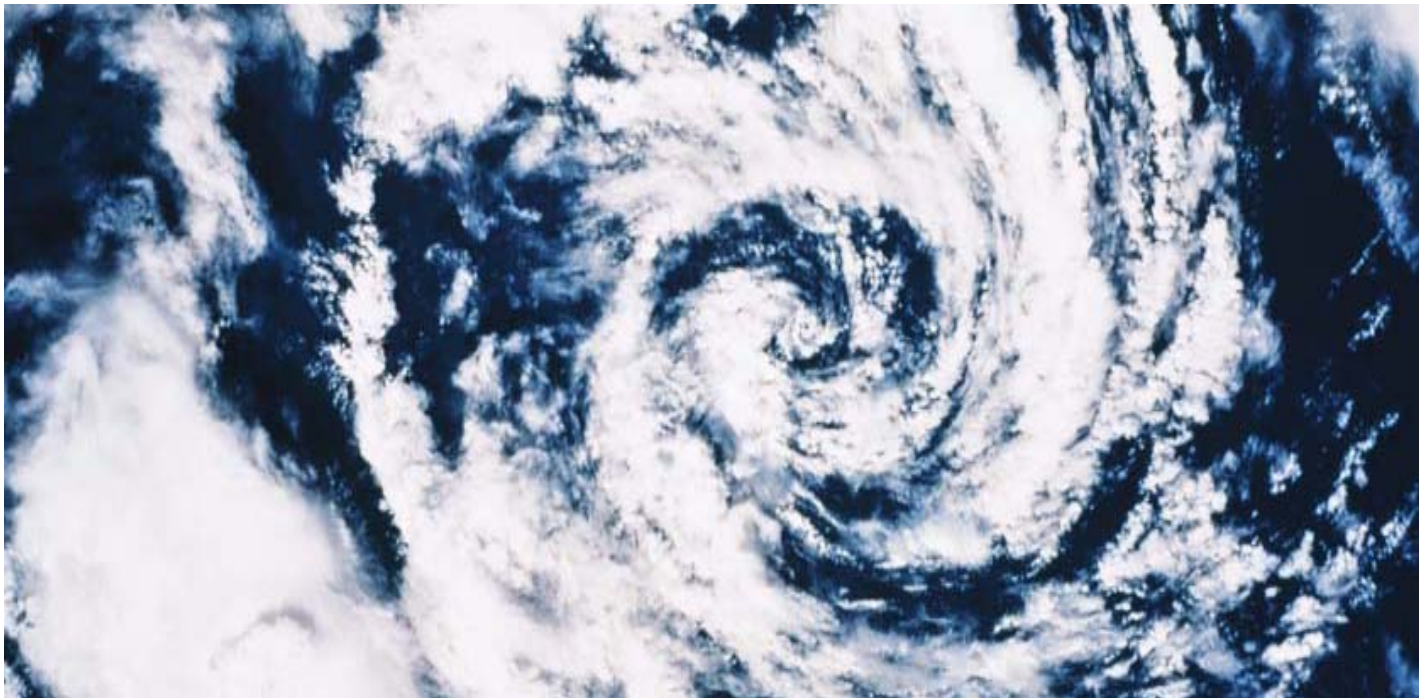
02 Micro-algae to biofuel

03 KEMA AlgaeValue™ Tool





A sure guide in a changing world of energy



Introducing KEMA

KEMA at a glance...

A trusted independent partner providing advise throughout the **entire chain of Energy**

Policy &
Strategy



Production



Trading



Transport &
Distribution



Use

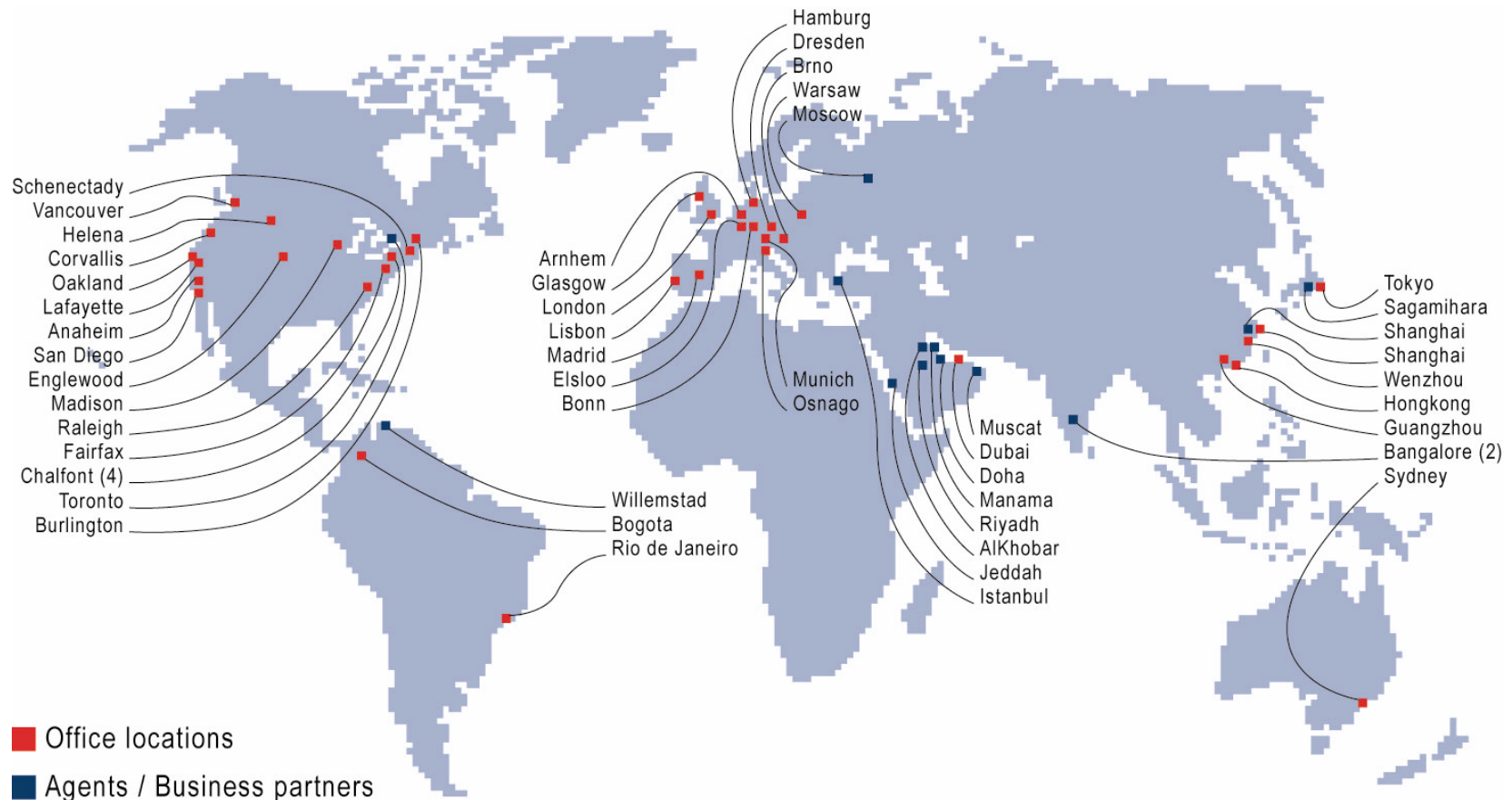


One company serving the diverse needs of the energy marketplace

KEMA 

Introducing KEMA

Global Presence ... Local Insight



■ Office locations

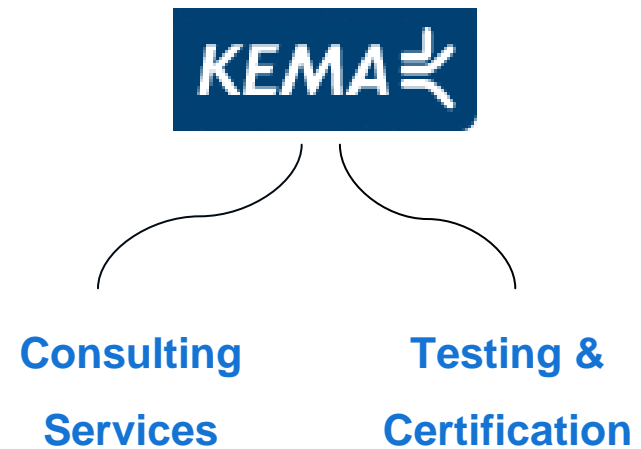
■ Agents / Business partners



Introducing KEMA

Global Presence ... Local Insight

- Energy focus
- 500 clients in 70 countries
- 1.700 professionals
- 80 years of experience



... we want to stay a **leading authority** in the professional services we provide

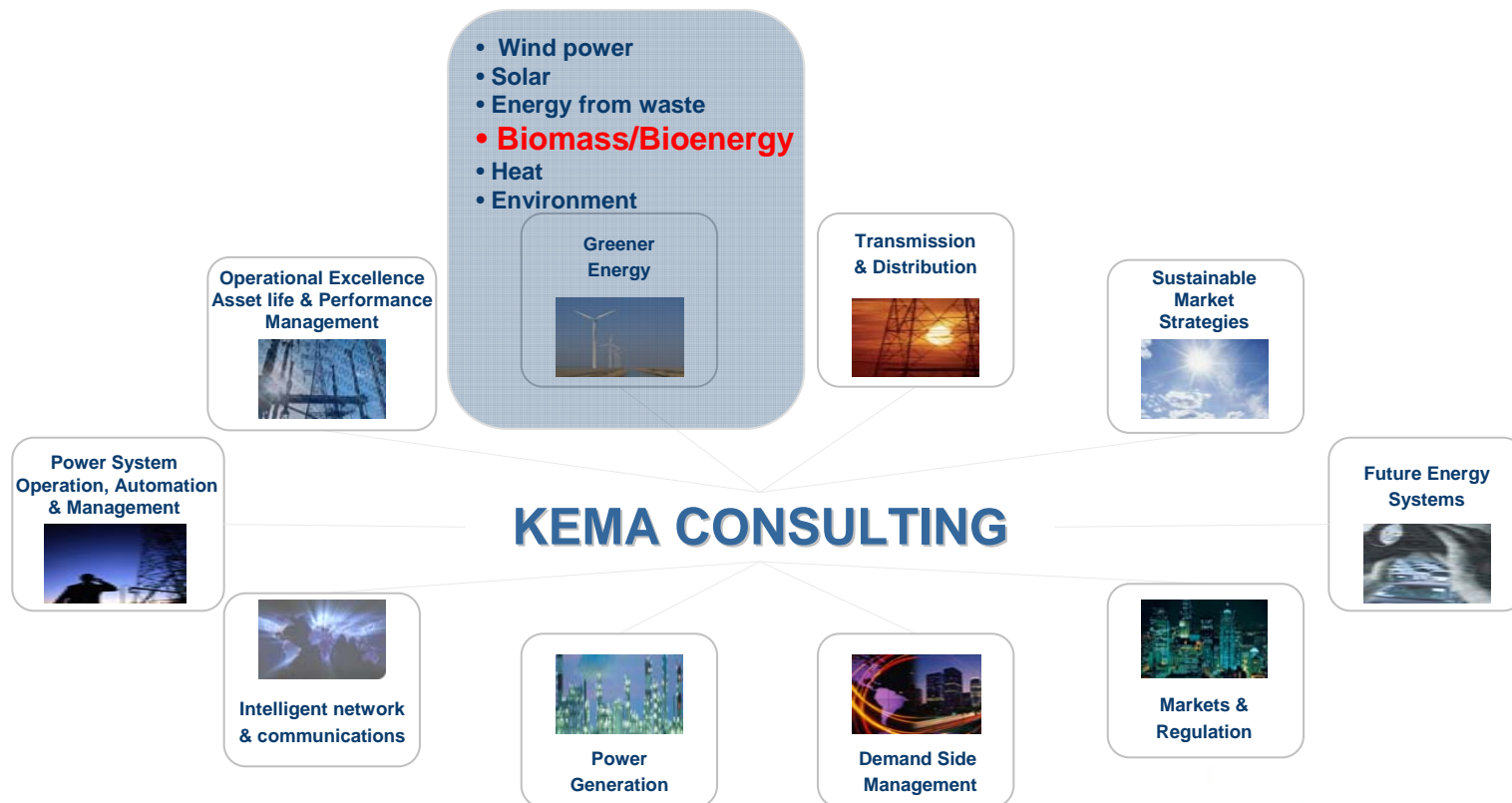
“we know the **technical consequences** of a **business decision** and the **business consequences** of a **technical decision**”



Introducing KEMA

Consulting Services – Greener Energy

Measurable results from business strategy to technology deployment



Introducing KEMA

The Market Issue of Renewable Energy - **KEMA Greener Energy** – offers consultancy services for:

- **Feasibility,**
 - **Efficiency and**
 - **Security**
- of renewable energy generation.

