TESTING AND RISK PROFILING OF SUSTAINABLE AND BIO-BASED TECHNOLOGIES

How to bring new technologies successfully in a competitive market.

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ARISE SYMPOSIUM '18: CIRCULARITY THROUGH DESIGN

University of Twente

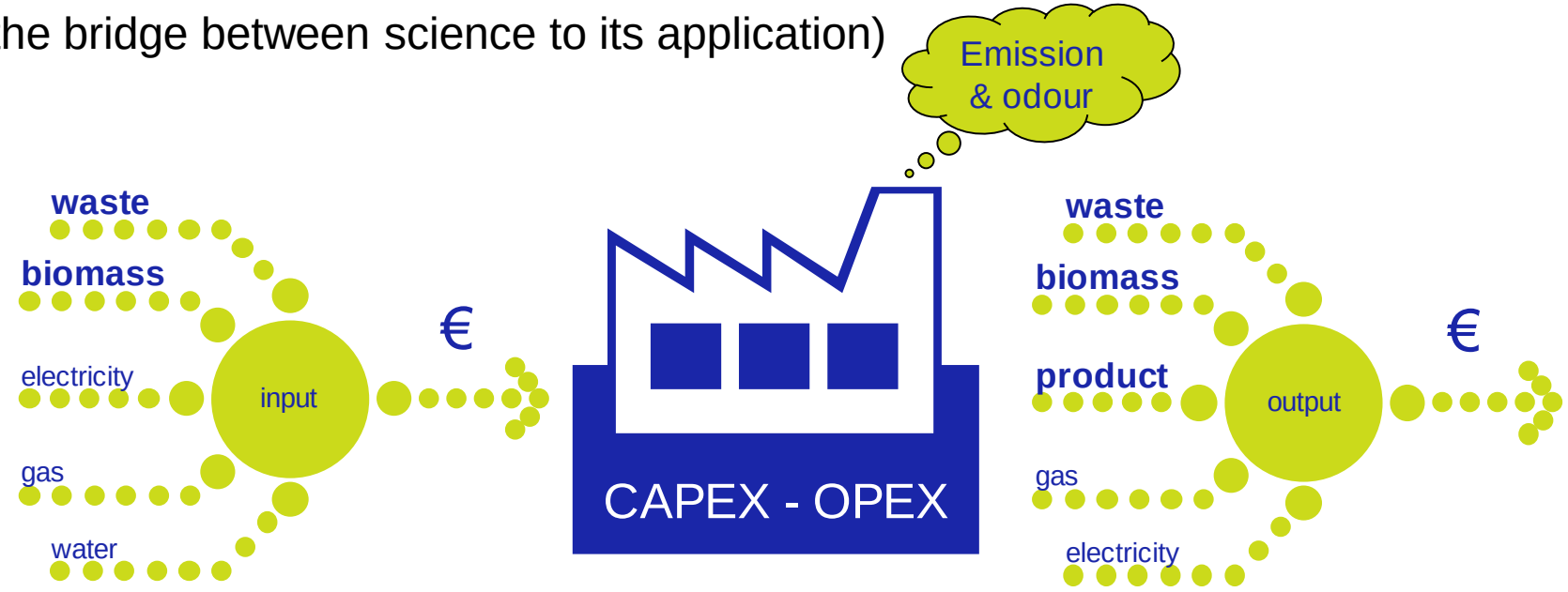
Our Job:

ingenia

Renewable technology based plants:

- Design, engineering
- Due diligence assessments for investors (NL, UK)
- Technology Investment Risk Analyses
- Business and market analyses
- Development of new technologies (waste feedstock)

(the bridge between science to its application)



Topics

Renewable & biobased technologies

Technology Investment Risk Profiling

Latest State of Art Technology

Examples

Monte Carlo Risk Analysis

Conclusions

Renewable & biobased technologies

- Renewable Technologies: Technologies that are used in sustainable energy production or the production of biobased materials.
- Short-cyclical (carbon), preserving biodiversity and ecosystems
- Netherlands: “Ladder van Lansink” principle

Examples:

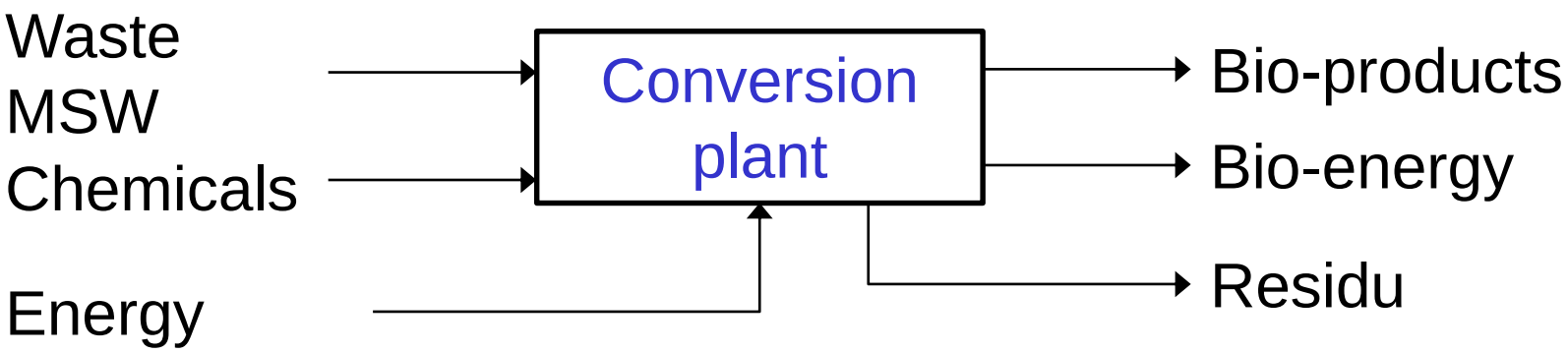
- Anaerobic digestion of manure and waste (biogas, CHP)
- Anaerobic fermentation of manure (biomethane) and N, P, K decay
- Pyrolysis of waste of recycled plastics (RDF)
- Gasification of waste
- Prune-wood-fired biomass power station (incineration, CHP, W-grid)
- Torrefaction from wood to bio-coal

