International Institute for Applied Systems Analysis
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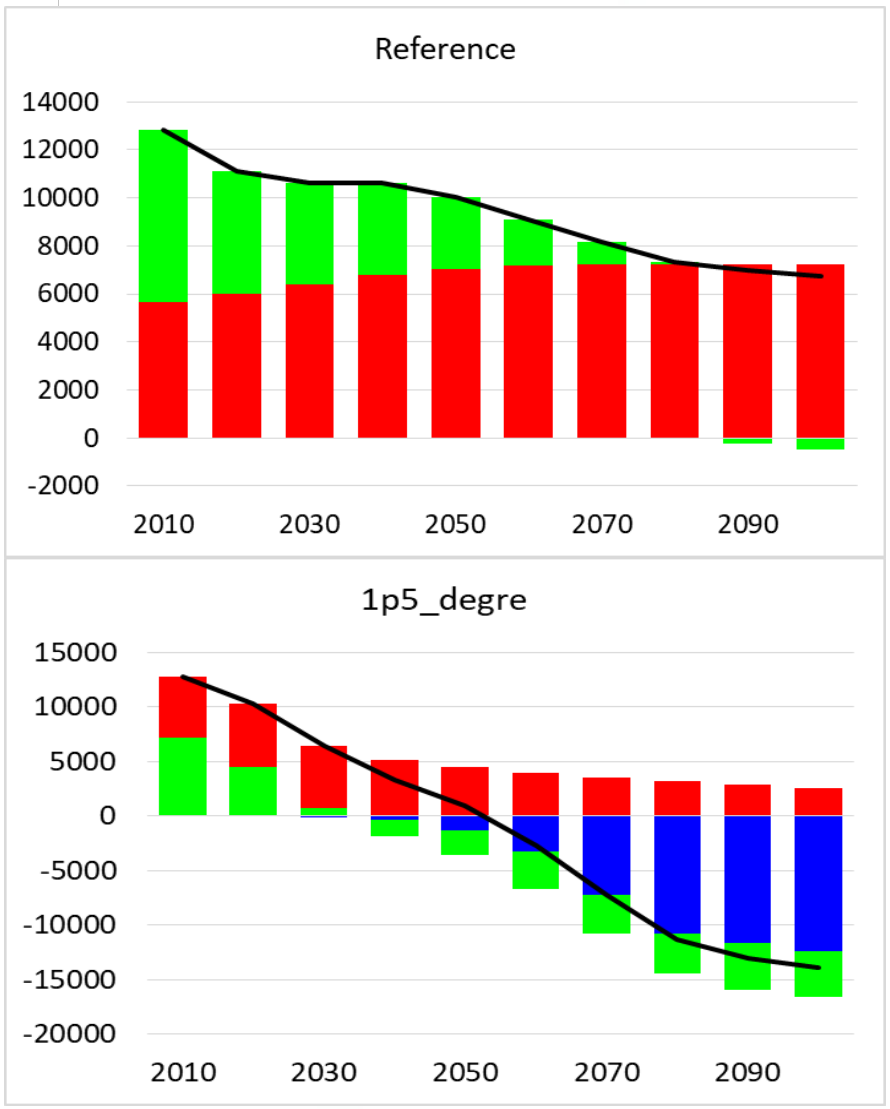
science for global insight

LUMIP Workshop: Impacts of Land Use and Land Management on Earth System Evolution, Biogeochemical Cycles, Extremes and Inter-Sectoral Dynamics
September 16-20, 2019, Snowmass

Land-based mitigation

Petr Havlík

Land-based contribution to 1.5° C



Emissions|non-CO2|Land Use

Emissions|CO2|Land Use

Emissions|CO2|Carbon Capture and Storage|Biomass

Emissions|GHG|AFOLU & BECCS

Source: Rogelj et al. NCC 2018

Land in the EU LTS

EU climate mitigation strategy

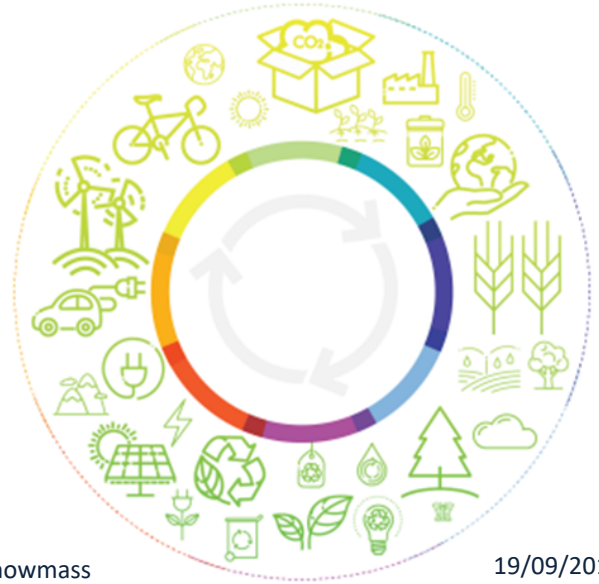
EUROPEAN COMMISSION

- 2020 targets: 20% GHG reduction,
- 2030 targets/NDC: 40% GHG reduc
  - -43% ETS: covering power plants and large industrial installations
  - -30% non-ETS covering smaller industries, transport, ag. non-CO
  - Limited access to LULUCF credits No specific target for agriculture
- 2050 climate strategy proposal: GH
  - Long-Term Strategy "A clean pla

Brussels, 28 November 2018

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773

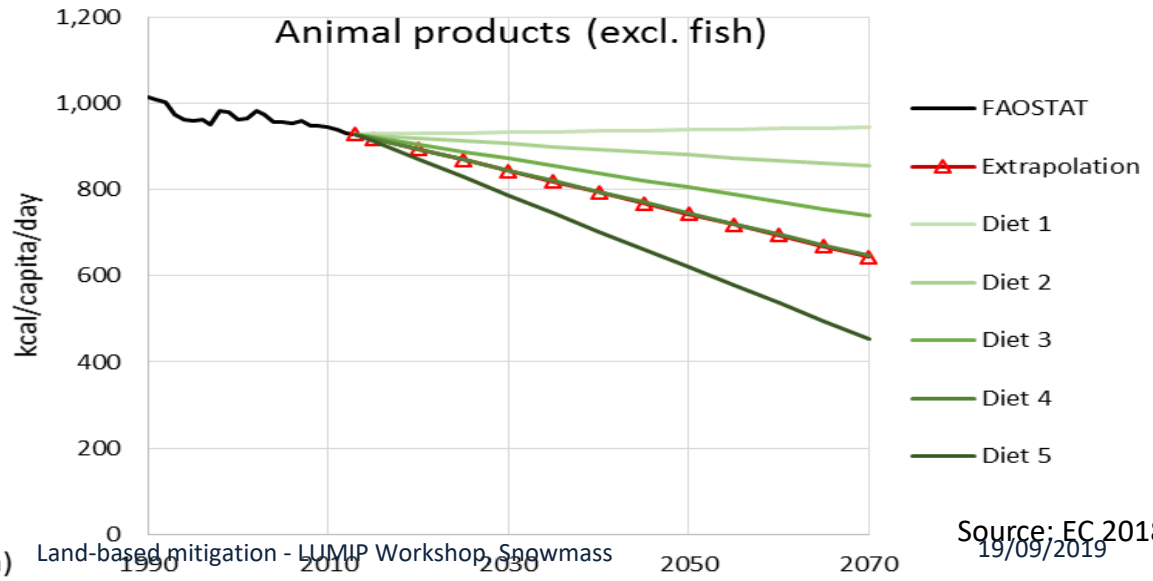
A Clean Planet for all
A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy



Lifestyle changes in EU LTS

- Several diet options tested
- LTS finally relied on Diet4
- Sensitivity around international trade response

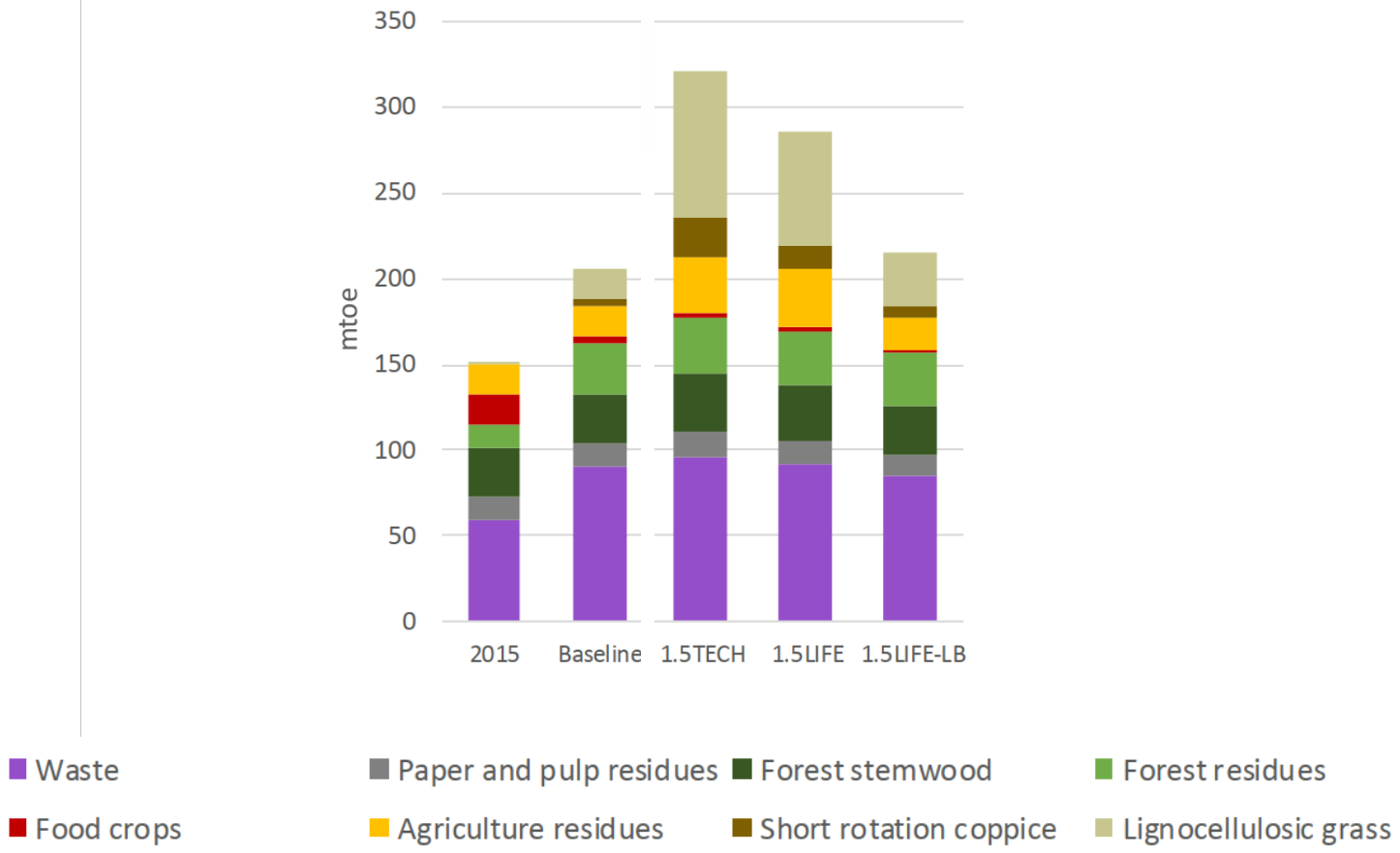
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Bovine meat	-50%	-50%	-50%	-50%	-50%
Sheep and goat meat	-50%	-50%	-50%	-50%	-50%
Milk	2010	2010	-50%	-50%	-50%
Pig meat	BAU	2010	BAU	2010	-50%
Poultry meat	BAU	2010	BAU	2010	-50%
Eggs	BAU	2010	BAU	2010	-50%



