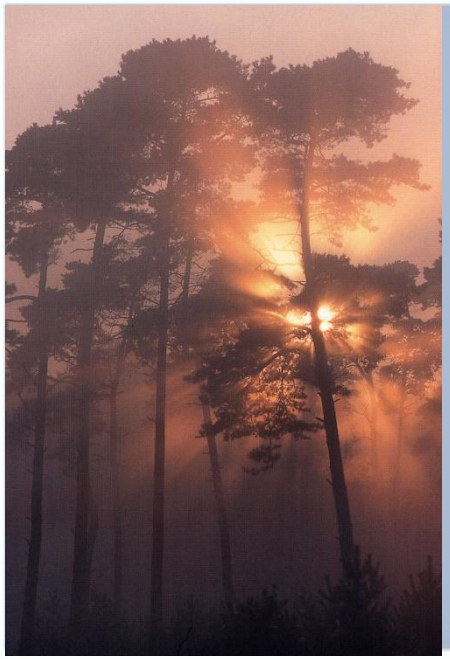
Biomass co-firing and full repowering - Recent developments and KEMA's expectations



IEA workshop on Cofiring
Biomass with coal

Copenhagen - March 27-28, 2012

Jan Middelkamp

Experience you can trust.

Content

- Current status of co-firing and repowering
- Technical developments
- Market developments
- Future of co-firing and repowering

Current status of co-firing and repowering

- UK
  - significant penetration of co-firing
  - e.g. Drax: >900 kton/a (2010)
  - various fuels: wood, crops, residues
  - >600 MWe equivalent
  - Tilbury : 750 MWe plant on wood pellets
  - ROC's system major driver
- Denmark
  - Avedore, Amager, Ensted, etc.
  - Dong: 1,5 Mt/a wood pellets to replace coal
  - wood chips, wood pellets, straw(pellets)
  - close to 1,000 MWe capacity

Current status of co-firing and repowering

- Belgium
  - Rodenhuize, Les Awirs, Ruien
  - mainly wood-based fuels
  - >300 MWe installed capacity
- Netherlands
  - Amer, Borssele, Gelderland, Maasvlakte, Buggenum
  - mainly wood, agro-industrial residuels, etc.
  - 3.2 TWh in 2010
  - MEP subsidy will end soon
  - ROC system for suppliers under discussion

Current status of co-firing and repowering

- USA
  - many projects on hold now
  - biomass carbon neutrality discussion
  - low gas prices
  - boiler MACT/EPA ruling strict for co-firing
  - future: apply at end-of-life coal plants

- South Africa
  - Eskom
  - plans for co-firing demonstration at Arnot PP
  - future: full scale applications

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Wood pellets

- Current status
  - well established technology
  - developed to commodity fuel
  - product standards developed
  - pellets used for co-firing and full repowering
  - secured supply

- Main developments
  - upscaling (e.g. Georgia Biomass plant)
  - product consistency at varying feedstock Q
  - power consumption / net efficiency
  - value chain approach

Wood pellets

The 750 kt/a Georgia Biomass wood pellet plant

Thermally treated biomass pellets

- Current status
  - similar as for wood pellets 10 – 15 years ago
  - demonstration plants (60 kt/a)
  - various reactor technologies
  - first production, but not yet commercial

- Main developments
  - optimization of design and process conditions
  - product quality and consistency
  - feedstock flexibility window
  - product standards

An integrated approach is required

Thermally treated biomass pellets

Topell biomass torrefaction plant

Source: Topell

KEMA

Thermally treated biomass pellets

Developers	Topell, Thermya, Horizon, Torr-Coal, …
Size	20 – 60 kt/a (2.5 – 8 t/h)
Biomass type	Various, but mainly experience with wood
LHV (MJ/kg)	20 – 24 MJ/kg
Cost (Capex)	40 – 80 EUR/kWth
Turn key	200 – 400 EUR/kWth

- Influencing aspects/parameters
  - reactor technology
  - moisture content in raw feedstock
  - pre-treatment/sizing
  - LHV of product

No technology proven yet, experience is being gained

Co-firing versus full conversion

	Co-firing	Full conversion
Wood pellets	Technically feasible Layout known Investment known Derate can be calculated Wide operational experience	Technically feasible Very case specific Investment known Derate can be calculated Some operational experience
Torrefied pellets	Limited co-firing tests Layout to be proven Investment is boundary cond. Derate can be calculated Limited operational experience	No tests yet Layout (!) to be proven Investments for modifications Derate can be calculated No operational experiences

