



IEA Bioenergy
Technology Collaboration Programme



How flexible bioenergy can support the transition to a renewable energy system

WBA Webinar: Bioenergy for Flexibility in Energy Systems

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Challenges in a renewable energy system

- Intraday mismatch of electricity supply and demand
- Seasonal (and regional) mismatch of energy supply
- Defossilisation of all sectors: domestic/industrial heat, transport on land, ships, aviation, chemical industry
- Negative emissions to compensate unavoidable CO₂ etc.



Challenges in a renewable energy system

Measures in electricity system beyond efficiency and demand-side management

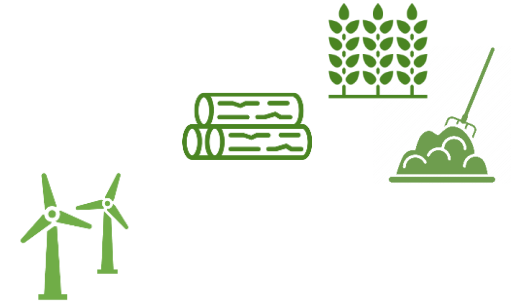
- **Intraday mismatch of electricity supply and demand**
Pumped-storage hydroelectricity, batteries etc.
- **Seasonal (and regional) mismatch of energy supply**
Reservoirs (dams)
- **Defossilisation of all sectors: domestic/industrial heat, transport on land, ships, aviation, chemical industry**
Heat pumps, District heating with waste incineration,
Electrification of cars, trucks, processes
- **Negative emissions to compensate unavoidable CO₂ etc.**
(Direct air capture of CO₂)



Challenges in a renewable energy system

What about biomass?

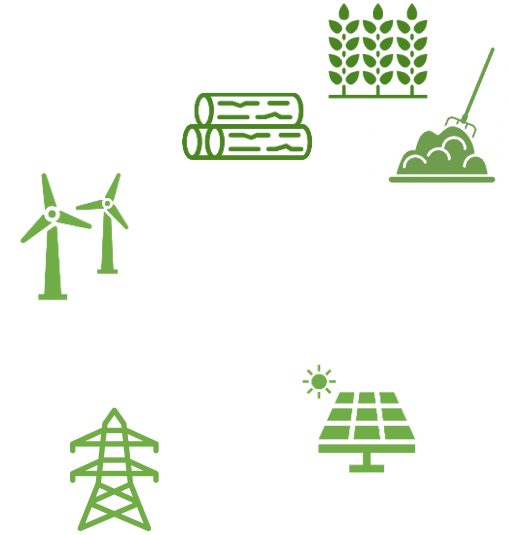
- Intraday mismatch of electricity supply and demand
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Challenges in a renewable energy system

Biomass is a valuable wild card!

- Intraday mismatch of electricity supply and demand
- Seasonal (and regional) mismatch of energy supply
- Defossilisation of all sectors: domestic/industrial heat, transport on land, ships, aviation, chemical industry
- Negative emissions to compensate unavoidable CO₂ etc.



Flexible bioenergy vs. intraday electricity mismatch

Feedstocks

Intermediates (limited spatial and temporal flexibility)

Application (variable)

Wet biomass
(usually not storable)

Dry biomass
(storable)

Product gas

Biogas

Pyrolysis oil

Pellets, Chips

CHPs: Heat (storage) & (flexible) Power



ICE, steam turbines, ORC: ramp up/down < 5 min, 0-100% load
Combustion, gasification: several hours, 30/50-100% load



Flexible biomass vs. seasonal mismatch

Feedstocks

Wet biomass
(usually not storable)

Dry biomass
(storable)

Intermediates (limited spatial and temporal flexibility)



Product gas

Biogas

Pyrolysis oil



Energy carrier (storable, large spatial and temporal flexibility)

(storable, large spatial and temporal flexibility)