Major clients are industry and government.

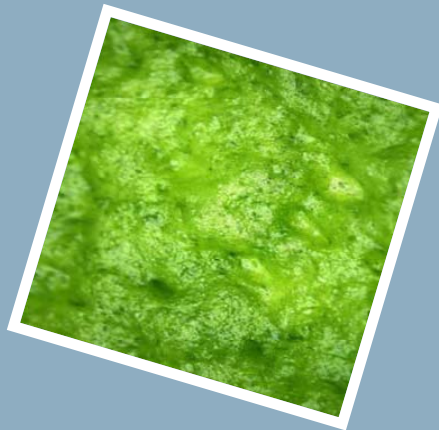
Greener Energy

- Wind power
- Solar
- Energy from waste
- **Biomass/Bioenergy**
- Heat
- Environment



Micro-algae to Biofuel

Micro-algae cultivation for biofuel and fine chemicals production



- High potential for biofuel production
- High potential for production of high-value chemicals
- Higher yield than any land crop
- CO₂ reduction by fossil substitution
- 3rd generation biofuel (non-food crop)

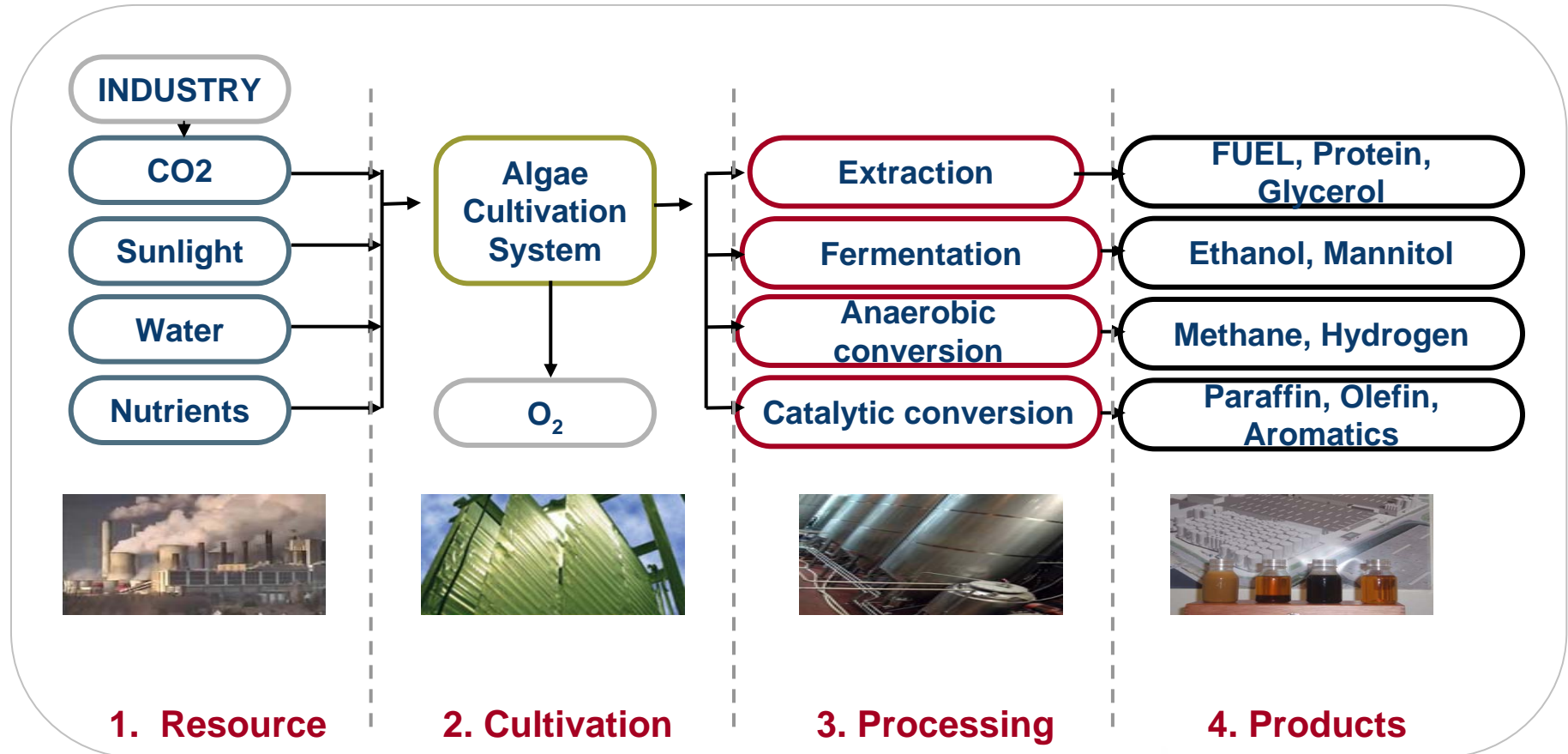
Micro-algae to Biofuel

From cultivation... → to scale... → to technology...

