

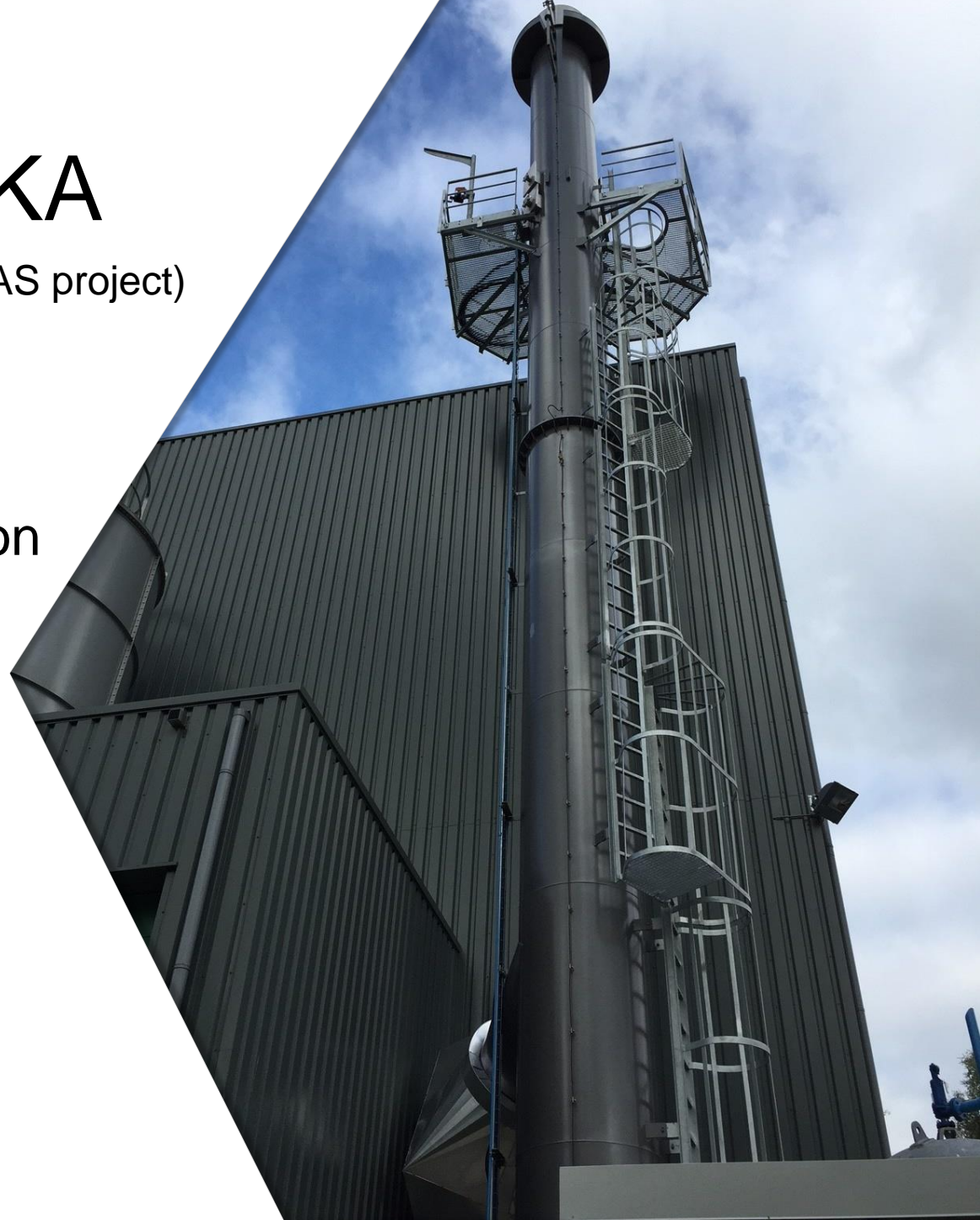
Reject gasifier ESKA

BTX co-production (ESKA-ECN ESKAGAS project)