Source: EC 2018

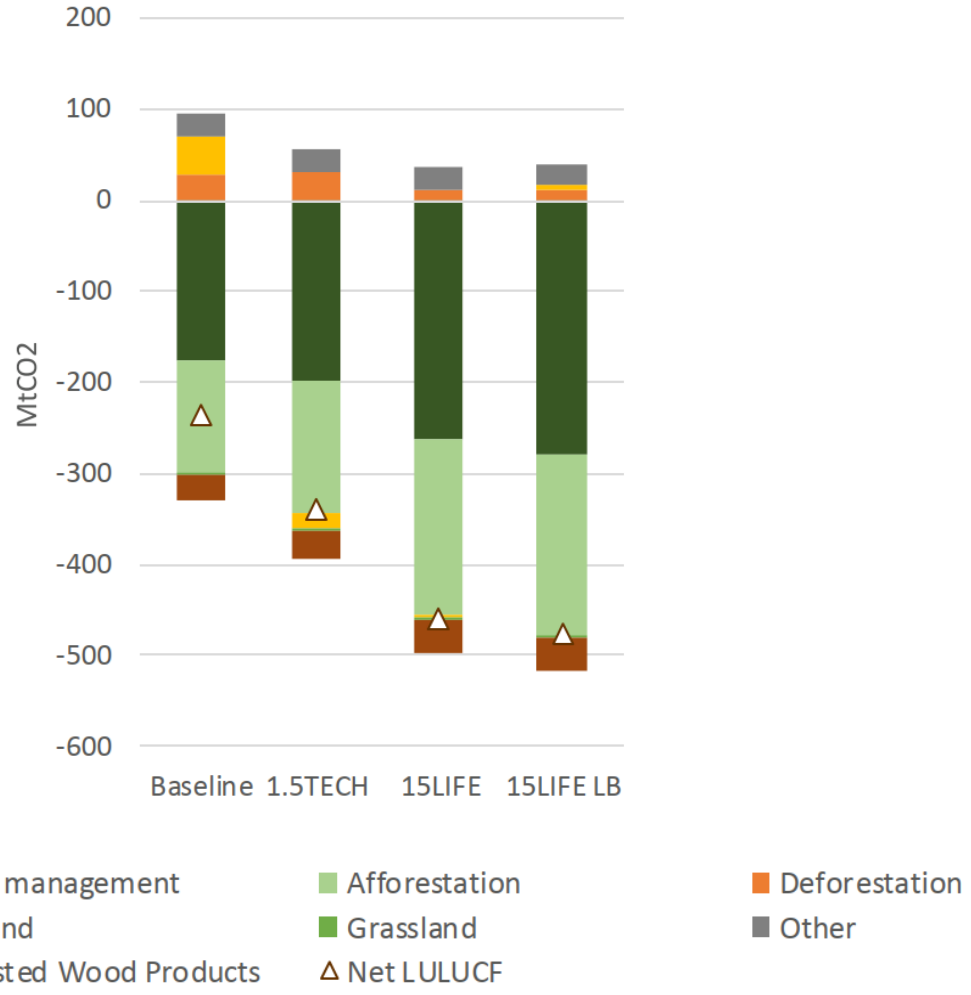
a)