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Biomass value chain developments

- Local and regional
  - wood chips/scraps, including B-wood
  - waste streams, e.g. sewage sludge
  - energy crops, e.g. miscanthus
  - agricultural residues, e.g. at Rotterdam harbor

- Regional and global
  - wood pellets (13 Mt/a; co-firing ≈ 3Mt/a)
  - expected: 50 Mt/a in 2020 (Biomass P&T)
  - wood chips (32 Mt/a)
  - torrefied biomass (→.. kt/a)

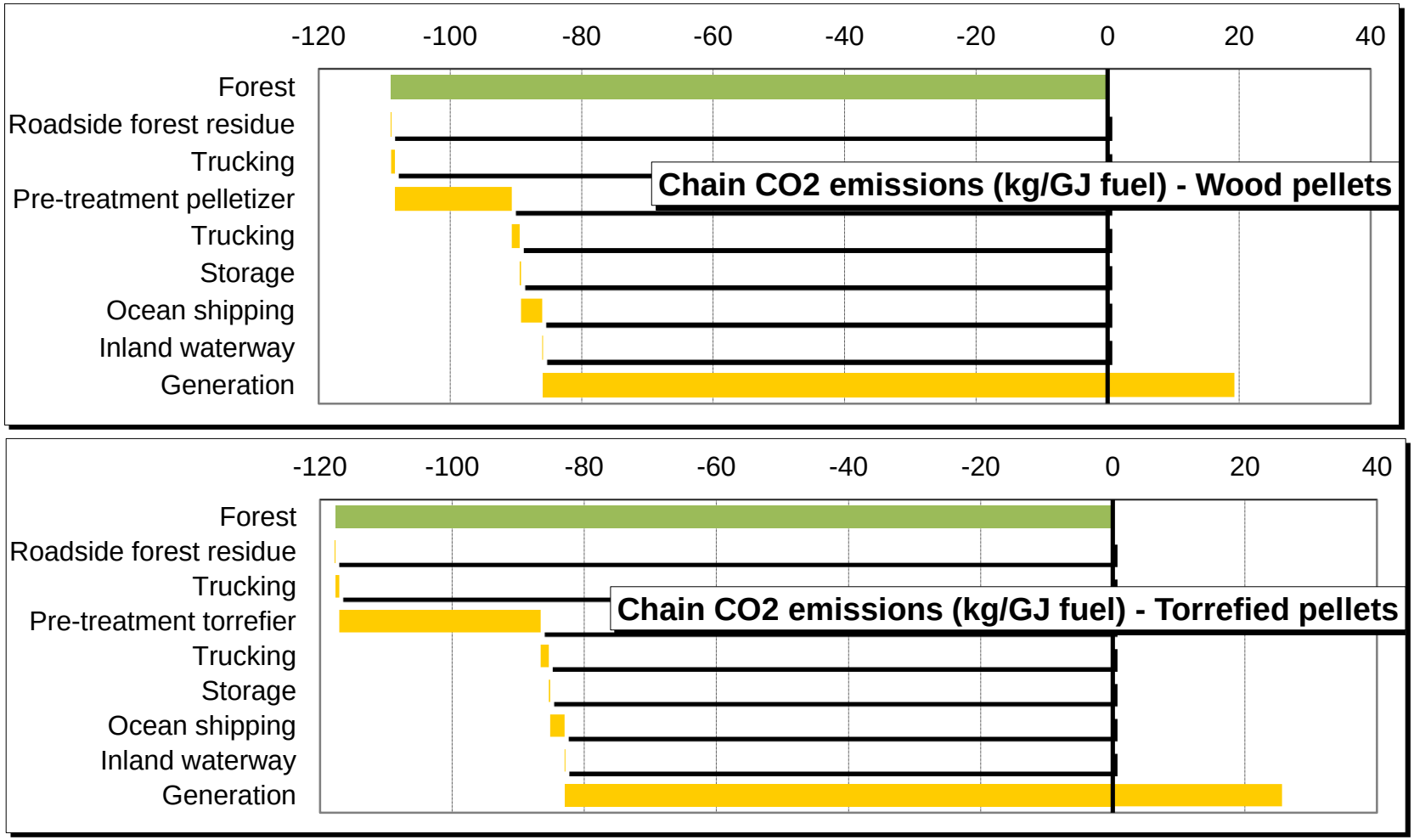
Biomass value chain developments

- Trends
  - demand for “commodity fuels”
    - large demand requires constant fuel quality
    - more easily change of supplier
    - current focus on wood pellets
  - development of thermally treated biomass
    - seen as important future commodity fuel
    - various market segments
    - new competition