IEA Bioenergy Task 33 –
Workshop on Waste gasification

May 8th 2018

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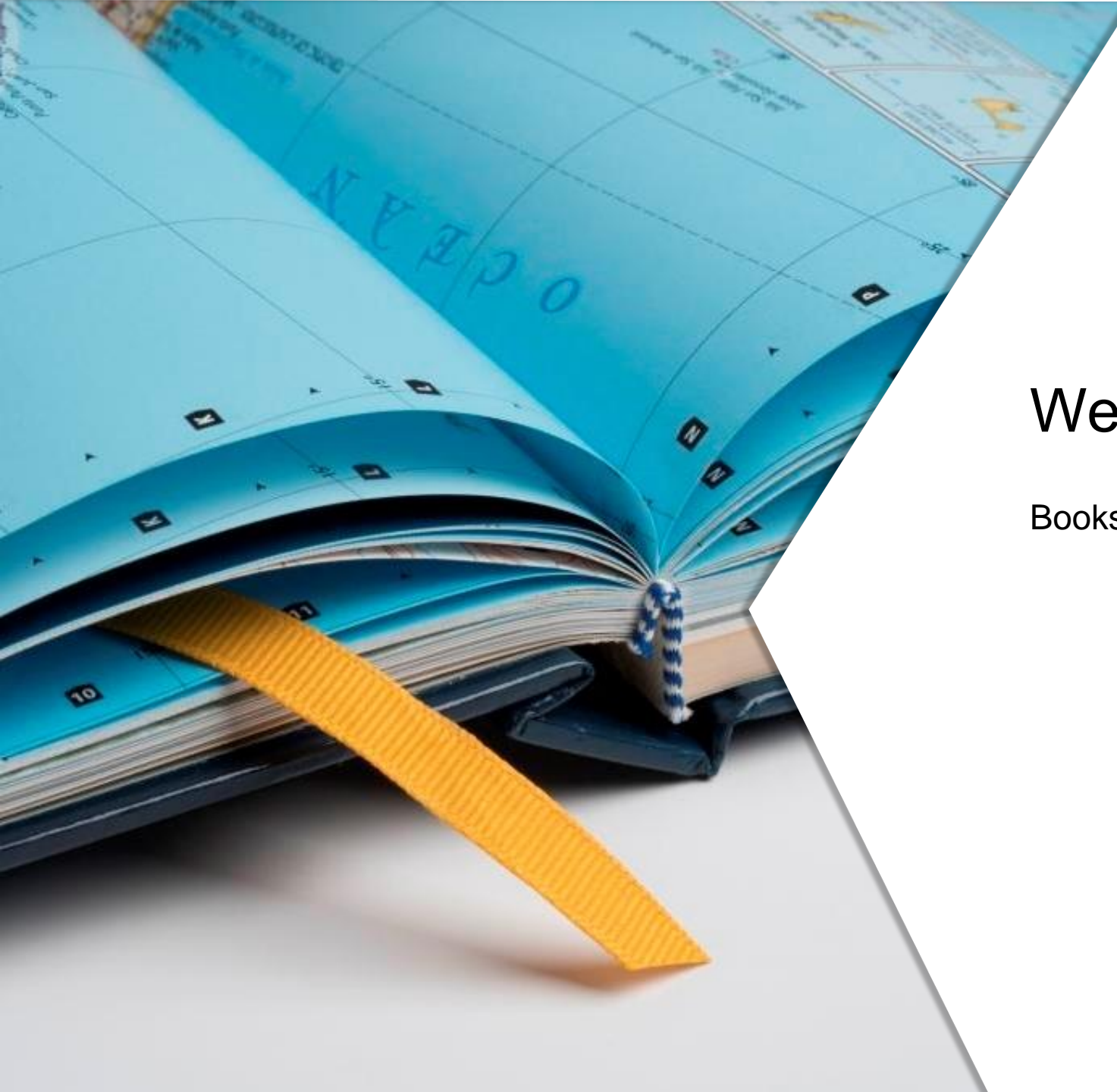
Content

- ESKA
- Socio-economic developments
- The initiative of ESKA: CFB gasification of paper rejects
- What are the results?
- ECN and ESKA in the project ESKAGAS
- On-site measurements
- Lab-experiments and co-production
- Conclusions