EU LTS: Bioenergy by feedstock in 2050



Source: EC 2018

EU LTS: LULUCF emissions and sinks 2050



Source: EC 2018

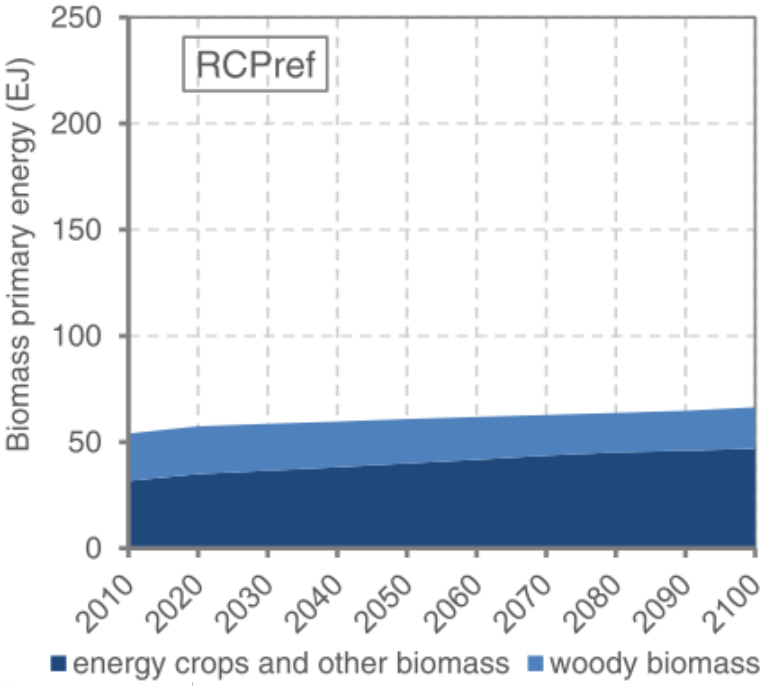
EU LTS Agriculture GHG emissions

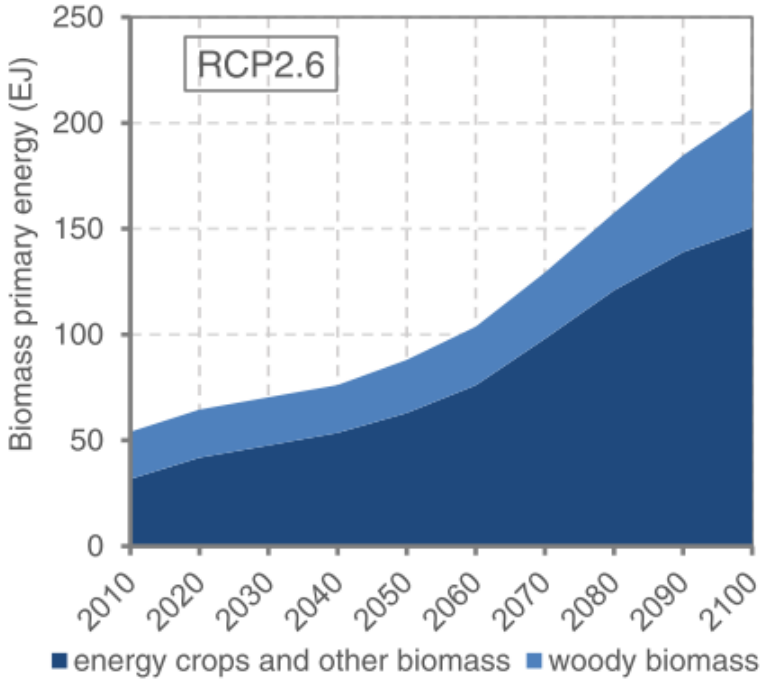
Source: EC 2018

Global forest sector implications of PA

Forest sector contribution

- Total global biomass use for energy

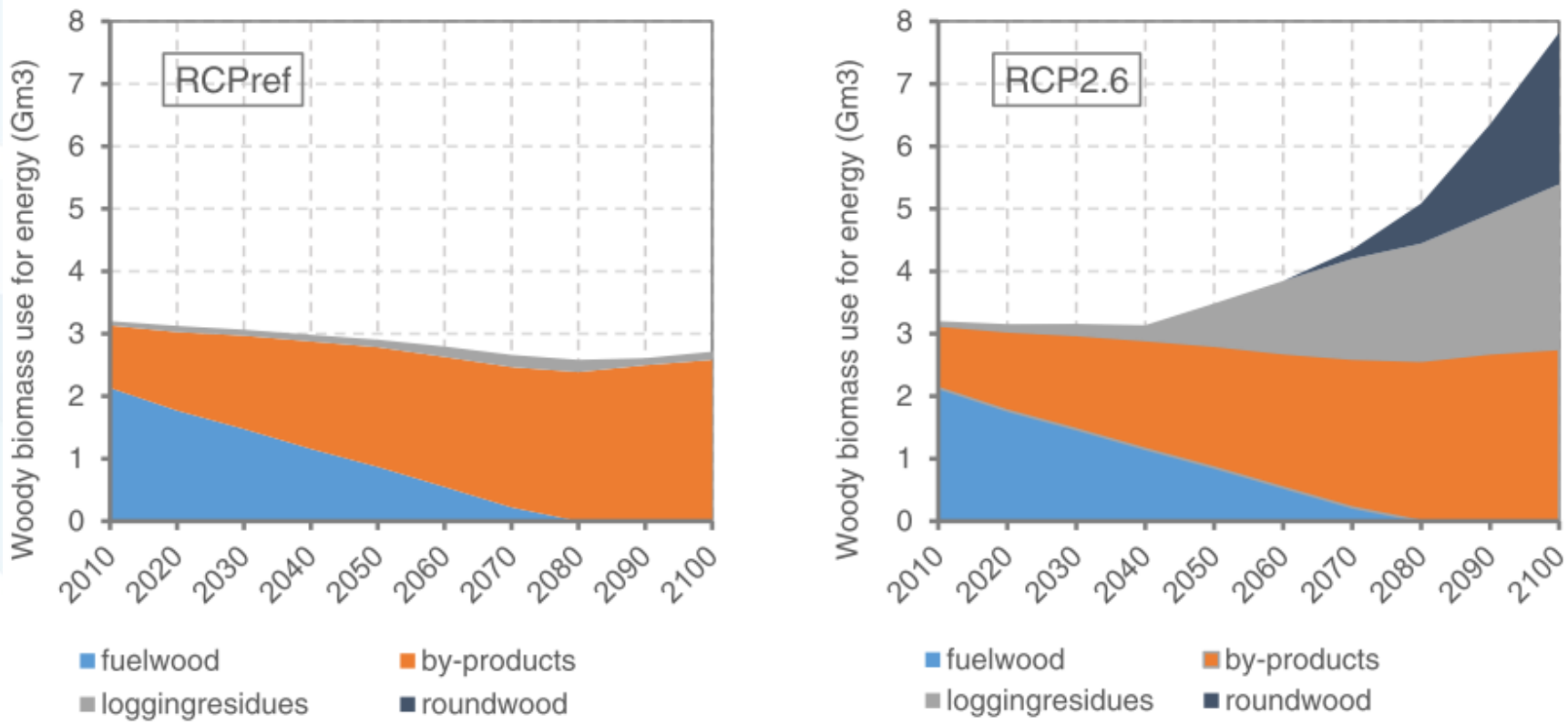




Source: Lauri et al. 2017

Forest sector contribution

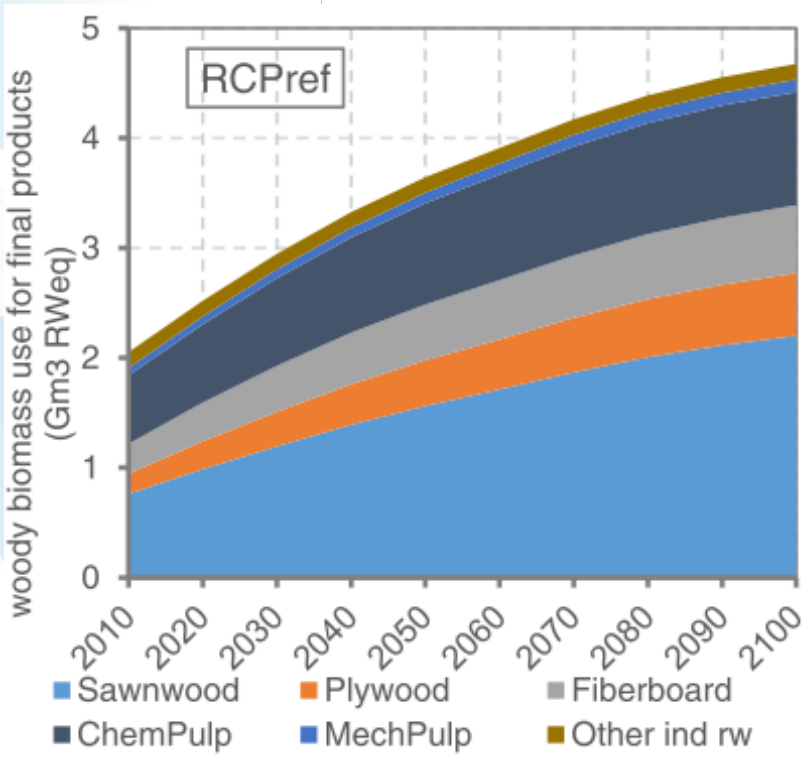
- Global woody biomass use for energy

