

UNIVERSITY OF TWENTE.

Renewing the Carbon basis of Prosperity

Jean-Paul Lange

(Chemical Bio-refining)

Inaugural lecture – July 4th 2013

Content

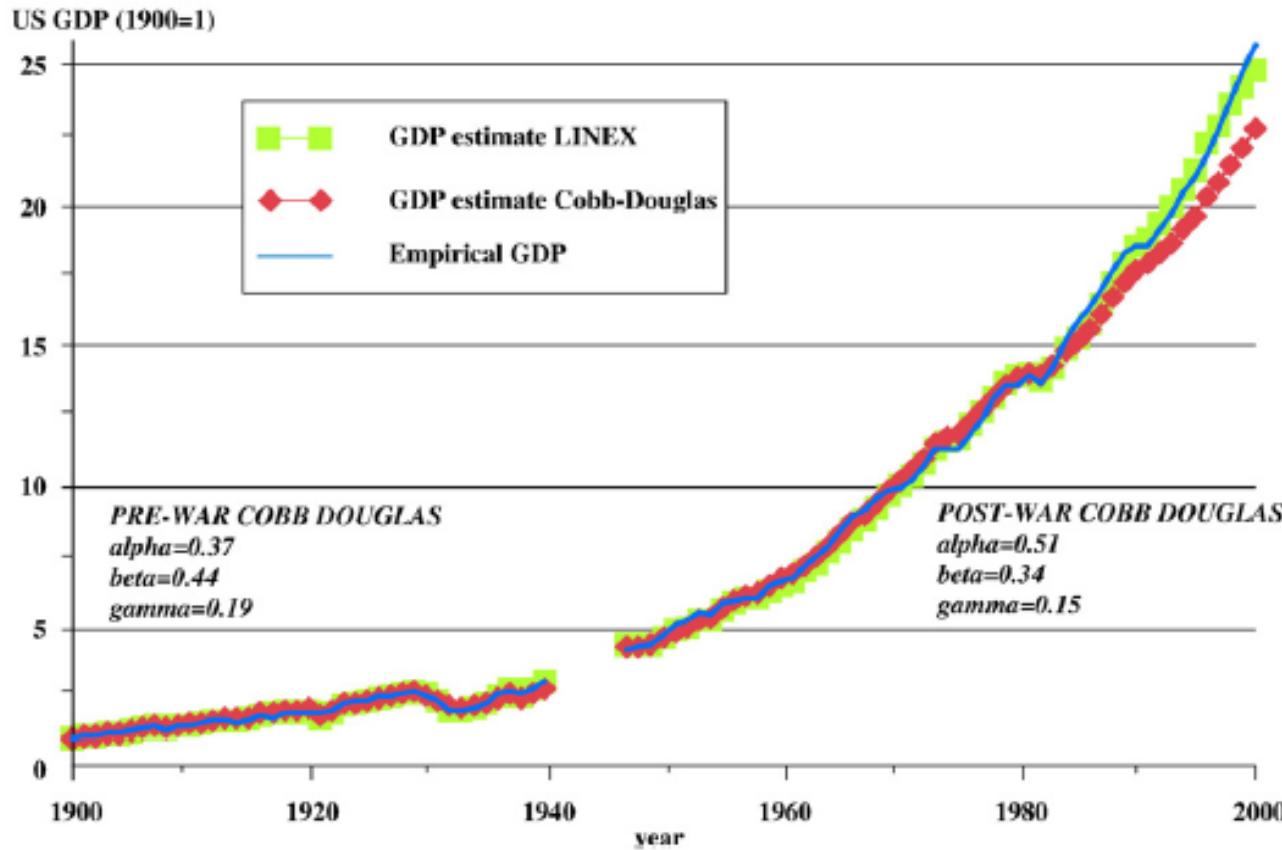
- Old vs. New Carbon
- Valorizing the new Carbon
- Beyond the carbon

