IEA Bioenergy
Technology Collaboration Programme

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

Workshop Bioenergy in a Net Zero Future, Lyon

T.J. Schildhauer, Paul Scherrer Institut, Switzerland; Task 44

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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 CO_2 etc.

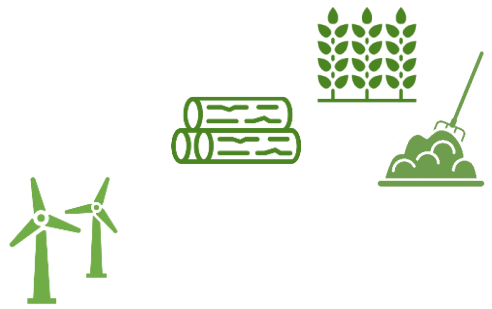
Challenges in a renewable energy system

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 CO_2 etc.
  - (Direct air capture of CO_2)

Challenges in a renewable energy system

What about biomass?



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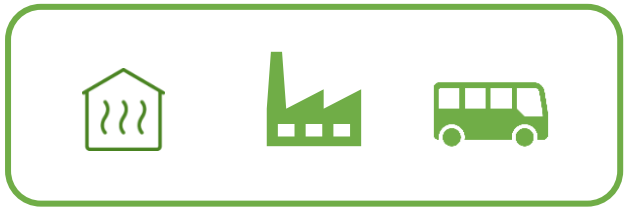
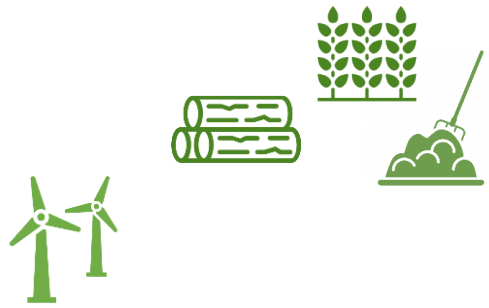


- Negative emissions to compensate unavoidable CO_2 etc.

Challenges in a renewable energy system

Biomass is a valuable wild card!



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David Bellot - http://svg-cards.sourceforge.net/

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

Intermediates
(limited spatial and temporal flexibility)

Energy carrier
(storable, large spatial and temporal flexibility)

Application
(variable)

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

Wet biomass
(usually not storable)

Product gas

Biogas

CO_2

CO_2

Hydrogen

Methane
LNG

Transport &
Mobility

Dry biomass
(storable)

Pellets, Chips

CHPs: Heat (storage)
& (flexible) Power

Pyrolysis oil

Stabilised Oil

Flexible biomass vs. **seasonal mismatch**: Synergy with H_2

Feedstocks

Intermediates
(limited spatial and temporal flexibility)

Energy carrier
(storable, large spatial and temporal flexibility)

Application
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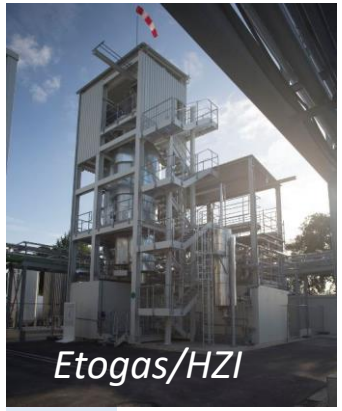


Biomass based PtX enables value creation (and business case?) to support PV/wind (over)capacity!

Wet biomass
(usually not storable)

Dry biomass
(storable)