Hydrogen

Methane
LNG

Pellets, Chips

Stabilised Oil

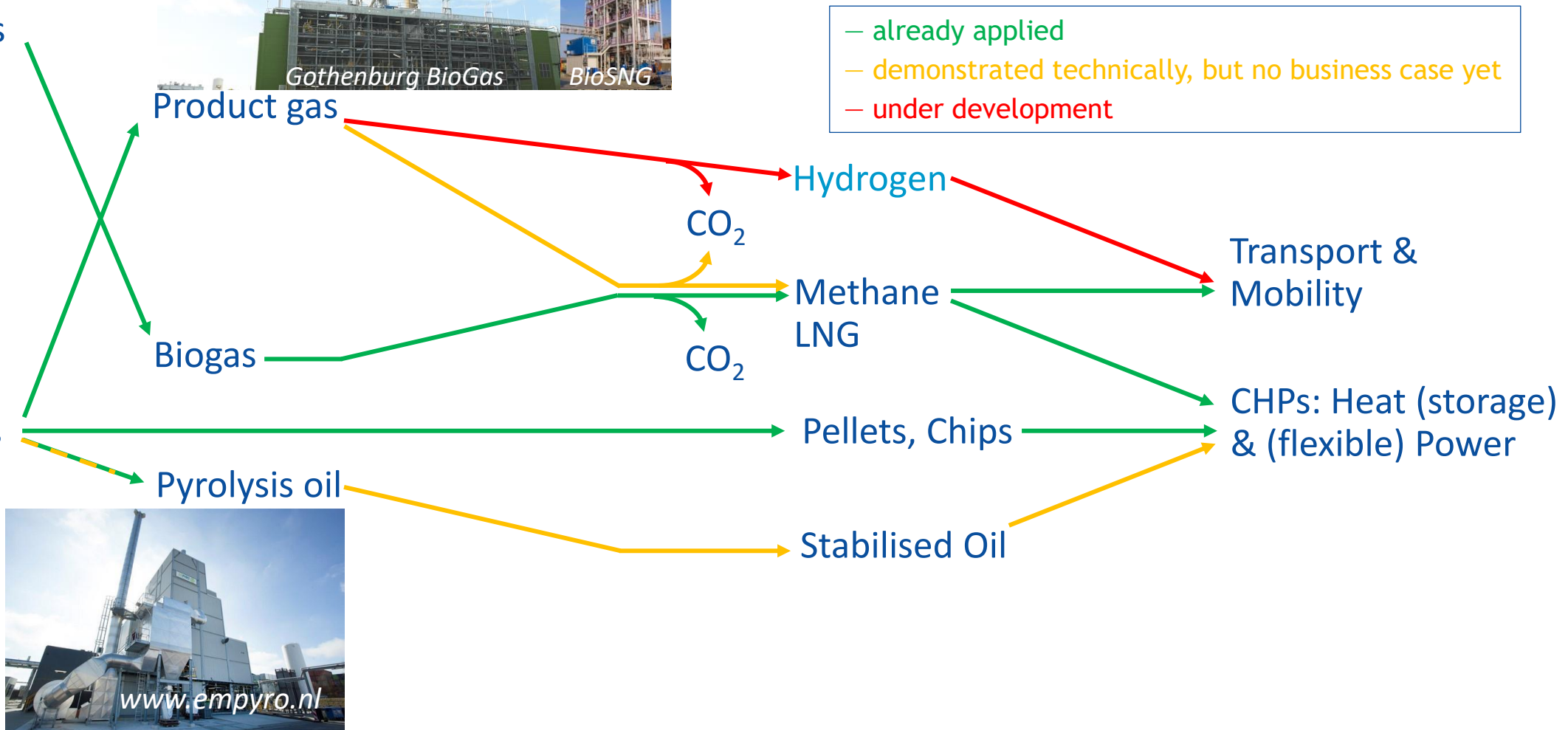
Application (variable)

(variable)

Transport & Mobility

CHPs: Heat (storage) & (flexible) Power

- already applied
- demonstrated technically, but no business case yet
- under development



Flexible biomass vs. seasonal mismatch: Synergy with H₂

Feedstocks

Wet biomass
(usually not storable)

Dry biomass
(storable)

Intermediates (limited spatial and temporal flexibility)

Product gas

Biogas

Pyrolysis oil



Energy carrier (storable, large spatial and temporal flexibility)

Hydrogen

Methane
LNG

Pellets, Chips

Stabilised Oil

Application (variable)

Transport & Mobility

CHPs: Heat (storage) & (flexible) Power

Biomass based PtX enables value creation (and business case?) to support PV/wind (over)capacity!