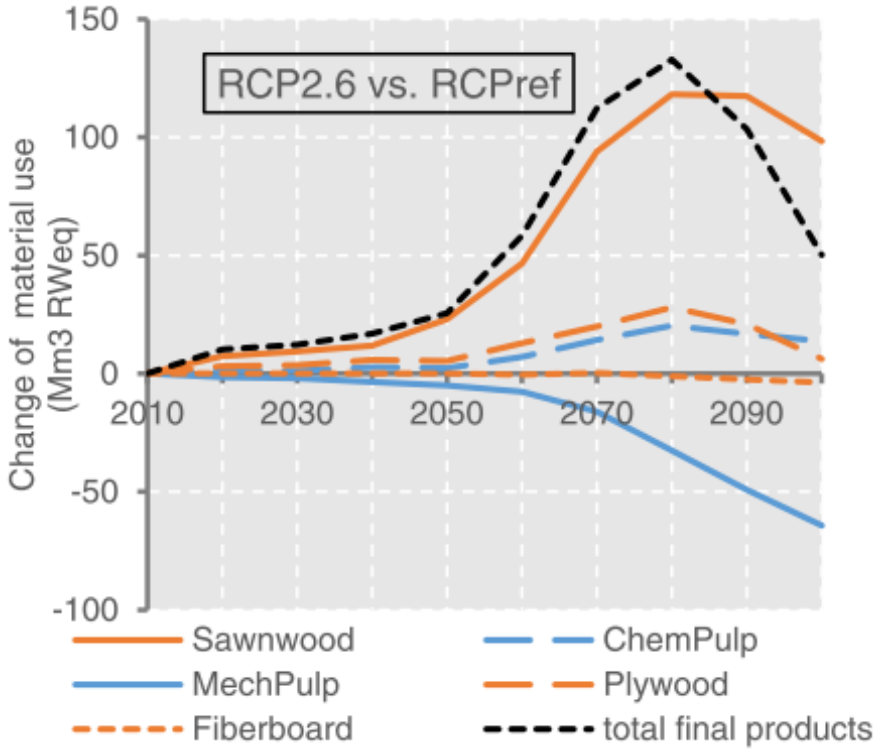


Source: Lauri et al. 2017

Forest sector contribution

- Woody biomass material use in terms of final products



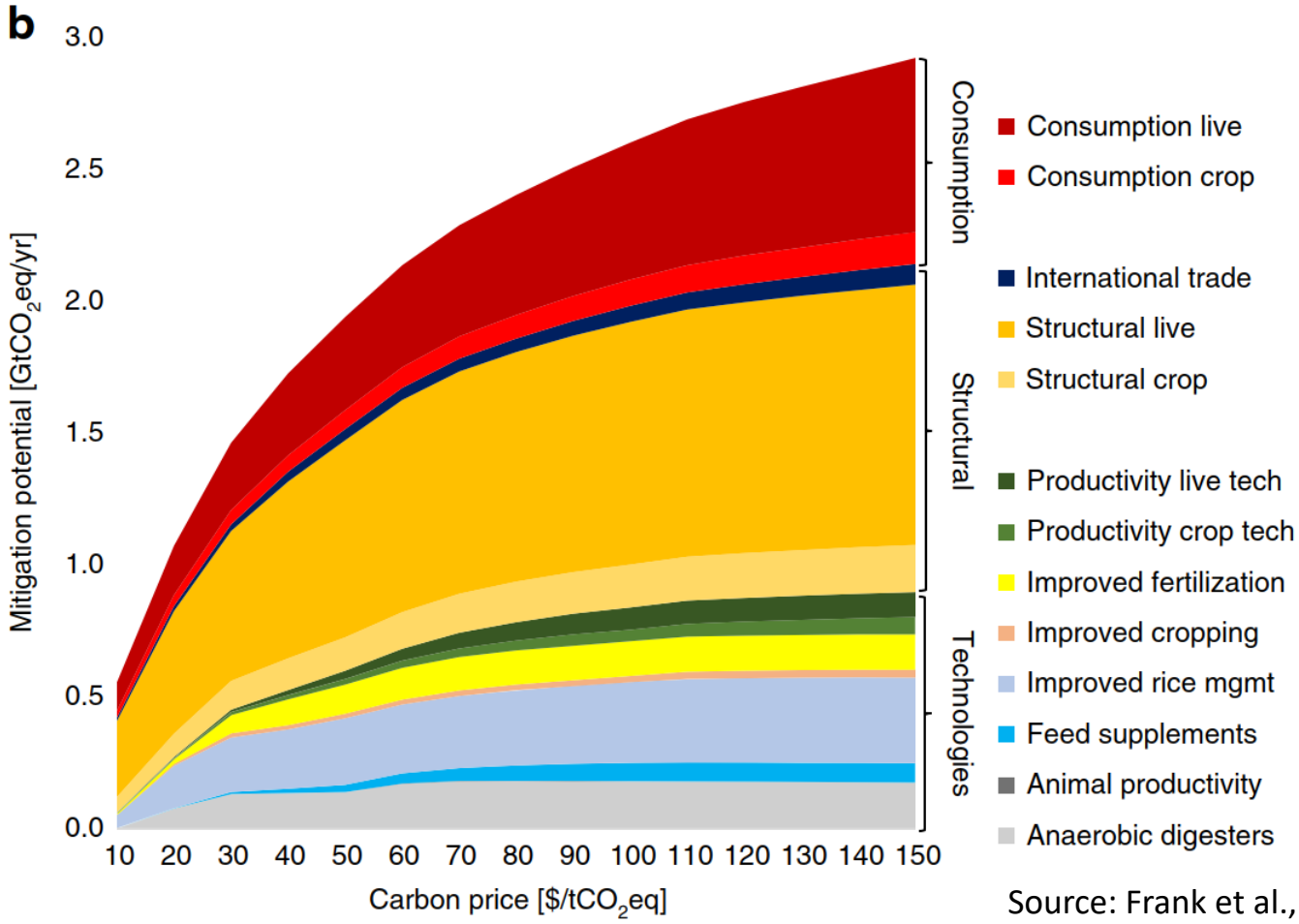


Source: Lauri et al. 2017

Agricultural non-CO2 mitigation

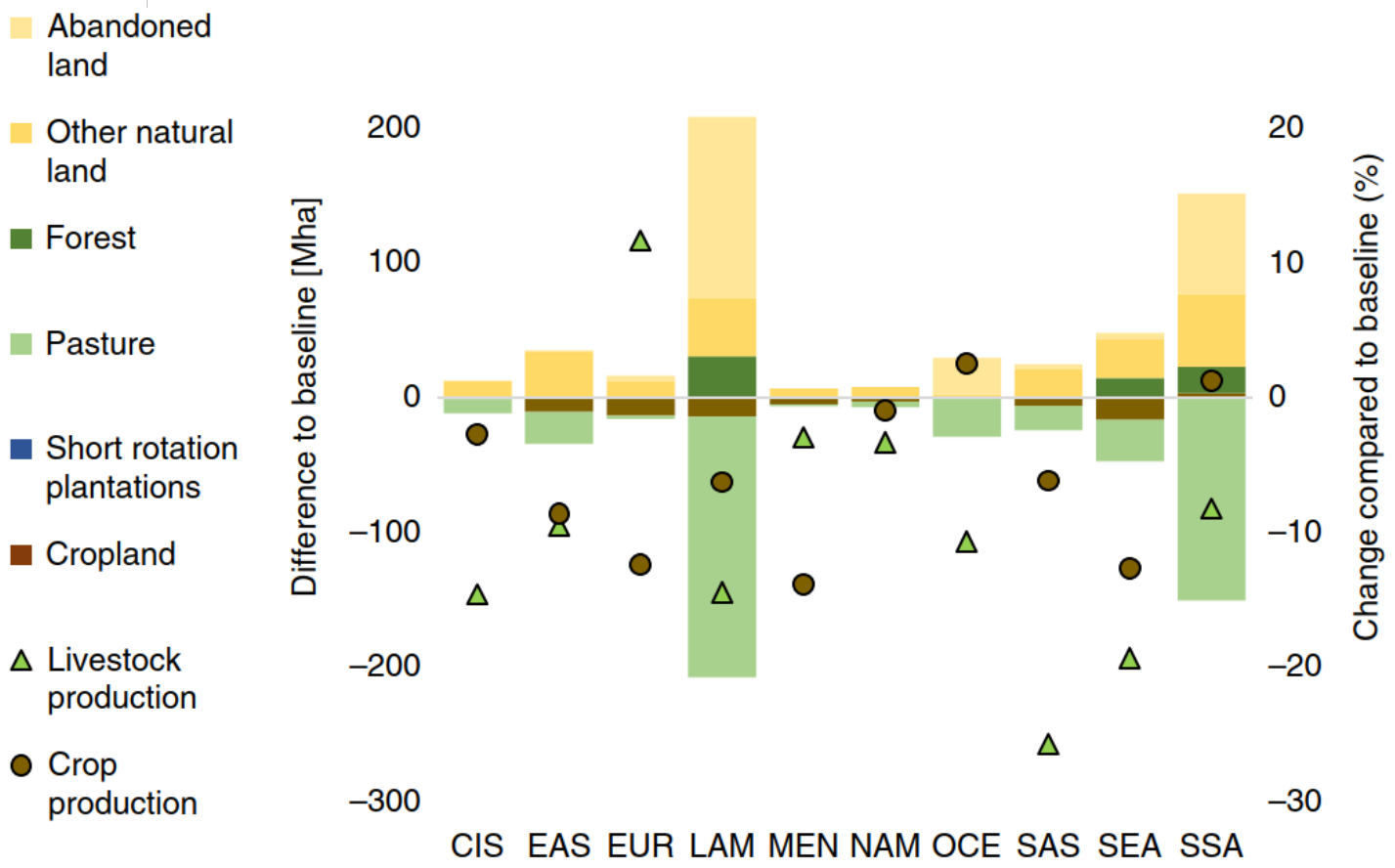
Agriculture emissions mitigation wedges

- Annual non-CO_2 abatement potential by 2050



Source: Frank et al., NCOMM 2018

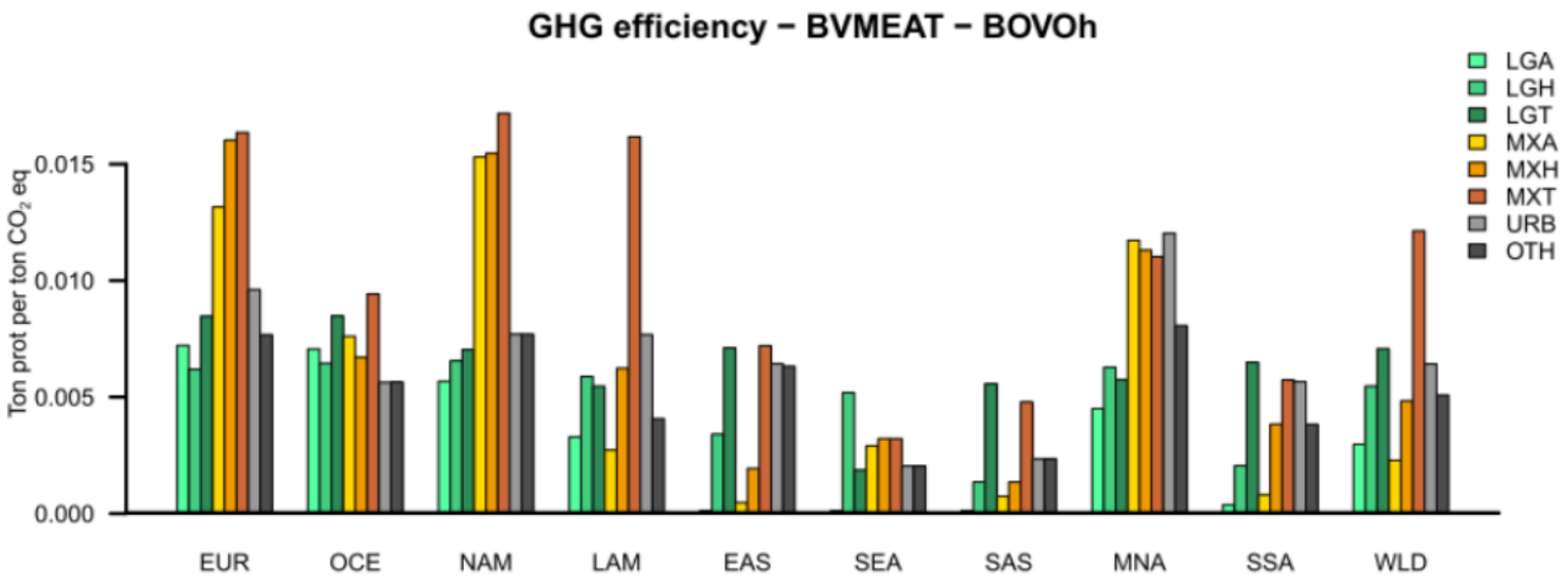
Land use implications of non-CO2 abatement