Examples

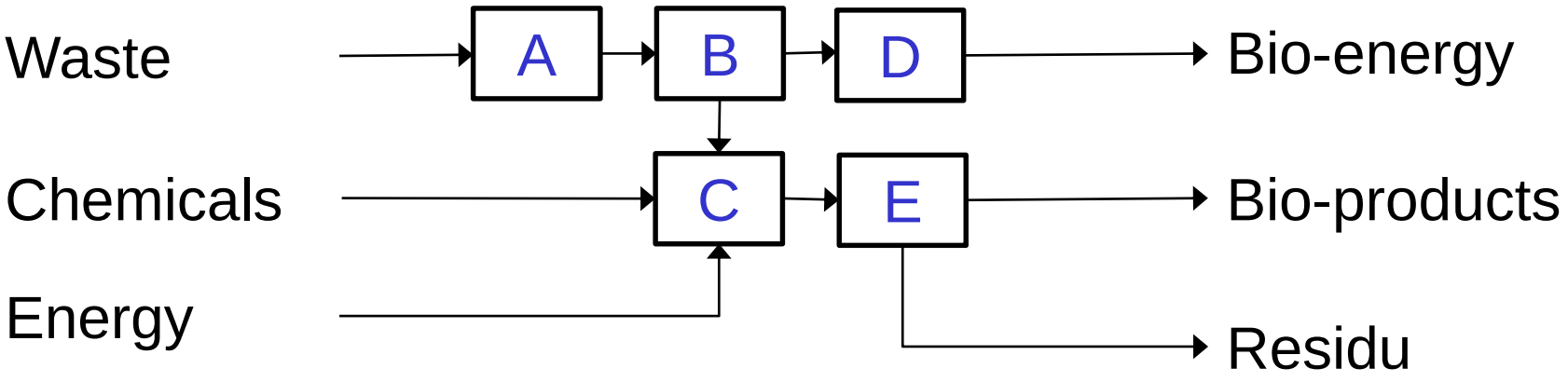
Biomass plant (district heat)

Anaerobic waste digestion & bio-methane production

The plant



The technologies: chemistry, physics, biology, thermochemical, ….



Technology Investment Risk profiling

→ Goal: to quantify the risks and effects (impact) of
the combination of the applied conversion technologies
within the framework of the mass and energy balances.

→ Taking into account the effectiveness of mitigating measures

→ Quantitative Output = Input for Investors

→ Is part of a due diligence investigation

→ Multidisciplinary approach

Focus

- Technologies:
  - TRL & BAT
  - mass and energy balances and its sensitivity,
  - operational characteristics, MTBF, MTTR
  - redundancy, maintenance

- Business economics:
  - Financial business plan (cash flow analysis),
  - Markt analysis (supply chain)
  - Rivalry: Porter 5-Forces model
  - Macro-environmental factors: PESTEL analysis

- Entrepreneur:
  - Legal: market conformity supply and sales contracts
  - Implementation phase: project management, procedures, (sub)contracting
  - ORCA: organization, communication & approach