Product gas

Biogas

Pyrolysis oil

H_2

CO_2

H_2

CO_2

H_2

Hydrogen

Methane
LNG

Pellets, Chips

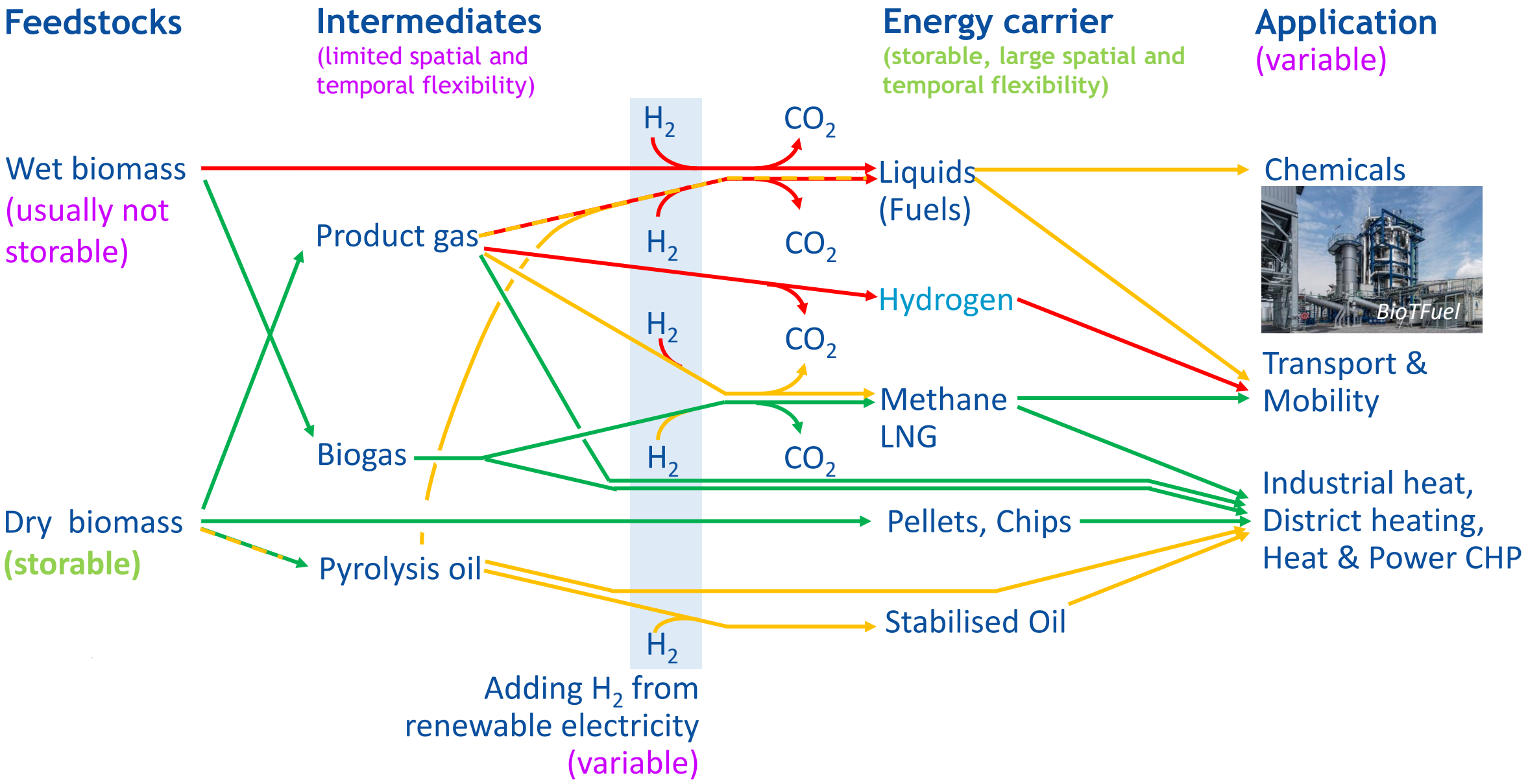
Stabilised Oil