Source: Frank et al., NCOMM 2018

Structural change: Closing efficiency gaps

- Large efficiency gaps prevail between production systems and regions

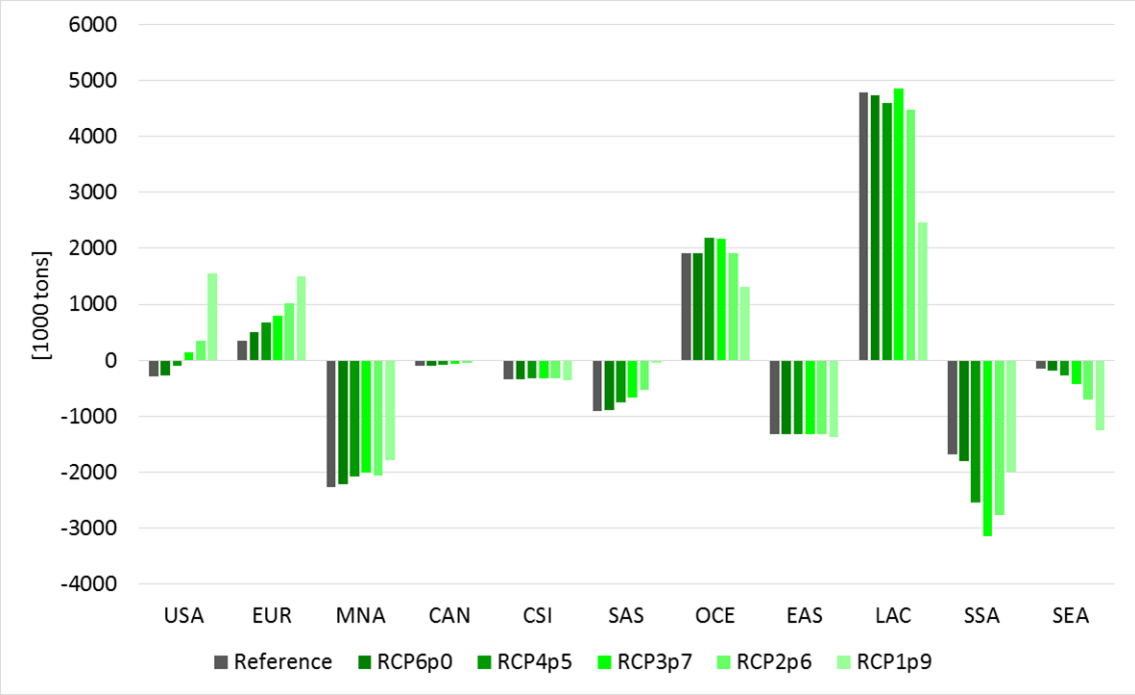


Source: Herrero et al. PNAS 2013

Integration of the regional and global

- Mitigation and international trade

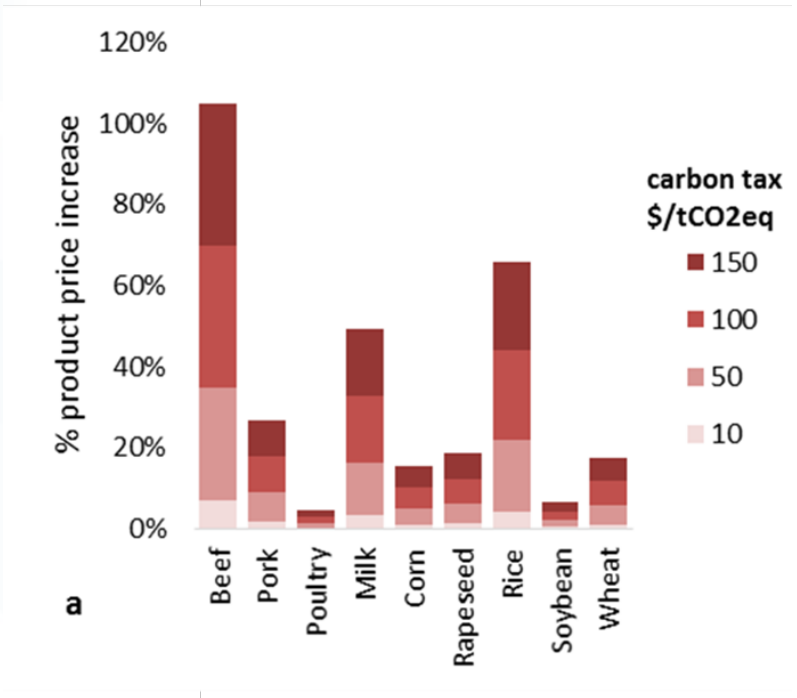
Beef net trade by 2050

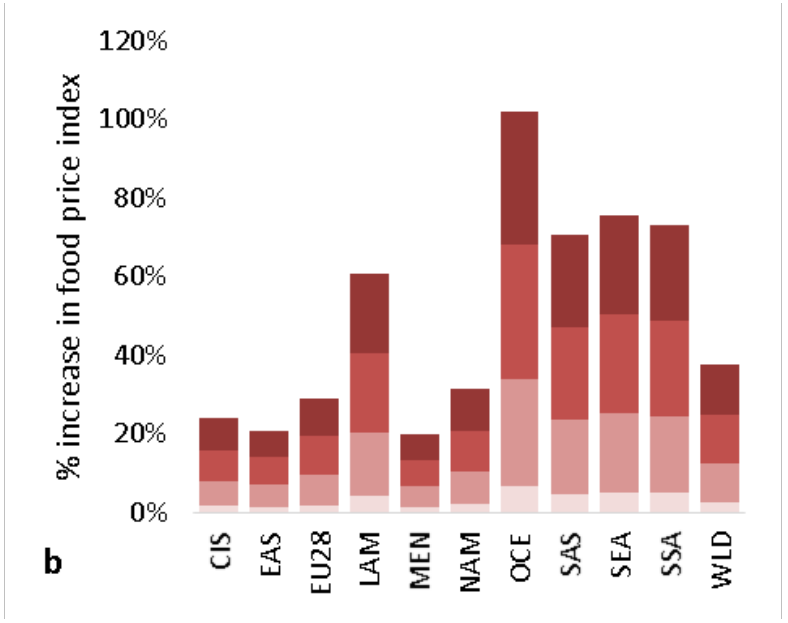


- Mitigation policies will change relative competitiveness across regions

Food availability implications

- Carbon price affects commodity prices depending on GHG intensity

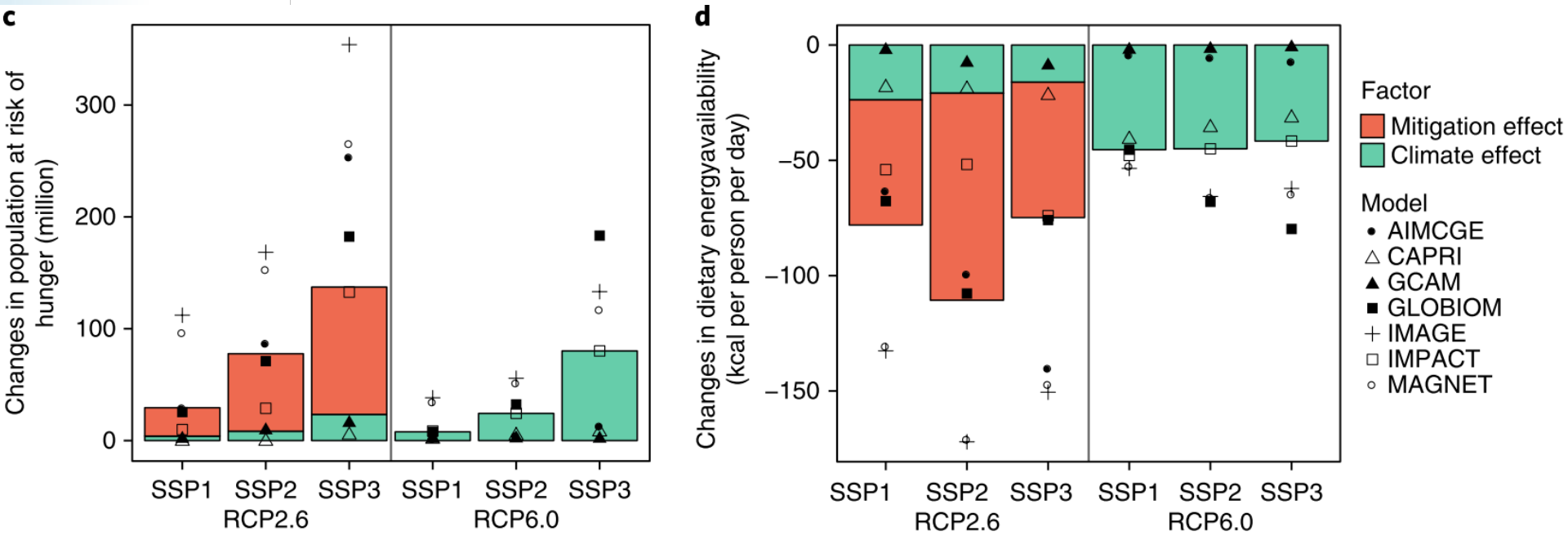




Source: Frank et al. ERL 2017

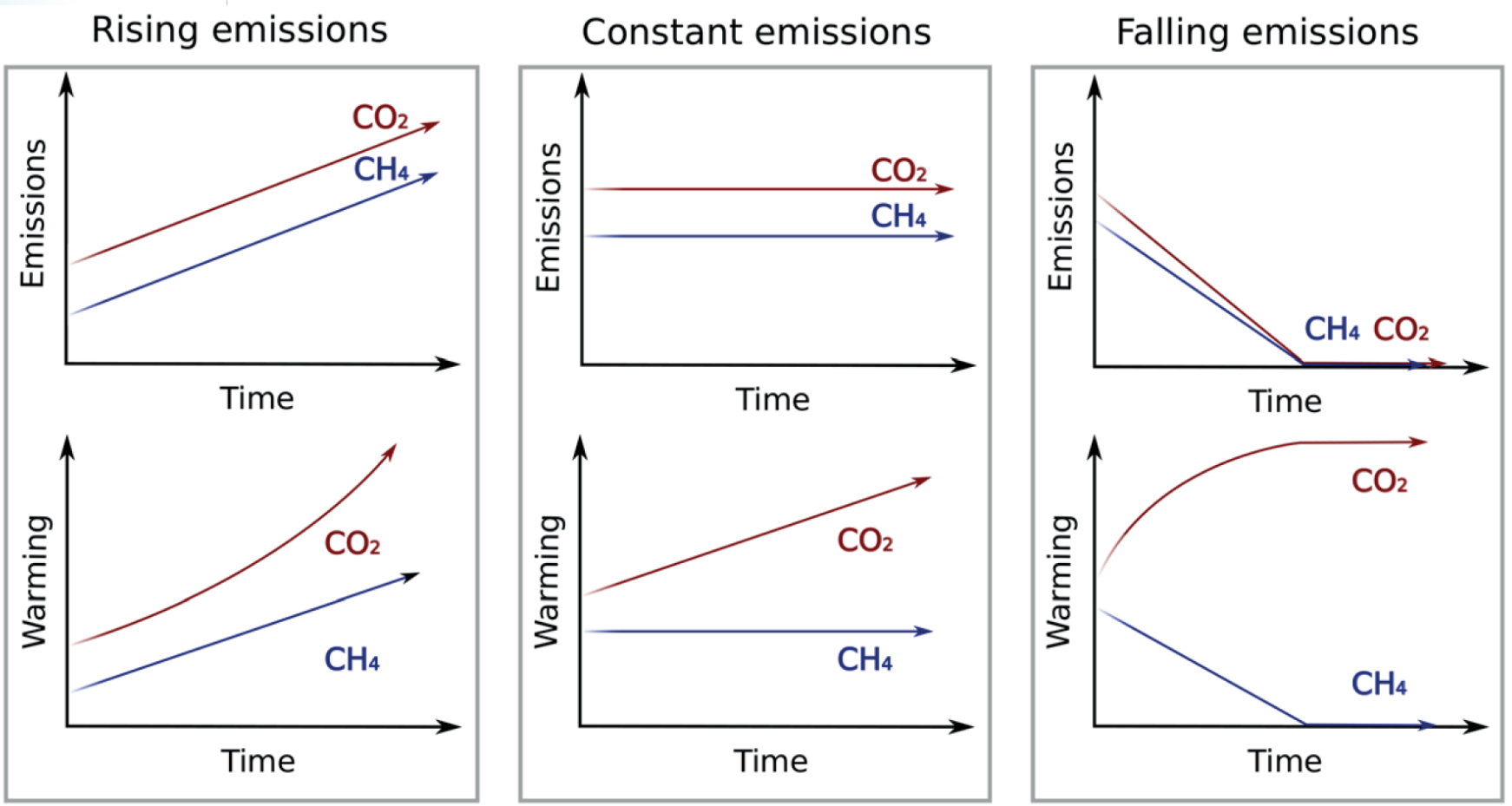
Food availability implications

- Carbon tax worse than climate change impacts



Source: Hasegawa et al. NCC 2018

Short lived methane

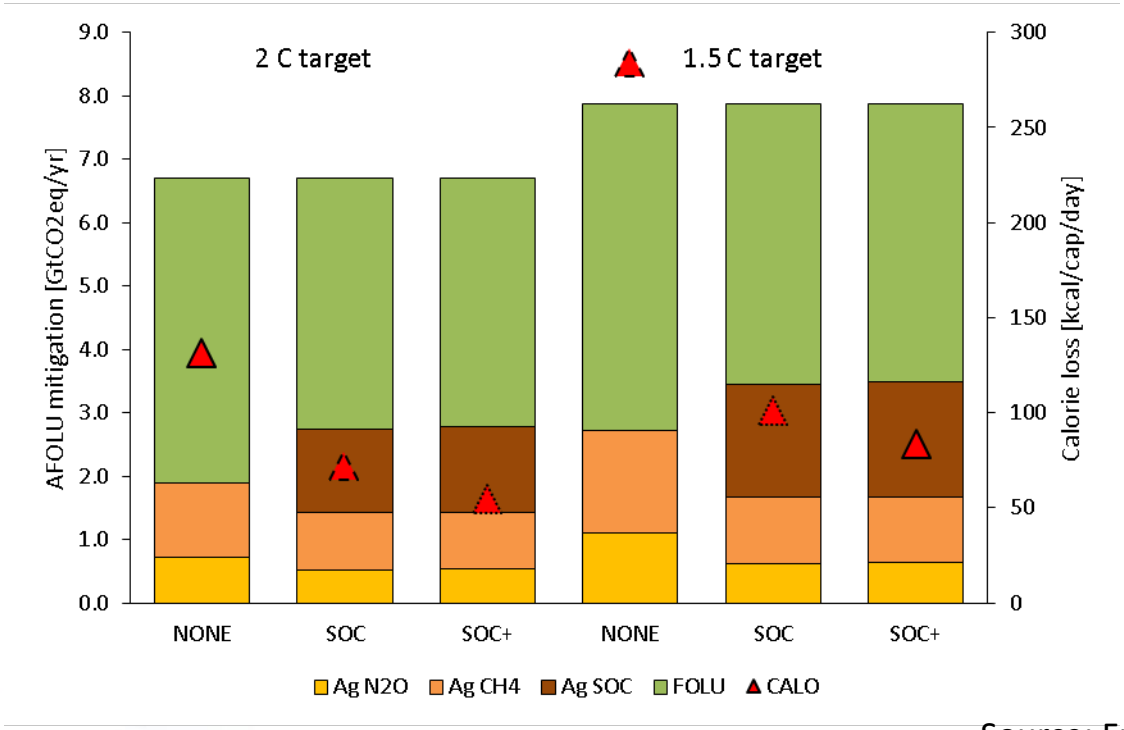


Source: Allen et al. 2017

Sustainable development goals (SDGs)

Moderating trade-offs: Remunerating sinks

