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IEA Bioenergy Webinar

Future Prospects for Wood Pellets Market

IEA Bioenergy Task 40 Team

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Energy Technology Network

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Technology Advancements on Wood Pellets

Cost Reduction and Quality Improvement

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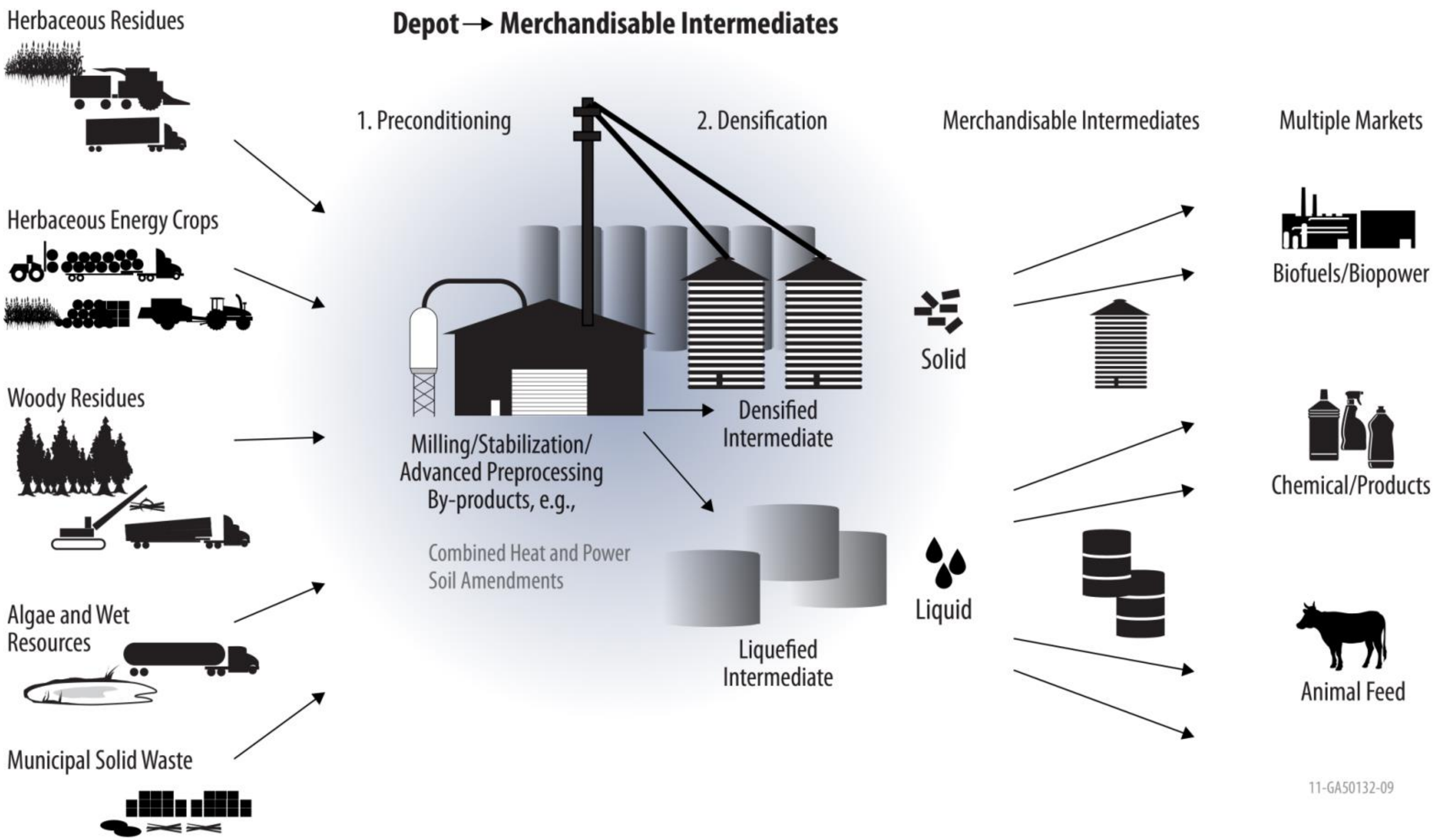
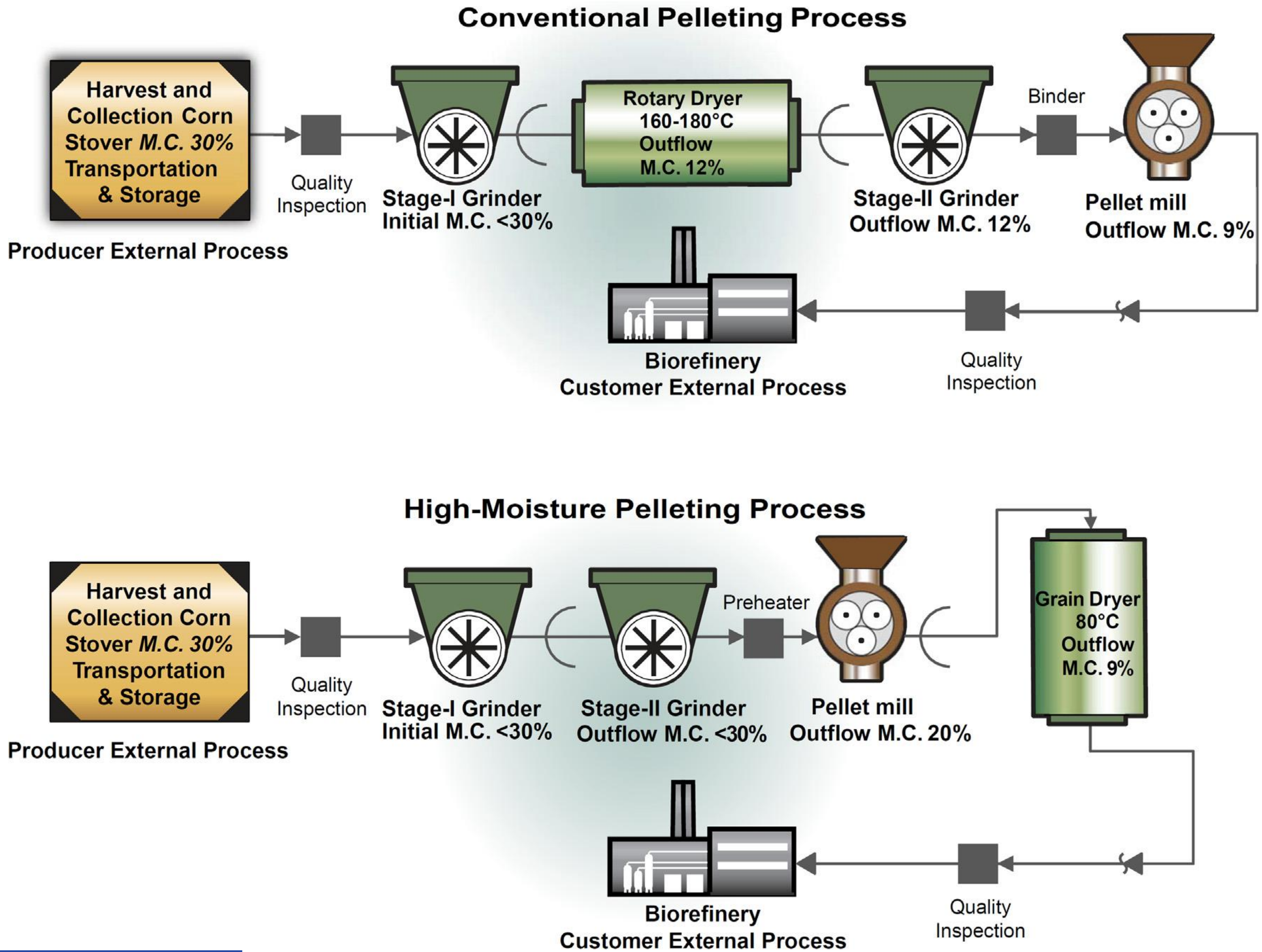
with contributions from Jaya Shankar Tumuluru, J. Richard Hess, Patrick Lamers, and Uwe R. Fritsche