Transport &
Mobility

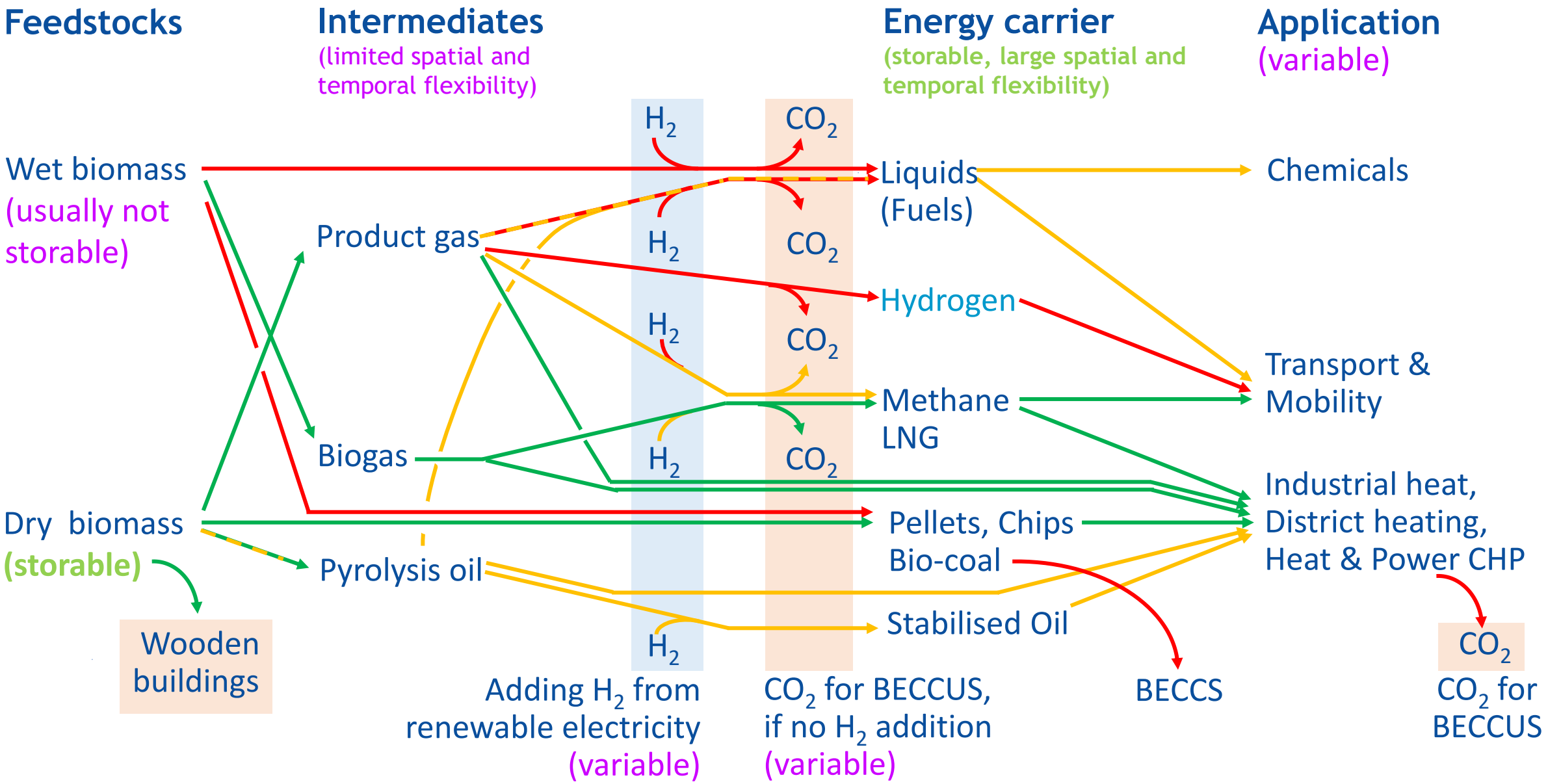
CHPs: Heat (storage)
& (flexible) Power

Adding H_2 from renewable electricity (variable)

