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## Case 5: Power sector

# Evaluation of integrated biorefinery technologies in power industry

Herman den Uil (ECN, the Netherlands)

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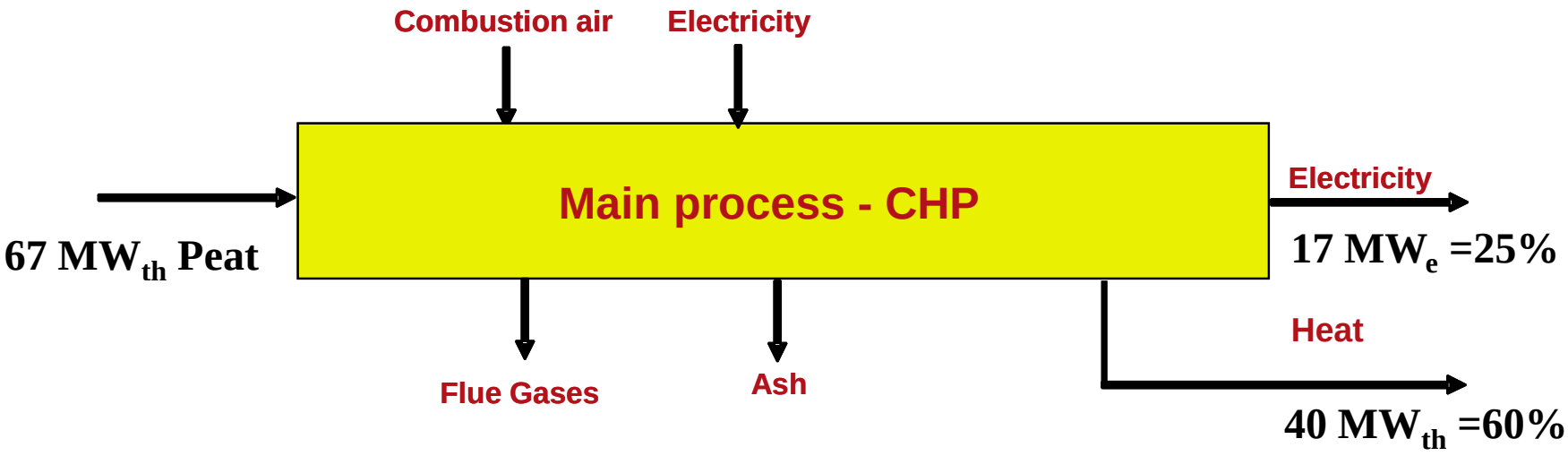
# Introduction

- 2 cases:
  - Co-production of pyrolysis oil
    - Reference : Combustion based power production
    - Biorefinery : Use existing combustor in production of pyrolysis oil
  - Co-production of chemicals
    - Reference : Gasification based power production
    - Biorefinery: Valorise high value products in syngas