Blessing – Curse - Opportunities

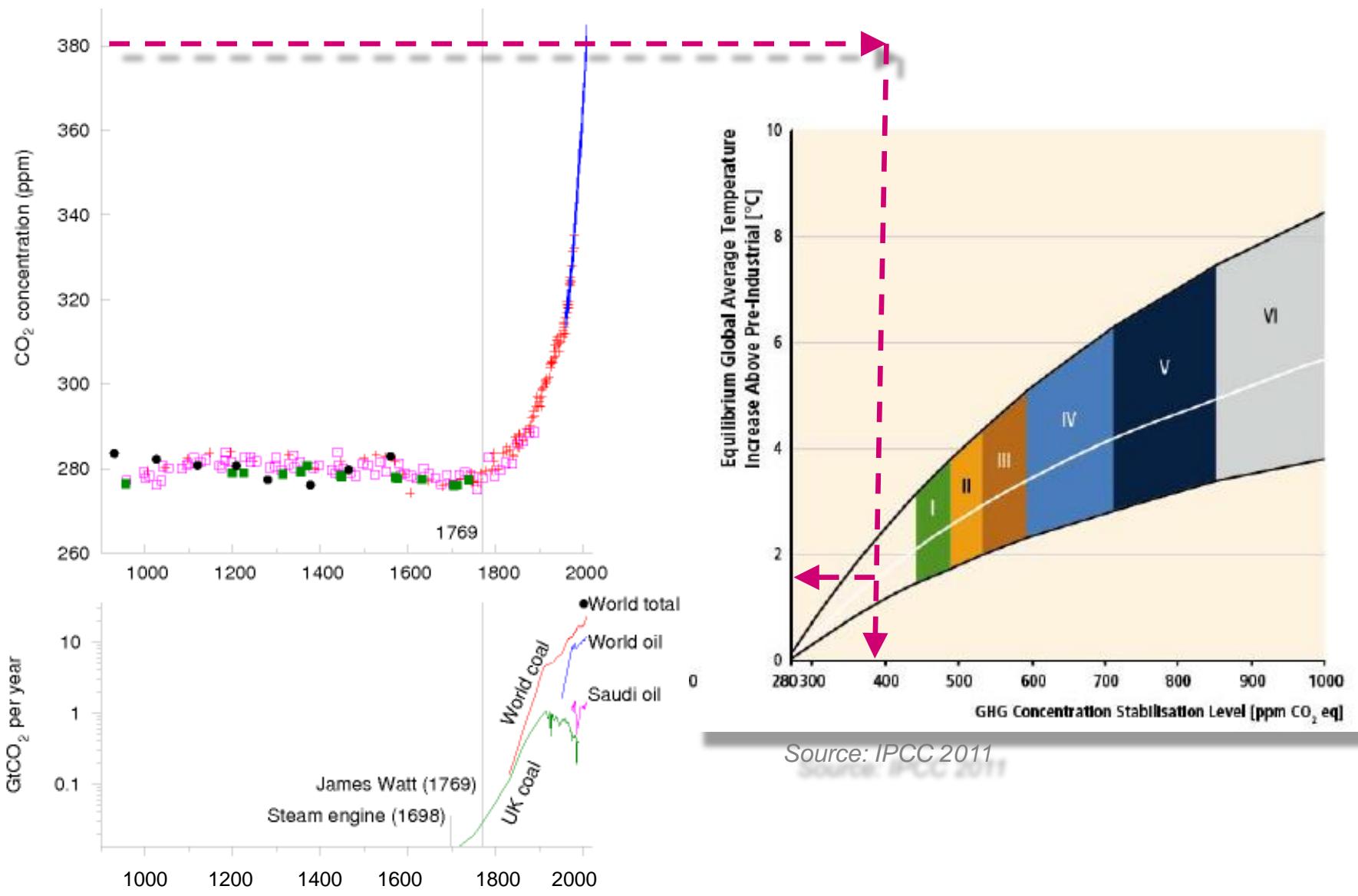
OLD vs. NEW CARBON

Blessing - prosperity

$$GDP = A * \text{capital}^{\alpha} * \text{labor}^{\beta} * \text{energy}^{\gamma}$$

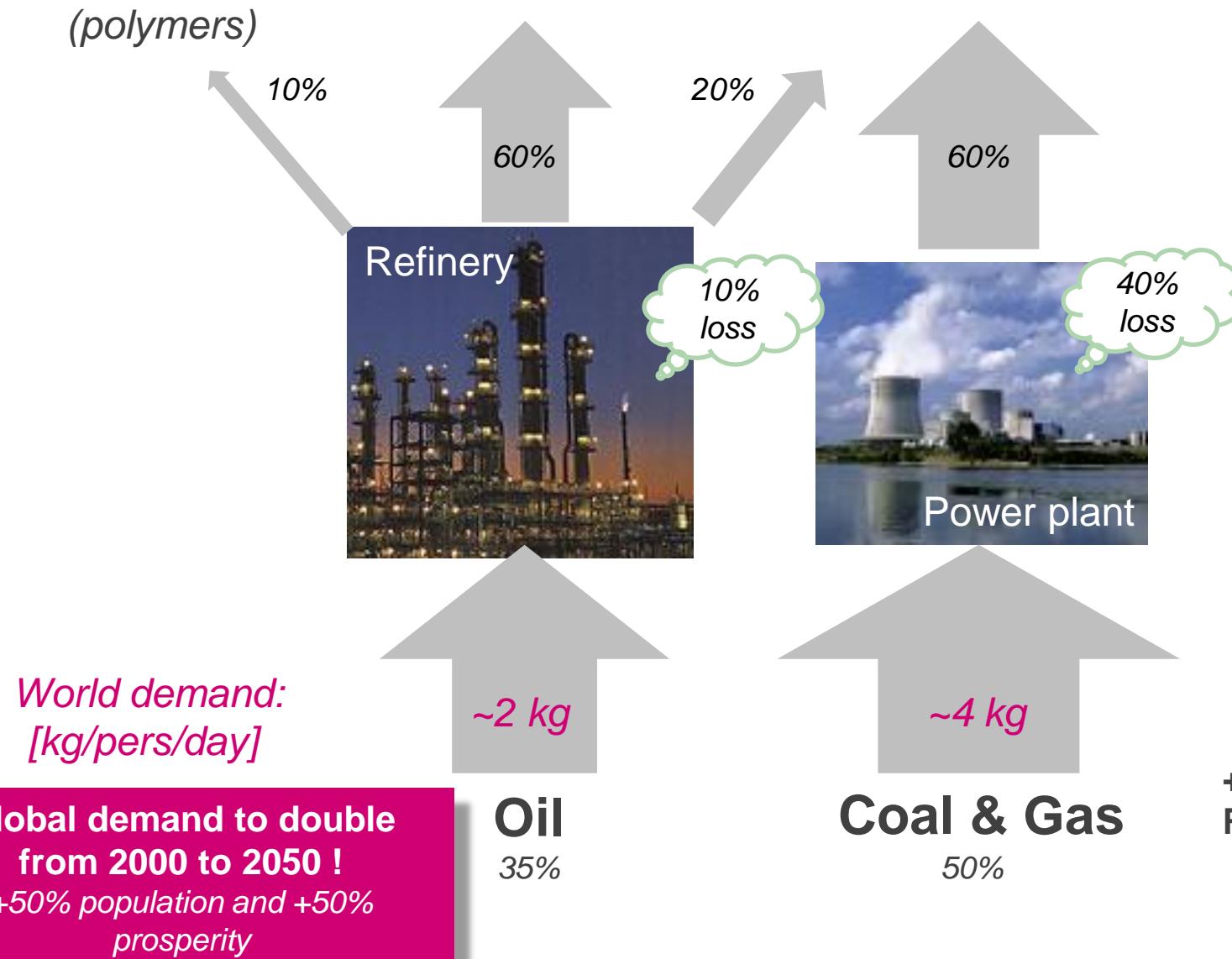


Curse – climate change



Fossil energy consumption (500 EJ/y)