Scientific background

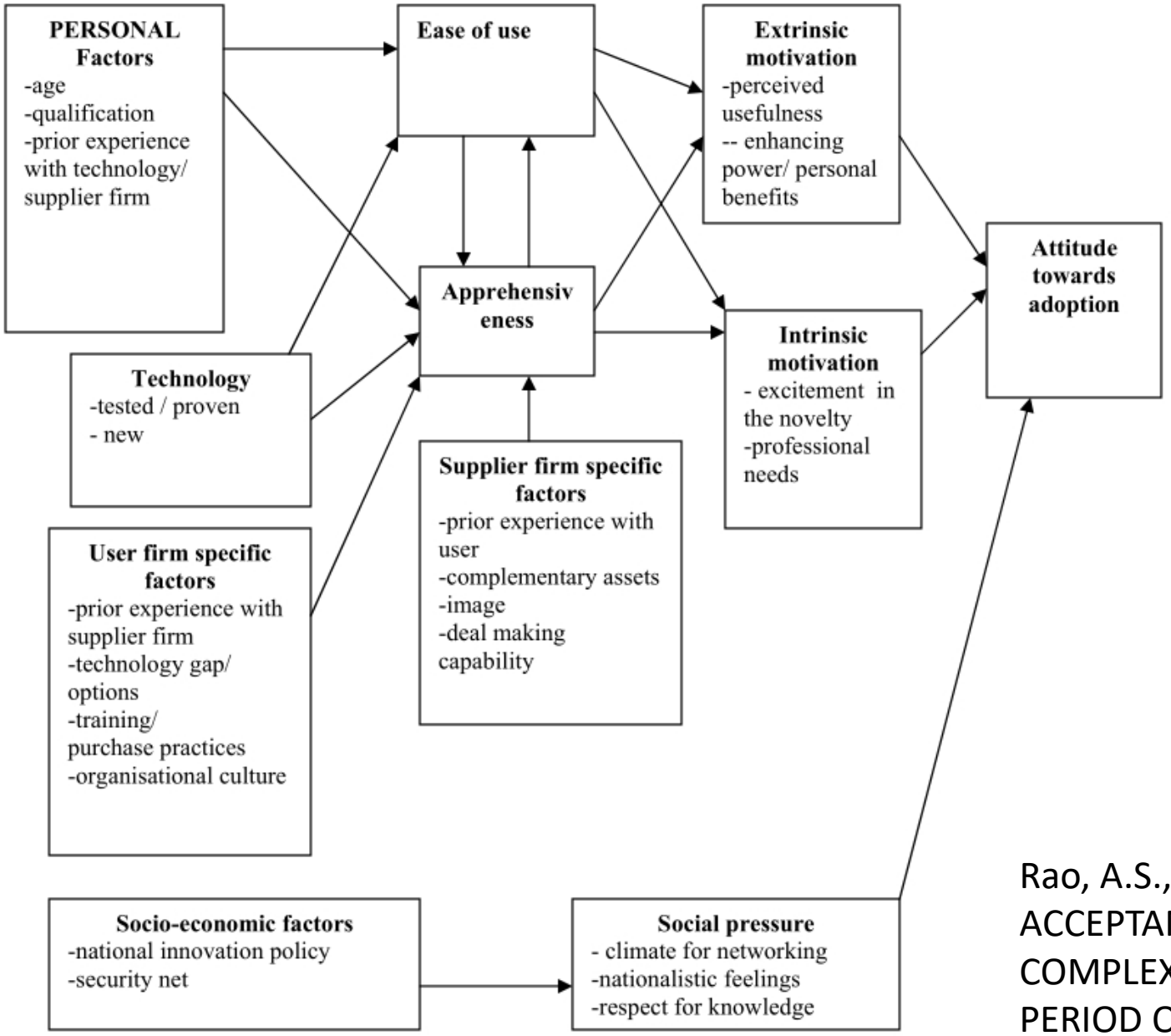
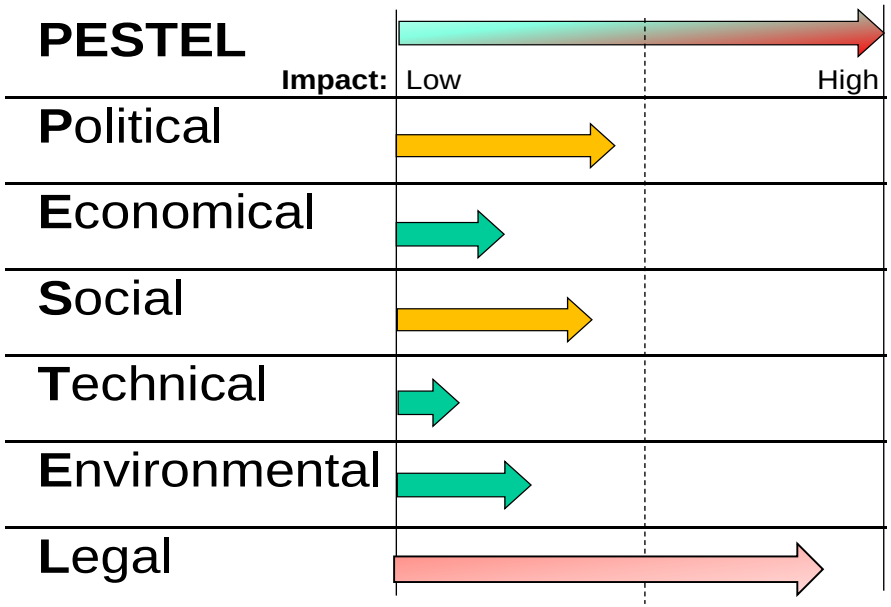


Fig1: Technology Acceptance Model

Rao, A.S., TECHNOLOGY ACCEPTANCE MODEL FOR COMPLEX TECHNOLOGIES IN A PERIOD OF RAPID CATCHING-UP, Dept of Scientific and Industrial Research, New Delhi 2016

Can we beat incumbent companies?



After you have completed a PESTEL analysis you should be able to use this to help you identify the strengths and weaknesses for a SWOT analysis.