ESKA

We're in



We're in books

Books are forever





We're in stationery





We're in puzzles
and games





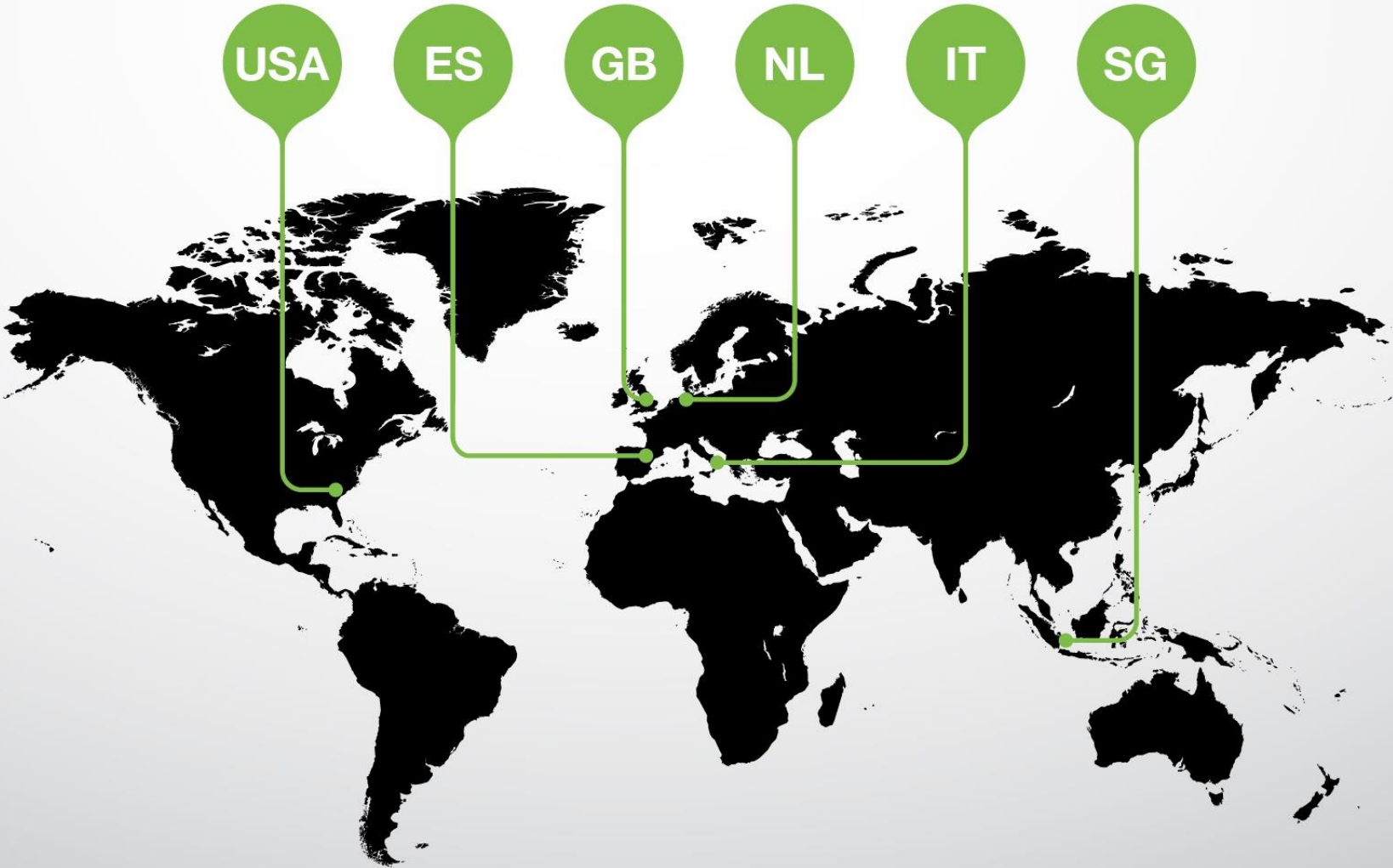
We're in luxurious packaging





We're in more

We're global



Developments

Society:

- Useful handling of mass, energy, waste
- No hinder, safer, cleaner
- Space conscious

•Economics:

- Raw materials for recycling become scares, expensive, polluted
- Increased cost for residue disposal
- Despite strongly improved energy-efficiency, the overall energy cost increase

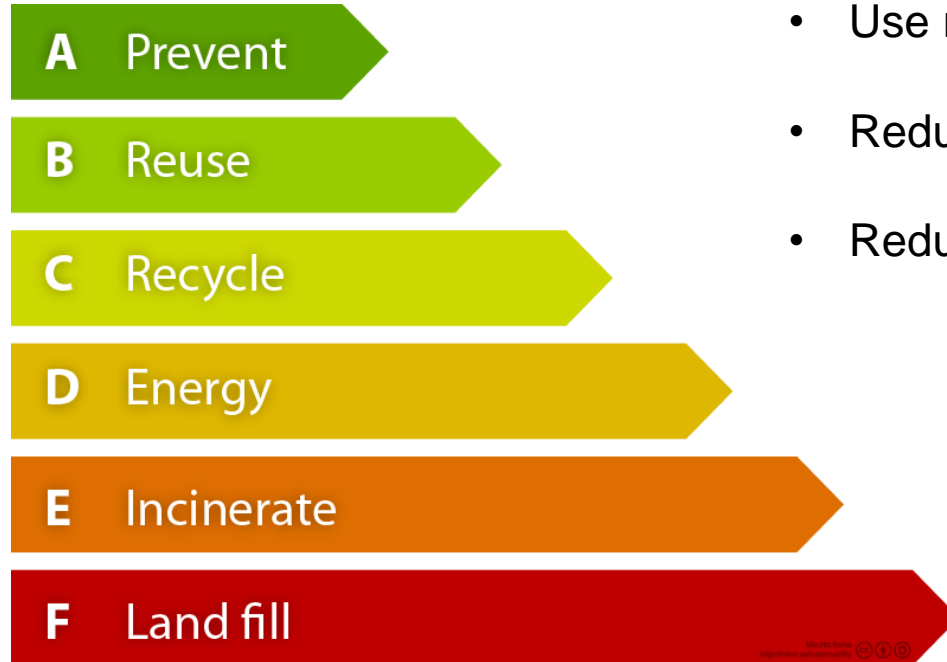
- **Both developments pose a threat for us**