- Land based mitigation without considering soil organic carbon would lead to a rise in undernourishment of 40 to 170 million people in 2050
- While including the SOC into the mitigation portfolio would limit the additional number of undernourished to 10 - 40 million people



Source: Frank et al. ERL (2017)

SDG compatible land mitigation potential

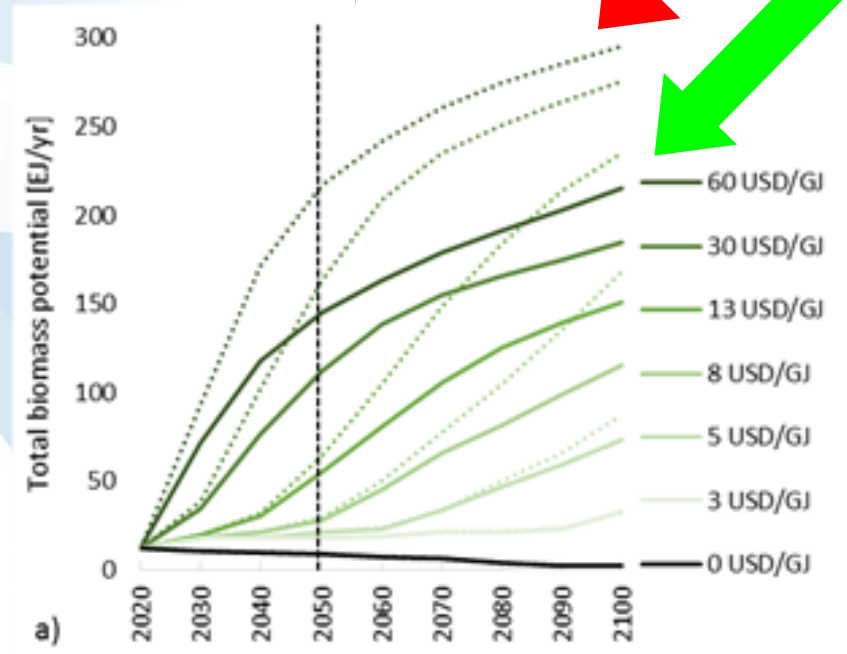
- *Food security (SDG2)*
  - Developing countries reach minimum total calorie intake levels that limit undernourishment below 1% by 2030
- *Dietary preferences (SDG12)*
  - Based onon USDA recommendations for healthy diets and animal calorie intake decreased to 430 kcal/capita/day by 2030.
  - Halving current food waste by 2030
- *Sustainable water use (SDG6)*
  - Irrigation water consumption in agriculture does not conflict with ecosystem services and environmental flows
- *Biodiversity protection (SDG15)*
  - Achieving the AICHI Biodiversity target 11 and increase total surface of protected areas to 17% by 2030
  - No conversion of highly biodiverse areas