State of Art Technology

Technology Readiness Level TRL

TRL9 **Operations**

TRL8 **Active Commissioning**

TRL7 **Inactive Commissioning**

TRL6 **Large Scale**

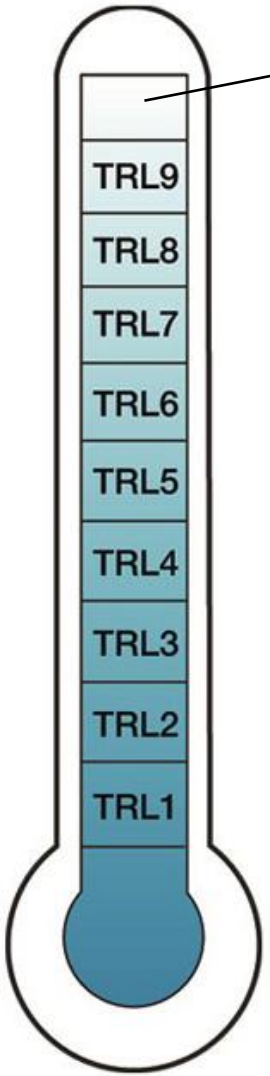
TRL5 **Pilot Scale**

TRL4 **Bench Scale Research**

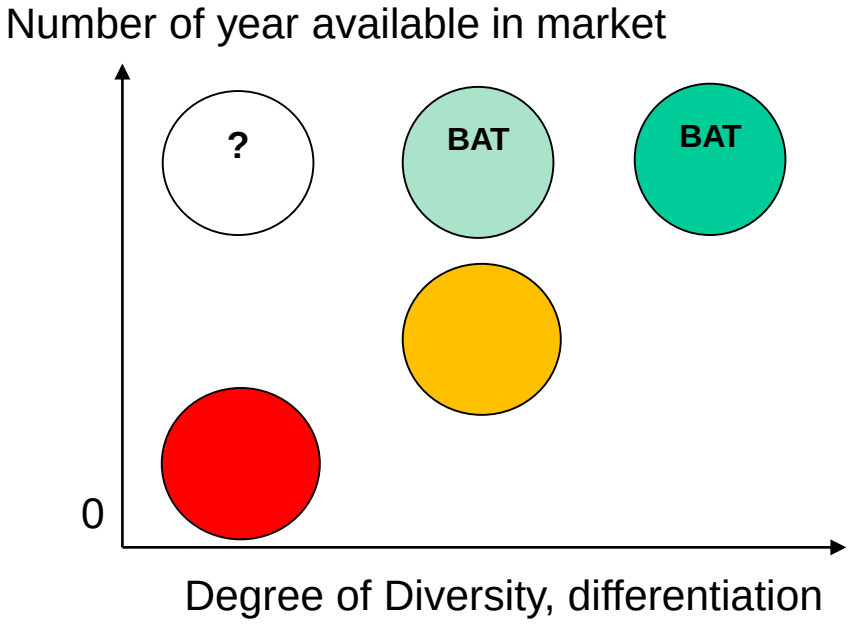
TRL3 **Proof of Concept**