Petrochemicals Transport Heat & Electricity



Tomorrow's prosperity needs C-neutral energy

No alternative to Biomass

**Petrochemicals Transport
(polymers)**

Heat & Power



- Efficiency
- Shift coal → gas
- CCS

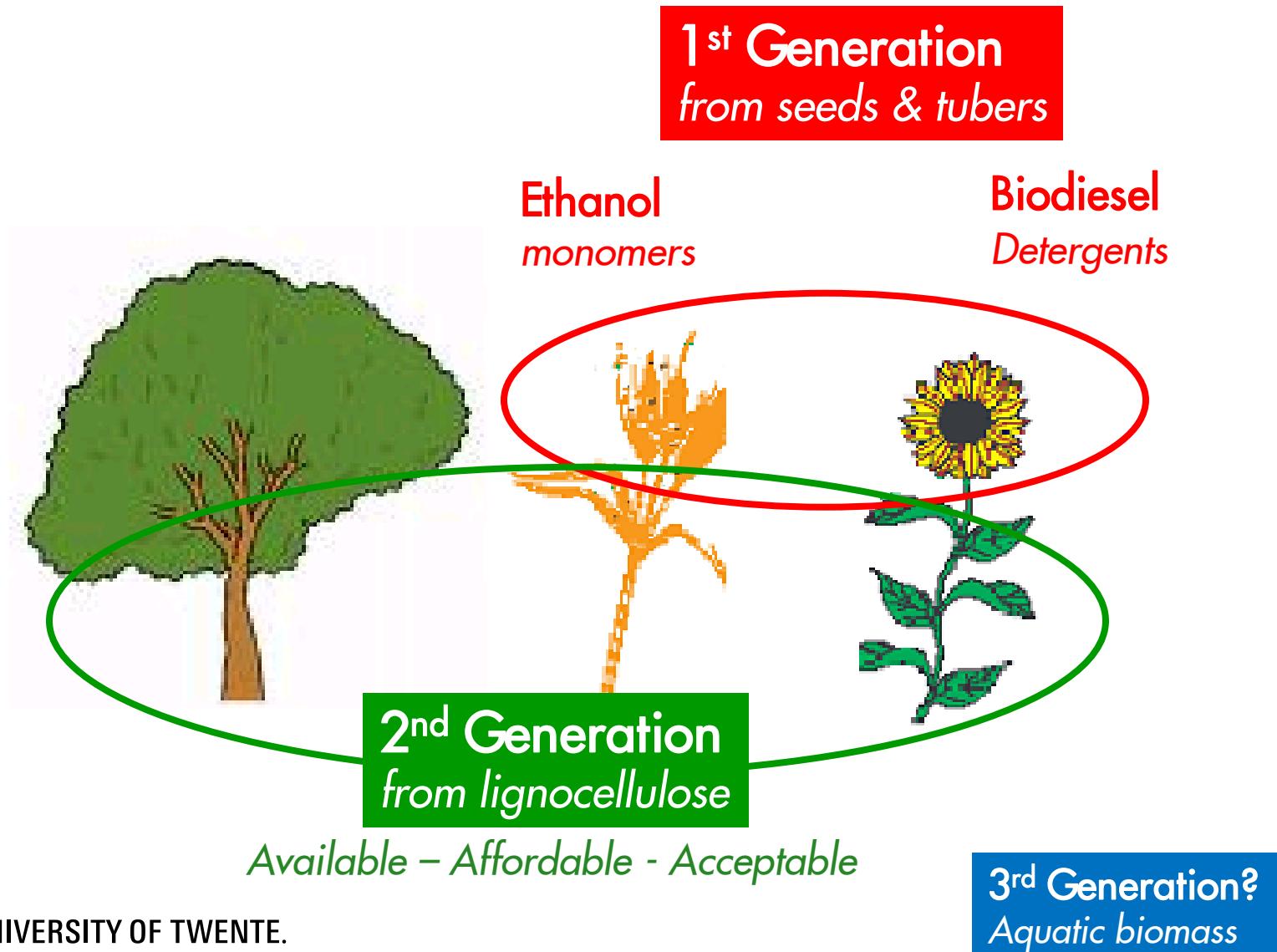
Oil

Biomass

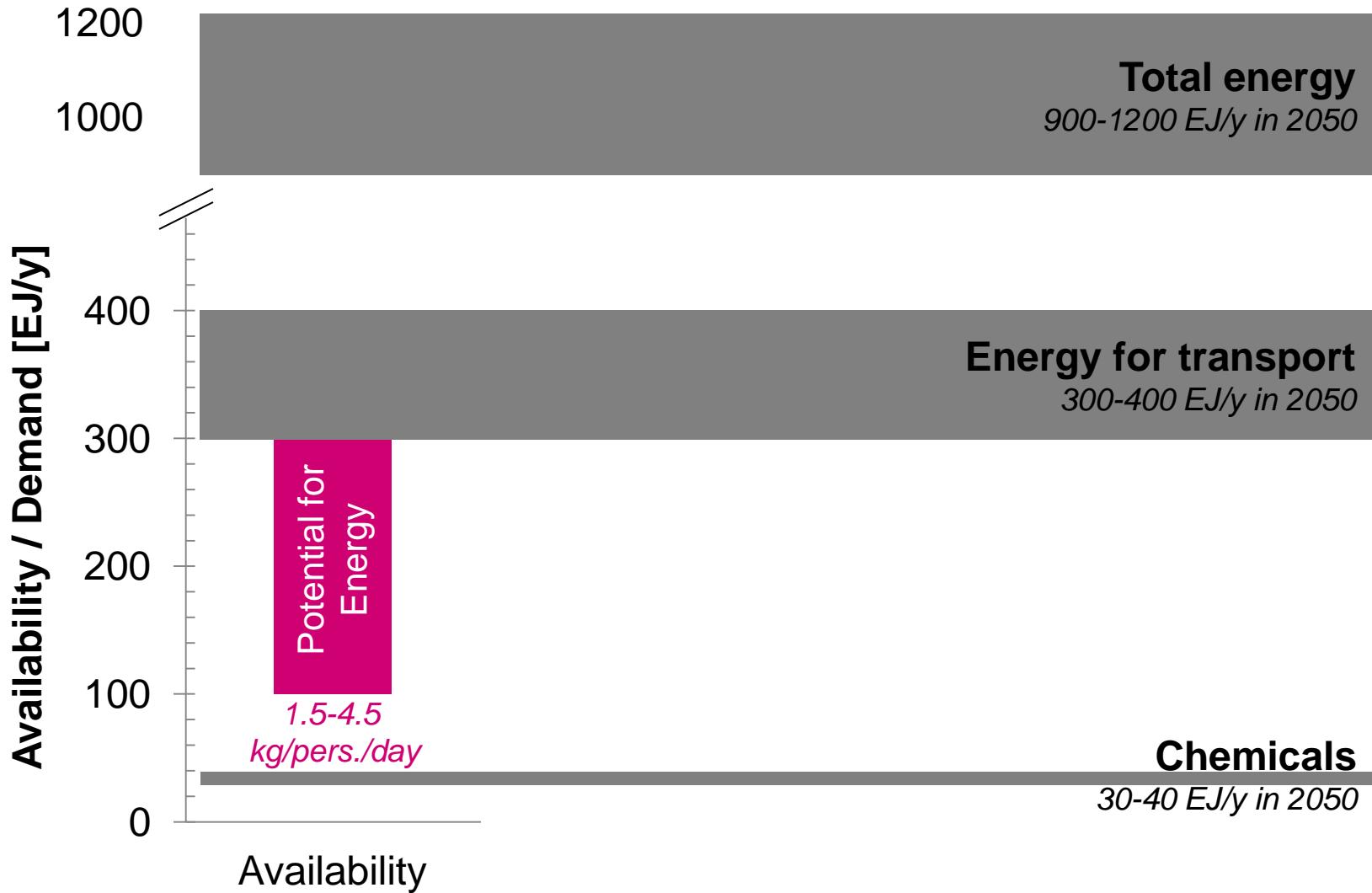
Coal & Gas

**Solar, Wind
Water**

Which biomass?