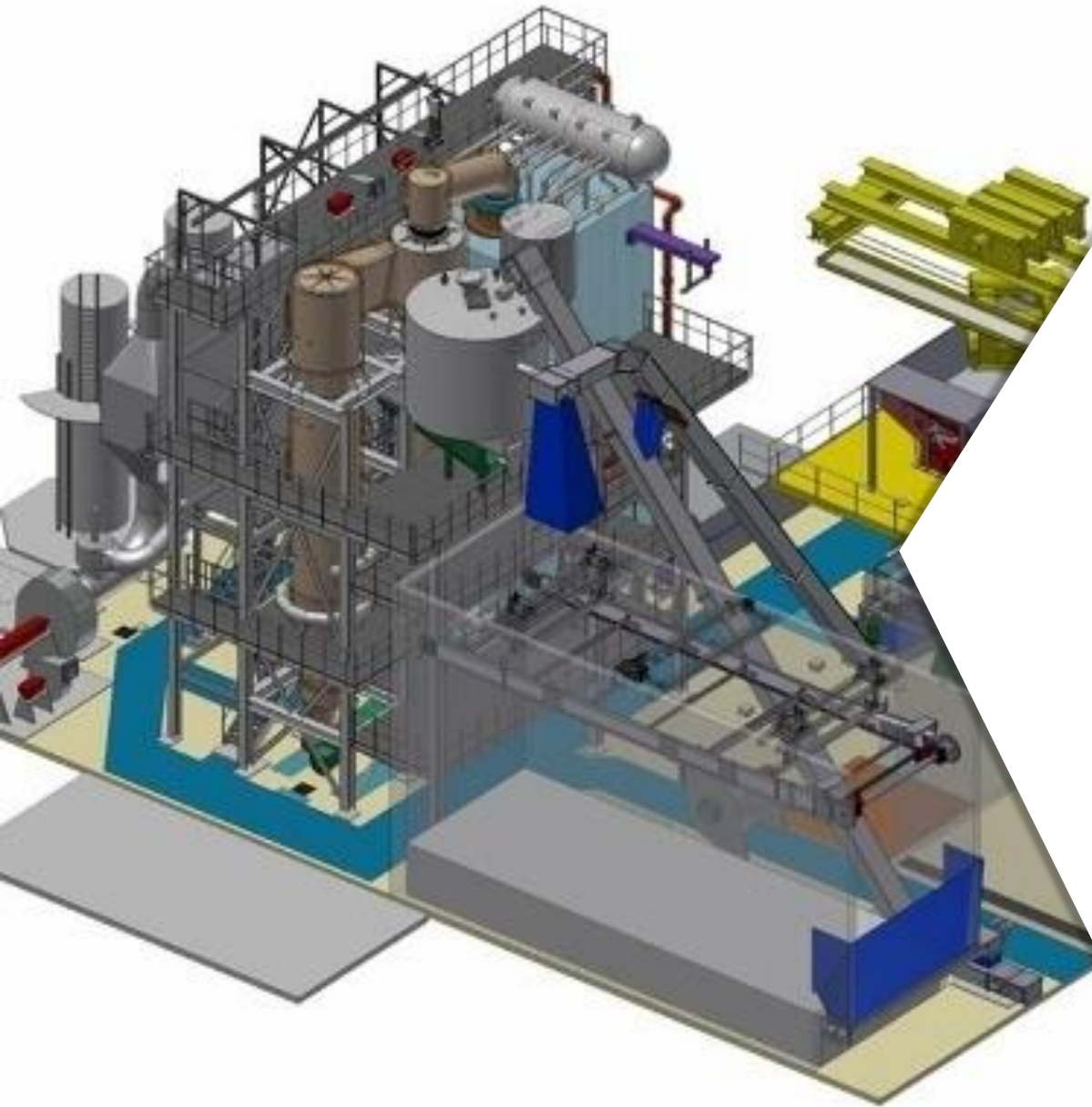


The opportunity

Lansink's Ladder, waste management hierarchy:

- Recycle paper
- Use residues for steam production
- Reduce natural gas use
- Reduce residues disposal





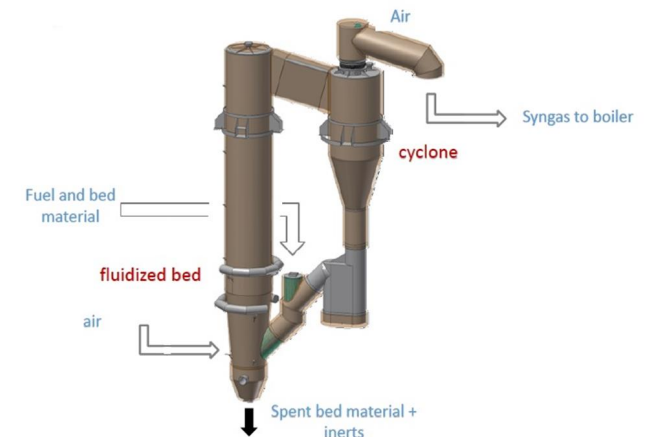
Our initiative

Process 25 kton/a paper rejects to produce steam for direct use in the cardboard production line in Hoogezand