TRL2 **Invention and Research**

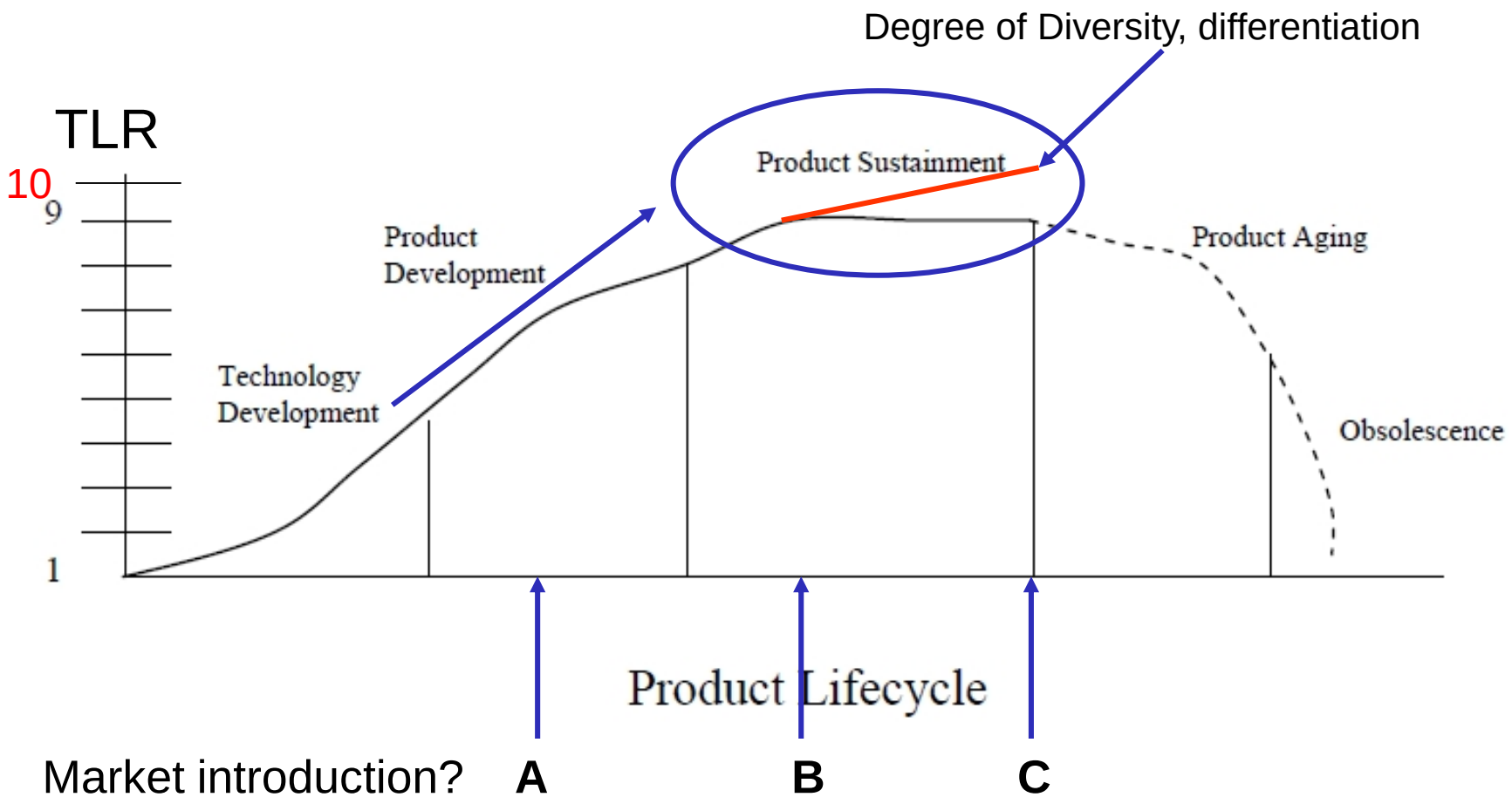
TRL1 **Basic principles**



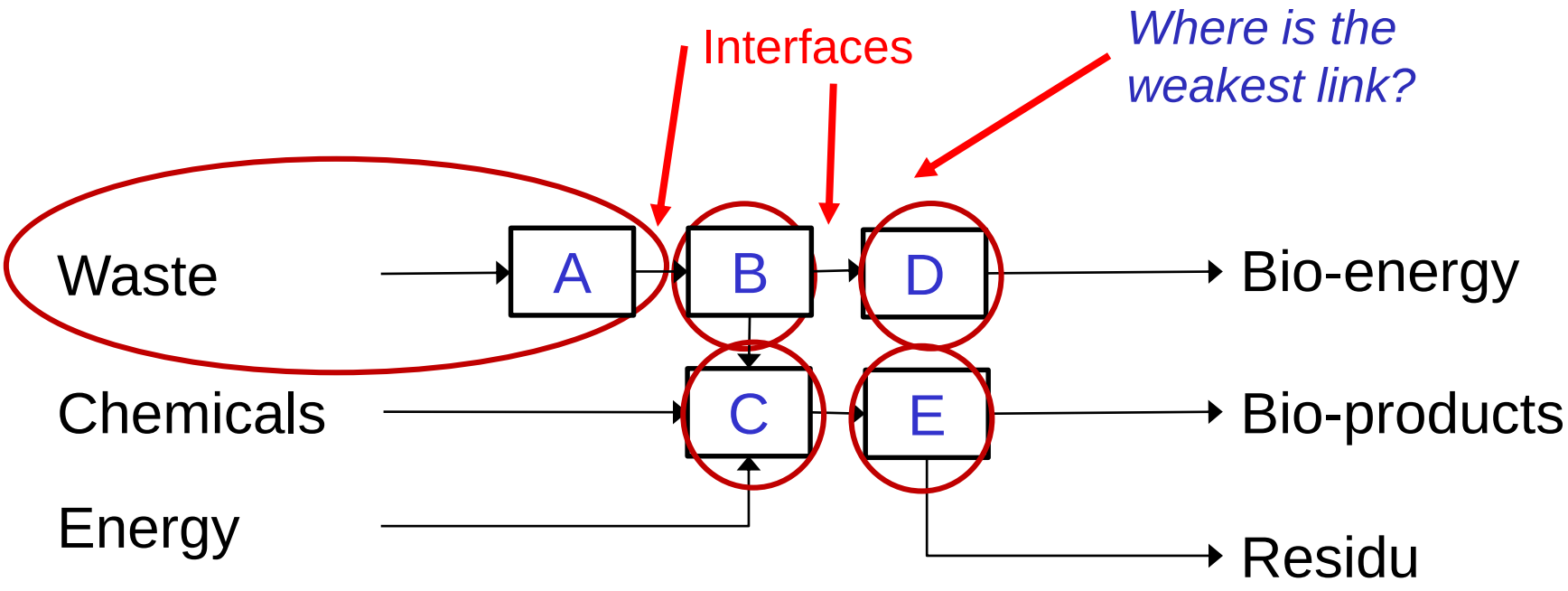
Best Available Technologies BAT



TLR and lyfecycle

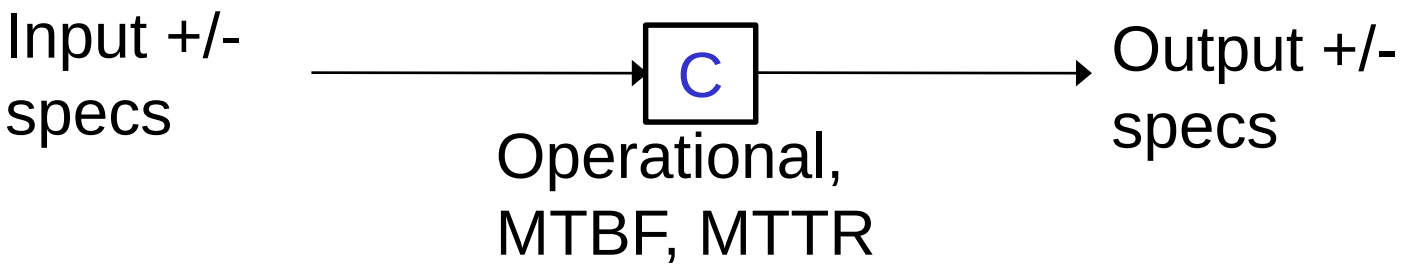


Where are risks?



More Unit Operations = higher chance of problems:
Cascade Effects !