Biomass Depot and Supply Chain



Conventional versus Advanced High Moisture Pelleting



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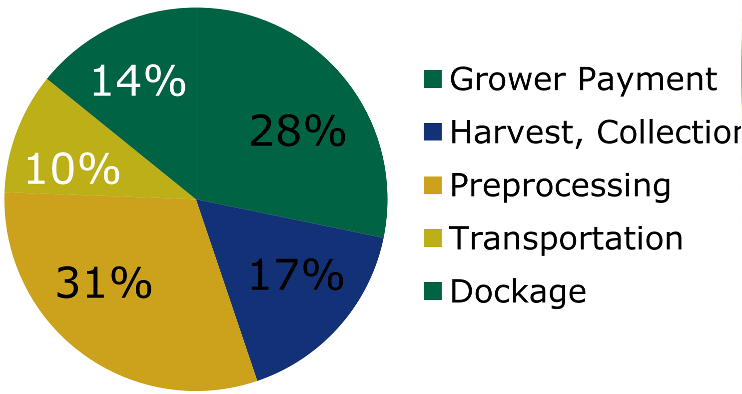
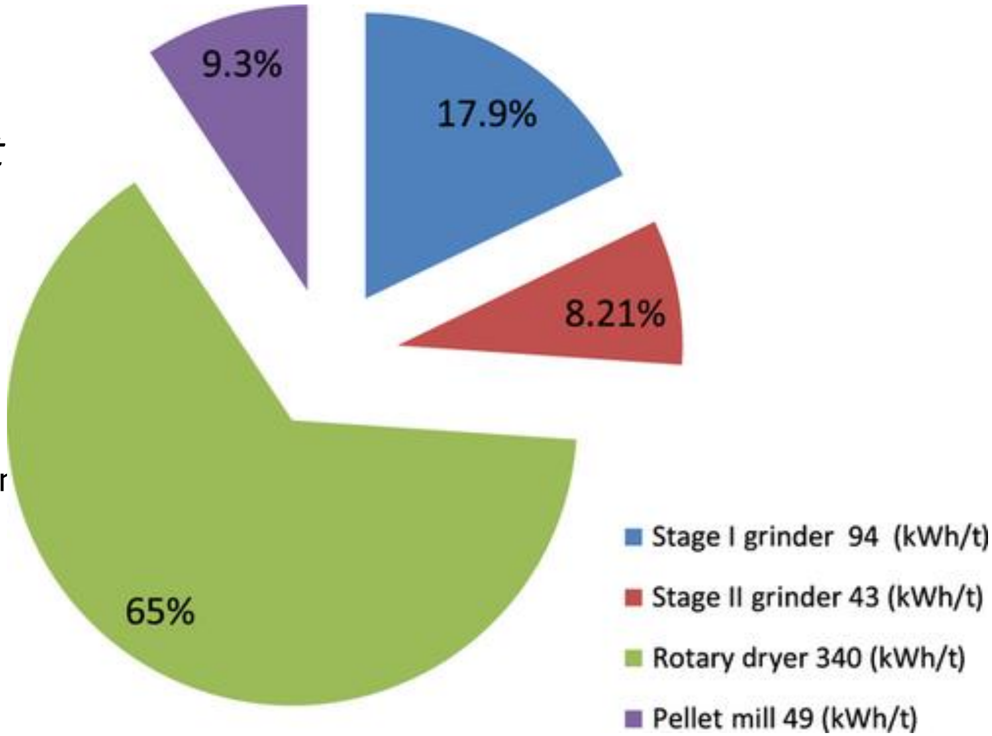
Source: Lamers et al. (2015): Bioresource Technology, 194, 205–213

Energy Consumption of Unit Operations during Conventional Pelleting

Energy consumption of various unit operations in conventional pelleting of high moisture biomass (Yancey et al., 2013)





Preprocessing is the largest single cost associated with biomass feedstock

Distribution of feedstock costs based on 2013 SOT (about $141/dry ton, total) (conventional preprocessing system).

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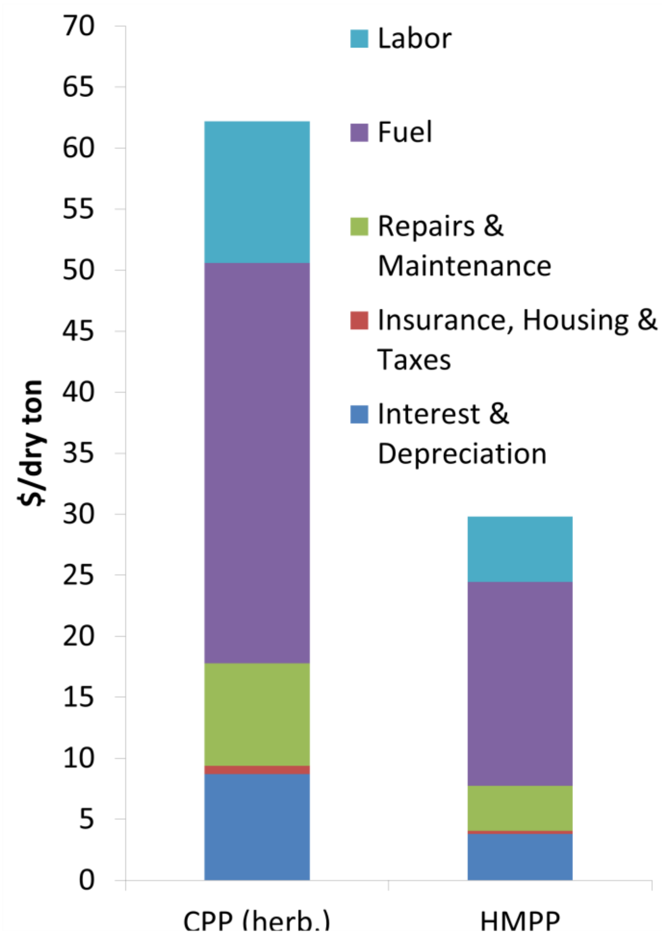
Note: Dockage: replacement, disposal & conversion costs

Advantages of Advanced High Moisture Pelleting

- Biomass is pelleted at moistures >20% (w.b.).
- Biomass loses moisture (5-10%, w.b.) due to frictional heat developed in the die
- Eliminates the rotary drying step and saves capital cost and energy.
- Drying is optional (pellets can be dried only when highly durable and aerobically stable pellets are needed) and low-cost dryers such as grain or belt dryers which operate at low temperature (60–80ºC)
  - No VOC emissions (VOC emitted results in formation of photo-oxidants which are harmful for humans if they inhale and also has detrimental effect on photosynthesis causing damage to forests and crops).
  - Reduced risk of fire and explosion
  - Low quality heat can be used for drying
  - Better control over the product moisture
  - Less capital intensive

Techno-economic Analysis



TEA comparison of preprocessing of corn stover bales at high moisture content (30%, w.b.)