# Reference case: Combustion based power production

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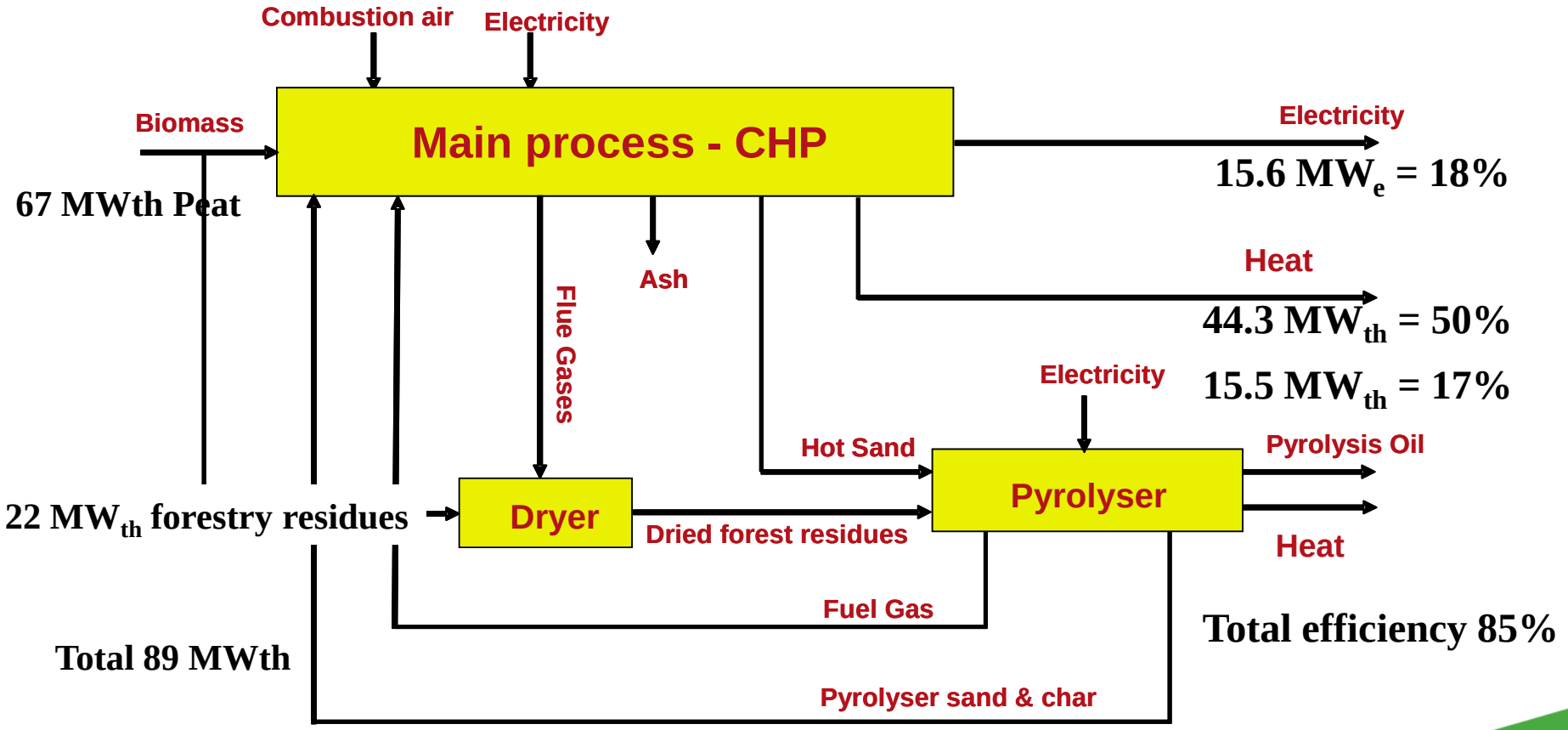
# Integrated biorefinery case

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# Results techno-economic assessment

- Medium scale - Combustion:
  - Reference case:
    - ✓ Investment — 34 M€
    - ✓ Electricity production costs — 60 €/MWh
  - Biorefinery case:
    - ✓ Additional investment — 10 M€
    - ✓ Electricity production costs
      - ➢ Pyrolysis oil at 90 €/ton — 88 €/MWh
      - ➢ Pyrolysis oil at 220 €/ton — 60 €/MWh

# Technical & commercial feasibility

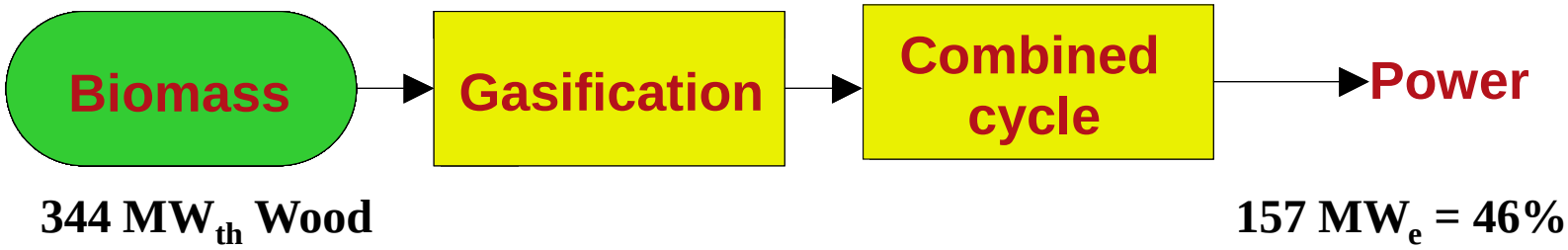
- Technical feasibility below average 64.6 vs. 70.7
  - Pros
    - √ No significant downstream processing required
  - Cons
    - √ Immature technology
    - √ Application of product not developed
- Commercial feasibility below average 65.8 vs. 71.0
  - Pros
    - √ Renewable product and positive for the environment
  - Cons
    - √ Introduction of new products required

# SWOT analysis

| | |
|---|---|
| Strength | Oil as intermediate product: storage, use of feedstock … |
| Weaknesses | Unproven technology<br>Varying quality of oil |
| Opportunities | Increasing oil price<br>Upgrading to 2nd generation biofuel |
| Threats | Pyrolysis oil might have unwanted properties<br>Competition with other bio oil products |