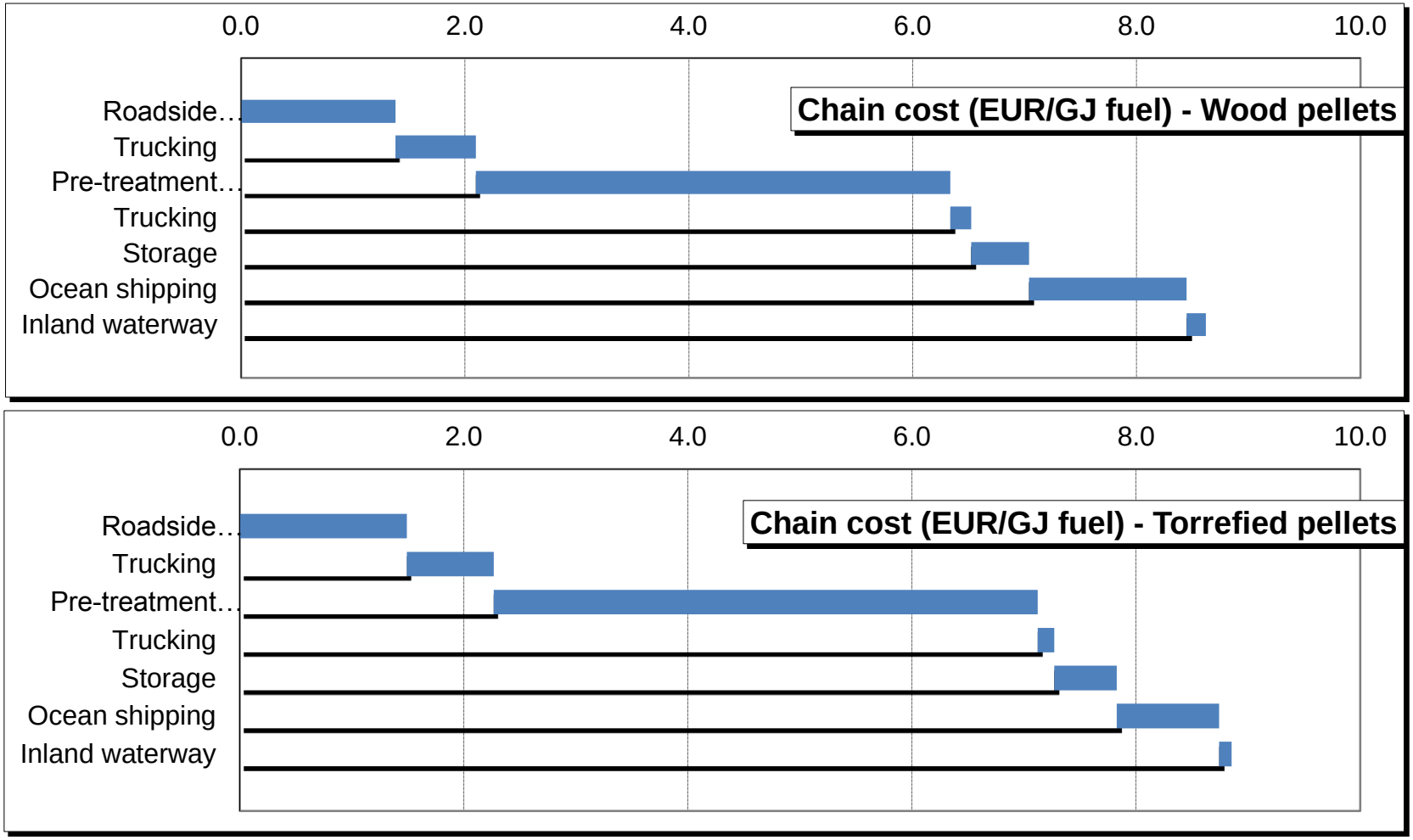
Biomass value chain developments

- Trends (Cont'd)
  - entering the value chain
    - RWE: 750,000 t/a pellet plant in Georgia,US
    - Vattenfall: 1 Mt in five years in Liberia
    - minimize price of pellets, but…
    - taking a commercial risk