Fuel cost is significantly lower for High moisture pelleting process (HMPP) compared to conventional pelleting process (CPP) mainly due replacing rotary dryer with grain or belt dryer.

Lower capital costs using HMPP resulted in lower interest and depreciation.

Repairs, maintenance, insurance, housing and taxes are also lower for HMPP process.

ELSEVIER

Bioresource Technology

Volume 194, October 2015, Pages 205–213

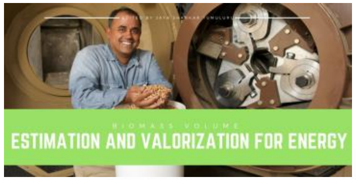
Techno-economic analysis of decentralized biomass processing depots

Patrick Lamers[a], Mohammad S. Roni[a], Jaya S. Tumuluru[a], Jacob J. Jacobson[a], Kara G. Cafferty[a], Jason K. Hansen[a], Kevin Kenney[a], Farzaneh Teymouri[b], Bryan Bals[b]

Show more

https://doi.org/10.1016/j.biortech.2015.07.009

Pellets Quality Improvements via Advanced Characterization and Process Optimization

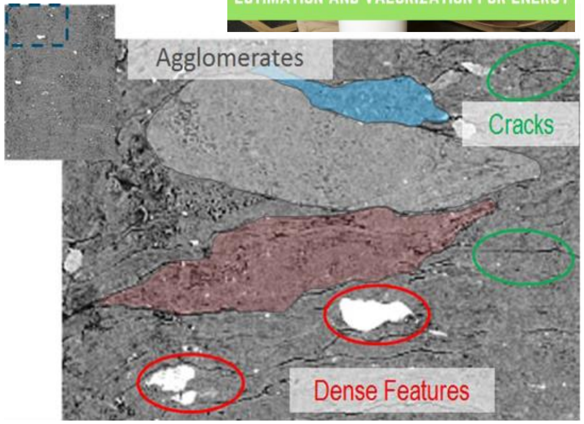


Pellet characterization studies

CT-scan: X-ray CT provides **3D non-destructive** images of pellets and enables spatial and morphological characterization without destroying pellet. Helps to understand the agglomerate size and surface area of the pellet particles.

Focused Ion Beam Tomography: 3D analysis of the pellets. Helps to understand the material flow in the pellet die and in turn the microstructure formation.

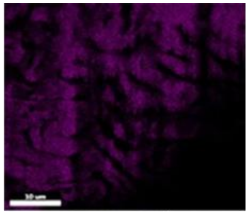
Energy-dispersive X-ray spectroscopy (EDS) Mapping: Quantification of carbon, silicon and oxygen distribution in the pellet.