Replace/reduce natural gas driven CHP and disposal of residues

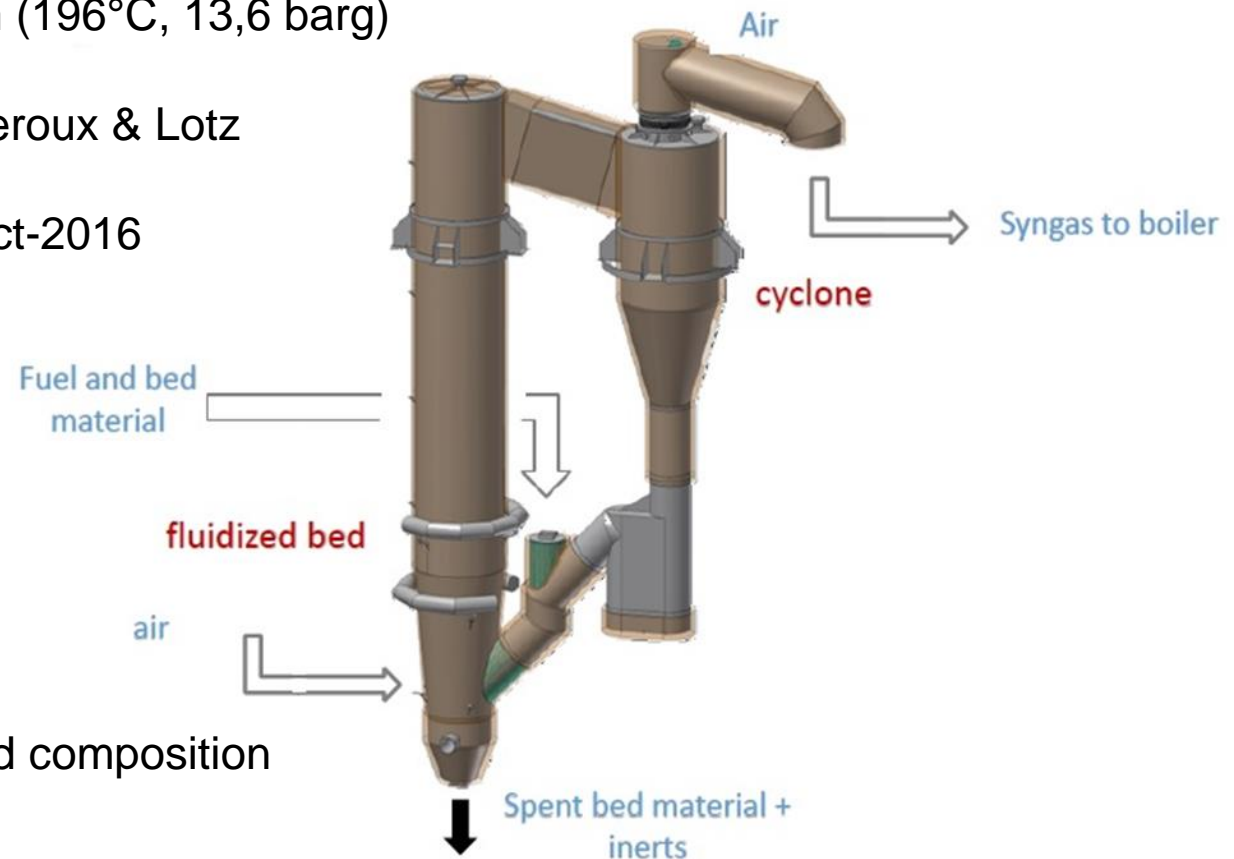
Basis of the initiative

- Convert paper recycling residues into energy for own use. Close ESKA's cycles
- Reduce the market-driven risks of energy and residues
- Located at the factory premises Hoogezand
- Must fit within the existing noise permit
- Must comply to the current odor permit
- Very low flue gas emissions
- High mass- and energy efficiency
- Earthquake resistant