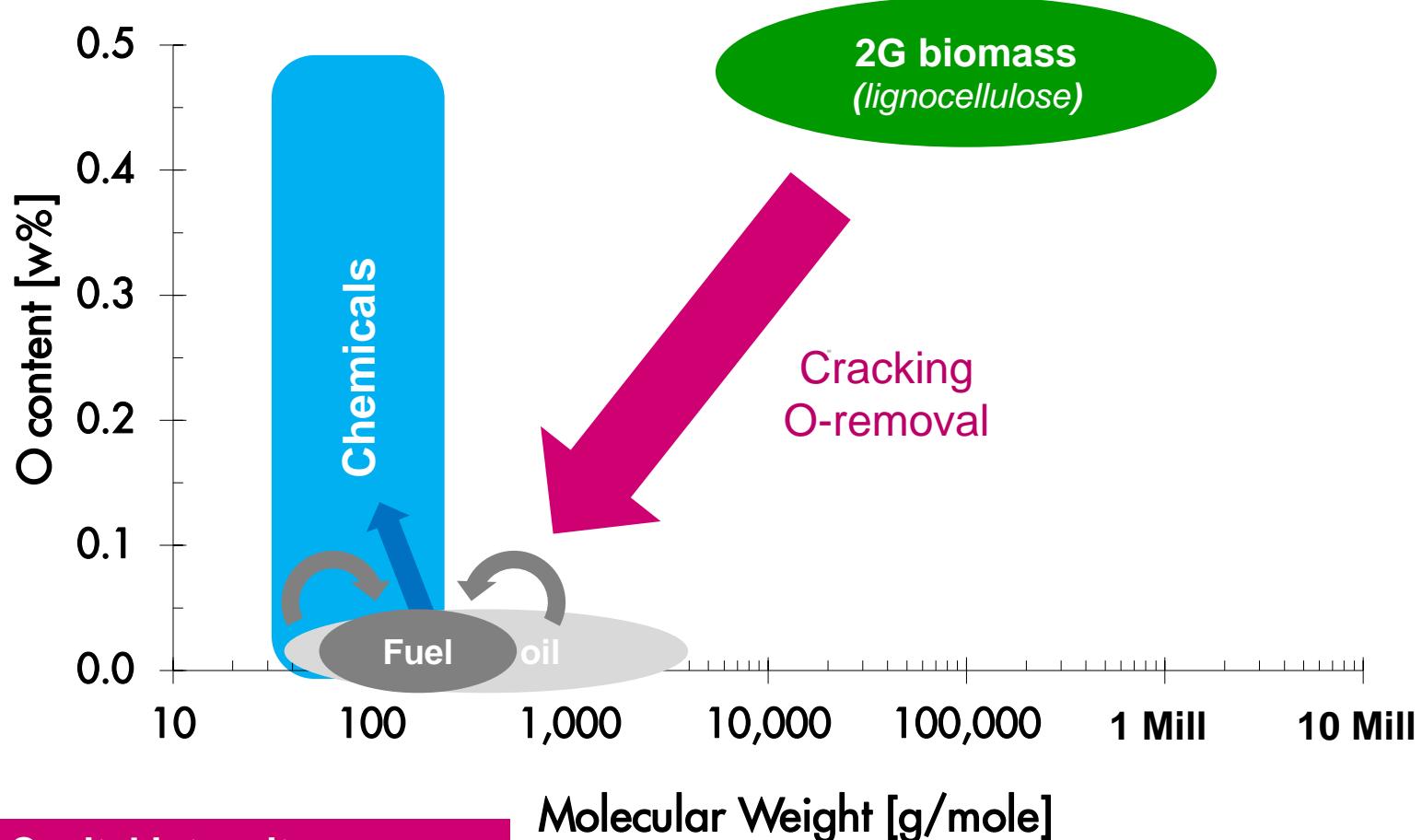
Do we have enough biomass by 2050?