Biomass value chain developments



Biomass value chain developments

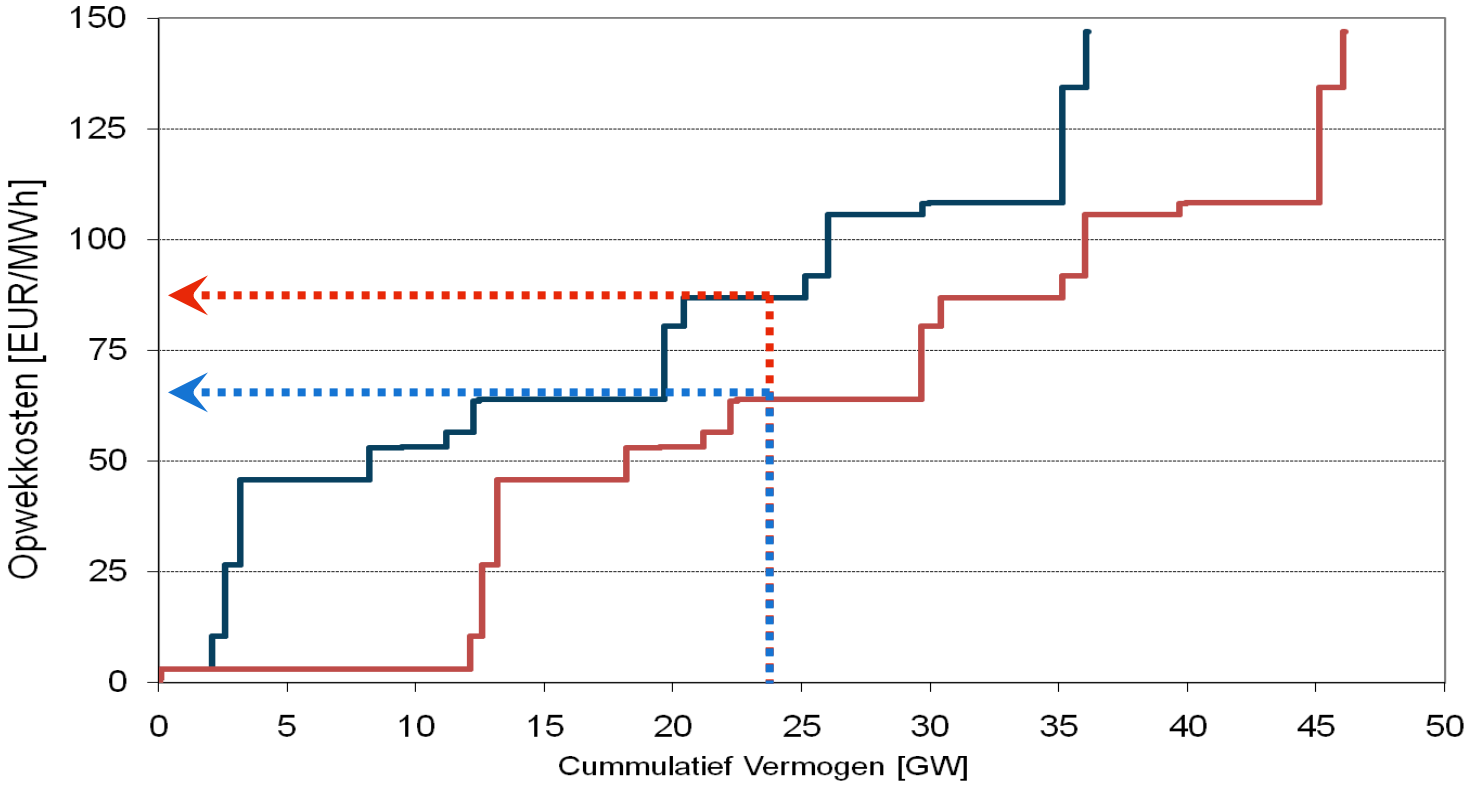


Power market developments

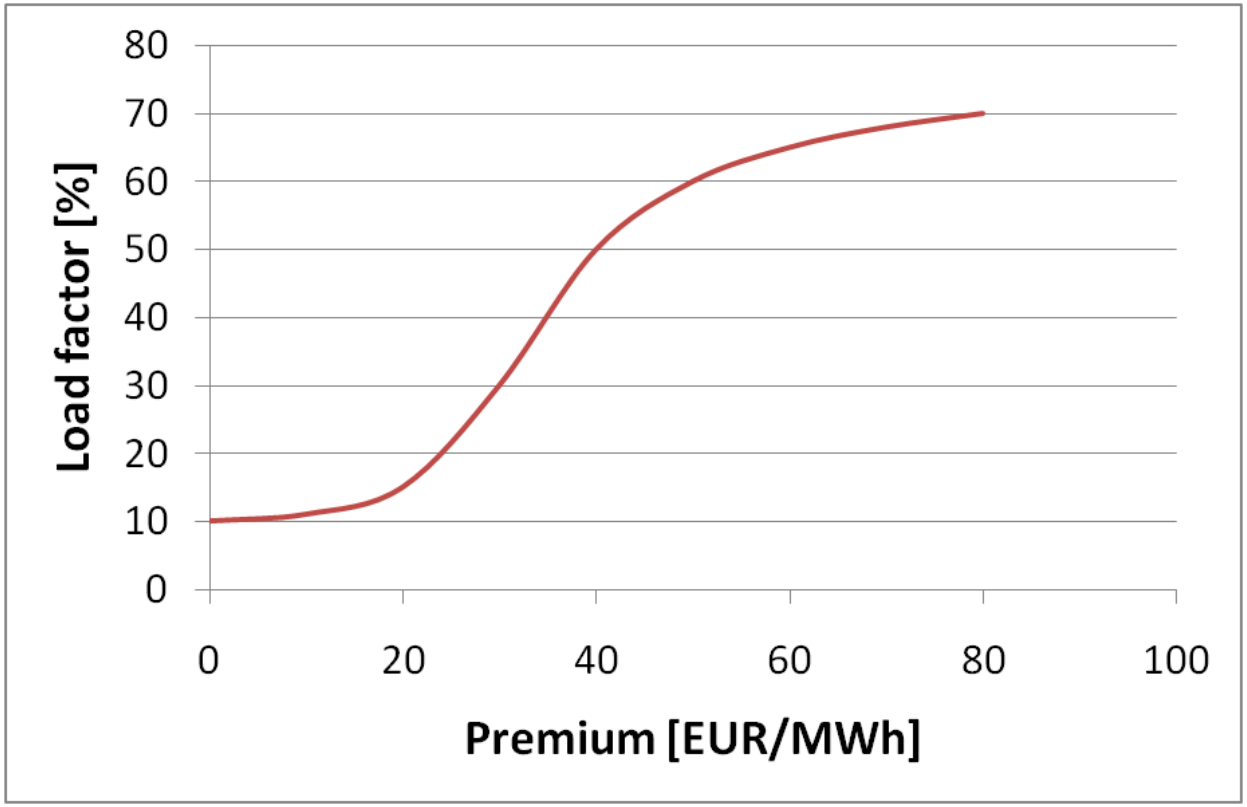
- Coal fired power plants under public discussion
- Current gas prices low
- Non-dispatchable renewables result in
  - low power prices
  - lower merit order position for coal fired units
  - lower number of full load equivalent hours
  - existing power plants: >flexibility required

Power market developments

- Cost of electricity at increased wind power



Power market developments



Required: solid incentives resulting in a reliable long term premium on biomass-based power

Socio economic market aspects

- Increasing demand for larger volumes of affordable, reliable and sustainable biomass, that can meet EU sustainability criteria
- Regions where biomass is widely available and relatively cheap
  - Russia, Belarus, Ukraine, Slovakia
  - Brazil, Africa, Canada, US
- Financing hurdles, tendency to wait and see:
  - investments in therm. treated biomass limited
  - significant investments in wood pellet plants

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Future of co-firing and repowering

- Tough conditions for biomass co-firing:
  - Still low incentives from current CO_2 price
  - Limited or no solid political and financial incentives in many (EU) countries
  - Coal fired plants under discussion → co-firing affected
  - Low gas price
  - Investors suffer from uncertainties
  - Biomass politically not undisputed
  - Public opinion is not improving…

Future of co-firing and repowering

- However…
  - power from biomass is proven technology
  - lowest renewable EUR/kWe investment costs
  - High thermal efficiency at existing power plants
  - Significant renewable targets to be achieved soon

Co-firing and full scale coal to biomass conversion could be a solution to meet short term renewable targets in both EU and US

Will there be a future for co-firing and repowering?

Yes, but not in too many countries and only when there is a significant premium on green power from biomass