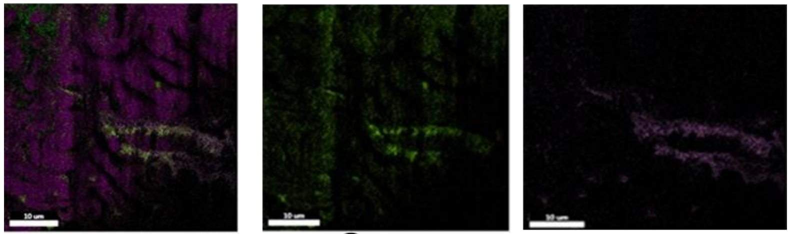


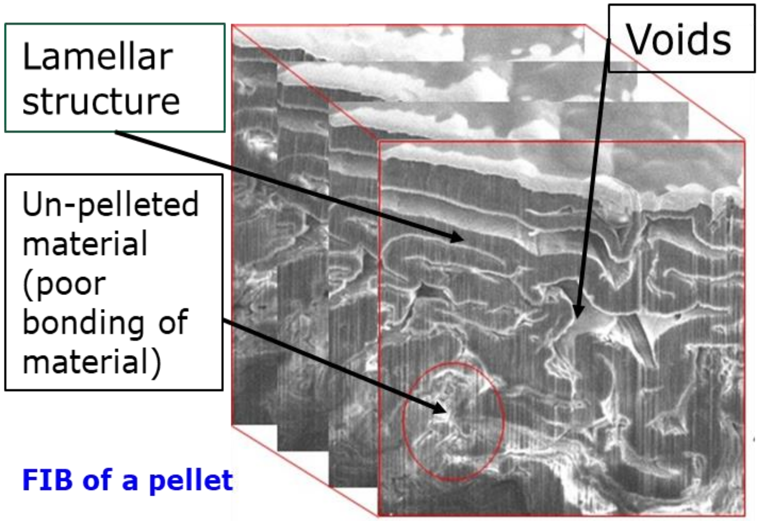
CT-scan of a pellet

Primary Features Extracted:
Cracks, Dense Features and Agglomerates

EDS mapping of pellet







FIB of a pellet

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Current market status

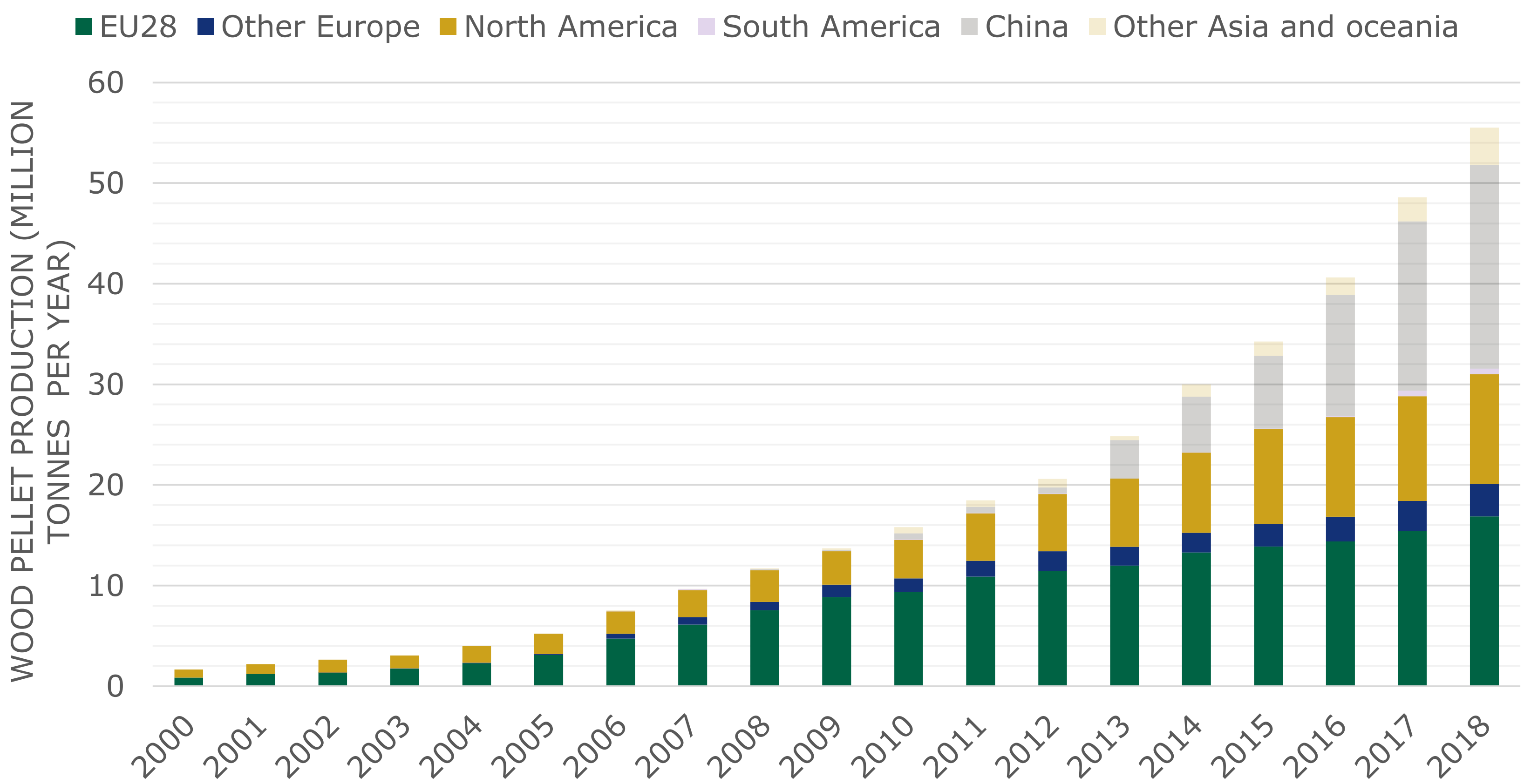
Global wood pellet production and supply chain cost estimates

Ric Hoefnagels

with contributions from Lotte Visser, Fabian Schipfer, Michael Wild

Global pellet production

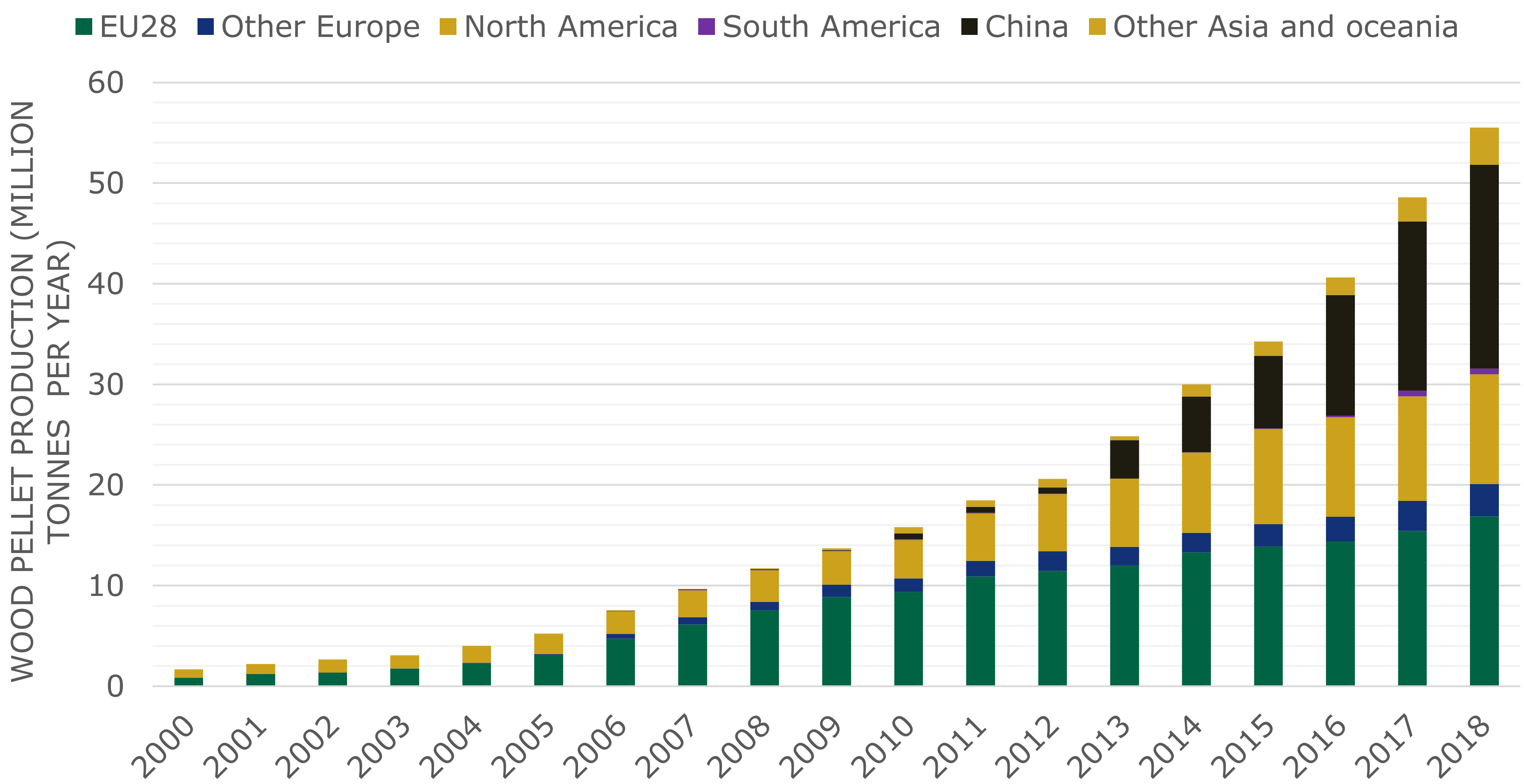
- Wood pellet production has developed rapidly in the past two decades
- In particular in Europe and North America



Source: Lamers et al. (2014) and European Bioenergy Outlook (2019)