SDG compatible land mitigation potential

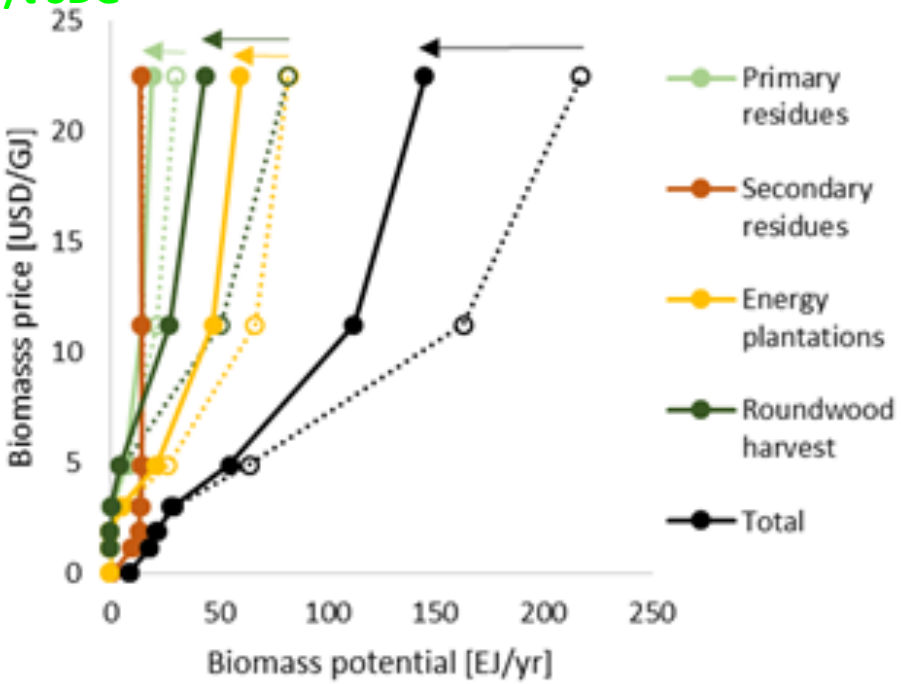
w/o SDG

w/t SDG

Global biomass potential



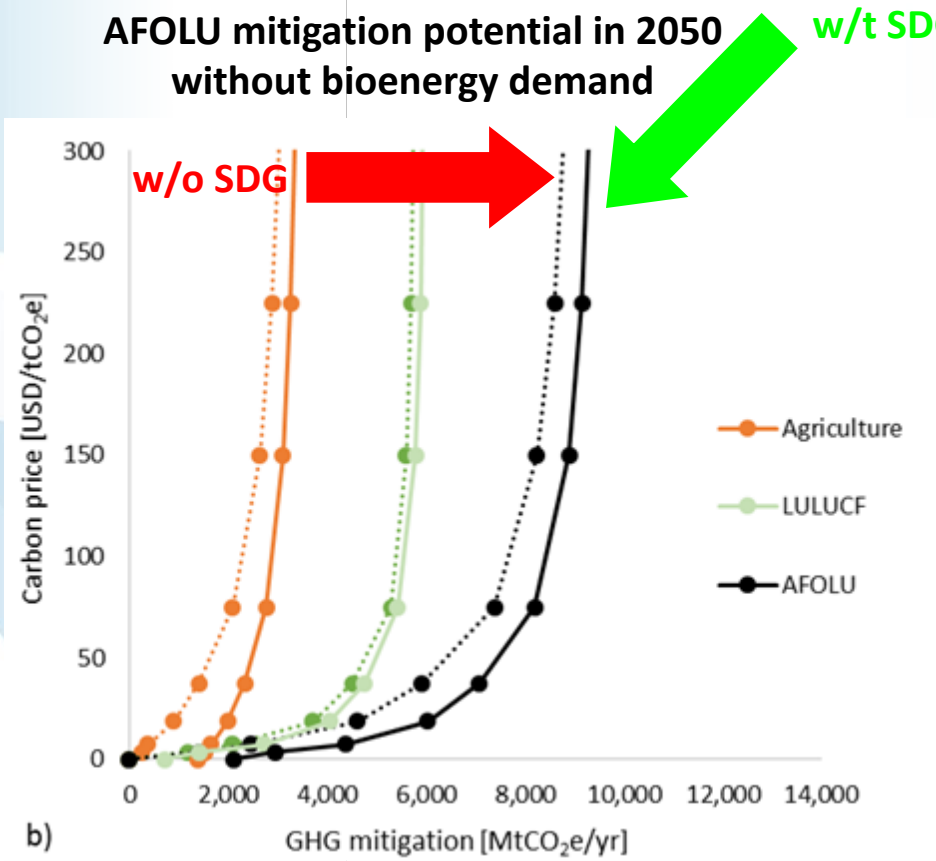
Global biomass potential in 2050



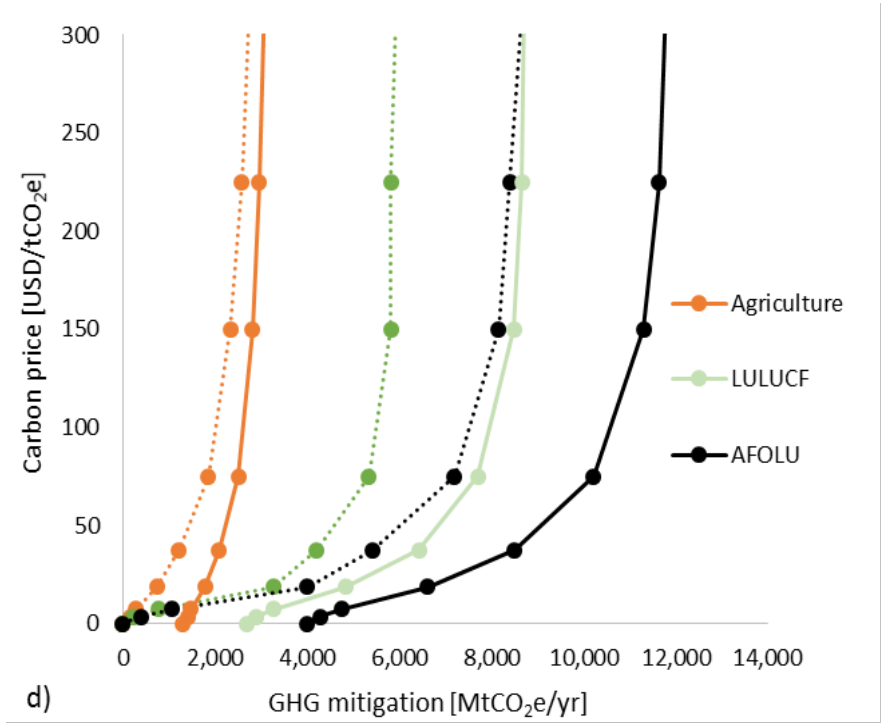
Source: Frank et al. forthcoming

SDG compatible land mitigation potential

AFOLU mitigation potential in 2050 without bioenergy demand



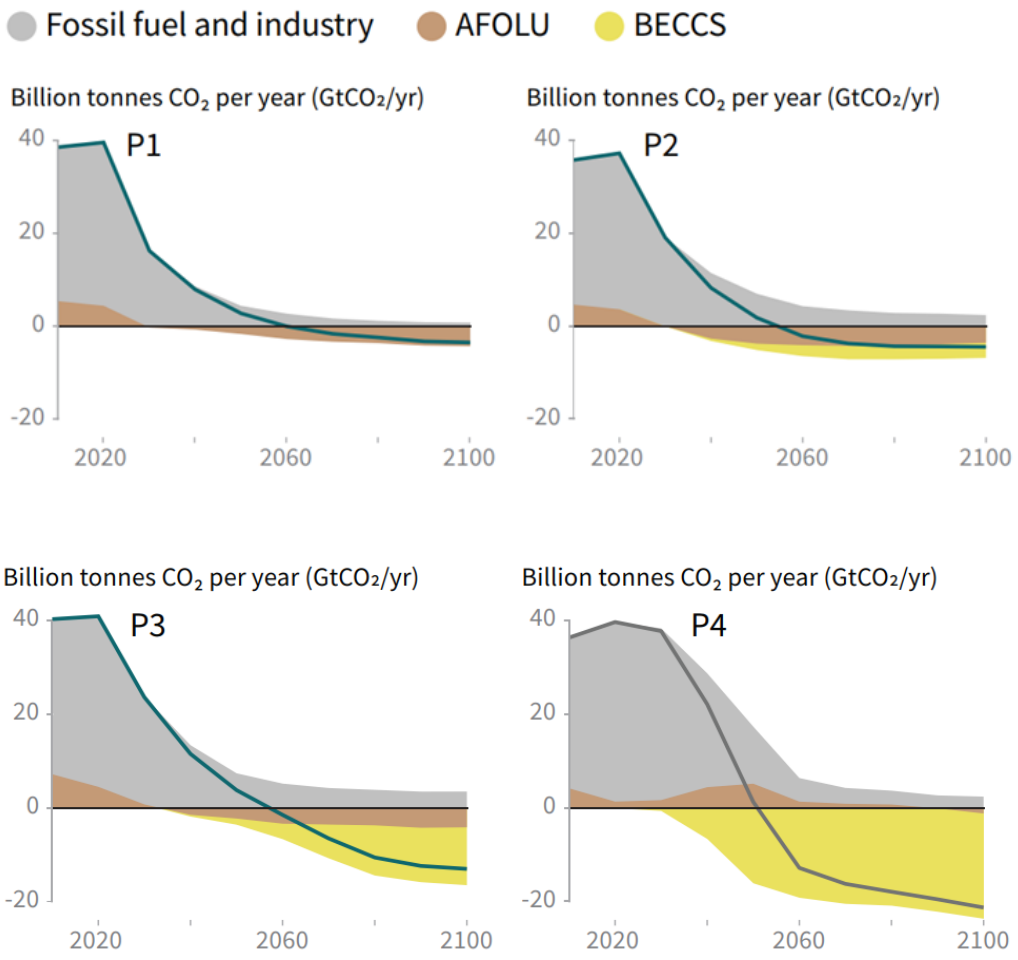
AFOLU mitigation potential in 2050 with bioenergy demand



Source: Frank et al. forthcoming

Behavioral change

Behavioral change *versus* BECCS



Source: IPCC SR15

Behavioral change versus BECCS

Change in EU consumer beef price (compared to 2010,%)

	2030	2050
Sustainability outlooks		
REF0	-3	-9
REF-	-2	-5
REF+	-4	-12
Diet shift scenarios		
Balanced & sufficient diet	**75**	**275**

- All contextual scenarios project an increase in meat purchases, reducing meat consumption thus requires a trend reversal
- Large price increases (up to 275% by 2050) to counteract the current trends

?

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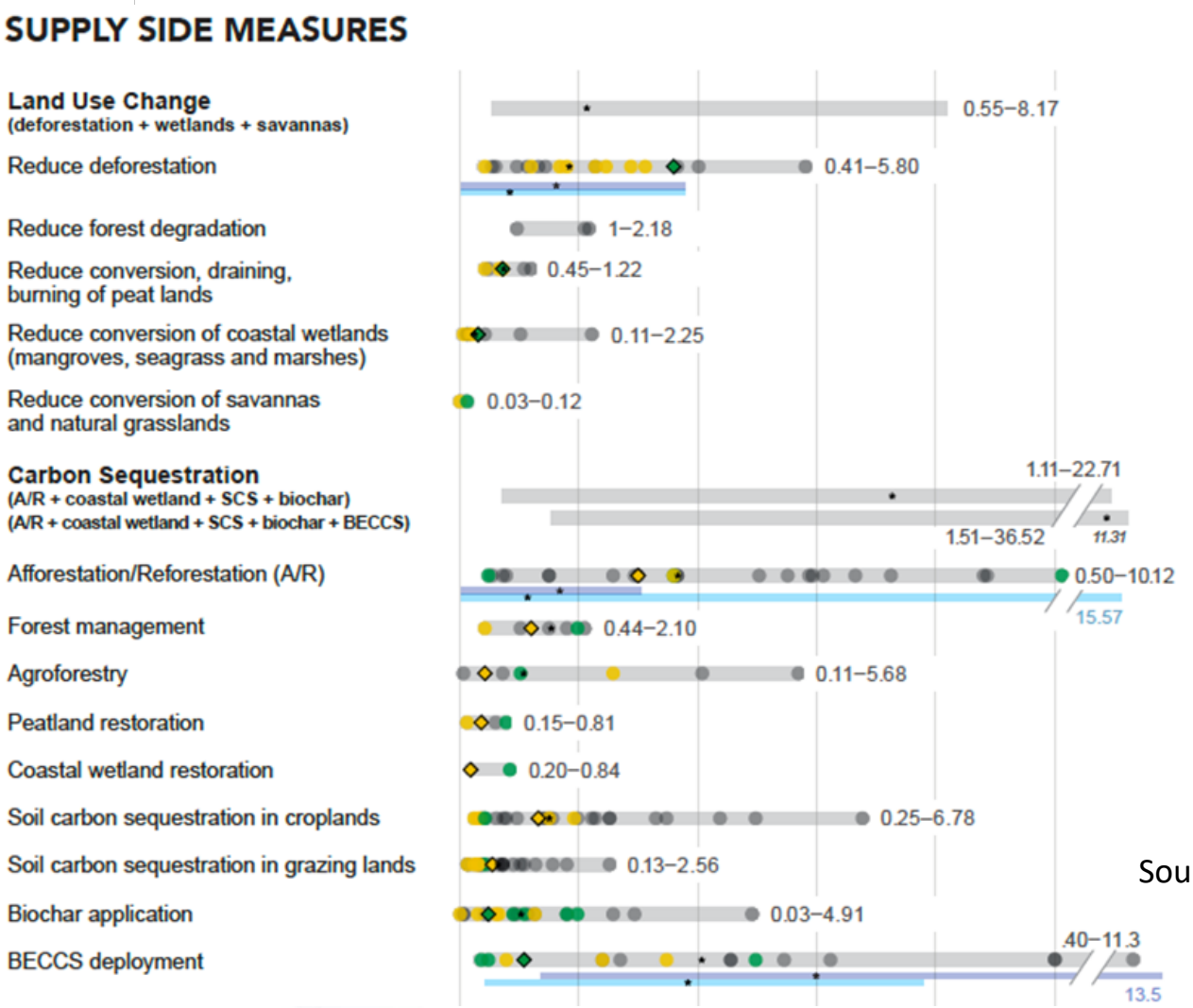
Source: MAGNET simulations and SHARP data for 4 countries