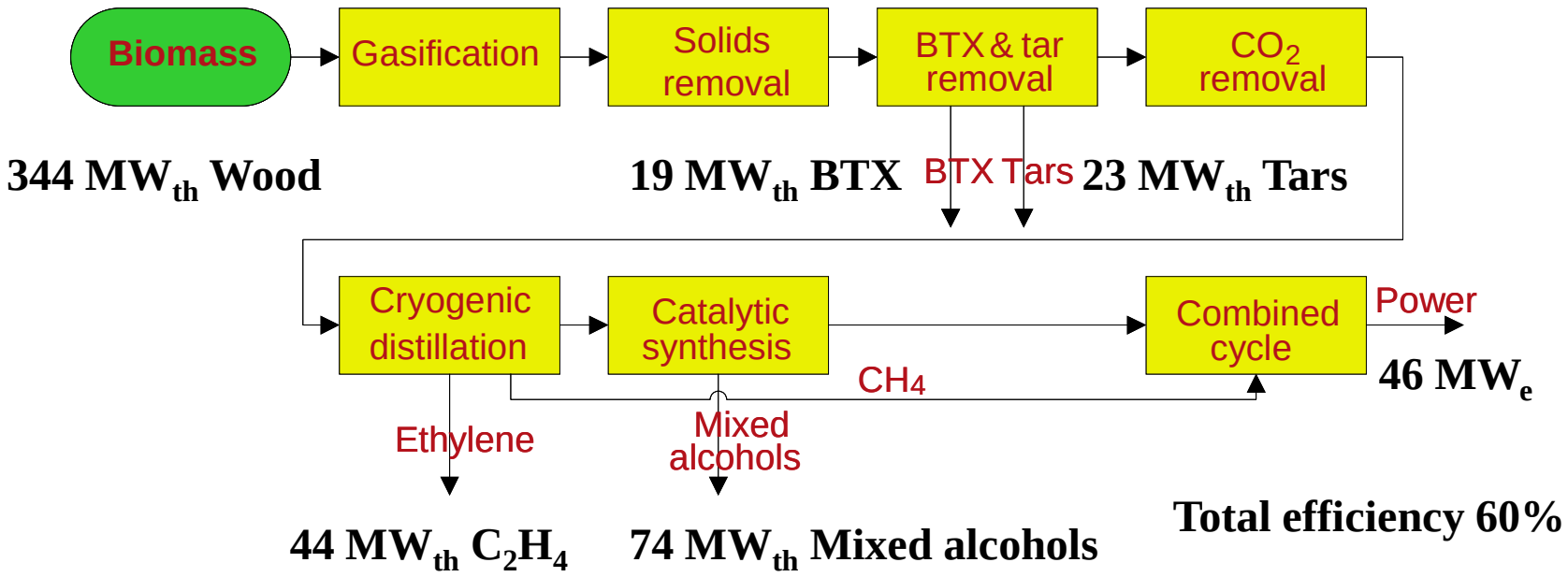
# Reference cases

- Large scale -gasification



# Integrated biorefinery case

- Large scale + co-production chemicals & alcohols

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# Results techno-economic assessment

- ✓ Large scale - Gasification
  - Reference case:
    - ✓ Investment 230 M€
    - ✓ Electricity production costs 74 €/MWh
  - Biorefinery case:
    - ✓ Additional investment 62 M€
    - ✓ Electricity production costs 48 €/MWh
    - ✓ Or revenues from chemicals are more than enough to cover all production costs

# Technical & commercial feasibility

- Technical feasibility below average 53.4 vs. 70.7
  - Cons
    - √ Immature technology
    - √ Complex integrated process
- Commercial feasibility below average 68.4 vs. 71.0
  - Pros
    - √ Renewable products and positive for the environment
  - Cons
    - √ No existing product/market combination for tars
    - √ No economical benefit for the users of the products

# SWOT analysis

| | |
|---|---|
| Strength | Existing markets for products<br>High value coproducts |
| Weaknesses | Unproven technology<br>Complex concept |
| Opportunities | Increasing oil price<br>Integration with existing chemical industry |
| Threats | Competition with biochemical biorefineries<br>Registration and safety issues for new chemical products |

# Summary and conclusions

- Energy efficiency:
  - For pyrolysis route, same as for stand-alone CHP 85%
  - For chemicals route increase from 45 to 60%
- Economics:
  - For pyrolysis route electricity production costs 60 → 88 €/MWh
    Depends on value of the pyrolysis oil
  - For chemicals route electricity production costs 74 → 48 €/MWh
    Revenues from chemicals cover all production costs
- Technical feasibility:
  - Lower than project average, primarily due to immaturity required process steps
- Commercial feasibiltiy:
  - Below project average due to (among other things) lack of existing markets

Thank you for your attention

For more information please contact

Herman den Uil

Energy research Centre of the Netherlands

denuil@ecn.nl

+31 224 56 4106

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