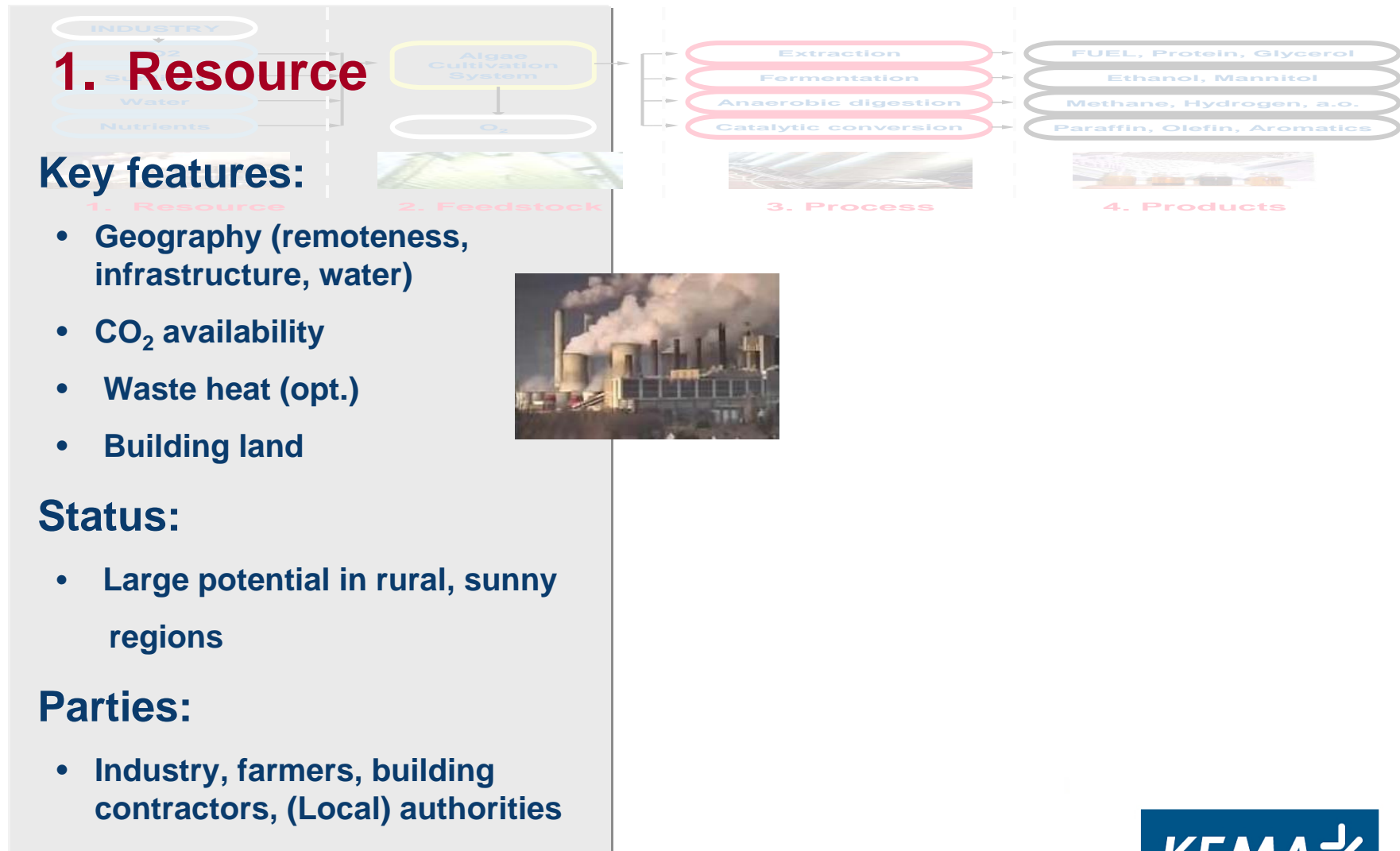


Micro-algae to Biofuel

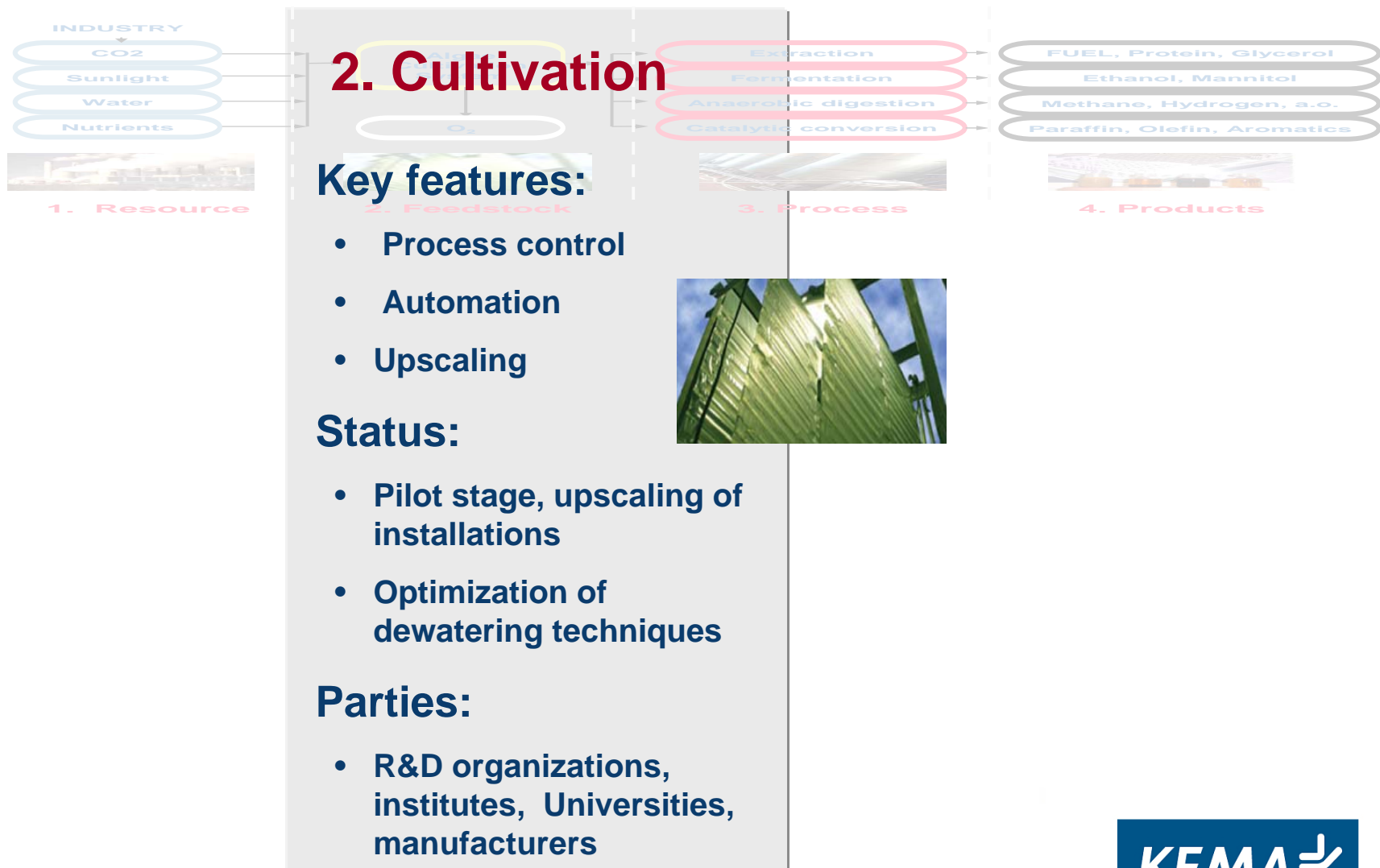
Process routes



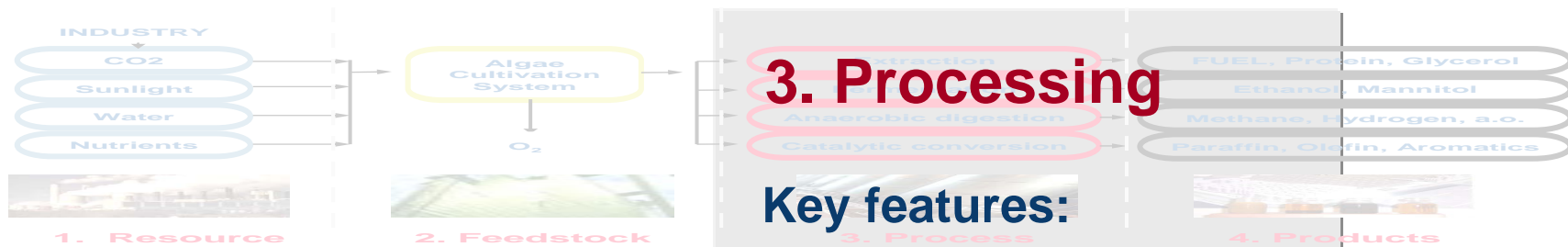
Micro-algae to Biofuel



Micro-algae to Biofuel



Micro-algae to Biofuel



3. Processing

Key features:

- Bulk separation
- Fine chemicals separation

Status:

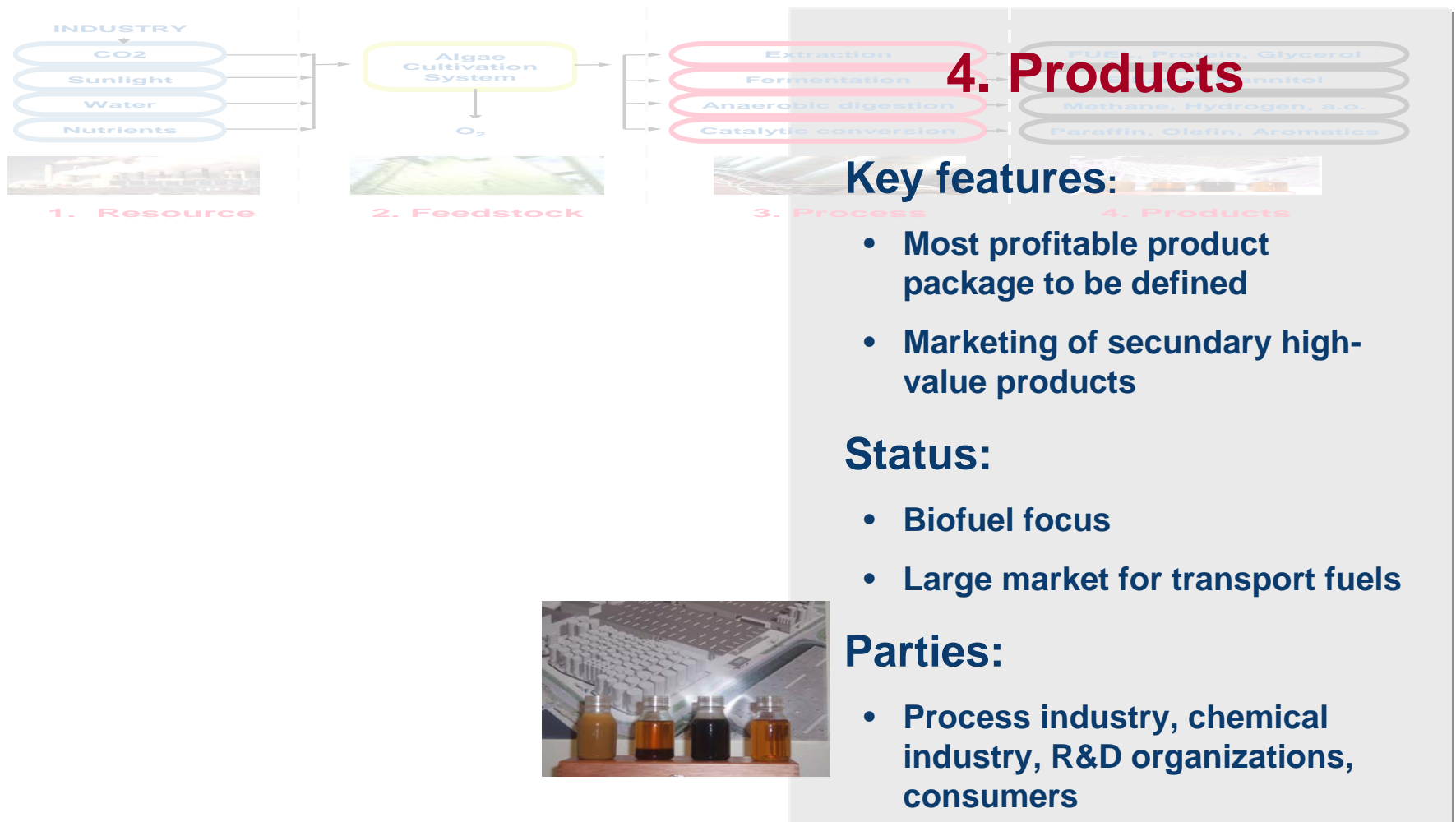
- Focus on fuel route (biodiesel/bioethanol)
- Technology optimisation
- Existing technologies, operational processes for oil-to-biofuel route.

Parties:

- Petrochemical industry, R&D organizations



Micro-algae to Biofuel



Micro-algae to Biofuel



1. Resource

Key features:

- Geography (remoteness, infrastructure, water)
- CO₂ availability
- Waste heat (opt.)
- Building land

Status:

- Large potential in rural, sunny regions

Parties:

- Industry, farmers, building contractors, (Local) authorities



2. Cultivation

Key features:

- Process control
- Automation
- Upscaling

Status:

- Pilot stage, upscaling of installations
- Optimization of dewatering techniques

Parties:

- R&D organizations, institutes, Universities, manufacturers



3. Processing

Key features:

- Bulk separation
- Fine chemicals separation

Status:

- Focus on fuel route (biodiesel/bioethanol)
- Technology optimisation
- Existing technologies, operational processes for oil-to-biofuel route.

Parties:

- Petrochemical industry, R&D organizations



4. Products

Key features:

- Biofuel focus
- Marketing of secondary high-value products

Status:

- Large market for transport fuels
- Most profitable product package to be defined

Parties:

- Consumers, process industry, chemical industry, R&D organizations

Micro-algae to Biofuel

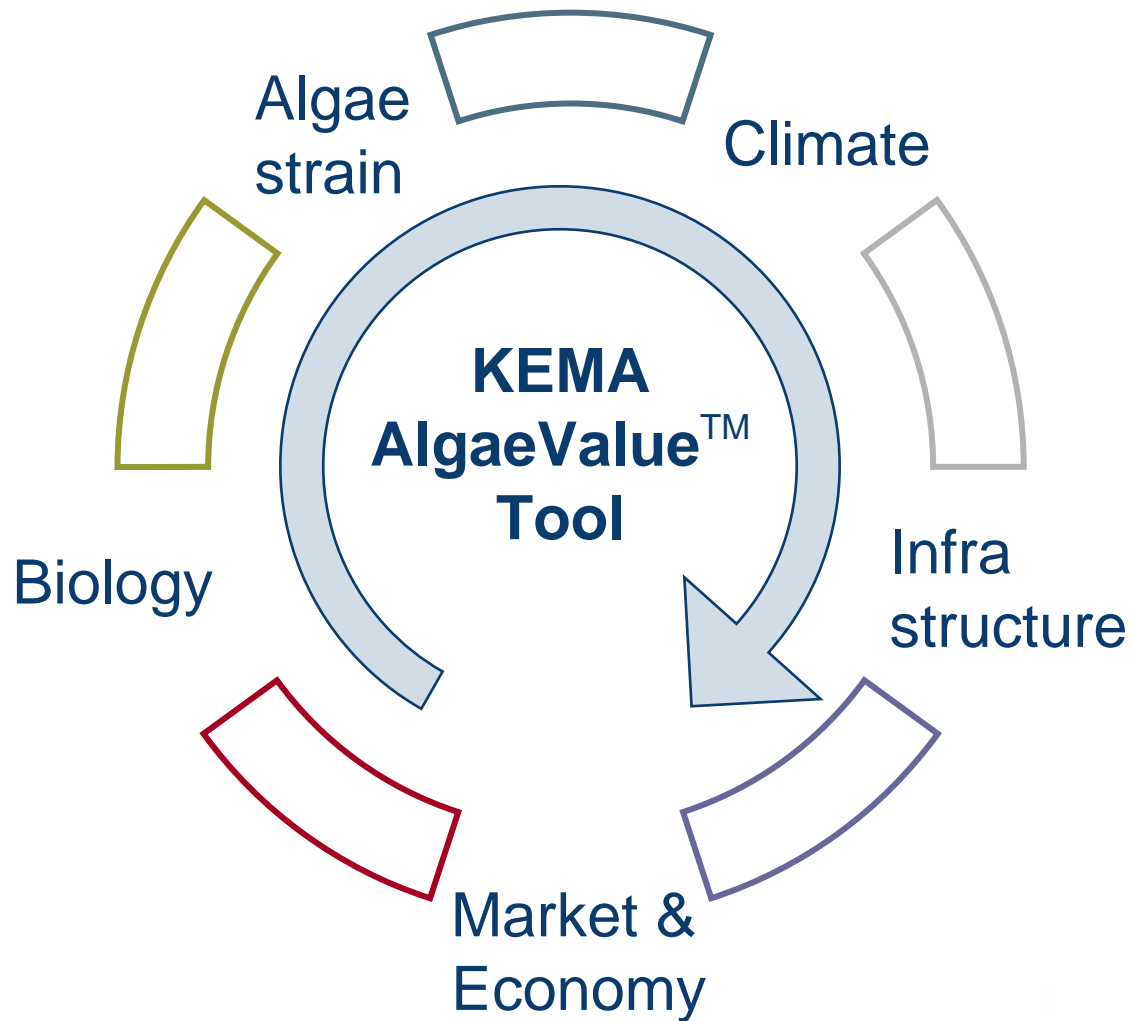
But...