Waste input = no homogeneous composition



Rating Scale for Technology Risk Driver (example)

Viewpoint	Very Low	Low	Nominal	High	Very High
Lack of Maturity	Technology proven and widely used throughout industry	Proven through actual use and ready for widespread adoption	Proven on pilot projects and ready to roll-out for production jobs	Ready for pilot use	Still in the laboratory
Lack of Readiness	Mission proven (TRL 9)	Concept qualified (TRL 8)	Concept has been demonstrated (TRL 7)	Proof of concept validated (TRL 5 & 6)	Concept defined (TRL 3 & 4)
Obsolescence	(Obsolescence not an issue)	(Obsolescence not an issue)	Technology is the state-of-the-practice; emerging technology could compete in future	Technology is stale; new and better technology is on the horizon in the near-term	Technology is outdated and use should be avoided in new systems; spare parts supply is scarce
Cost multiplier	0.68	0.82	1.0	1.32	1.75

Branche/technology specific!

Source: *Valerdi & Kohl (2004)*
An Approach to Technology Risk Management, MIT, Cambridge

RISMAN method

Probability of occurrence

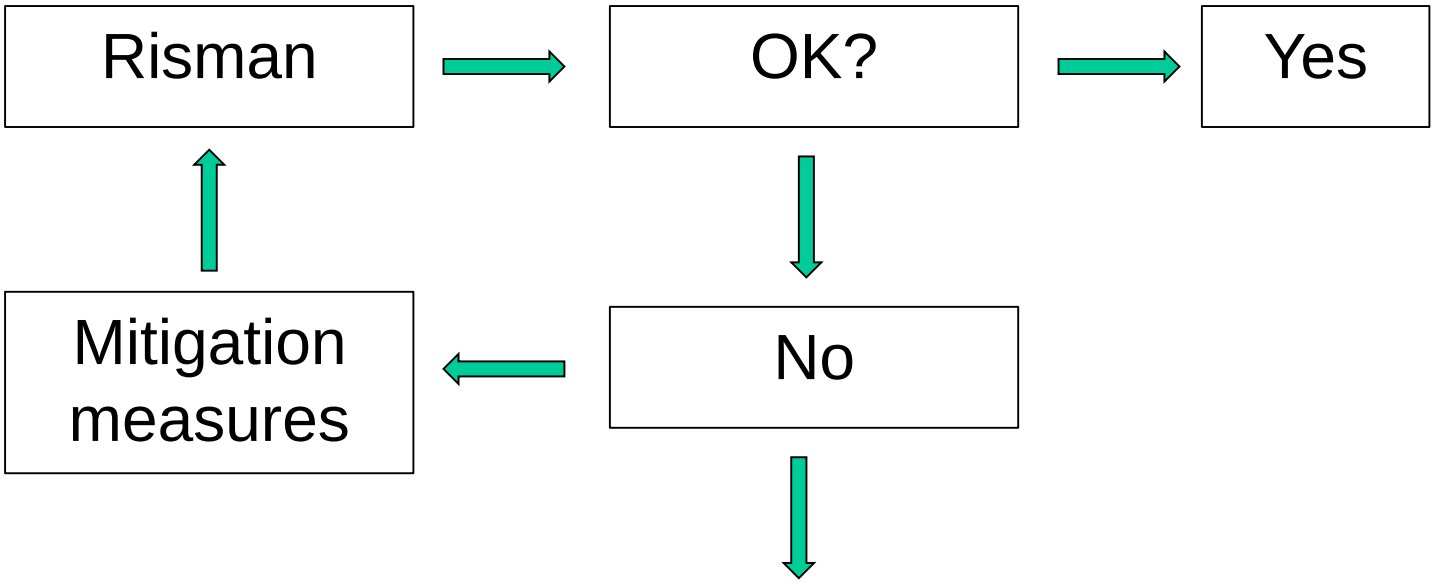
rating	categorization	probability of occurrence
1	extremely unlikely	- Once per 100 years, or - <0,1% of the time (1 in >1000)
2	very unlikely	- Once per 10 years, or - <1% of the time (1 in >100)
3	unlikely	- Once per year, or - <10% of the time (1 in >10)
4	likely	- Multiple times per year, or - about 50% of the time
5	very likely	- Multiple times per month/week/day, or - usual

Seriousness of event

rating	categorization	consequence or effect
1	acceptable	- Availability: operating hours >7500 hours per year, and/or - possible damage or additional repair might be < € 10.000
2	moderate	- Availability: operating hours <7500 hours per year, and/or - damage or additional repair is € 10.000-100.000
3	important	- Availability: operating hours <4000 hours per year, and/or - damage or additional repair is € 100.000-500.000
4	serious	- Availability: operating hours <2000 hours per year, and/or - damage or additional repair is € 500.000-1.000.000
5	disastrous	- Availability: the plant is shut down for over 1 year, and/or - damage or additional repair is > € 1 million