Challenges – Options

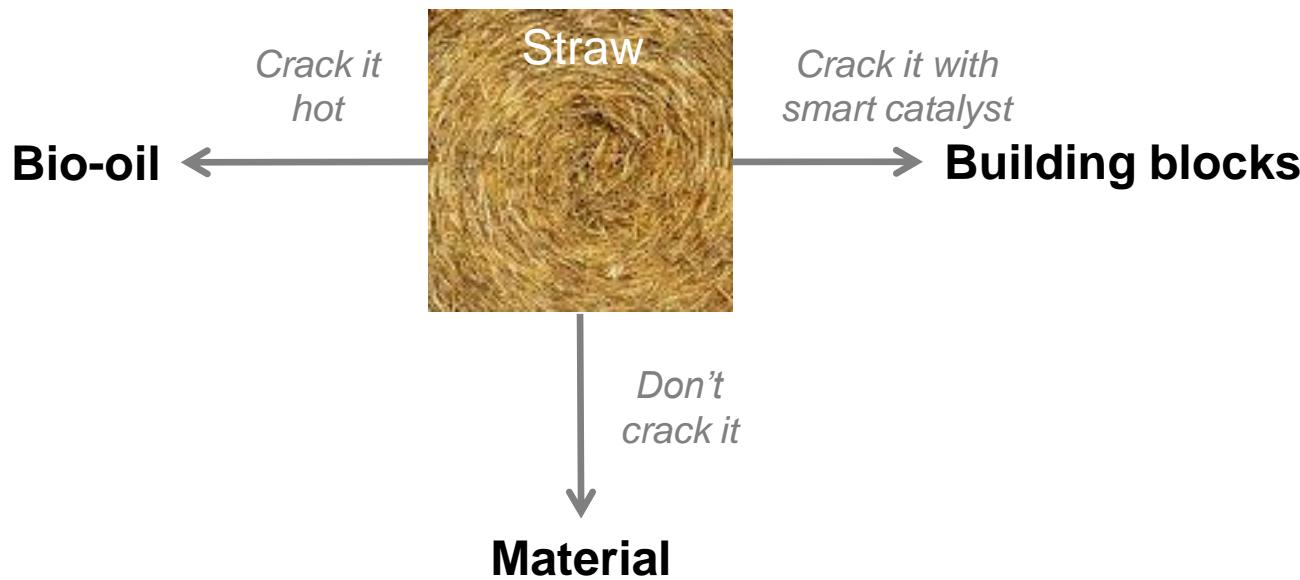
VALORIZING THE NEW CARBON

Conversion: demanding chemistry

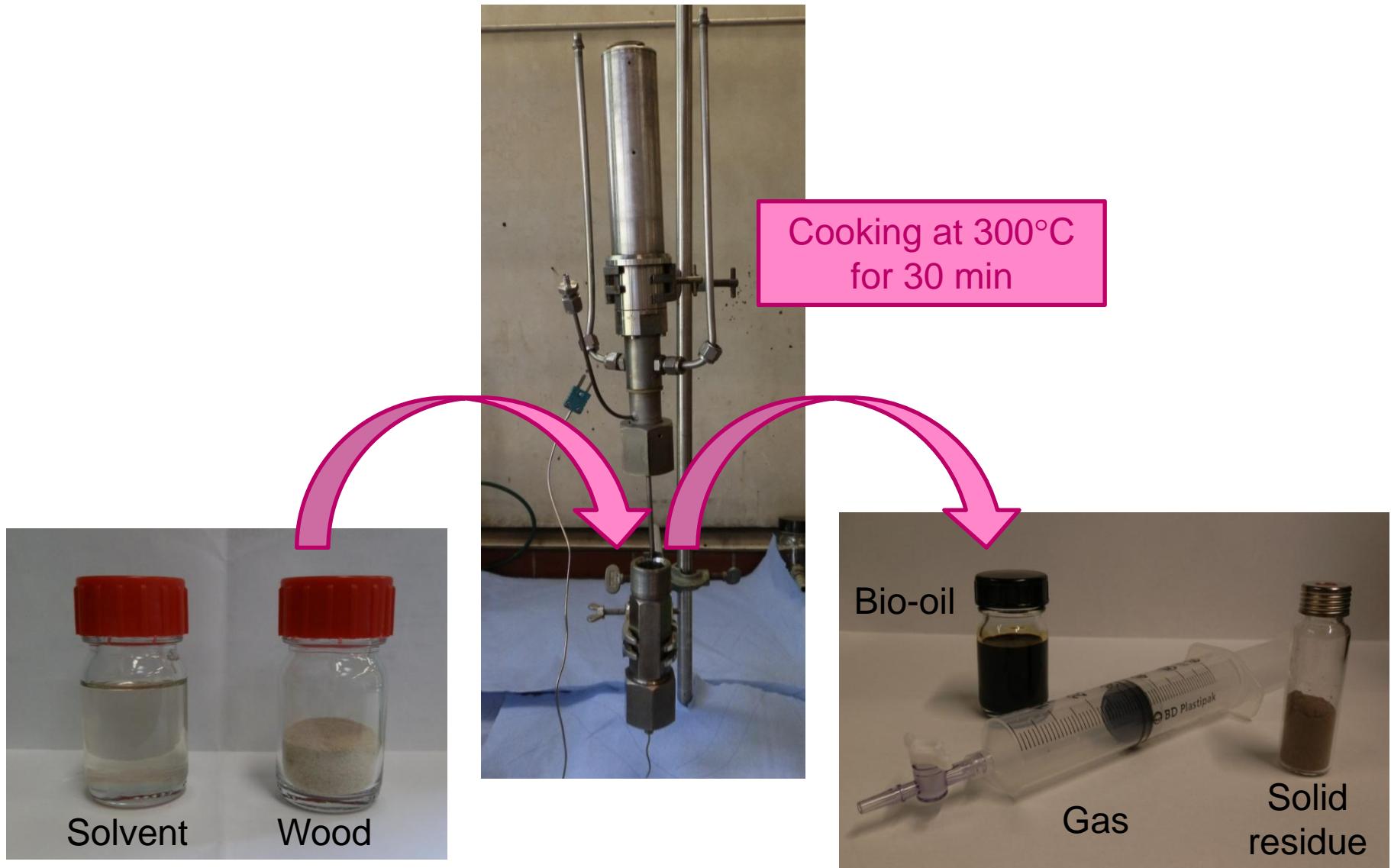


Capital intensity:	
2G Biofuel	40-60 \$/L ann. Capacity
1G Biofuel	2 \$/L

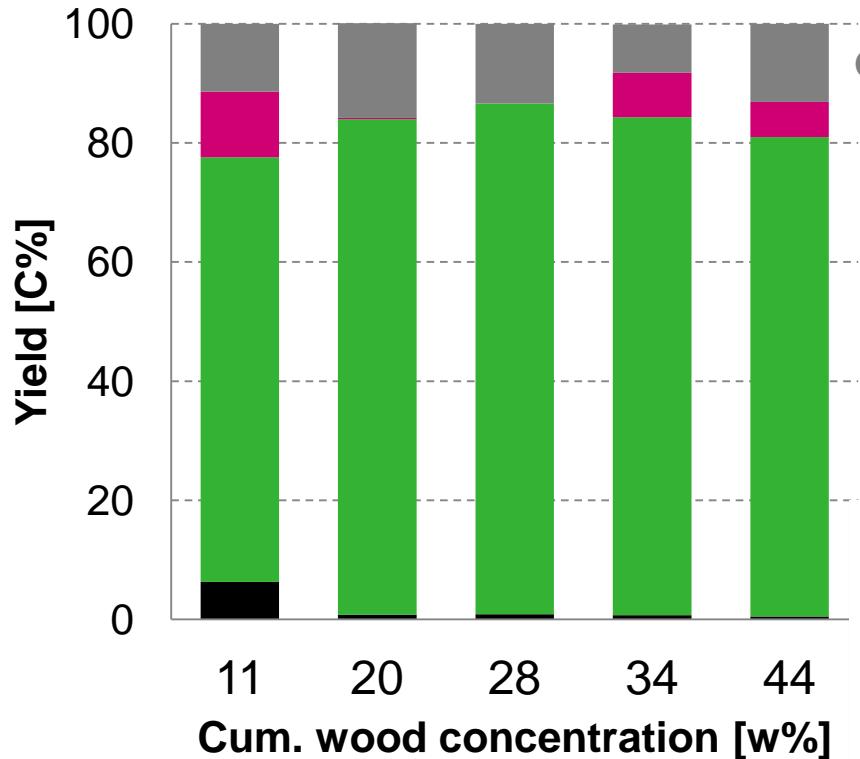
Three approaches to biomass conversion



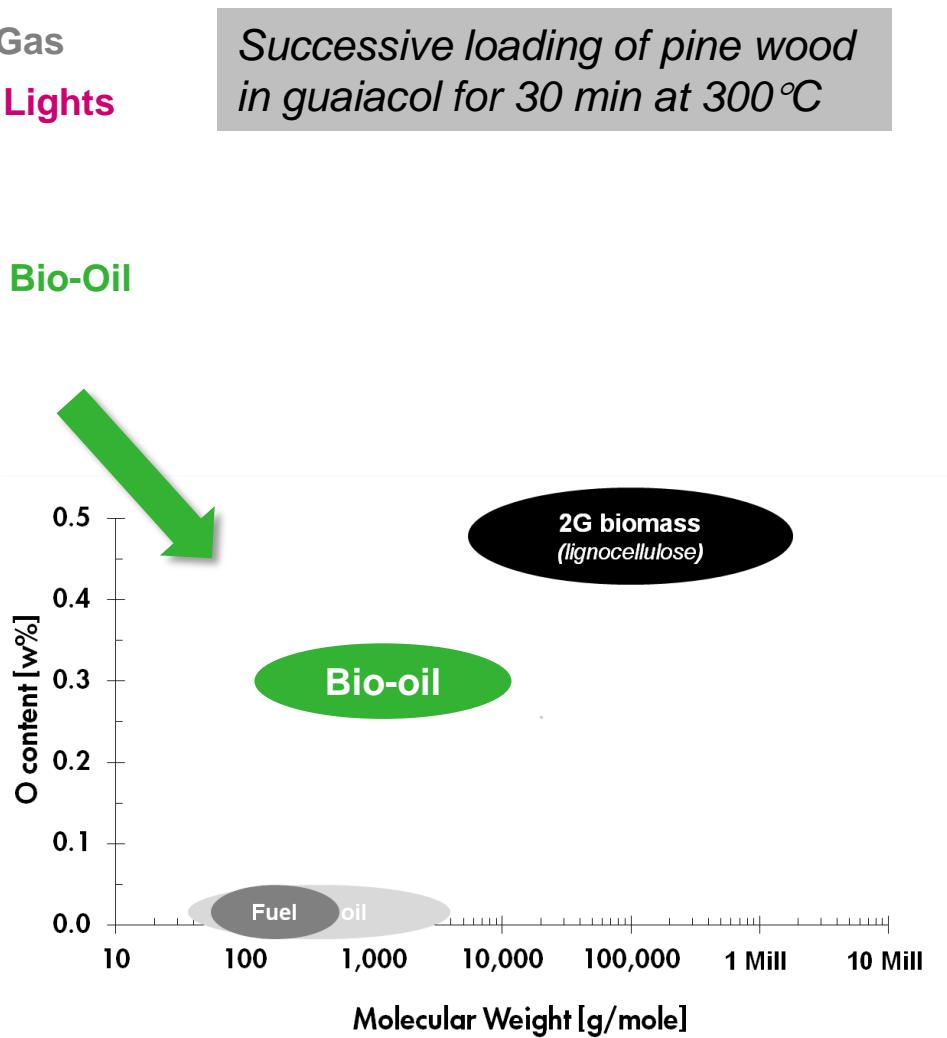
Dissolving biomass in liquid



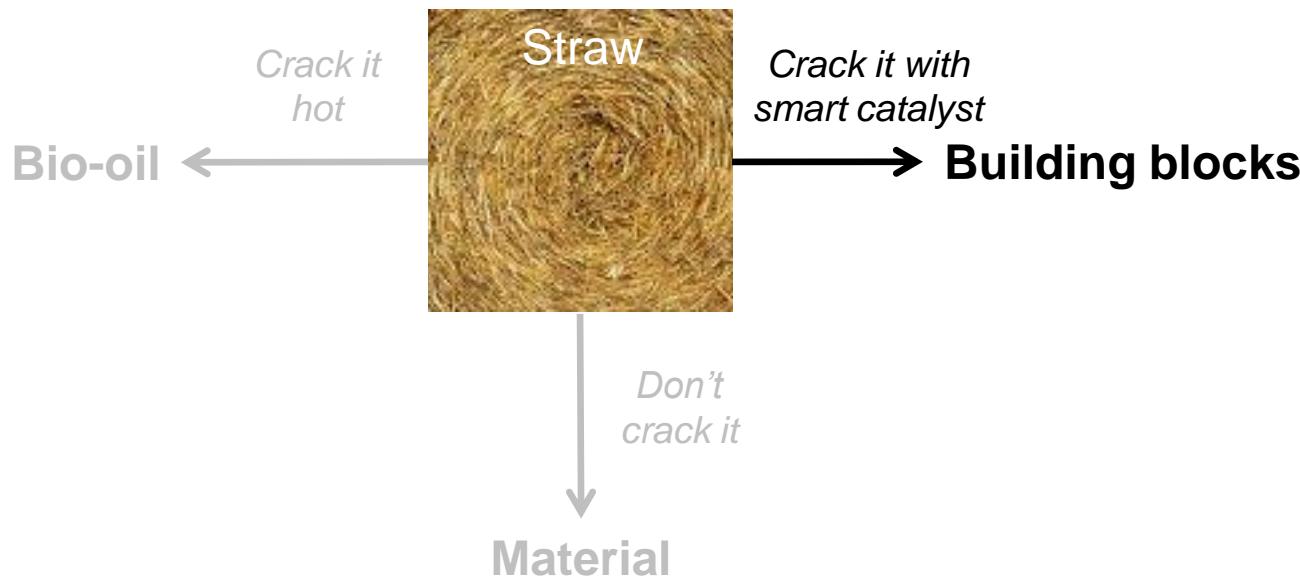