Important questions from clients and investors:

- **When** will algae cultivation be profitable?
- **What product** from micro-algae will be most profitable?
- How can **research** improve profitability?
- How do multi-disciplinary matters **relate**?
- Which **location** will be most suitable?
- What will total **investment costs** be?
- Where are **break-even points**?
- And even more...




KEMA AlgaeValue Tool





KEMA AlgaeValue™ Tool

A techno-economic prediction model for future development



We want:

- Consistent system yield indication
- Clear insight in cost/revenue build-up
- Easy cost/revenue sensitivity analysis
- Easy evaluation of concept changes
- Independent client-specific advice

The complex block features a light blue background. On the left, there is a circular diagram with a central white arrow pointing clockwise. Surrounding this central arrow are six smaller, colored arrows (yellow, orange, purple, red, grey, and green) pointing outwards in a circular pattern. To the right of this diagram, the text "We want:" is followed by a bulleted list of five items.

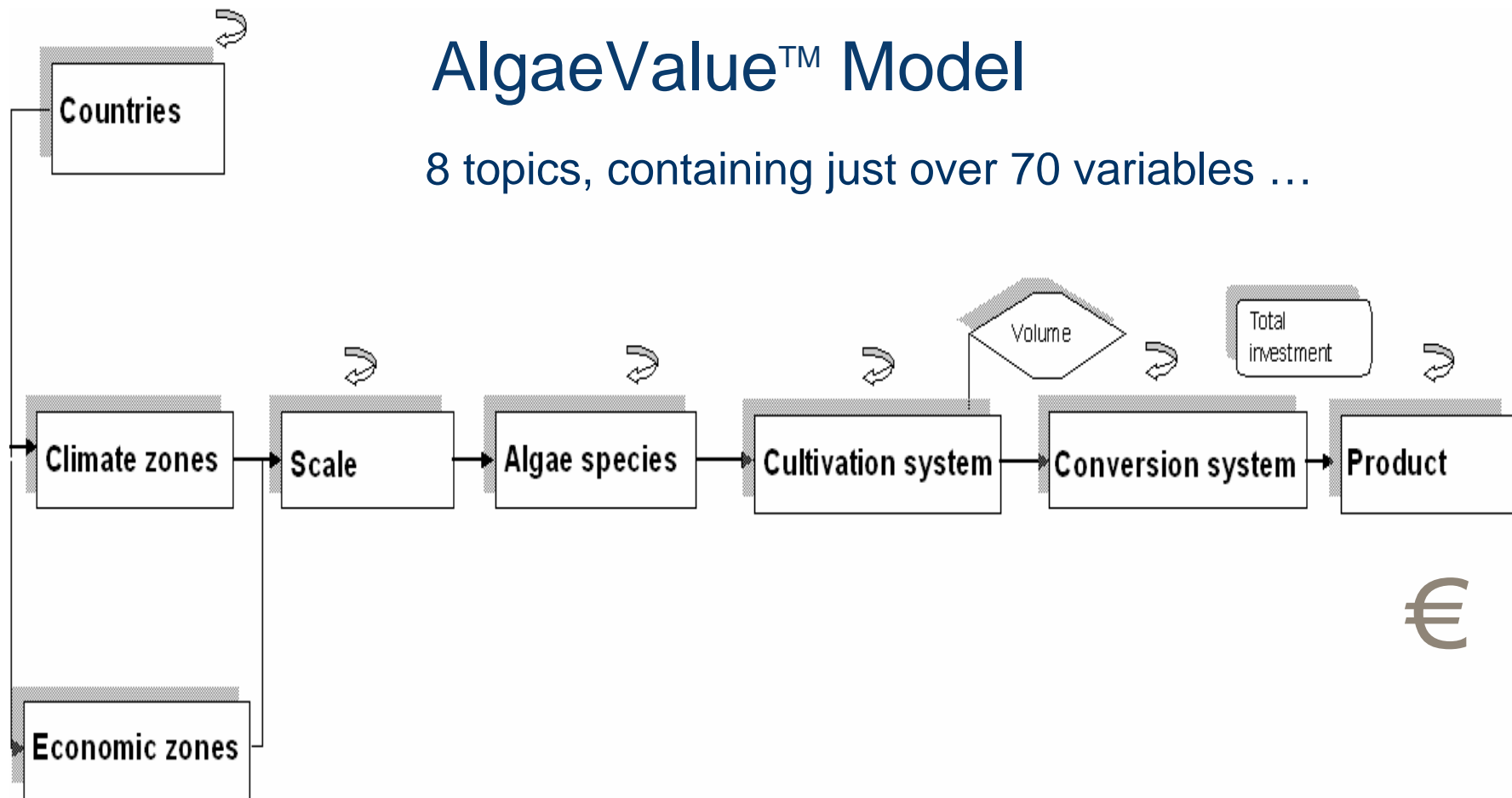
KEMA AlgaeValue Tool:

How?



AlgaeValue™ Model

8 topics, containing just over 70 variables ...



KEMA AlgaeValue Tool: Demonstration



Example cases: What is best option?

1. Netherlands	Mild climate	fuel	50 ha
2. Spain	Subtropical climate	fuel	50 ha
3. Sudan	Desert climate	fuel	50 ha

3 countries

6 algae species

3 cultivation systems



More options are possible...










4 conversion systems

15 different products ...

KEMA AlgaeValue Tool: Demonstration



AlgaeValue results:

<p>N </p> <p></p> <p></p>	<ol style="list-style-type: none"> 1. Botryococcus B., open system, extraction, Biodiesel 2. Botryococcus B., open system, extraction, Bio-gas 3. Botryococcus B., open system, extraction, Bio-eth. 	<p>- 1,73 mln Eur/yr</p> <p>- 1,82 mln Eur/yr</p> <p>- 1,90 mln Eur/yr</p>
<p>S </p> <p></p> <p></p>	<ol style="list-style-type: none"> 1. Botryococcus B., open system, extraction, Biodiesel 2. Botryococcus B., open system, extraction, Bio-gas 3. Botryococcus B., open system, extraction, Bio-eth. 	<p>- 1,50 mln Eur/yr</p> <p>- 1,76 mln Eur/yr</p> <p>- 2,00 mln Eur/yr</p>
<p>S </p> <p></p> <p></p>	<ol style="list-style-type: none"> 1. Botryococcus B., open system, extraction, Biodiesel 2. Botryococcus B., open system, extraction, Bio-gas 3. Botryococcus B., open system, extraction, Bio-eth. 	<p>- 1,88 mln Eur/yr</p> <p>- 2,21 mln Eur/yr</p> <p>- 2,76 mln Eur/yr</p>

KEMA AlgaeValue Tool: Demonstration



Conclusion:

None of selected biofuel options are profitable... yet...
...under current testcase conditions and taken
assumptions!

What to do now?

Let's have a closer look at some details...

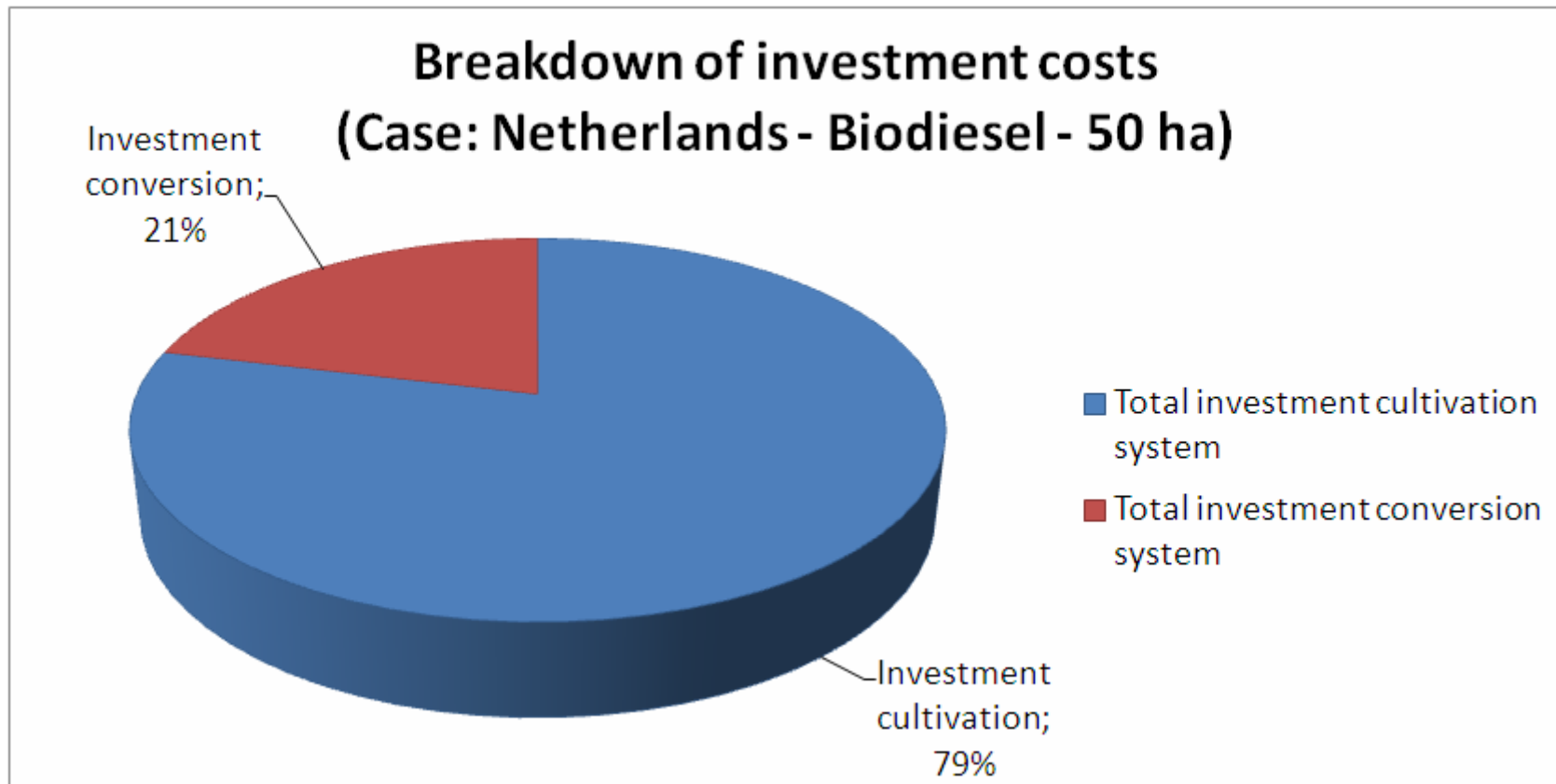
...for bottlenecks and insight!