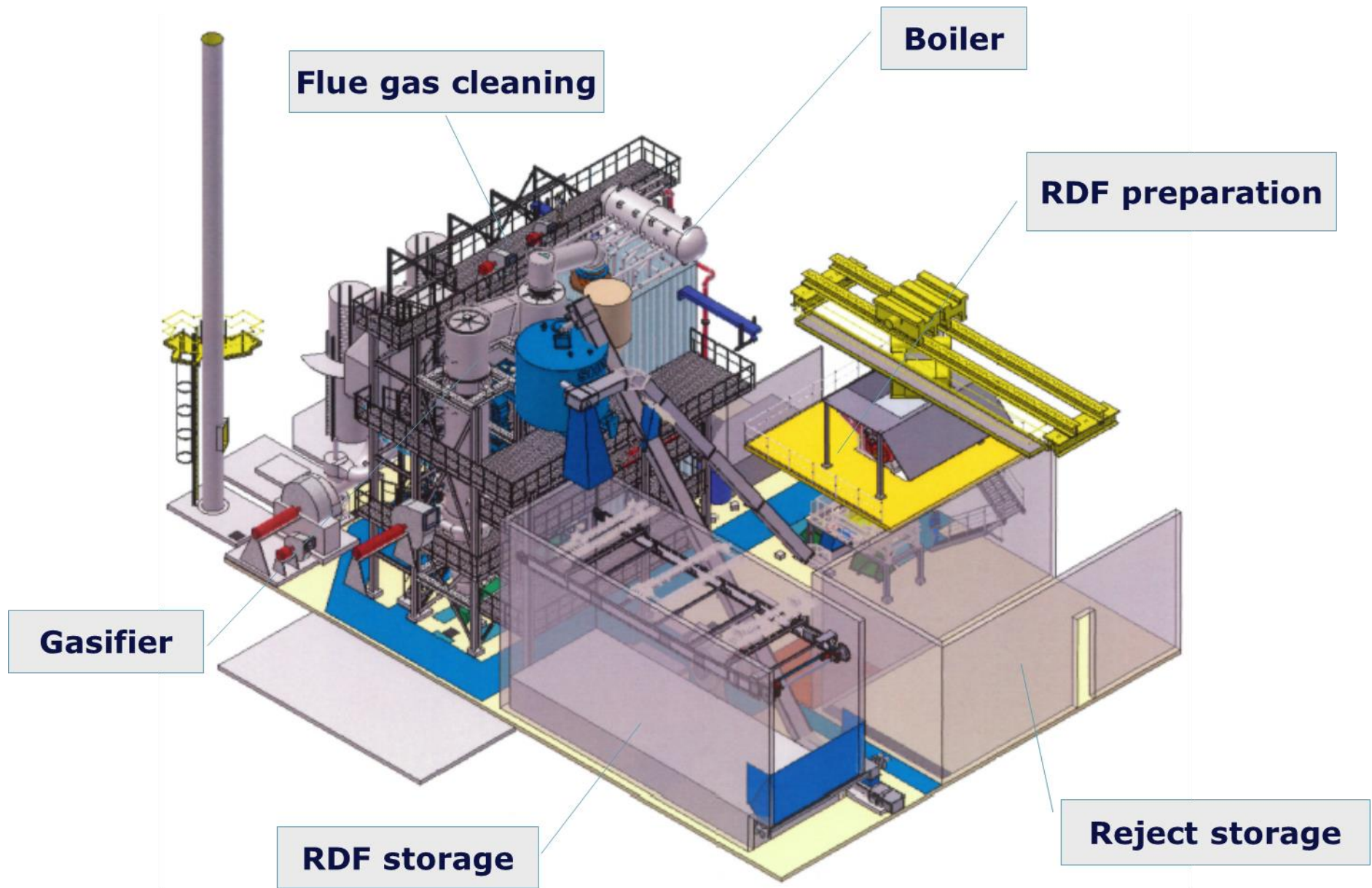


Reject gasifier

- 10 - 13 MWth input CFB gasifier, depending on LHV rejects
- Boiler produces 5 – 16 ton/h steam (196°C, 13,6 barg)
- System engineered and build by Leroux & Lotz
- Build in 2016, in operation since Oct-2016
- 5900 hrs uptime in 2017,
of which 4500 hrs on reject
- Fully automatic operation
- Current challenges are:
 - Not always at full capacity
 - Large variation in rejects LHV and composition
 - Not yet fully automatic operation
 - Blockages of gasifier, boiler and ash-handling
 - Broken thermal expansion joints

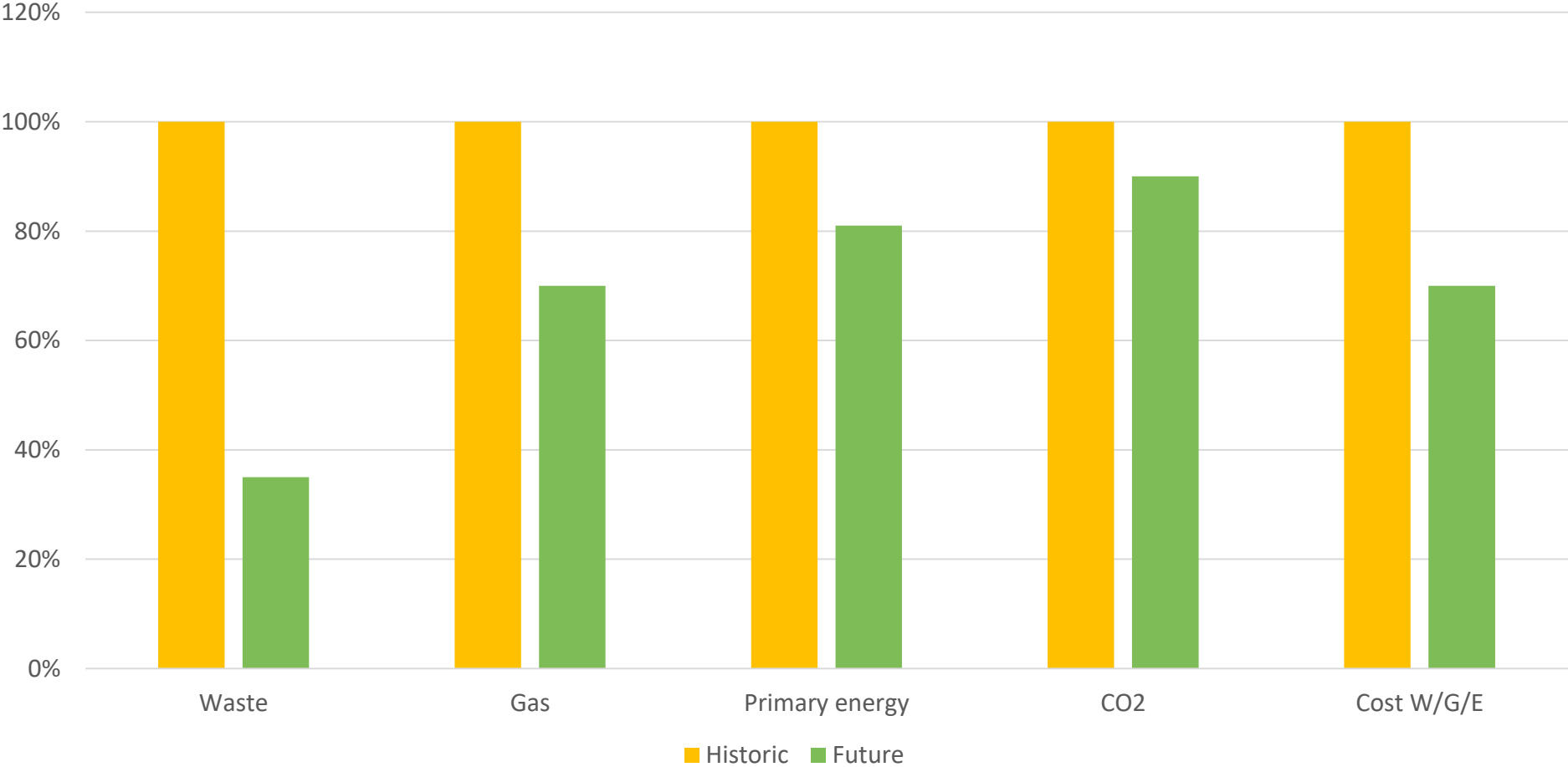


Plant view



Results

Indexed effects



TKI-toeslag project ESKAGAS

- Applied research project of ECN and ESKA, funded by TKI-BBE and ESKA
- The project focuses on options for valorization of the product gas of the paper rejects gasifier by co-production of high value products
- Quantification and value analysis of the co-products, their impact on the ESKA case and co-production routes are subjects in the ESKAGAS project
- The research results of this project can be used for other gasification technologies and projects, like the projects in Alkmaar (SCW, Ambigo) or Amsterdam (Blue Planet)
- Co-production is possibly the next step for these projects to prove that sustainability and value can be further increased