Global pellet production

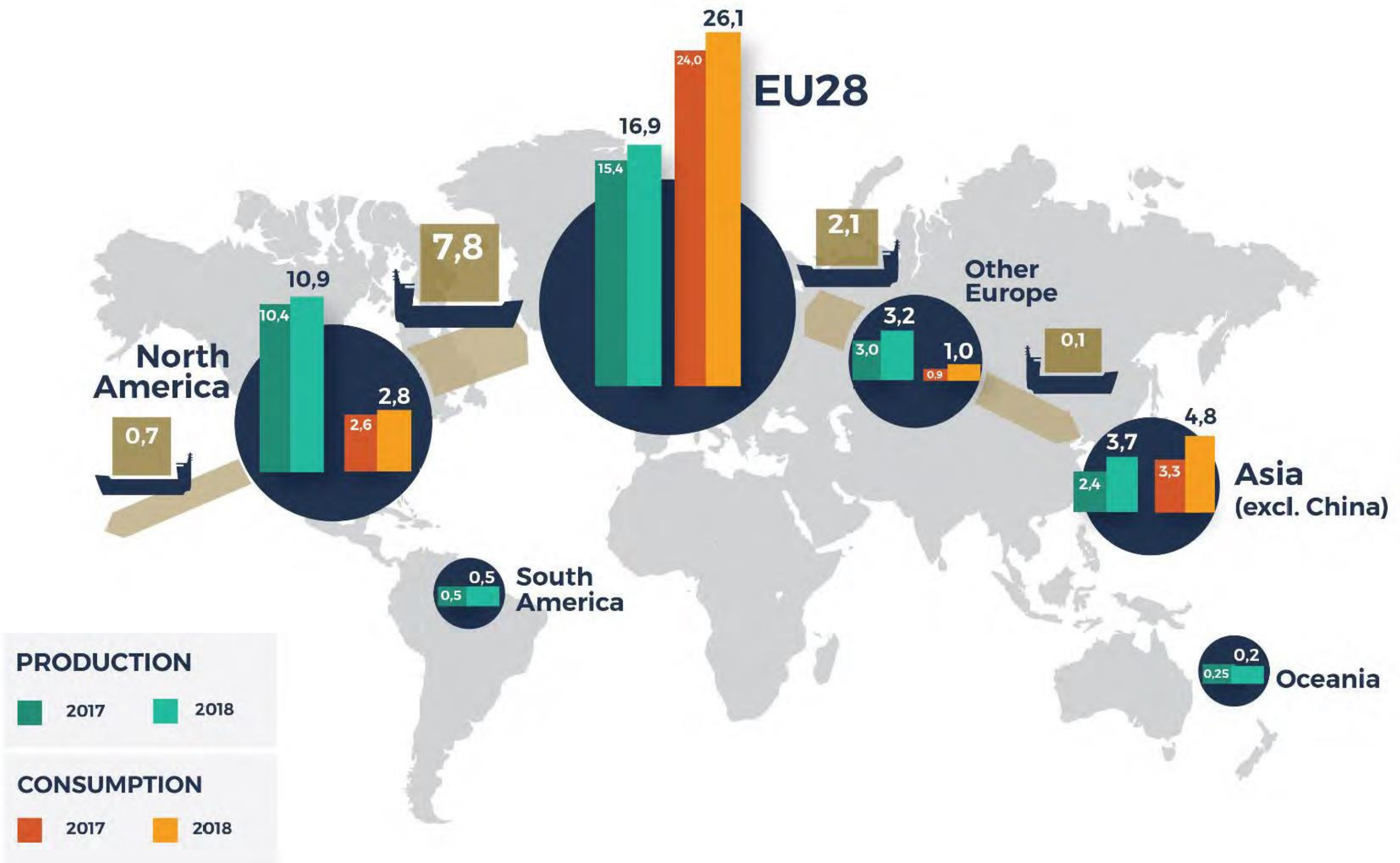
- But in the past 5 years, growth has shifted towards Asia, in particular China*.
- Production in South America and Oceania remains small.
- Agro-pellet production might ramp up in the future (e.g. China, Brazil)



Source: Lamers et al. (2014) and European Bioenergy Outlook (2019)

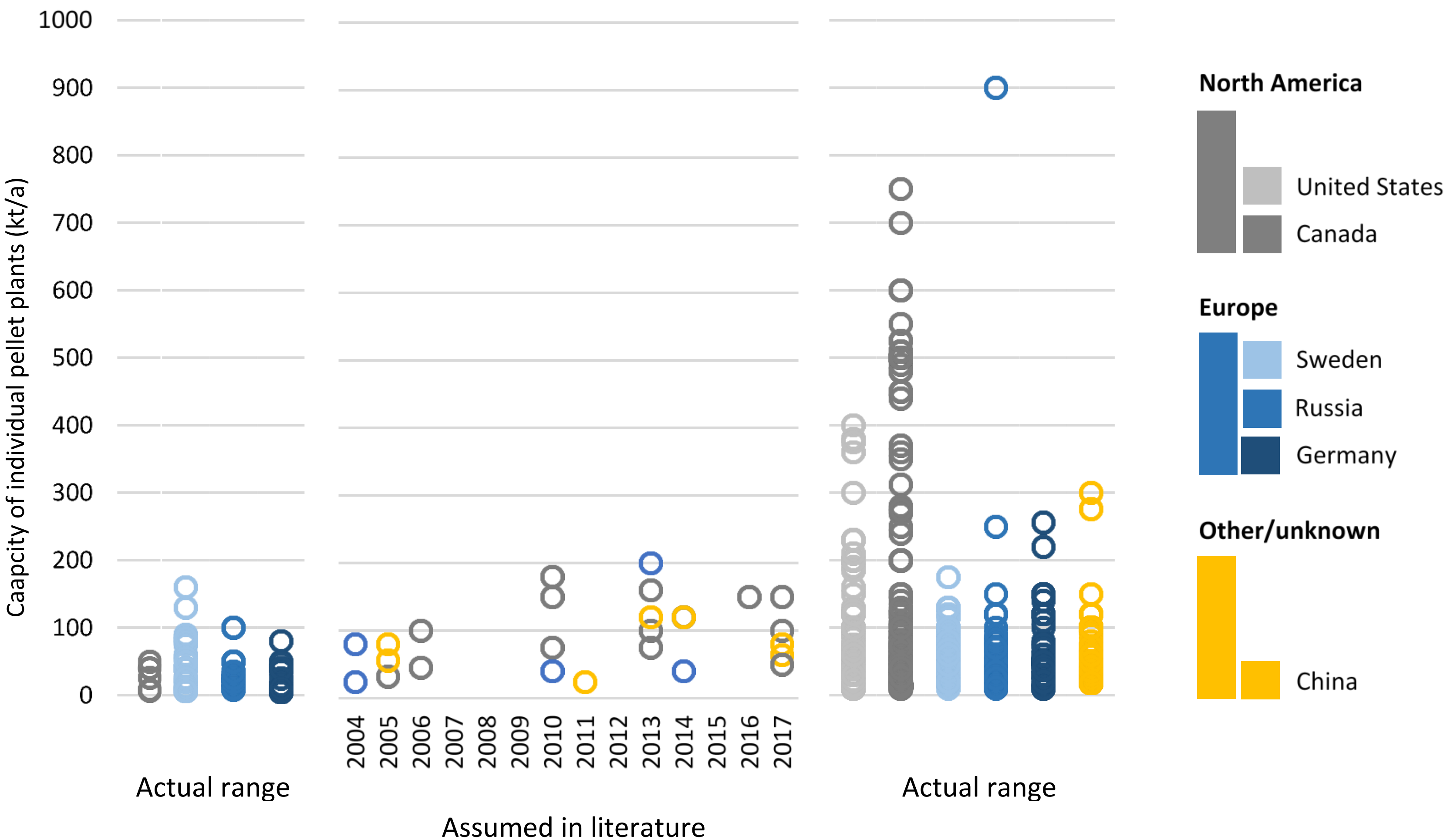
*) Data for China are however highly uncertain