Dissolving biomass in phenolic medium



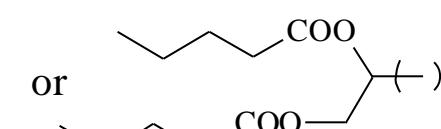
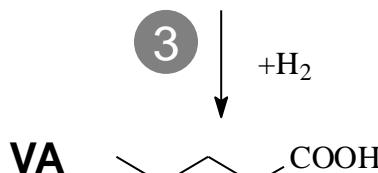
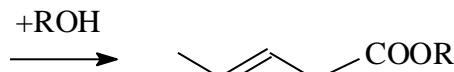
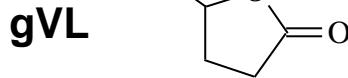
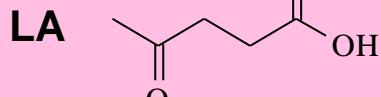
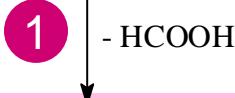
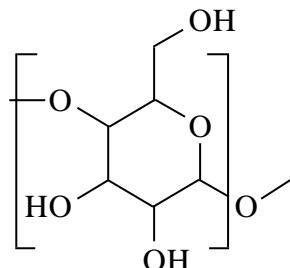
*Successive loading of pine wood
in guaiacol for 30 min at 300 °C*