Adding H₂ from renewable electricity
(variable)

H₂

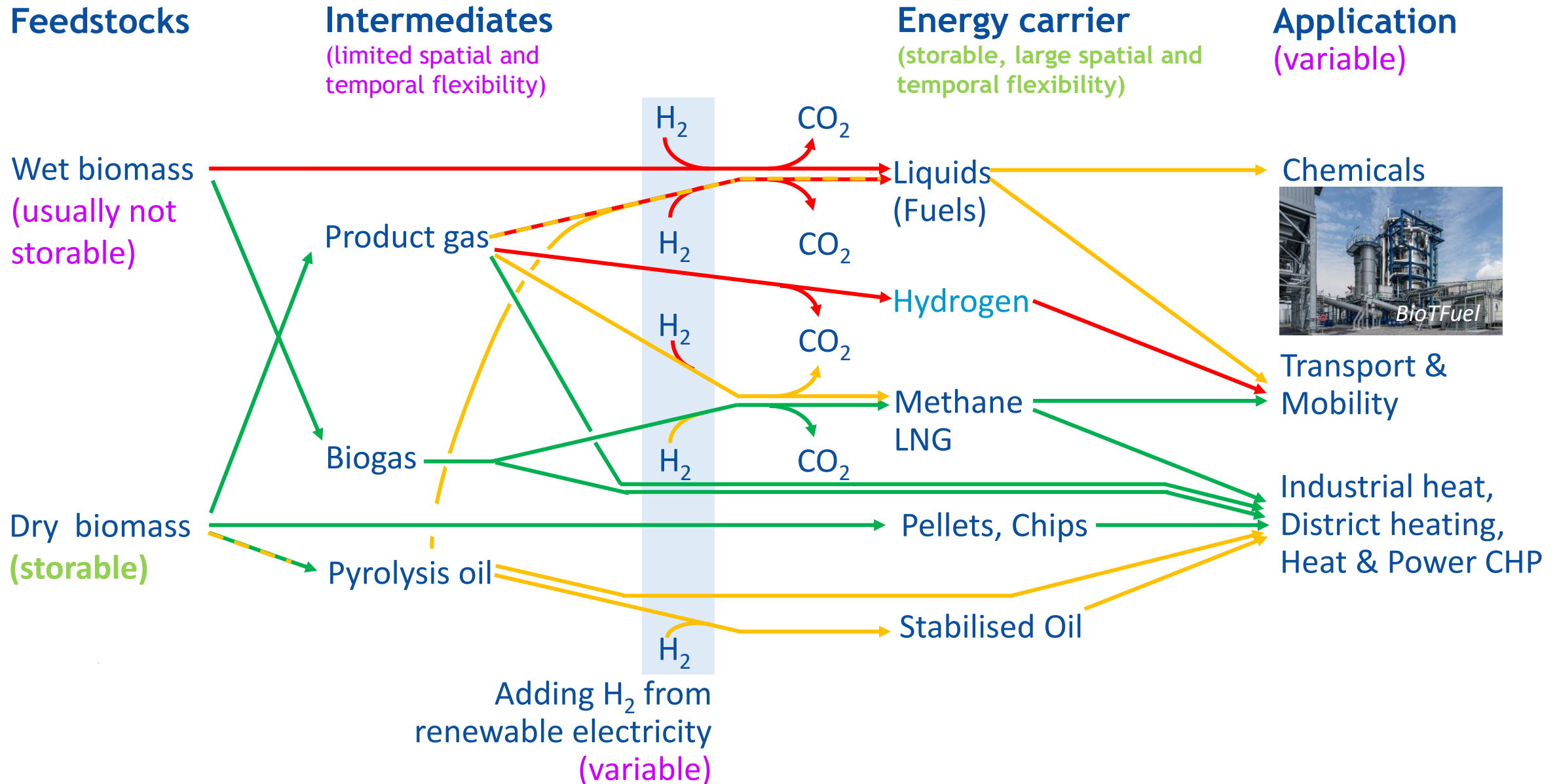
CO₂

H₂

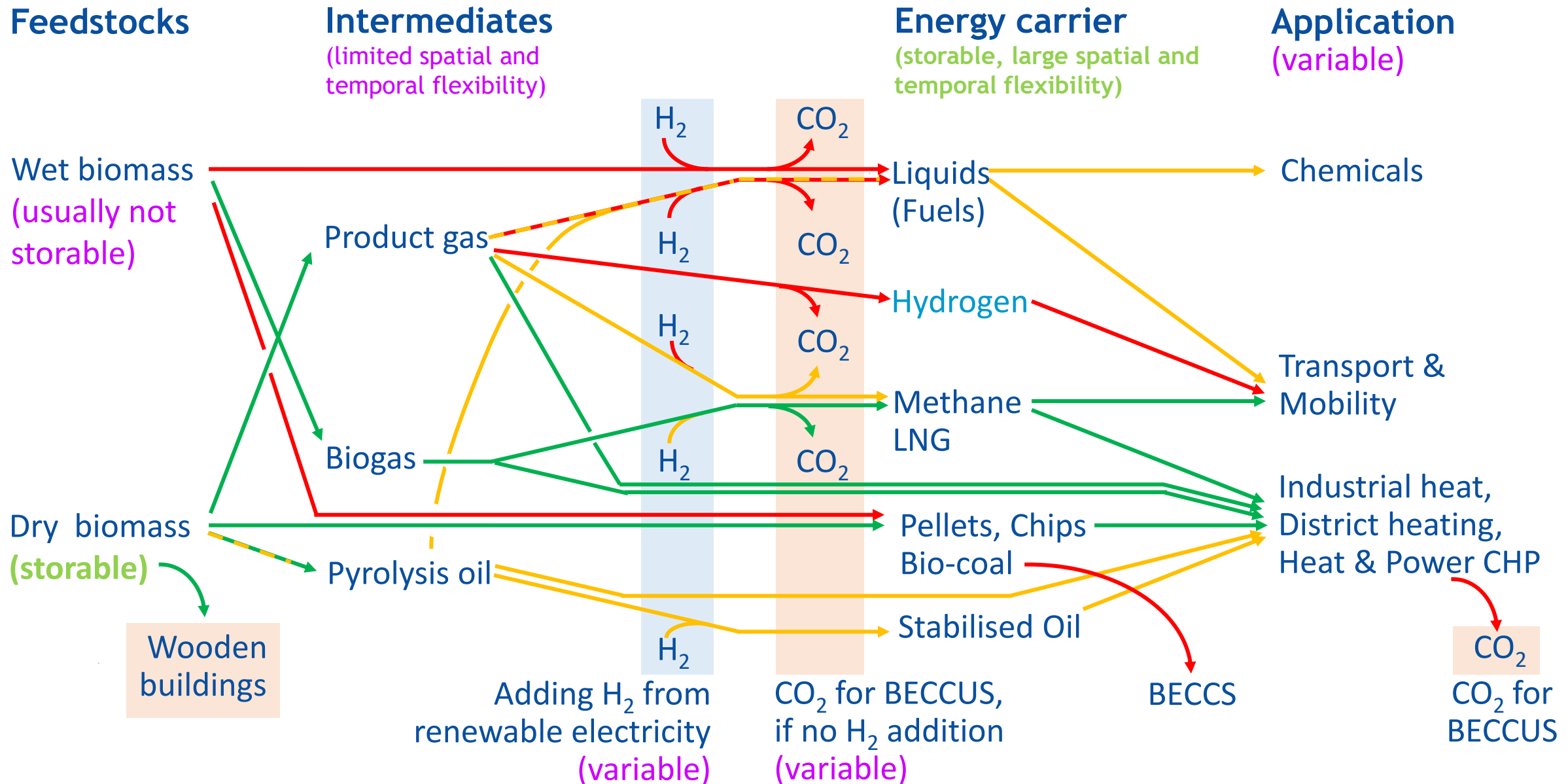
CO₂

H₂

Flexible biomass for defossilisation



Flexible biomass for negative emissions



Key messages flexible bioenergy

- Flexible biomass is a valuable wild card!
- Many services to the energy system: covering peak demands, offering seasonal storage and enabling negative emissions
- Biomass based PtX enables value creation (and business case?) to support PV/wind (over)capacity!
- Market regulations and incentives without preference for certain technologies, energy carriers or services!
- Technology development to increase flexibility and efficiency at small scale