World pellet production and trade



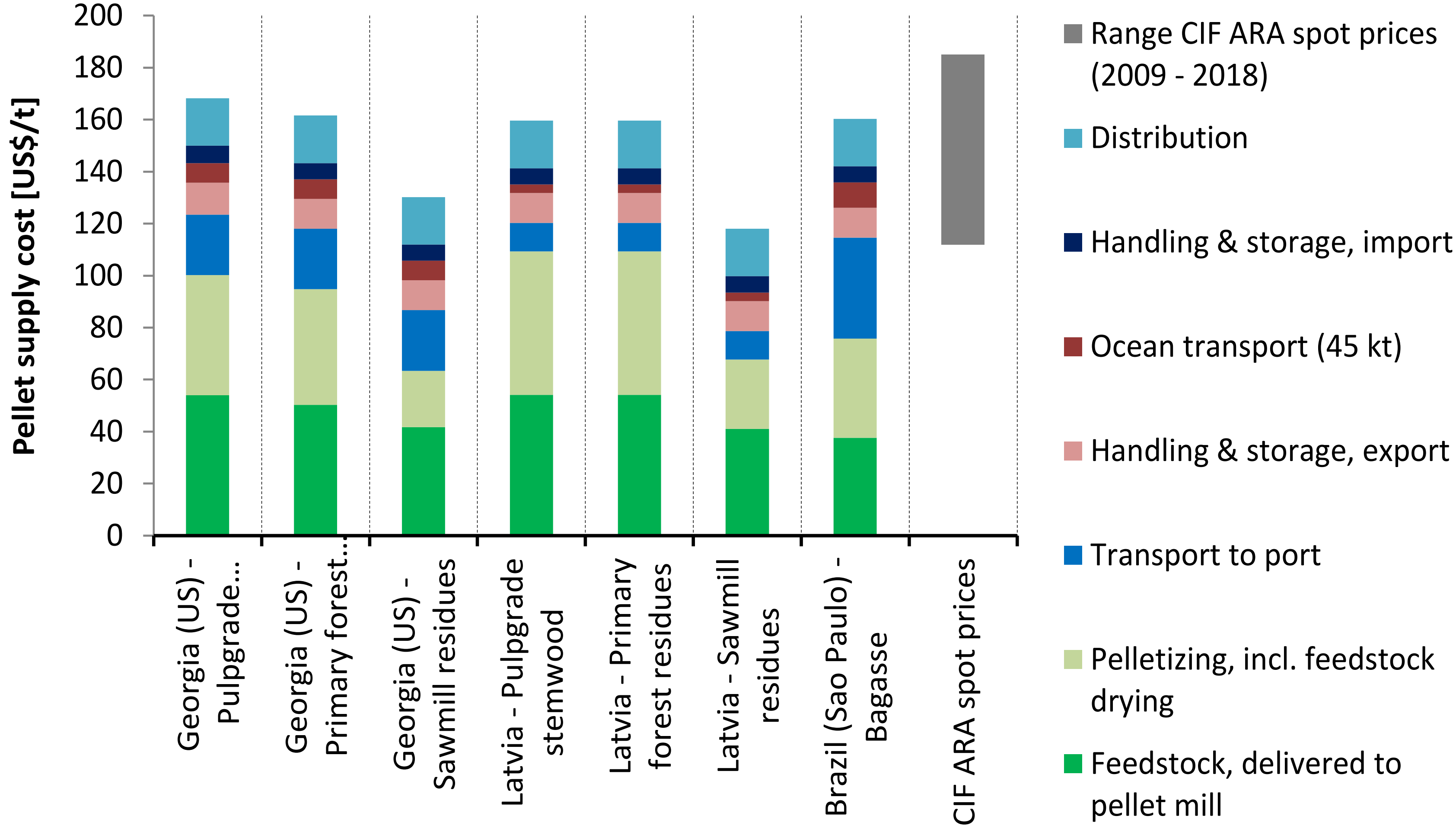
Source: European Bioenergy Outlook 2019, EPC survey 2019; FAO; FutureMetrics; Hawkins Wright; UNComtrade

Wood pellet analysis in literature vs actual developments



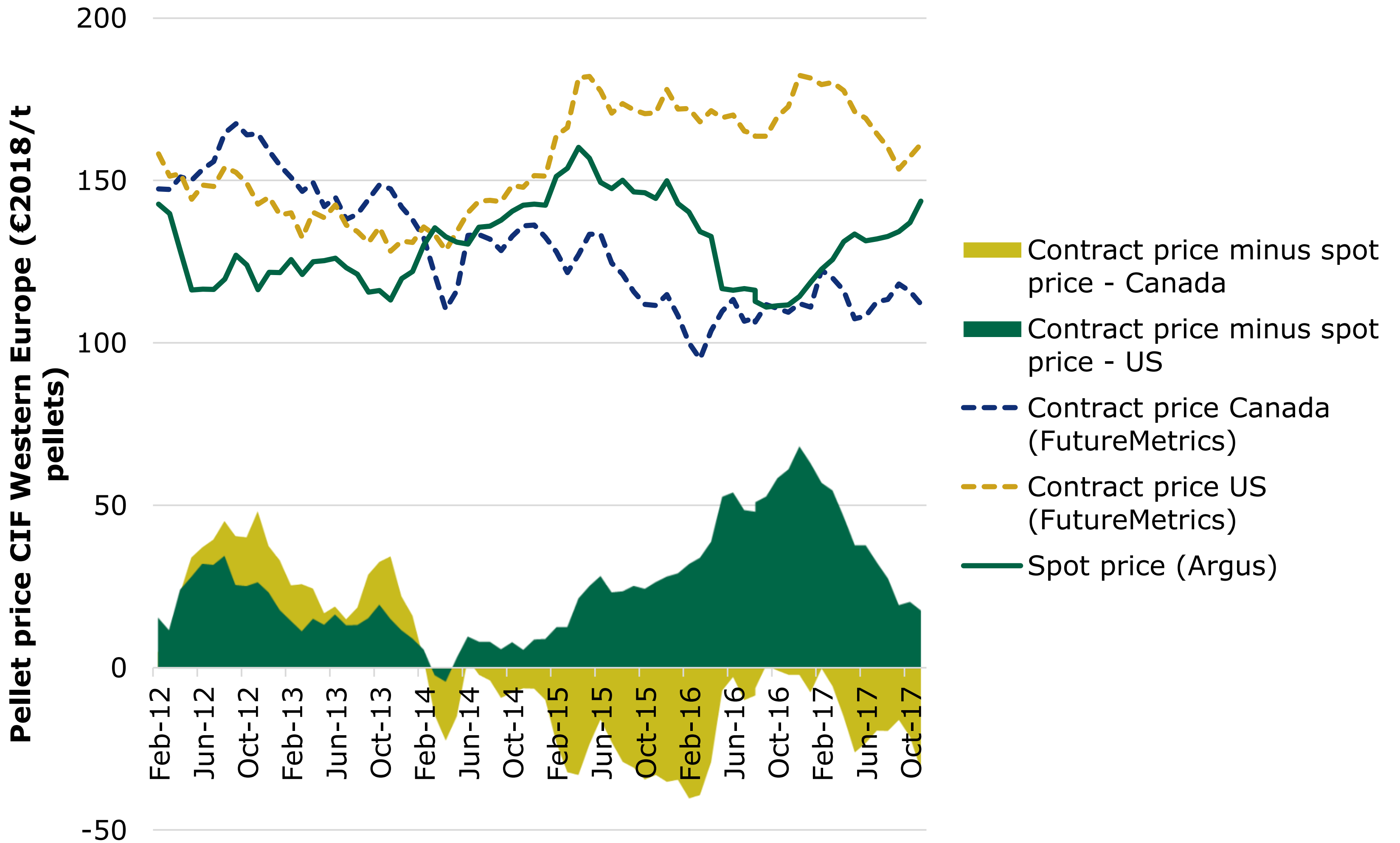
Source: Visser et al. 2019 Wood pellet supply chain costs – A review and cost optimization analysis. Renewable And Sustainable Energy Reviews (RSER)