KEMA AlgaeValue Tool: Demonstration



Netherlands

1/3

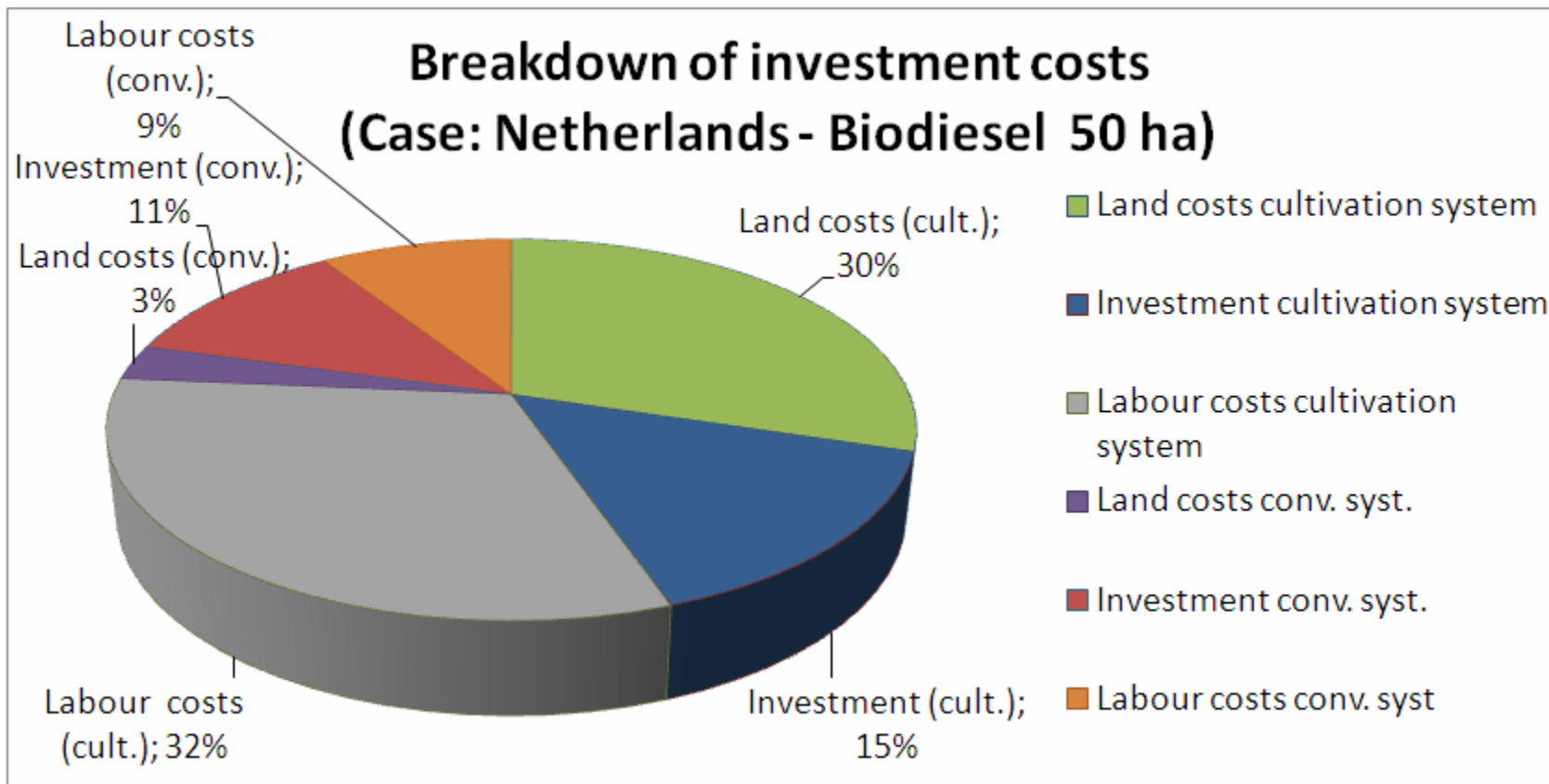


KEMA AlgaeValue Tool: Demonstration



Netherlands

2/3

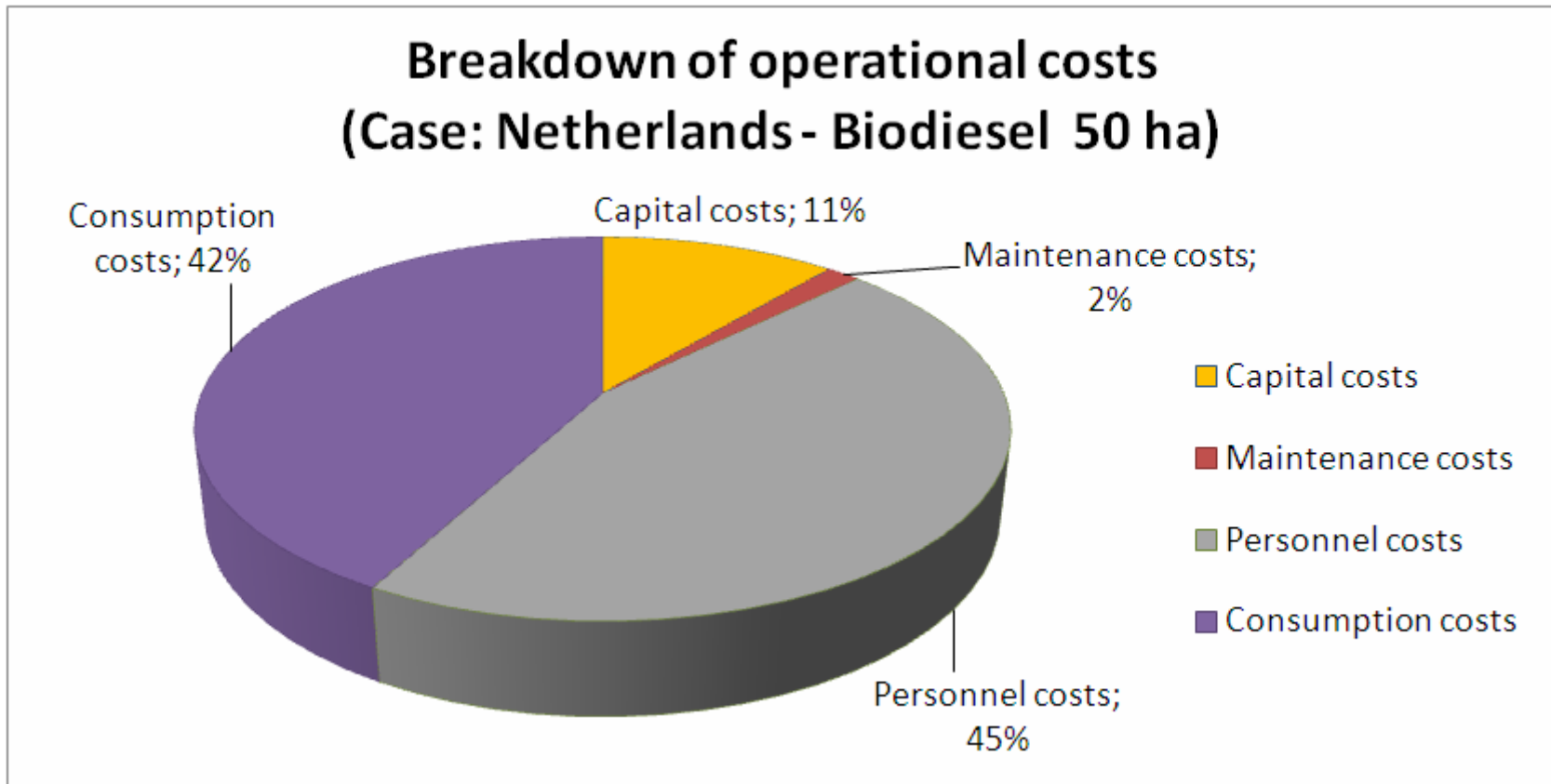


KEMA AlgaeValue Tool: Demonstration



Netherlands

3/3

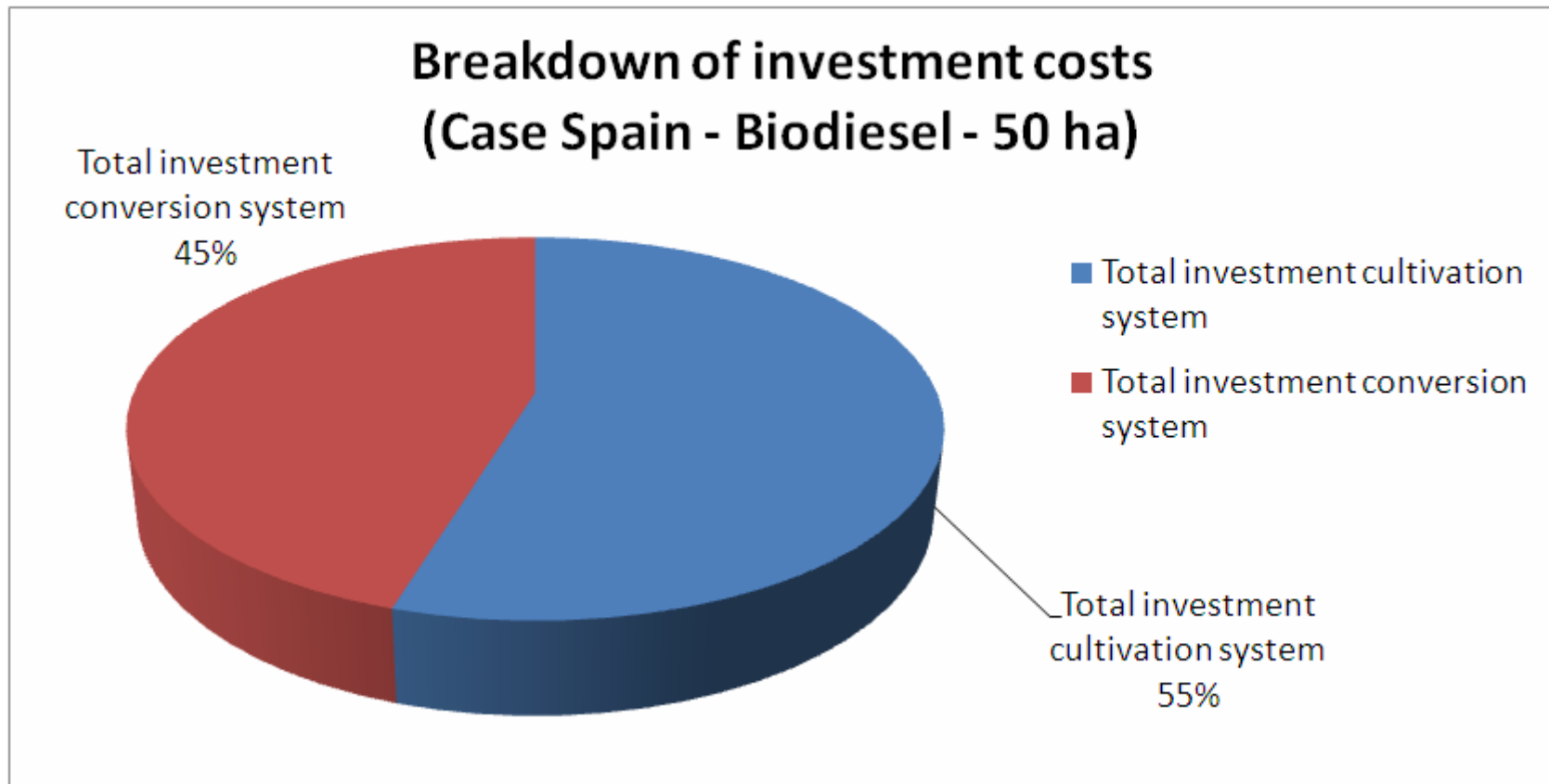


KEMA AlgaeValue Tool: Demonstration



Spain

1/3