Measurements at ESKA CFB

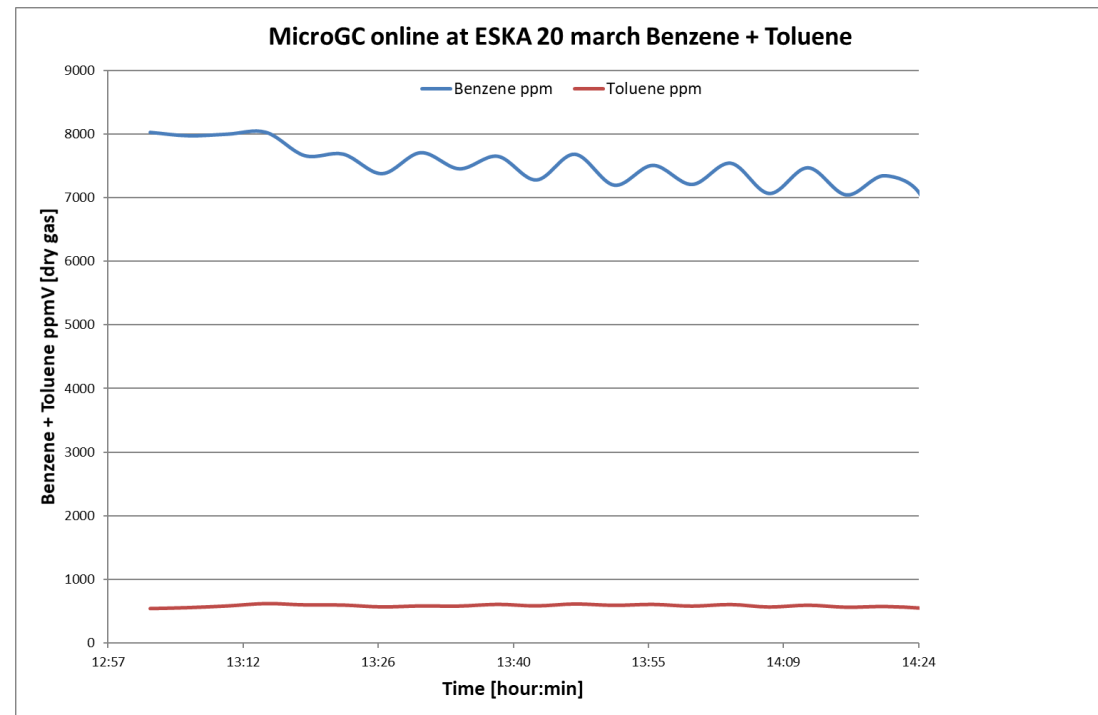
- Measurements taken by ECN on March 20th and 21st 2018
- Sampling point at CFB gas outlet
- Online gas monitors
- Micro-GC and tar guideline method



Measurements at ESKA CFB

Main gas components, March 20 March 21		
dry basis (vol%)		
CO	5.4	6.3
H ₂	5.2	2.8
CO ₂	15.5	14.7
CH ₄	3.4	2.6
N ₂	66.1	n.m.
C ₂ H ₂	0.1	n.m.
C ₂ H ₄	2.4	n.m.
C ₂ H ₆	0.1	n.m.
Benzene	0.8	n.m.
Toluene	0.1	n.m.
Ar	0.8	n.m.
Total	99.9	n.m.
H ₂ O (wt%)	38	26