Supply chain cost estimates



CIF ARA spot prices exclude distribution

Contract and spot prices of North American wood pellets delivered to the EU



Source: Future Metrics 2018 in Visser et al. 2019

Summary

- Wood pellet markets have shown continues growth in the past two decades from 1.6 Mt in 2000 to 55 Mt in 2018
- Growth has shifted from the EU and North America towards Asia.
- The supply chain cost of pellets delivered to a port in western Europe (Rotterdam) are estimated between 99.7 US$/t and 149 US$/t
- Production of agro-pellets might increase in the future due to constraint wood supply (China) or new markets (Brazil, bagasse) and appear to be cost competitive for export
- Cost estimates are based on literature that focused on relatively small plants (up to 200 kt/a), far below industrial export capacities (up to 900 kt/a)

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Market Outlook

Wood pellet prices developments and demand side considerations

Fabian Schipfer

with contributions from Ric Hoefnagels, Uwe R. Fritsche, Michael Wild

Residential and industrial wood pellet price development

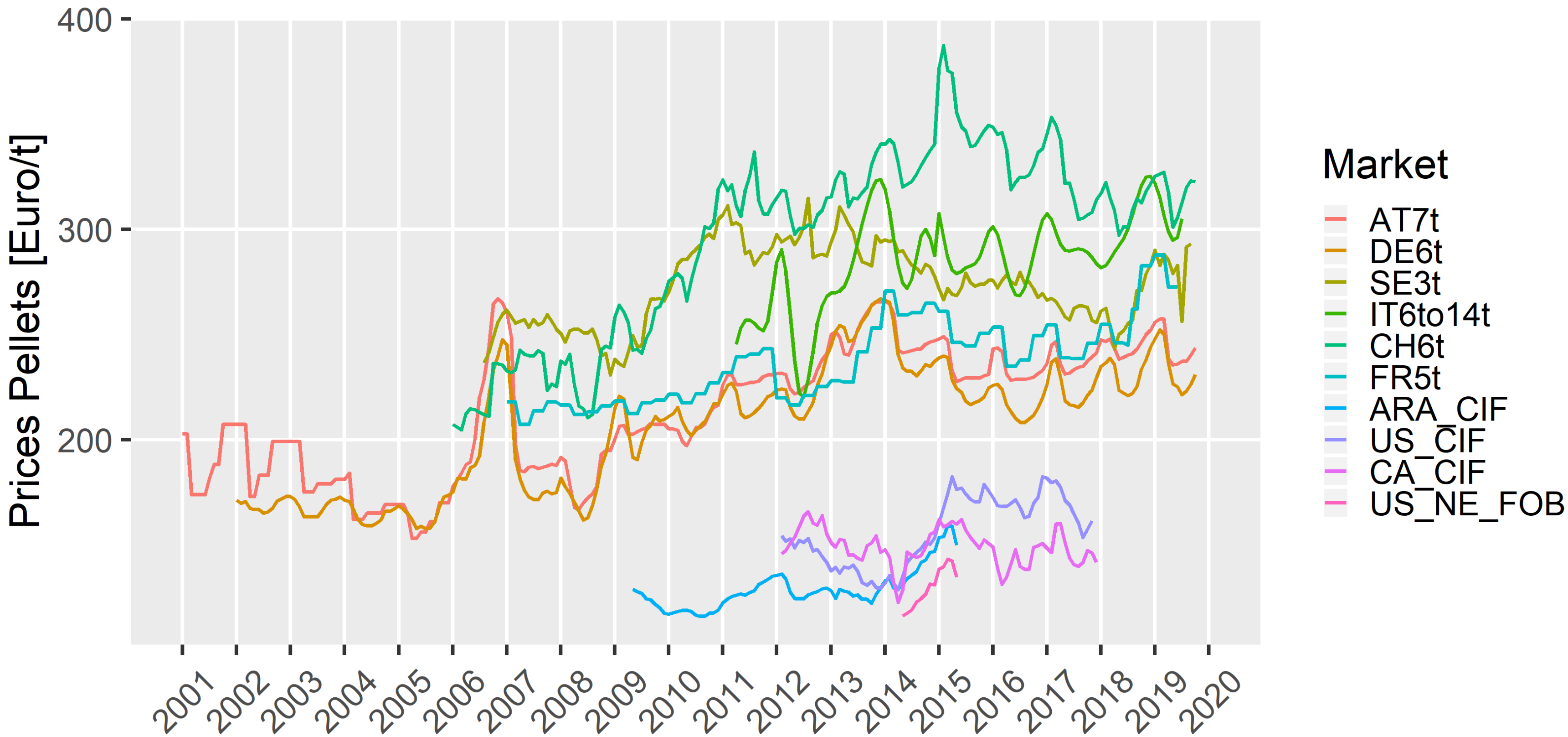


Figure 1: Wood pellet price development for residential (with VAT) and industrial (without VAT) markets. Sources: [ProPellets, 2018]; [DEPI, 2018]; [Pelletsforbundet, 2018]; [Laura Bau AIEL, 2018]; [Bundesamt für Statistik Schweiz, 2018]; [Beyond 20/20 France, 2018]; [Argus Media, 2016]; [FutureMetrics, 2018]; [Argus Media, 2018]; [Quandl.com, 2018]

Demand side considerations I
Further commoditization:

- ISO 17225-2 and EN 14961-2
- Public perception with respect to fungibility
- Transparency, data availability and quality
- Improved storage possibilities

Demand side considerations I Further commoditization:

- ISO 17225-2 and EN 14961-2
- Public perception with respect to fungibility
- Transparency, data availability and quality
- Improved storage possibilities

→ Increased fungibility (interchangeability)

→ Relatively low & stable European pellet price (excl. distance costs, taxes, seasonal fluctuations)