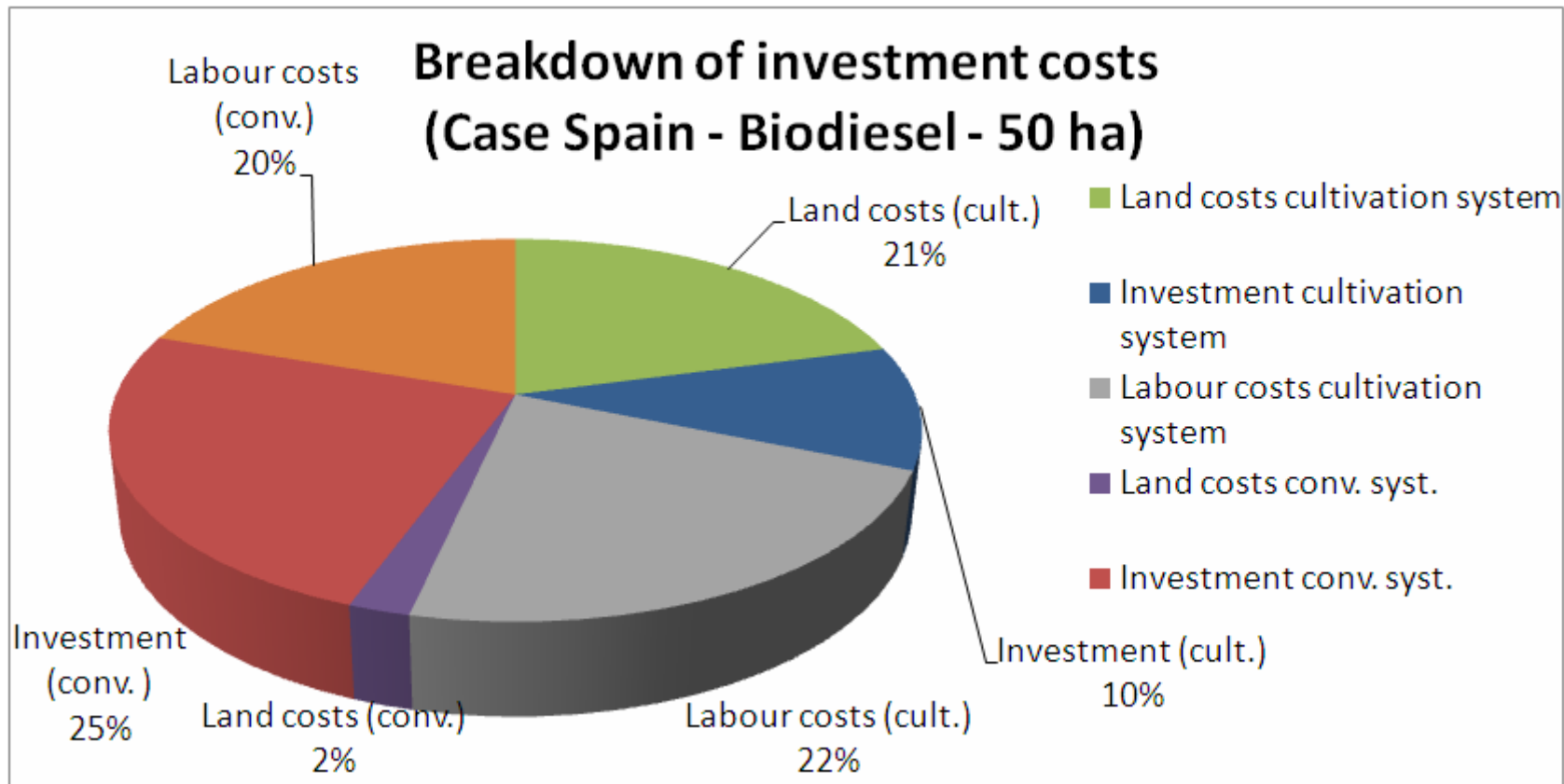


KEMA AlgaeValue Tool: Demonstration



Spain

2/3

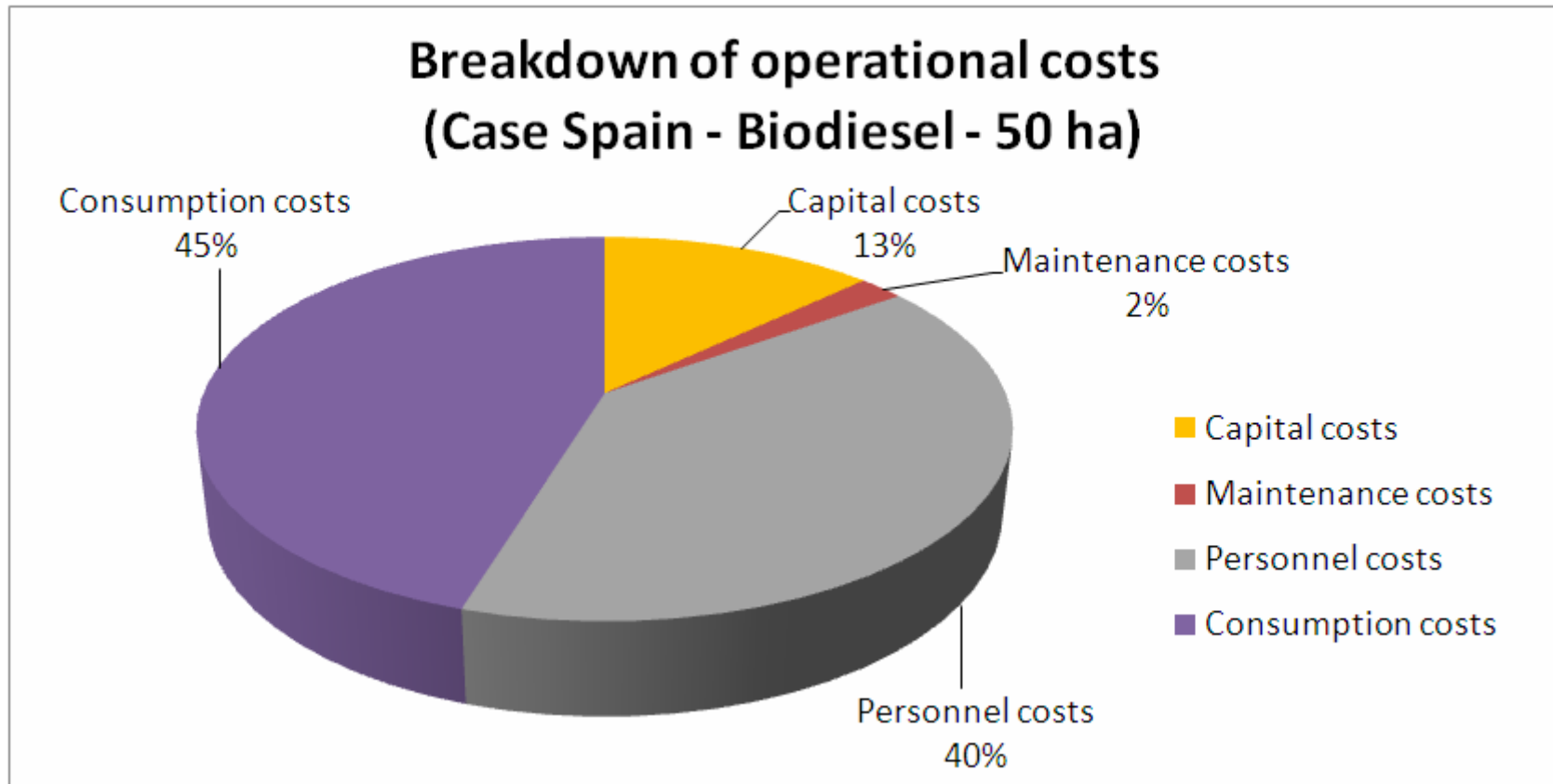


KEMA AlgaeValue Tool: Demonstration



Spain

3/3

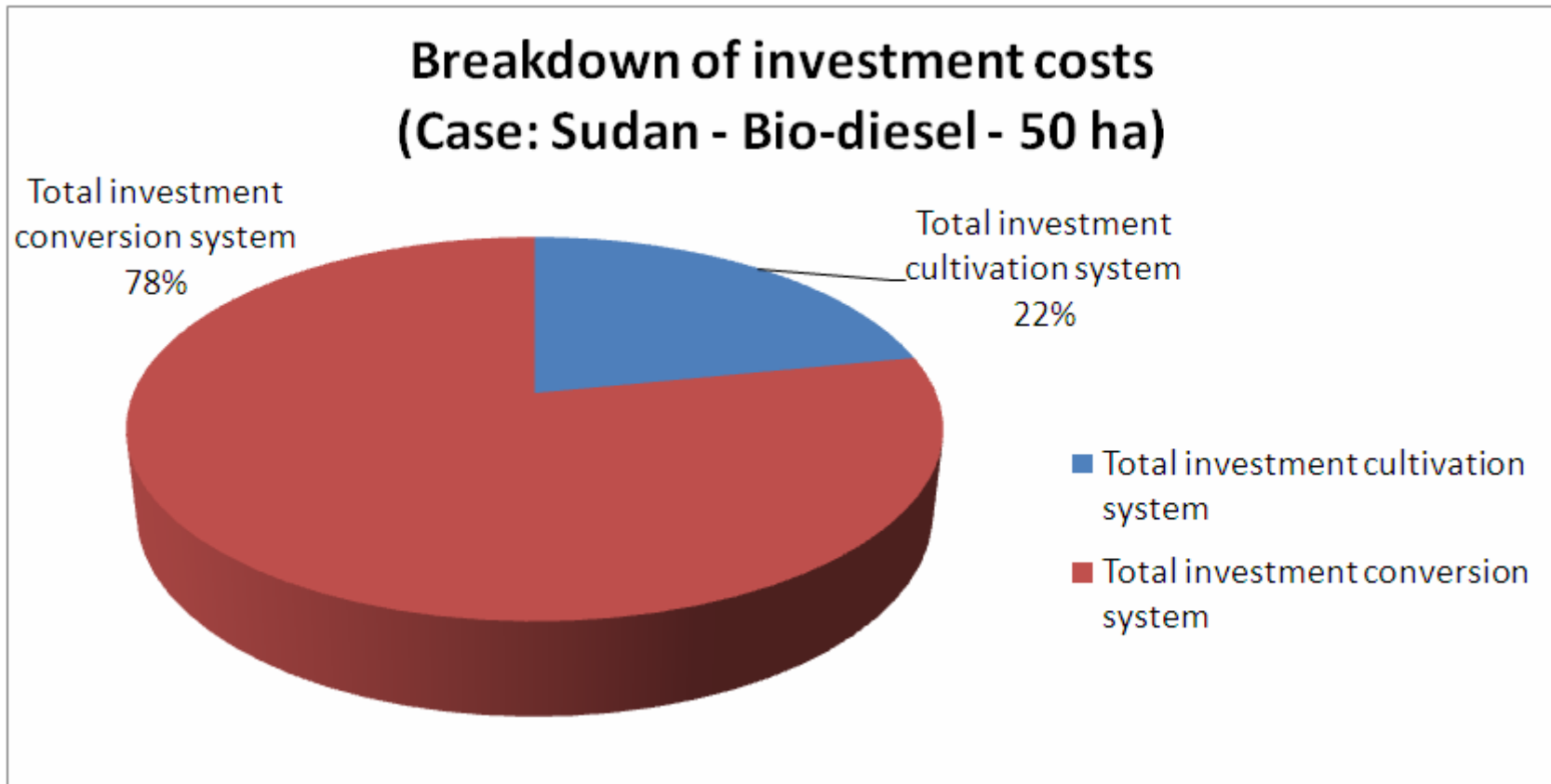


KEMA AlgaeValue Tool: Demonstration



Sudan

1/3

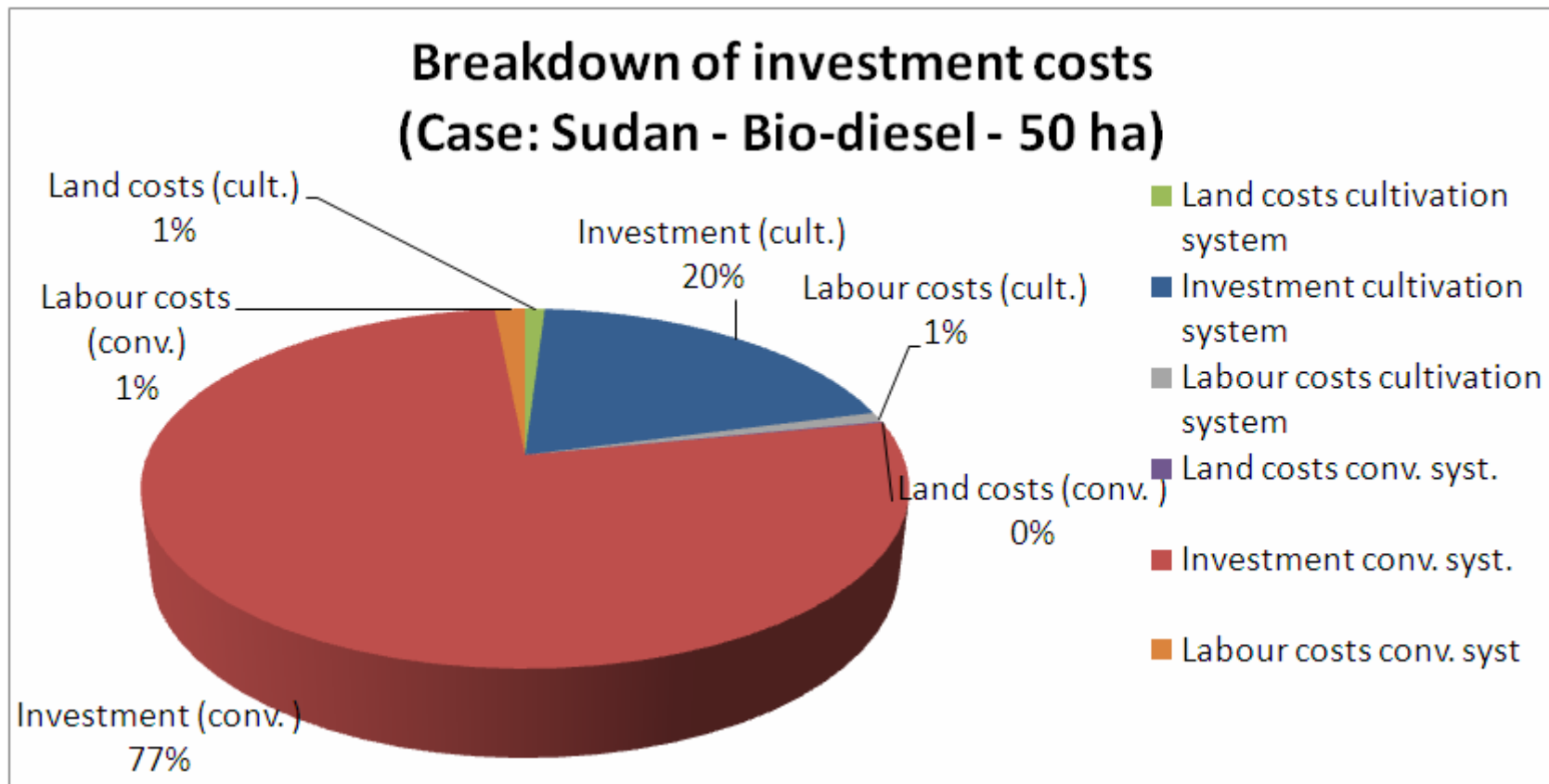


KEMA AlgaeValue Tool: Demonstration