- Correct representation in system models needed to find overall optimum
- Optimal solutions may differ from place to place

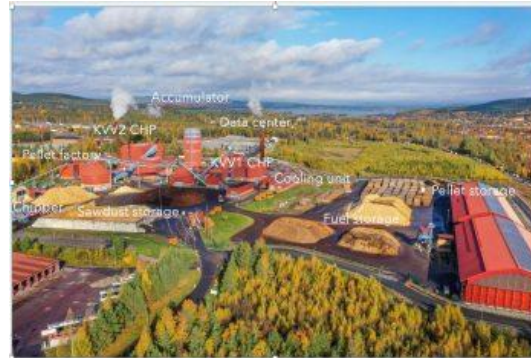
Many thanks for your attention!

Task 44: Best Practices:

<https://task44.ieabioenergy.com>



[E-gas plant](#) in Werlte, Germany
(Figure: e-gas GmbH)



<https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2024/02/Task-44-Best-Practice-Falun-Sweden.pdf>



[Waste2Value – From Waste to Value: Gasification and Upgrading of Syngas \(coming soon ...\)](#)



[Wood-based CHP with biochar production for negative emissions](#), Frauenfeld, Switzerland
(Figure: Carbonfuture)



IEA Bioenergy Task 44. Best Practices.
<https://task44.ieabioenergy.com/best-practices/>