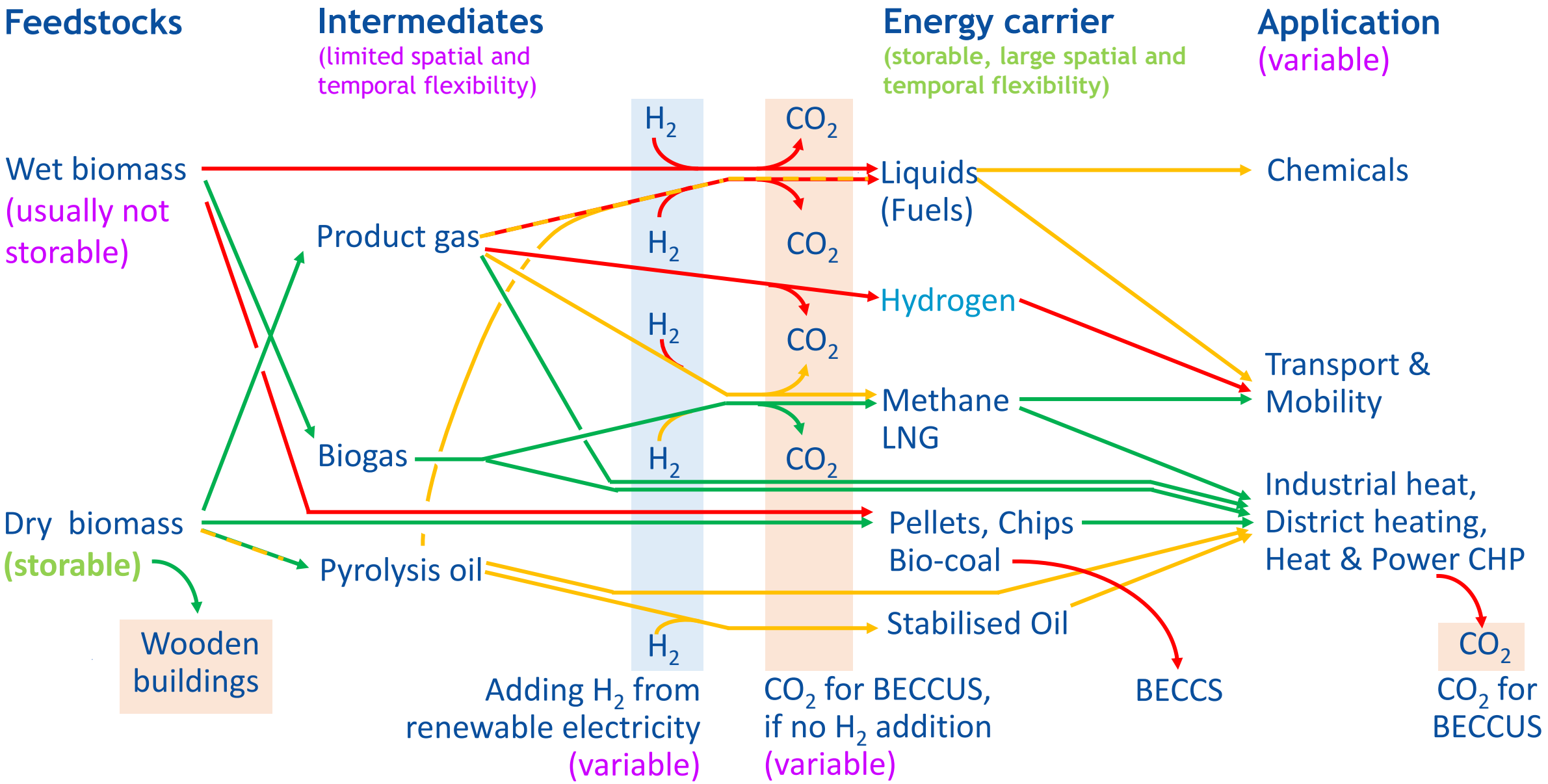
Flexible biomass for **defossilisation**



Flexible biomass for **negative emissions**



Flexible biomass: **What to use when what for?**



Flexible biomass: **What to use when what for?**

No “one fits all”

Strong regional differences:

- Type and amount of feedstock available: Biomass logistics (harbours, flat land or mountains)
- District heating or gas grid available? Transporting CH_4 or H_2?
- Synergies with H_2 local production or with regional CO_2 logistics?

Variations in time:

- PtX in summer to valorise PV, BECCS in winter?
- Methane production for CNG cars and heating in the next two decades, but change to H_2 production, when content of gas grid changes?

Market regulations and incentives to enable flexibility:

- Needed! Best: no preference for certain technologies, energy carriers or services!

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)

Vantaa Energy's Power-to-Gas integrated with Waste-to-Energy, Finland (Figure: Vantaa Energy)

Liquid Wind's e-methanol production facility, Sweden
(Figure: Övik Energi)

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/