Three approaches to biomass conversion



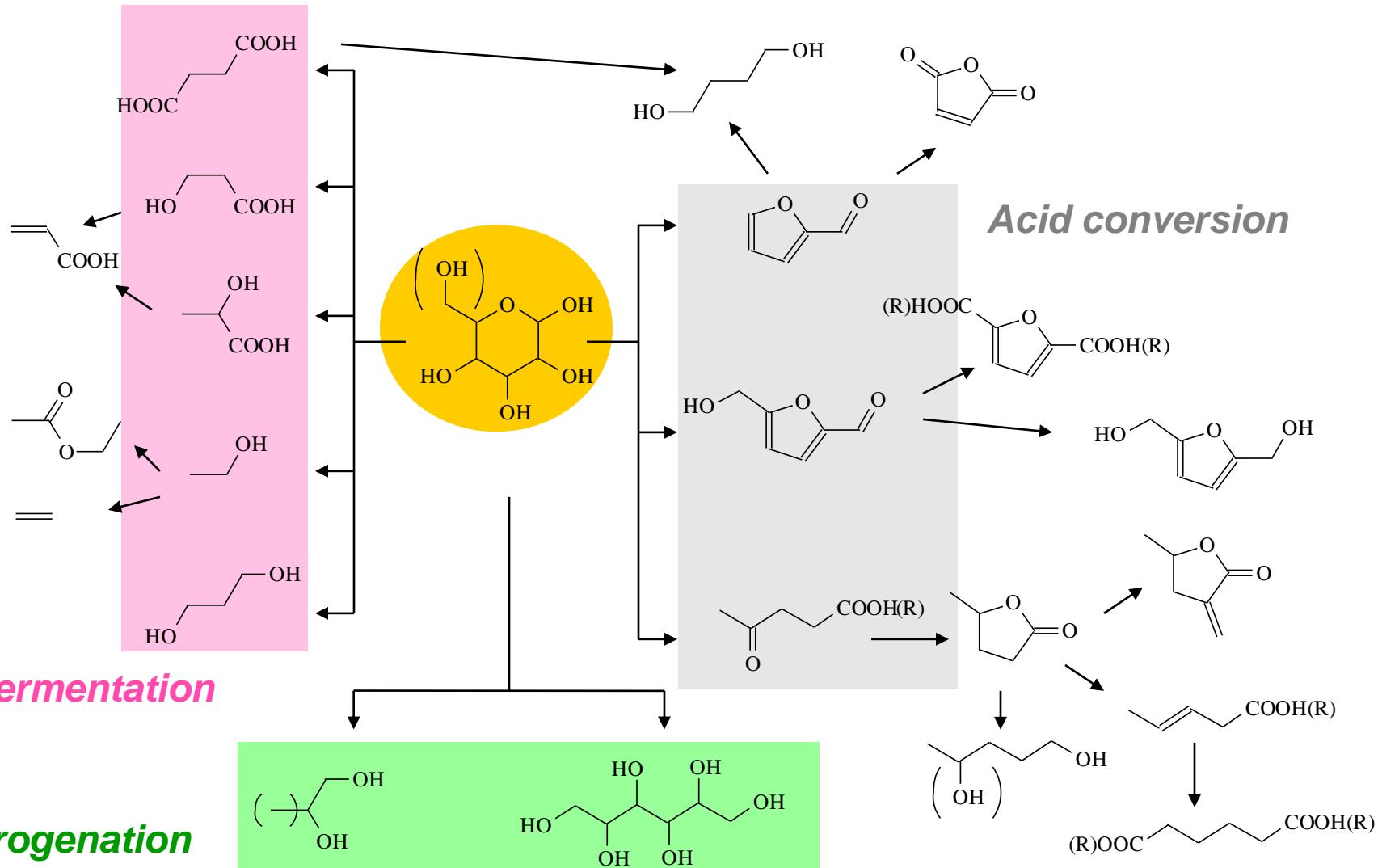
Valeric biofuels



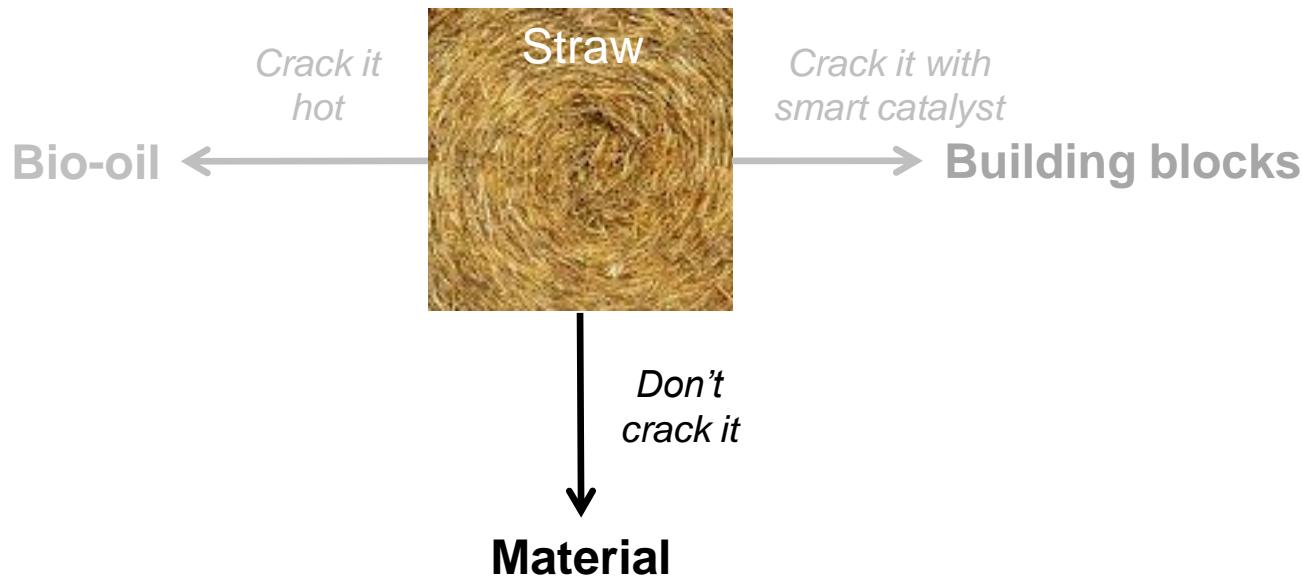
	1	2	3	4
Catalyst	H_2SO_4	Pt/TiO_2	Pt/ZSM-5	IER
Select. [mol%]	50-60	>95	>90	>95
Rate [$\text{t.m}^{-3}.\text{h}^{-1}$]	>0.1	>10	>1	>0.02 ^(a)
Conc. [w%]	3-5	>90	>50	>50

^(a) Integrated with distillation

Options in Bio-based Chemicals



Three approaches to biomass conversion



Cellulosic materials

Beyond the traditional uses ...

- Construction
- Textile
- Paper



UNIVERSITY OF TWENTE.

Cellulose reinforced steering wheel
(Science Museum's Antenna Gallery)



... New applications:

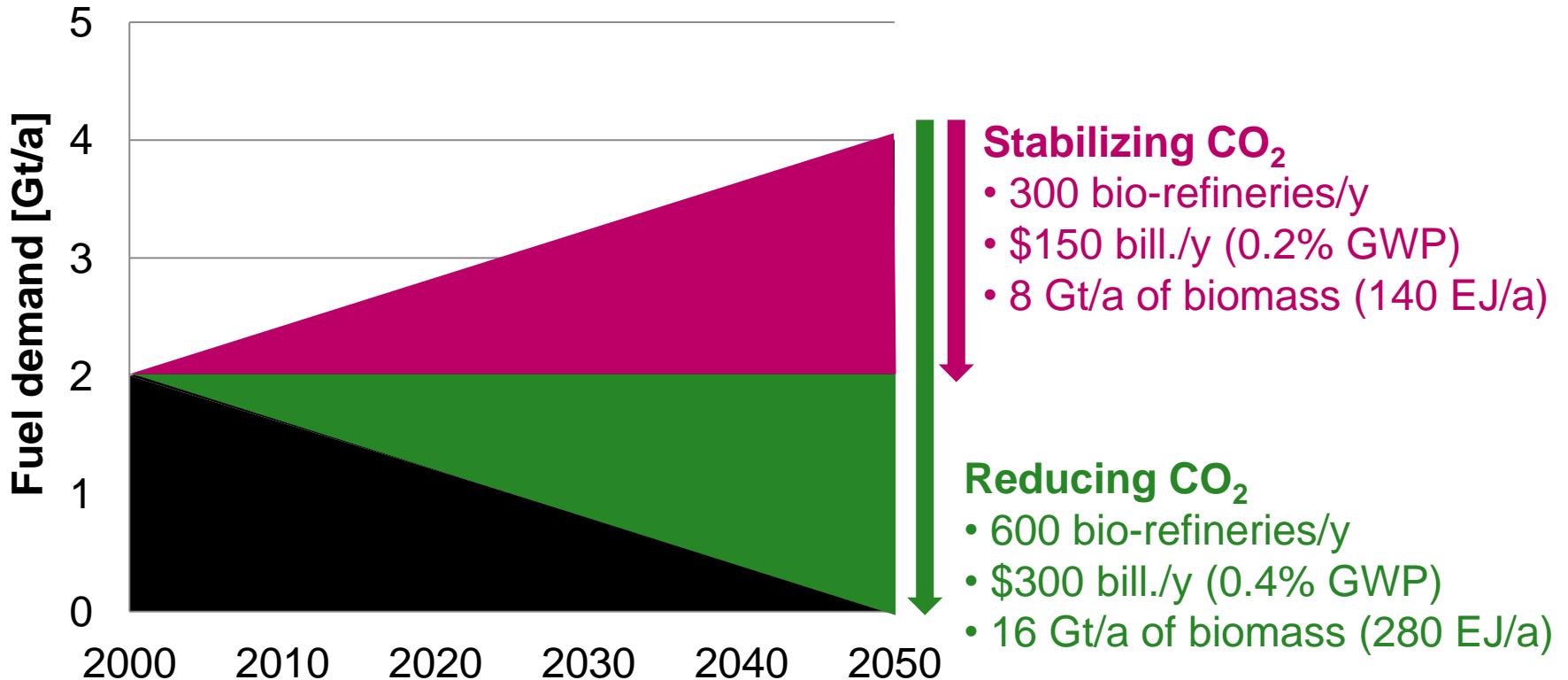
- Cellulose
 - reinforcement (plastic composites)
 - textile fibers
- Starch for
 - packaging
 - superabsorbent

Making the transition

BEYOND CARBON

UNIVERSITY OF TWENTE.

Transition needs money

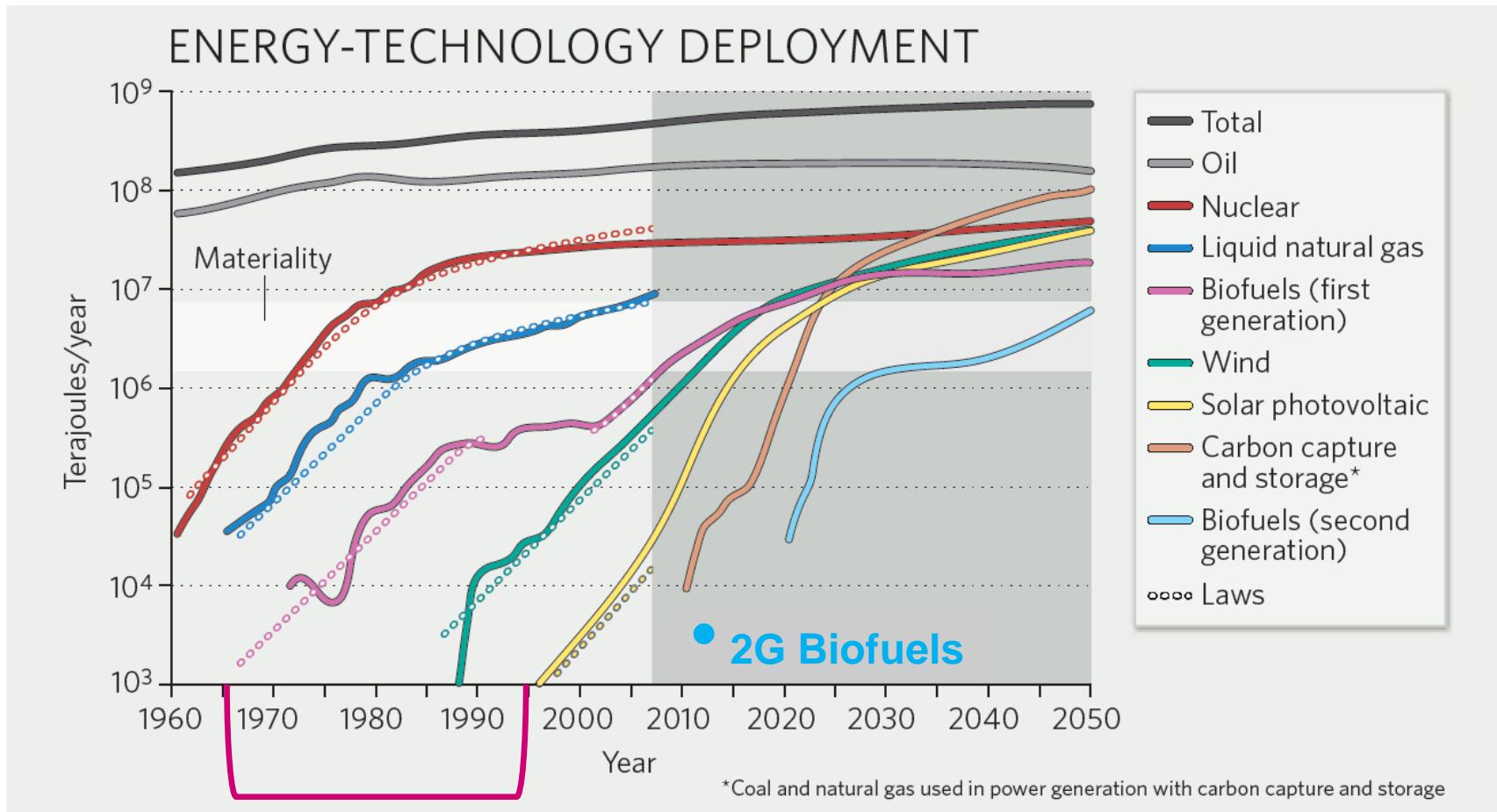


Premises

- Fuel demand growth at 1.5%/y
- 2G biofuel plant of 150 kt/a for \$500 mill.
- Gross world product \$83 trill. (2012)
- 4 t biomass / t biofuel

Transition needs time

HISTORIC DATA: OECD/IEA/PREDICTIONS: SHELL/INTERNATIONAL



~30 years to be significant (~1%)

Transition needs new economy

**From ‘Linear’ economy
With focus on Growth & Labor efficiency**

**To ‘Circular’ economy
With focus on resource efficiency**

- discourage resource mining & waste disposal
- stimulate sharing, repair & recycling
- *revisit today’s subsidies & taxes ?*

Today's journey

- Old vs. New Carbon
 - Blessing & curse of old carbon
 - Promises of biomass for material and energy
- Valorizing the new Carbon
 - Chemistry & economics challenges
 - Case studies: bio-oil, oxygenates, materials
- Beyond the Carbon
 - Transition needs money, time & circular economy

... ik heb gezegd!



UNIVERSITY OF TWENTE.