Sudan

2/3

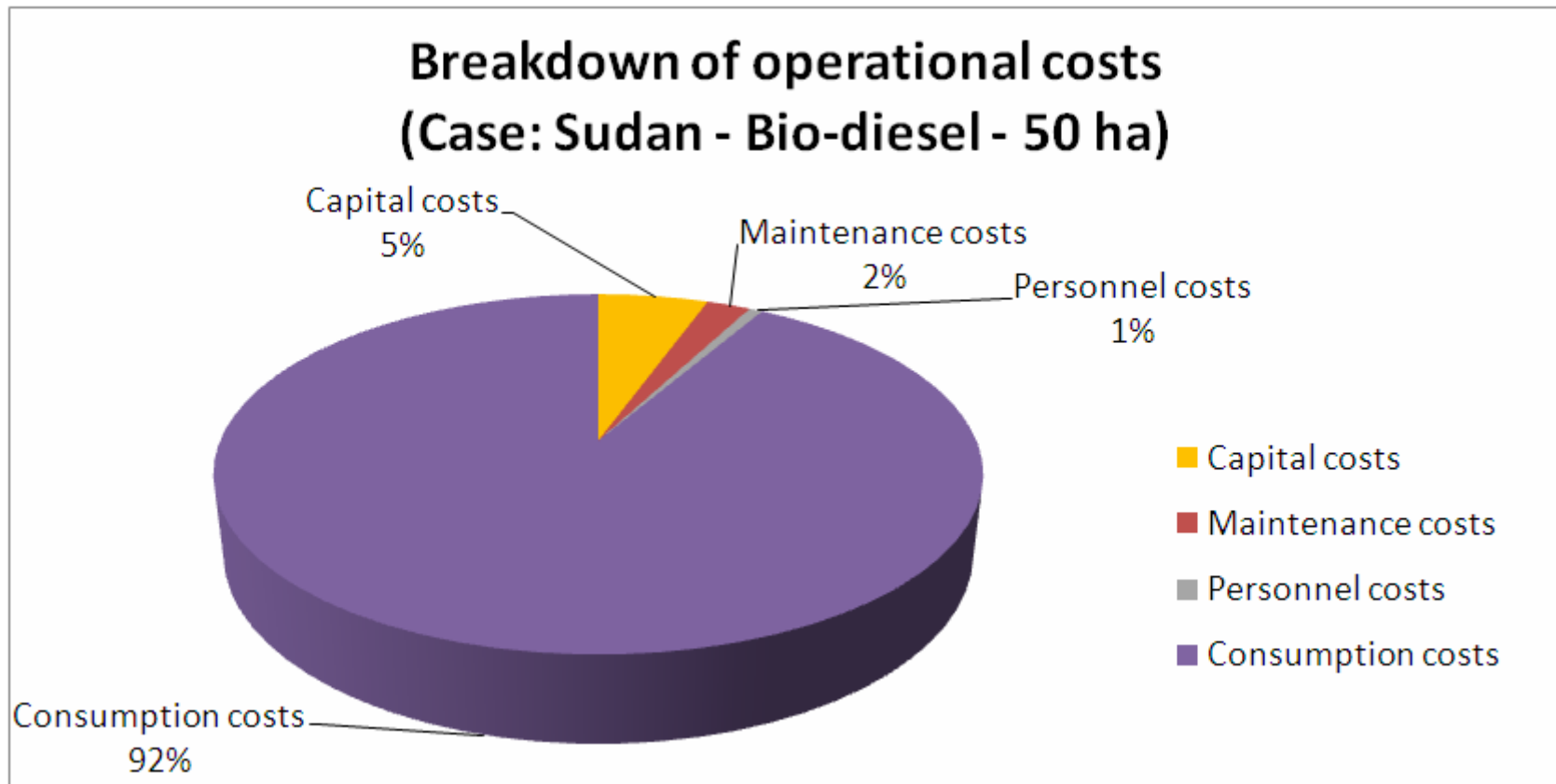


KEMA AlgaeValue Tool: Demonstration



Sudan

3/3



KEMA AlgaeValue Tool: Demonstration

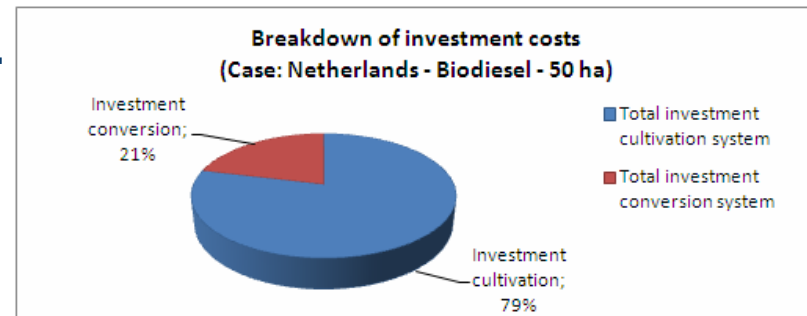


- **Note:**

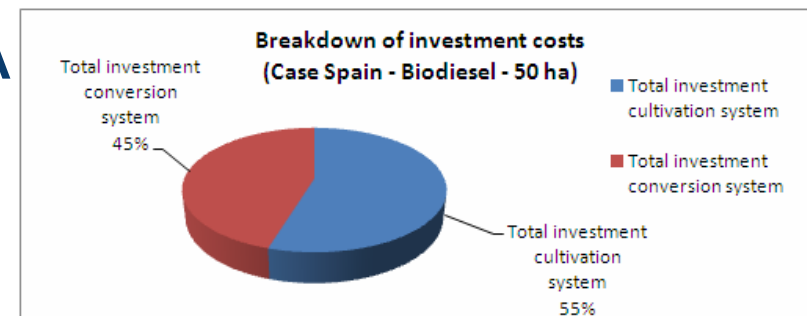
Different shares in **cultivation** and **conversion** investments per country

Explainable? Yes!