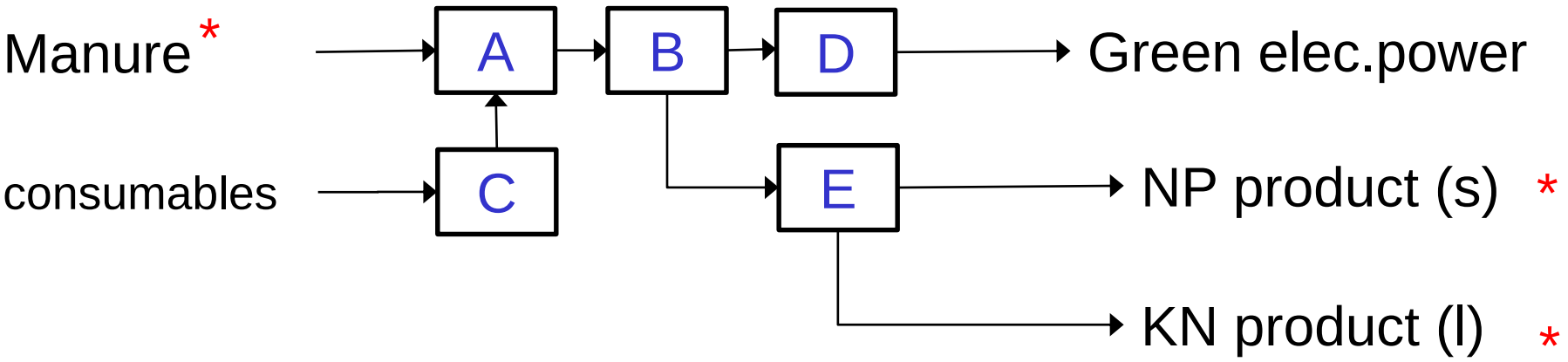
probability		1	2	3	4	5
seriousness		extremely unlikely	very unlikely	unlikely	likely	very likely
1	acceptable	1	2	3	4	5
2	moderate	2	4	6	8	10
3	important	3	6	9	12	15
4	serious	4	8	12	16	20
5	disastrous	5	10	15	20	25

RISMAN method



Sometimes:
"NO GO"
→ fundamental (design) problem

Example: Biogas production



A: Bioreactor
B: Post digestor
C: Shredder
D: CHP unit
E: Centrifuge

* Special issues

Some financial figures (Ingenia):

Biogas plant (complexity: **medium**): 1st year:

- 5-10% lower revenues
- 15-20% higher non-recurring expenses

(than in business plan estimated)

Biogas plant (complexity: **high**): 1st year:

- 10-15% lower revenues
- 20-30% higher non-recurring expenses

Market introduction of New technology TLR 8/9:

- Cost price (after Design for Construction) = + 30%

(if successfully implemented)

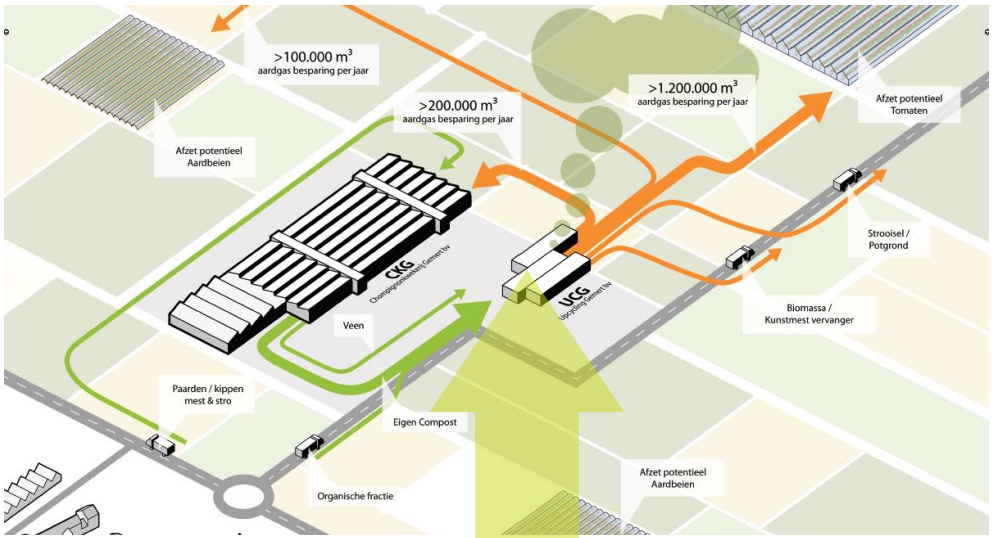
Biobased Economy Prijs

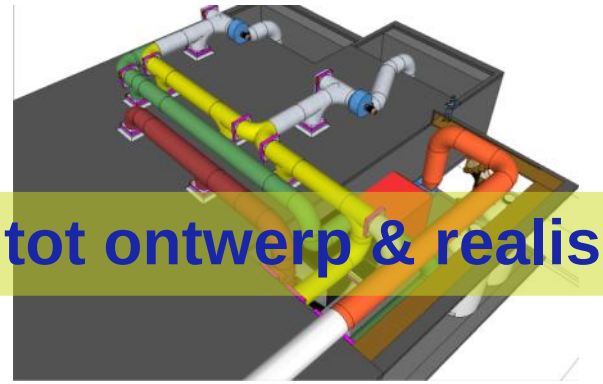
Herman Wijffels Prijs

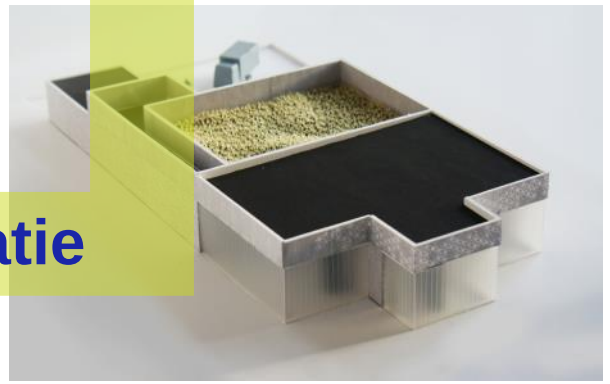
Example: Mushroom production farm

Biological drying of SMC:

- Pilot equipment
- Product development
- Design
- Market analysis
- Business case