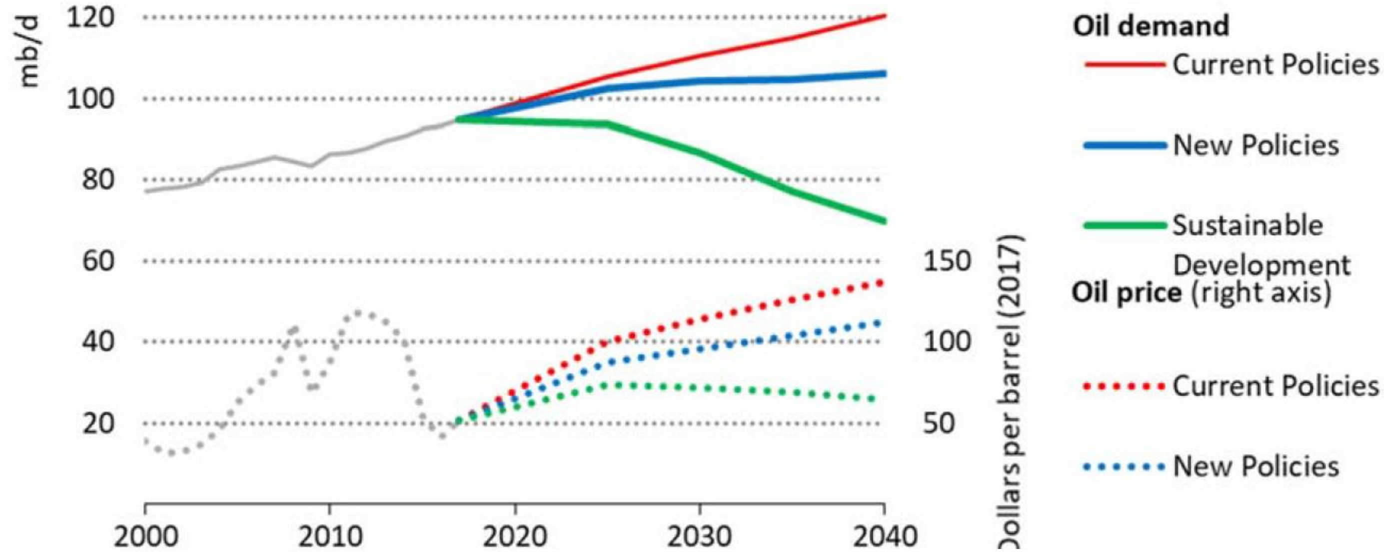
→ Extension of spatial consumer portfolio

→ Decreasing risks for suppliers

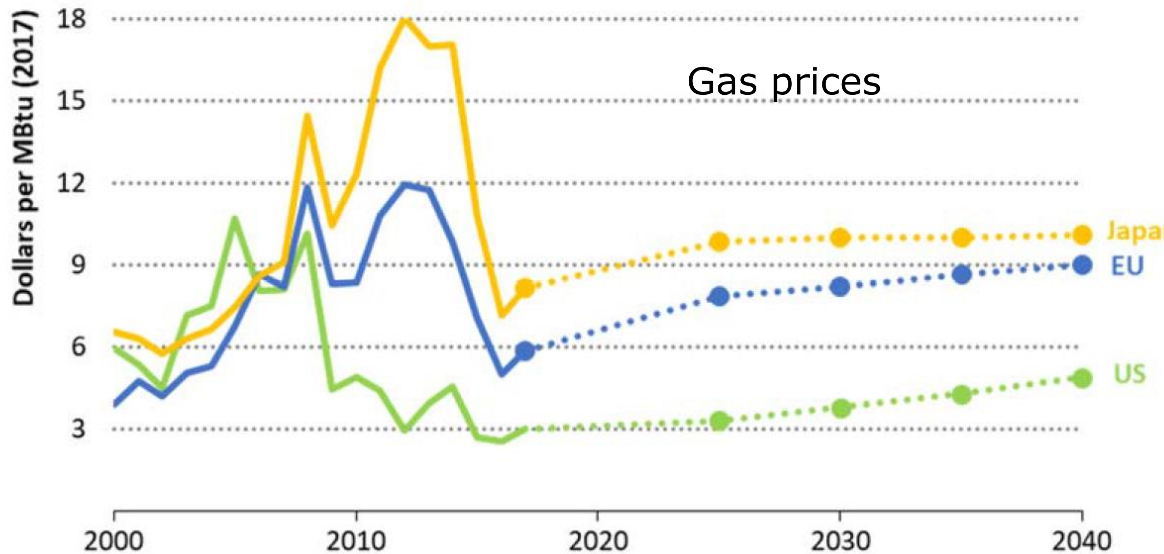
→ Increasing capacity utilization rates

→ BUT lower marginal profits

IEA WEO Oil, gas and coal price scenarios



Source: *IEA (2018)*



Source: IEA (2018), *World Energy Outlook 2018*, IEA, Paris, https://doi.org/10.1787/weo-2018-en.

Pellet price parity with fossil fuel prices

Table 1: Comparison between the World Energy Outlook "New Policy Scenario" fossil fuel prices in €/GJ and the average 2016 wood pellet import price at the ARA-ports

	2016	2030
Natural Gas (US & EU)	2.1 - 4.2	3.2 - 7.0
Steam Coal (US & EU)	1.7 - 2.3	2.2 - 2.9
Oil (World)	6.3	14.4
Wood pellets (ARA CIF*)	7.2	

Source: Own calculations based on IEA (2018), *World Energy Outlook 2018*, IEA, Paris, https://doi.org/10.1787/weo-2018-en and www.argusmedia.com

**Cost, Insurance & Freight*

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- Parity in 2016 at a 60$/t_CO2
- In 2030 depending on decoupling from oil price

Source: Own calculations based on IEA (2018), *World Energy Outlook 2018*, IEA, Paris, https://doi.org/10.1787/weo-2018-en and www.argusmedia.com

**Cost, Insurance & Freight*

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Future pellet markets

Examples from emerging sectors

Olle Olsson, Stockholm Environment Institute

Future pellet demand

- **Traditional sources of pellet demand under pressure, e.g.,**
  - Rapidly decreasing costs of wind & solar electricity
  - Heat pumps are becoming increasingly competitive
- **What is the outlook for pellet demand in other sectors?**
  - Heavy industry?
  - BECCS?

Heavy industry – steel examples

- Steel production 7% of global CO_2 emissions
- Blast furnace process dominates emissions ($Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$)
- Two possible routes of decarbonization: process shift or gradual reduction

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Two routes towards zero-emission steel

- **Route 1: keep blast furnace process, add CCS**
- **Route 2: hydrogen direct reduction (H-DR)**
- **Role for biomass in both routes**
  - Route 1: CCS is limited to about 80% emission reduction, addition of biomass can enable 100%
  - Route 2: as a source of carbon needed for the conversion of iron to steel

BECCS

- Combining bioenergy with carbon capture & storage -> BECCS
- BECCS and other negative emission technologies (NETs) likely necessary to stay within 2°
- Drax Power piloting BECCS based on pellets


Drax power station, picture by Paul Glazzard

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BECCS prospects

- **Power station BECCS technology still immature**
  - Public funding needed for scale-up & demos
- **How to incentivize negative emissions?**

Thank you!

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More Information on the Wood Pellet Report (Fritsch et al., 2019):

http://task40.ieabioenergy.com

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