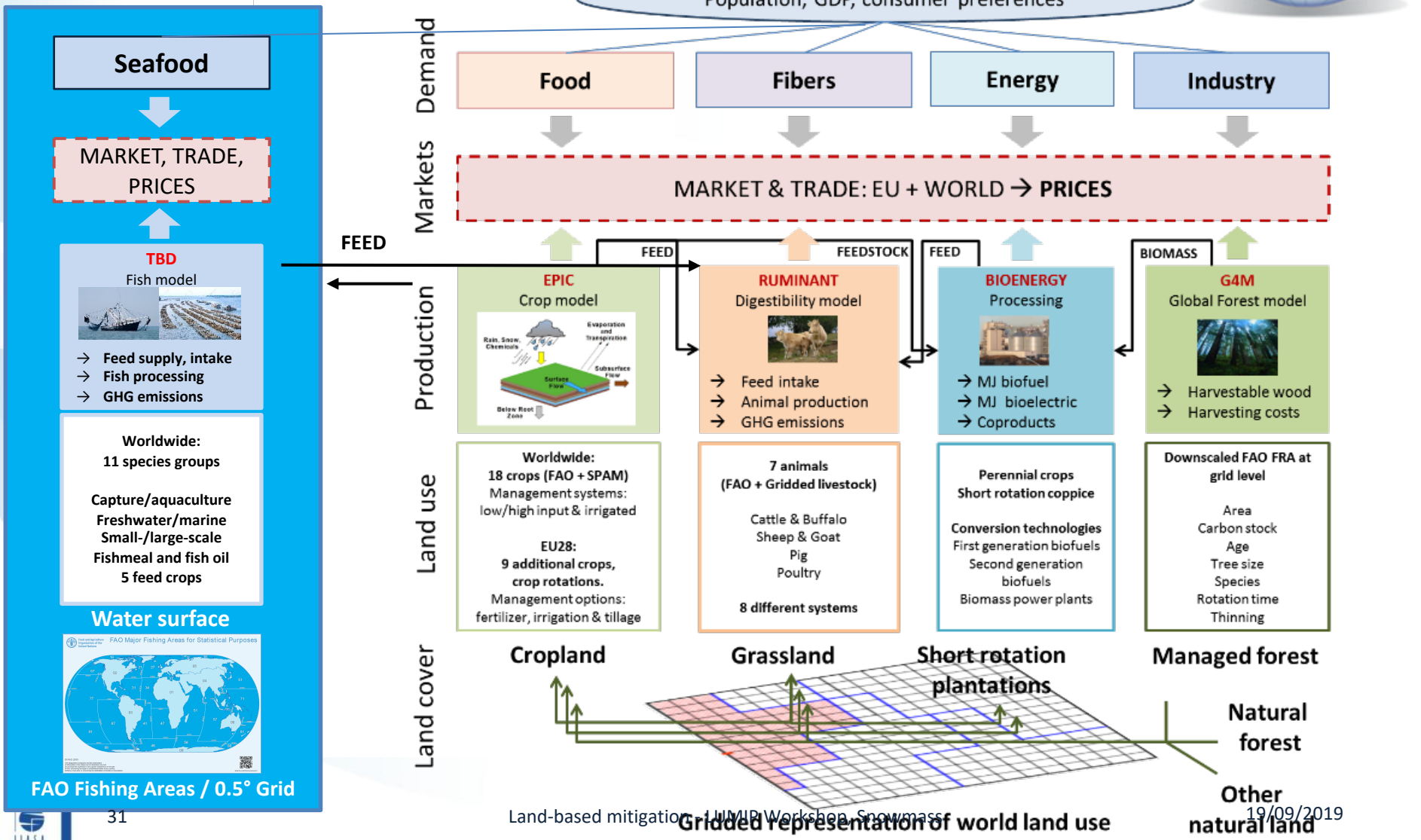
Final remarks

Key mitigation options representation?



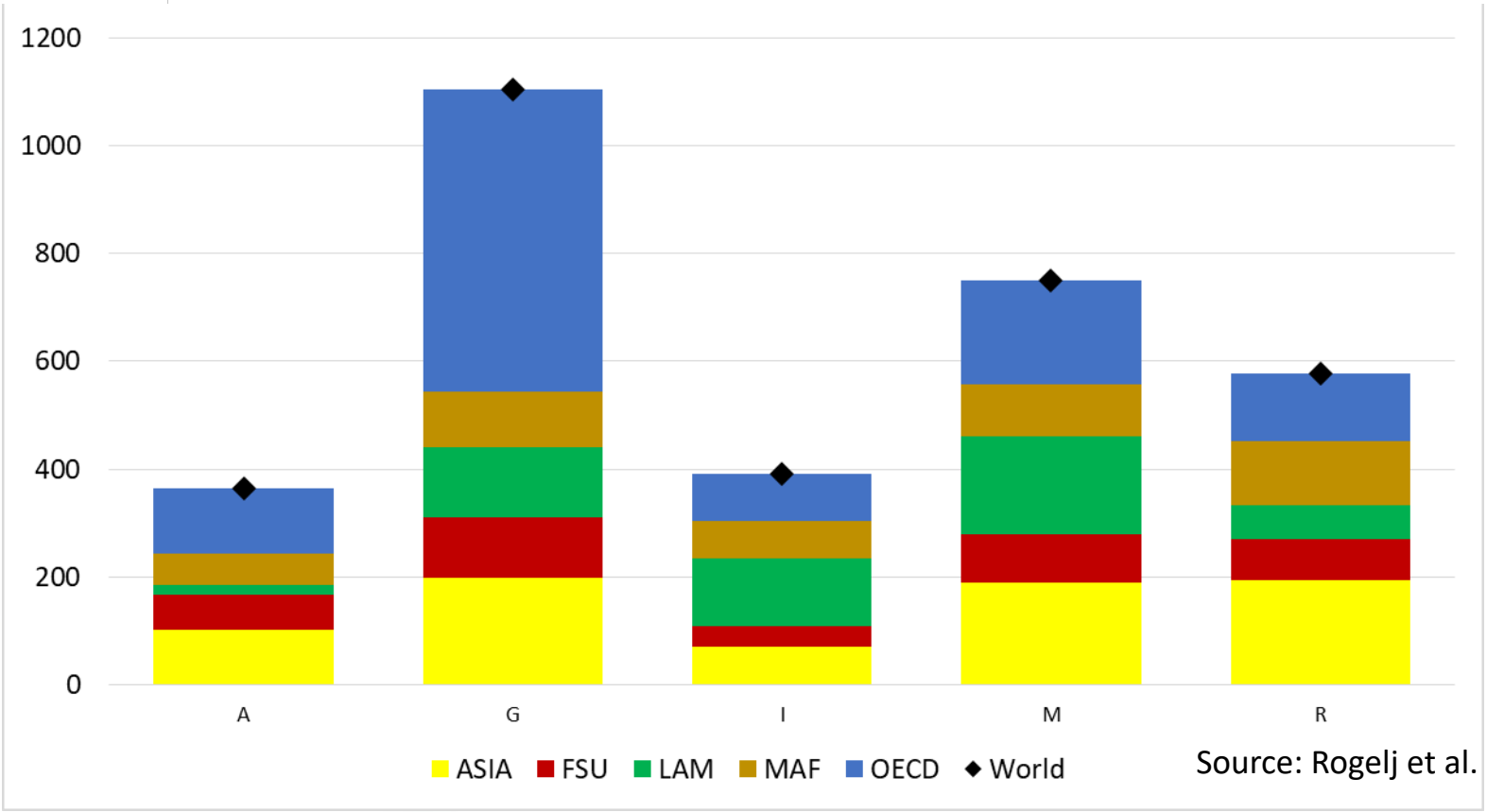
Source: Roe et al. NCC, in press

GLOBIOM


Seafood
MARKET, TRADE, PRICES
TBD
Fish model
→ Feed supply, intake
→ Fish processing
→ GHG emissions
Worldwide:
11 species groups
Capture/aquaculture
Freshwater/marine
Small-/large-scale
Fishmeal and fish oil
5 feed crops
Water surface
FAO Major Fishing Areas for Statistical Purposes
FAO Fishing Areas / 0.5° Grid
FEED
Population, GDP, consumer preferences
Demand
Food
Fibers
Energy
Industry
Markets
MARKET & TRADE: EU + WORLD → PRICES
FEED
FEEDSTOCK
FEED
BIOMASS
Production
EPIC
Crop model
RUMINANT
Digestibility model
→ Feed intake
→ Animal production
→ GHG emissions
BIOENERGY
Processing
→ MJ biofuel
→ MJ bioelectric
→ Coproducts
G4M
Global Forest model
→ Harvestable wood
→ Harvesting costs
Land use
Worldwide:
18 crops (FAO + SPAM)
Management systems:
low/high input & irrigated
EU28:
9 additional crops,
crop rotations.
Management options:
fertilizer, irrigation & tillage
7 animals
(FAO + Gridded livestock)
Cattle & Buffalo
Sheep & Goat
Pig
Poultry
8 different systems
Perennial crops
Short rotation coppice
Conversion technologies
First generation biofuels
Second generation biofuels
Biomass power plants
Downscaled FAO FRA at grid level
Area
Carbon stock
Age
Tree size
Species
Rotation time
Thinning
Land cover
Cropland
Grassland
Short rotation plantations
Managed forest
Natural forest
Other natural land
Gridded representation of world land use

Uncertainties in IAMs LU projections

- **Energy crops area** for 1.5 degree scenario in 2100 compared to 2010 [Million hectares]



Source: Rogelj et al. NCC 2018