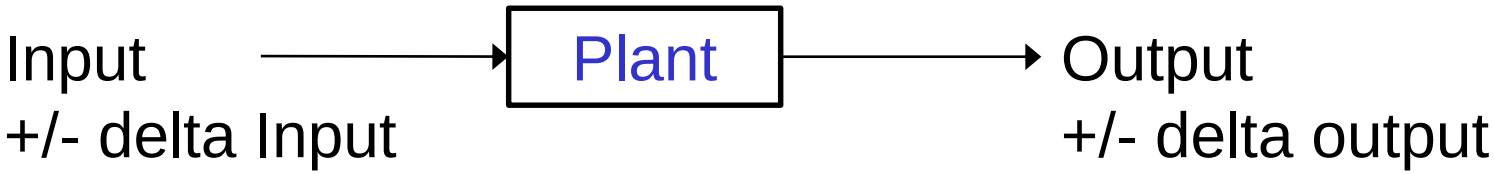






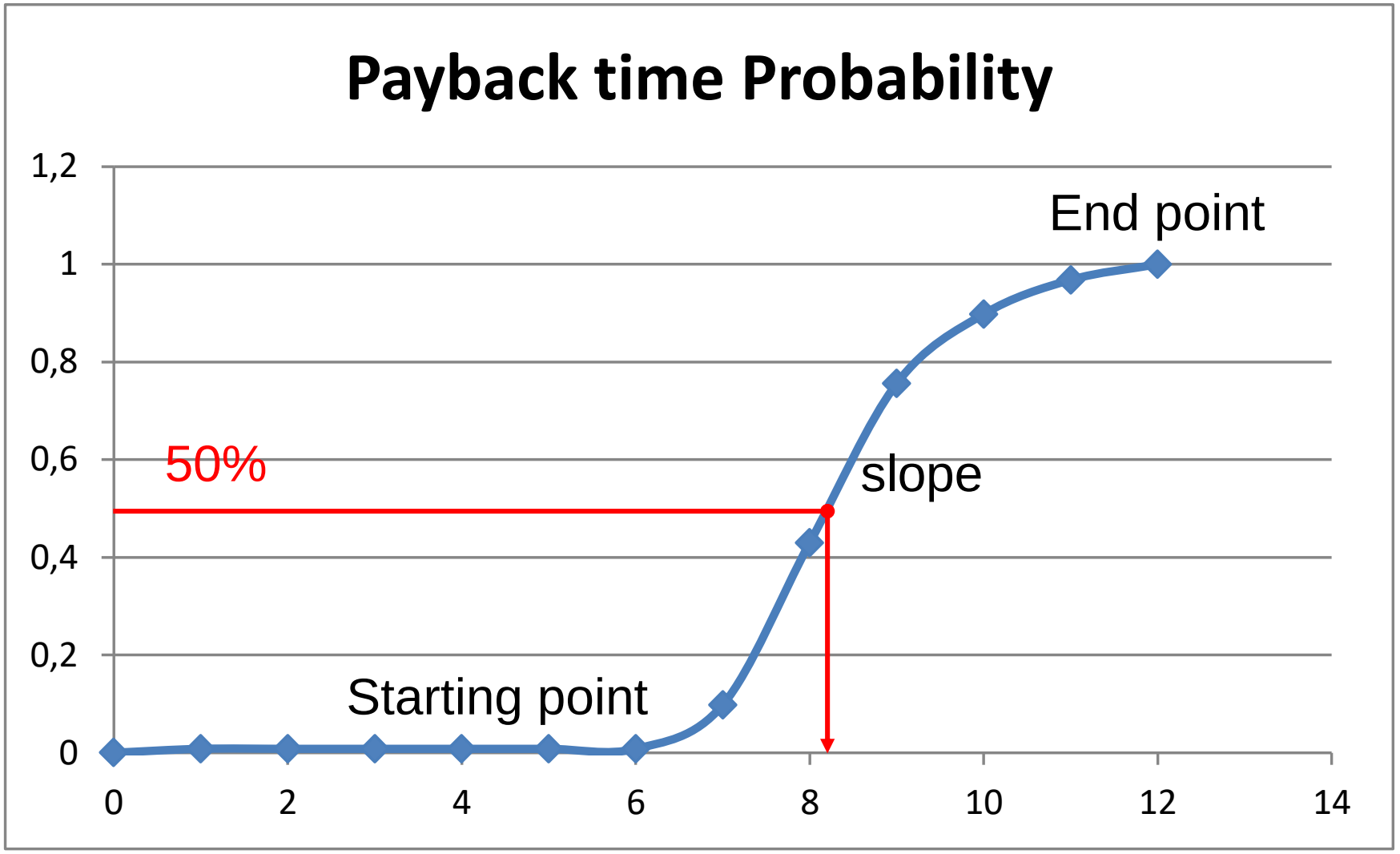
van pilot tot ontwerp & realisatie

Monte Carlo Risk Analysis



- Raw materials (costs)
- Gas yield
- Caloric value
- Ash content
- Sales
- …….

- Euro change
- IRR
- NPV
- PBT
- …….


Payback time Probability
1,2
1
0,8
0,6
0,4
0,2
0
0
2
4
6
8
10
12
14
End point
50%
slope
Starting point

Conclusions

- TIRP = **multidisciplinary** approach
- Assessing risks requires **knowledge** but also **experience**
- Many **pitfalls** for entrepreneurs in sustainable energy
- **Well thought over 'interfaces'** in contracts, but also in technical design are essential
- The more cross-linked sub-techniques are applied, the greater the chance of **problems**.
- Point of interest: **Cascade effects** and **redundancy**