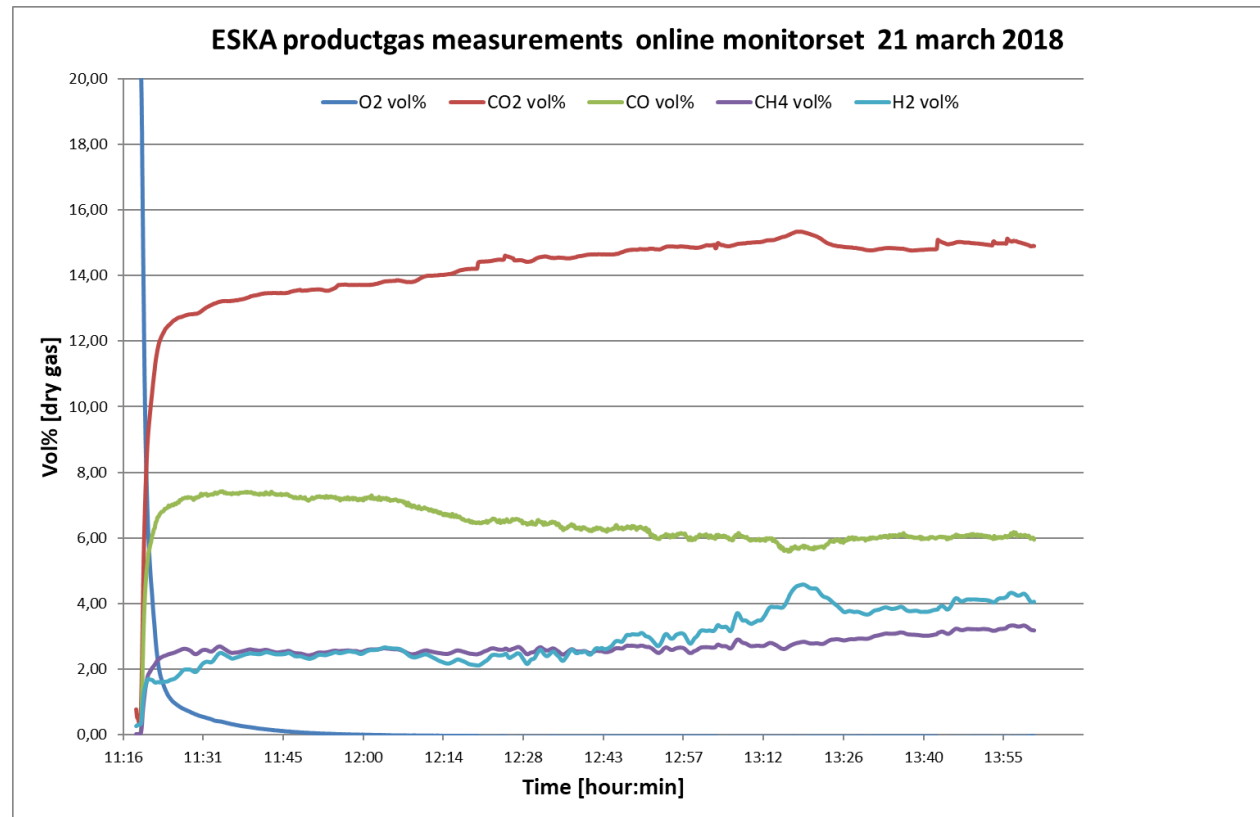
- CFB operated at moderately high ER: high concentration of N₂ and CO₂
- Despite high ER almost 1 vol% B+T and relatively low amount of C₂ for waste gasification



Measurements at ESKA CFB

Trace components, dry basis (ppmv)	March 20	March 21
Sum C ₃	228	196
Sum C ₄	251	302
Sum C ₅	67	84
Sum C ₆	0	0
H ₂ S	52	n.m.
COS	37	20
Thiophene	5	6
Methylmercaptane	0.26	0.13
Other S-organics	3	3
Tar (g/Nm ³)	17	12

- H₂S and COS in approximately same ratio
- Relatively low amount of C₃ – C₆



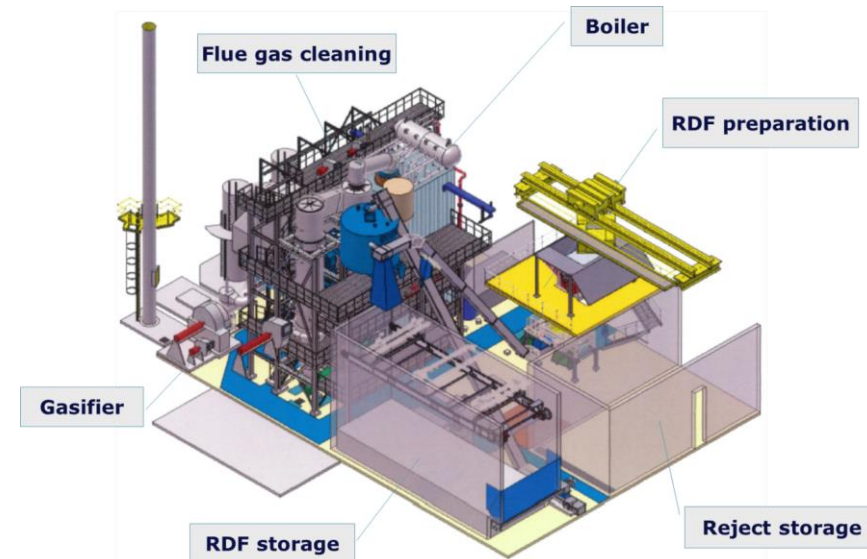
Valorization route & lab-experiments

- Product gas composition (High BTX, high N₂, rel. low C₂-C₆)
- Catalytic routes towards biofuels is less favorable
- C₂ to aromatics could yield an additional ±1 vol% BTX for co-production
- BTX co-production selected as viable route in case of ESKA
- Successful lab-scale experiment at ECN, using the same reject but different gasification and gas cleaning technology (MILENA – OLGA – BioBTX), conducted on May 2nd
- BTX separation efficiency: 98-99%
- BTX production: ±40 g/kg/h reject (dry basis)
- Extrapolated potential value in case of ESKA >400 k€ per year



Conclusions

- ESKA has proven that they can close their cycles by converting paper recycling residues into energy for own use
- The dependency of market driven prices for energy and residues is reduced
- Subsidy-free gasification plant is economically feasible
- Considering the challenging feedstock, the system operates very well
- Co-production of BTX from a direct gasifier seems (technically) feasible
- It indicates that (at sufficient scale) sustainability and value can be further increased





Questions?