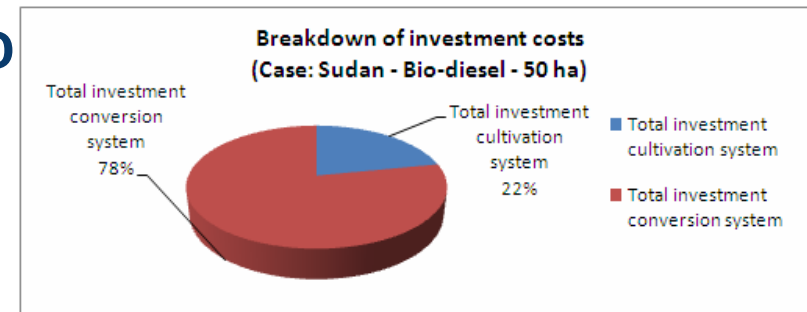
NL



SPA



SUD



KEMA AlgaeValue Tool: Demonstration

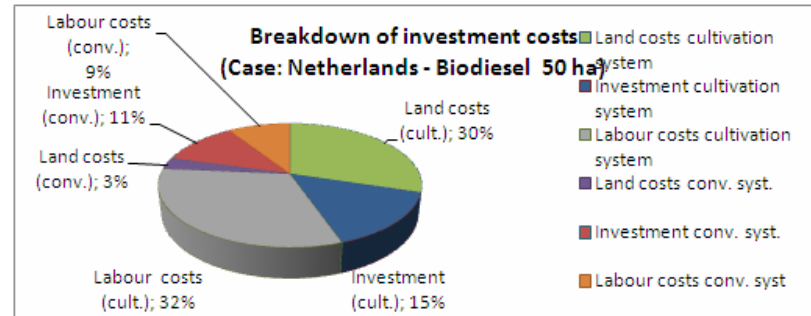


- Note:**

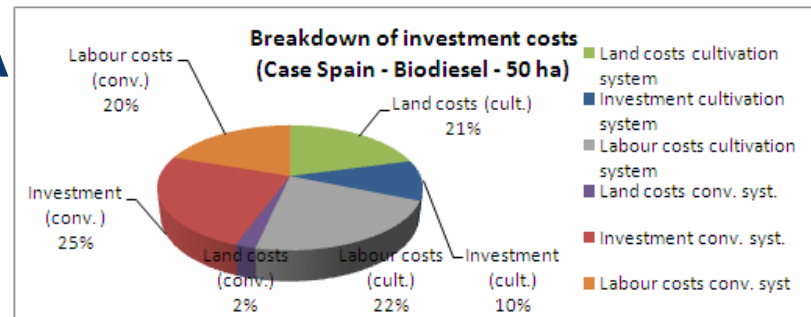
Different breakdown of investment costs per country

Explainable? Yes!

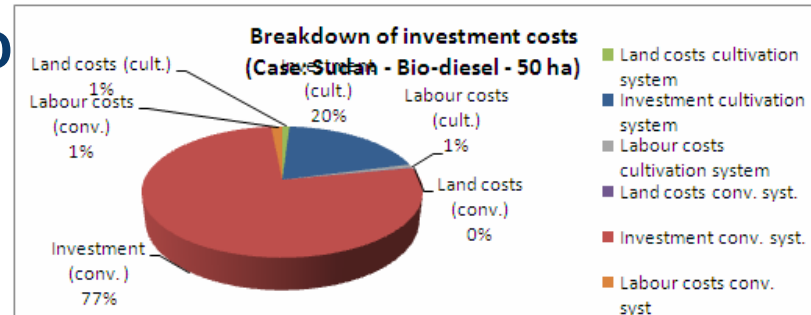
NL



SPA



SUD



KEMA AlgaeValue Tool: Demonstration

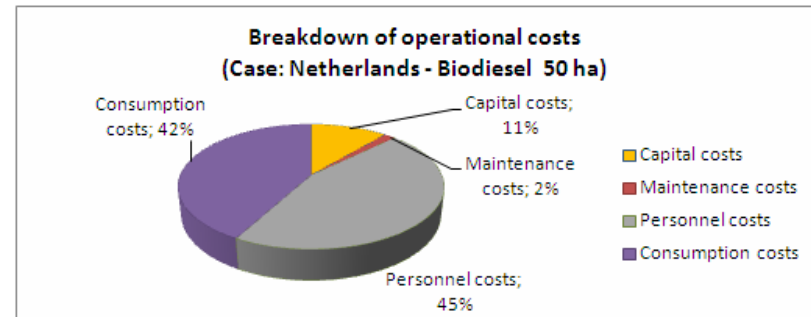


- **Note:**

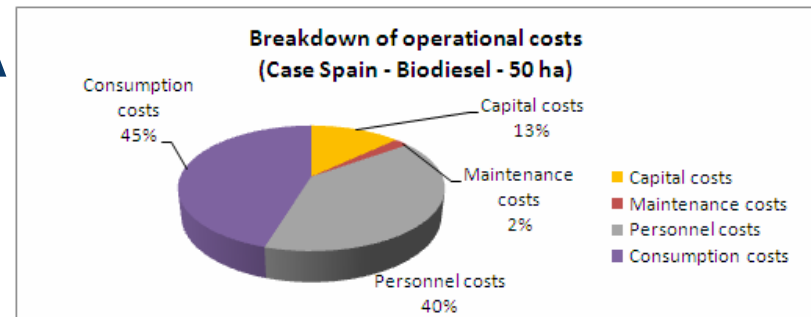
Different breakdown of **operational costs** per country

Explainable? Yes!

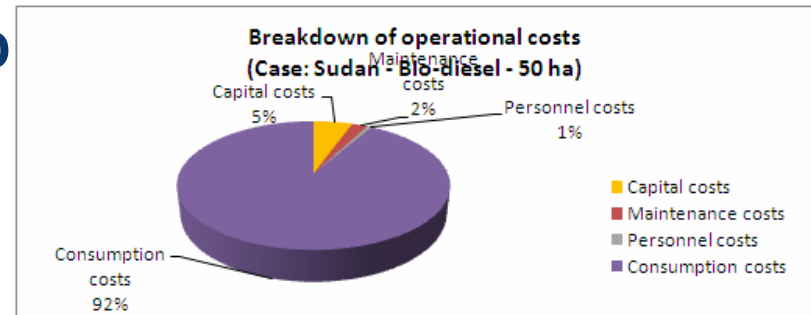
NL



SPA



SUD



KEMA AlgaeValue Tool: Demonstration



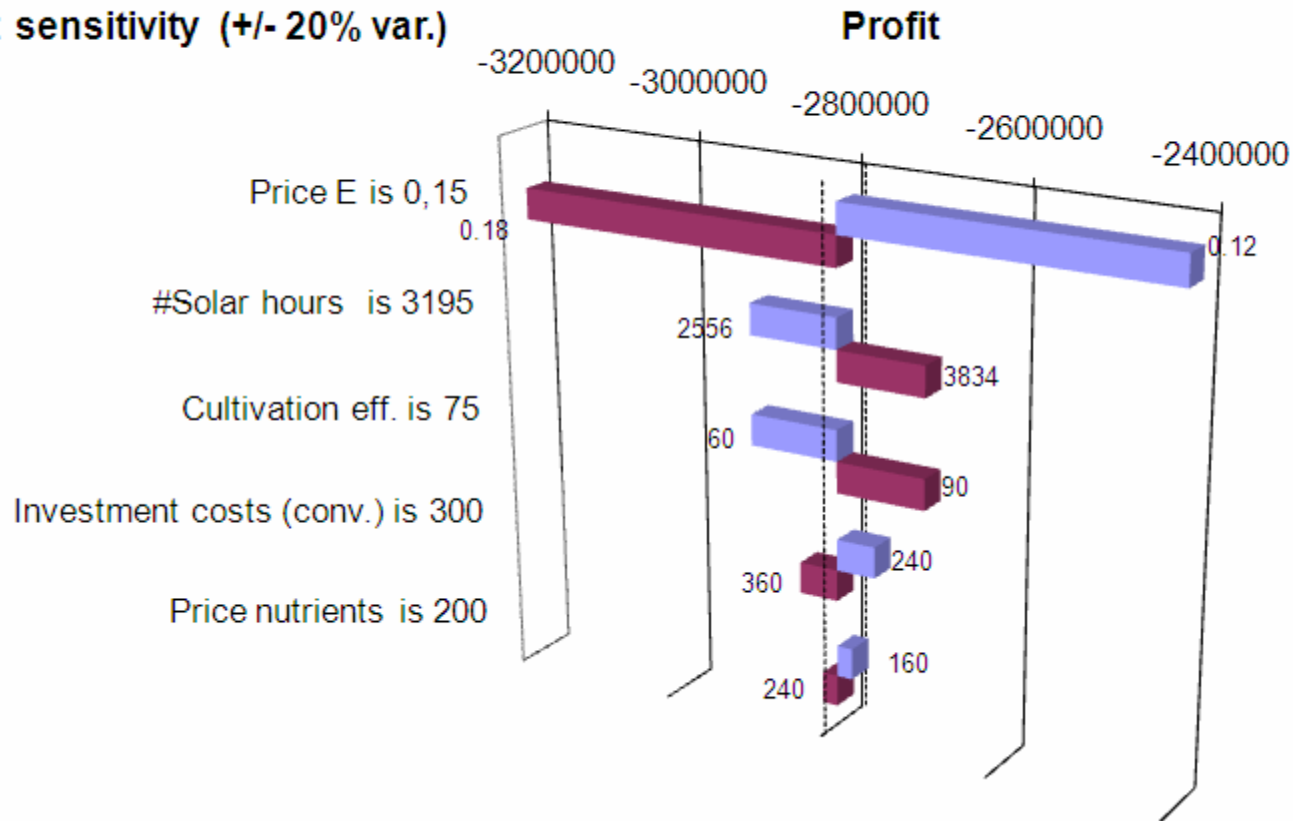
Further possibilities:

- Finding several break-even points by:
 - varying fuel market-prices
 - varying land prices
 - varying nutrient costs
 - etc...
- Do a sensitivity analysis: “which one hits hardest?”
- Alterate, recalculate...



Case: Sudan - Bio diesel - 50 ha

Cost sensitivity (+/- 20% var.)





KEMA AlgaeValue™ Tool...

How can KEMA help **you**?



Any independent advice about:

- System yield predictions
- Insight in cost/revenue build-up
- Cost/revenue sensitivity analysis
- Evaluation of concept changes
- Solving special client-specific problems



KEMA AlgaeValue™ Tool...

Already involved in algae-research or pilot project?



- KEMA invites **you** to (confidentially) share data for continuous model validation and up-to-date model improvement.
- KEMA likes to hear your opinion and is challenged by **your** algae project developments or plans.



Thank you for your attention

More info?

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