How much energy does your meal require?

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+ Quantify energy inputs into the food system
+ Understand local, regional, and global scales
+ Compare ‘eating philosophies’ in terms of energy use

Why do we care?

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Political: Secure access to inputs
Economic: Prices
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Today's Takeaway:

(1) The food system uses a lot of energy
(2) That isn't necessarily a bad thing
(3) Need to consider actual impact of energy use in comparison with alternatives

Understanding the energy inputs into food

Three main energy input phases:

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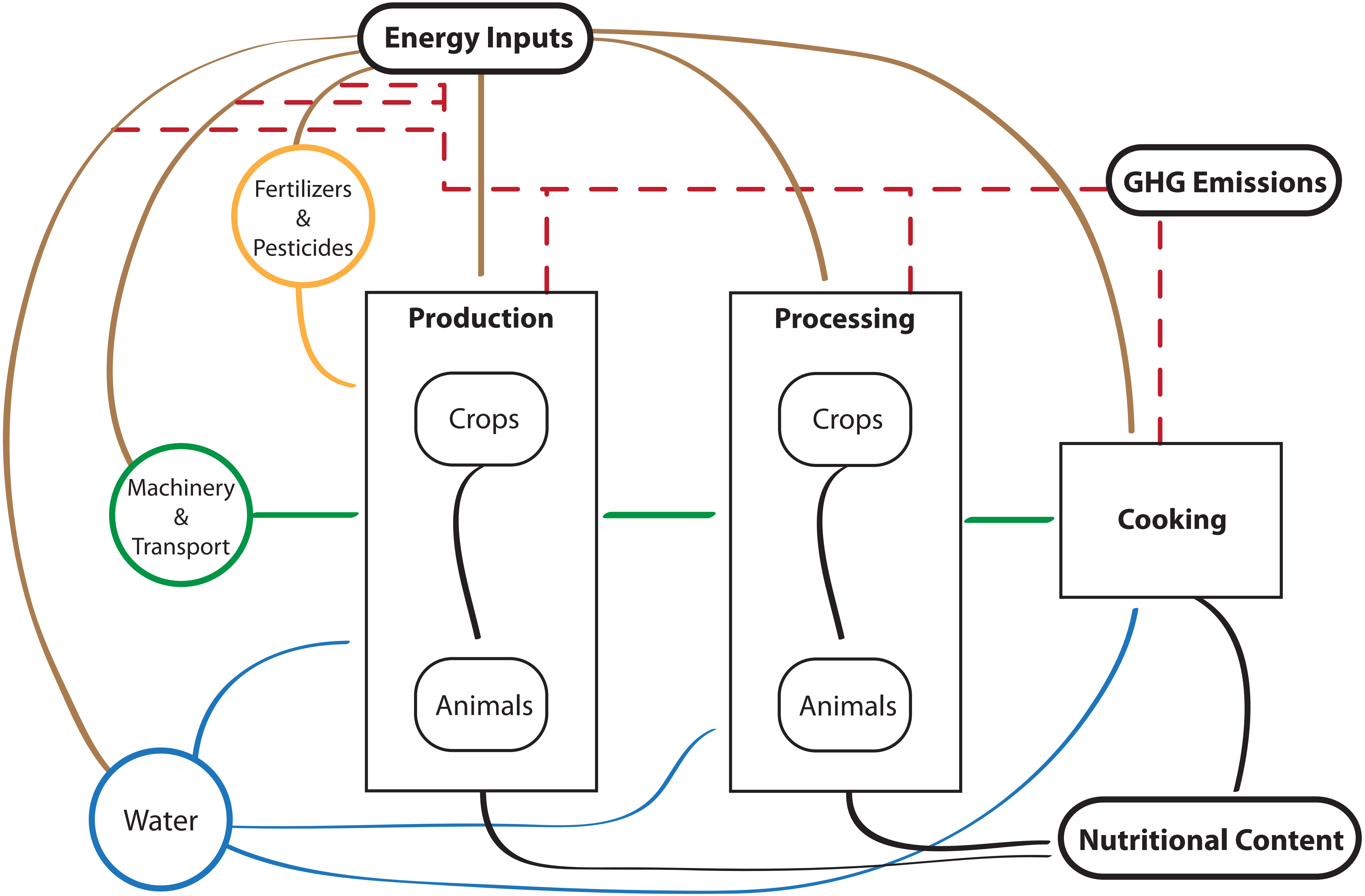
Understanding the energy inputs into food

Three main energy input phases:

Production	**Processing**	**Consumption**
		
Everything up to the farm gate	Between the farm gate and the point of sale	From point of sale to your mouth

Energy use can be **direct** or **indirect**

Basic flows in the food system



Global numbers to know

Global Energy Use: 474 EJ / 449 Quad Btu

(132,000 TWh or 15 TW equivalent)

Global GHG Emissions: 14-15 Gt C equivalent

(55 Gt CO_2e, ~75% is actually CO_2)

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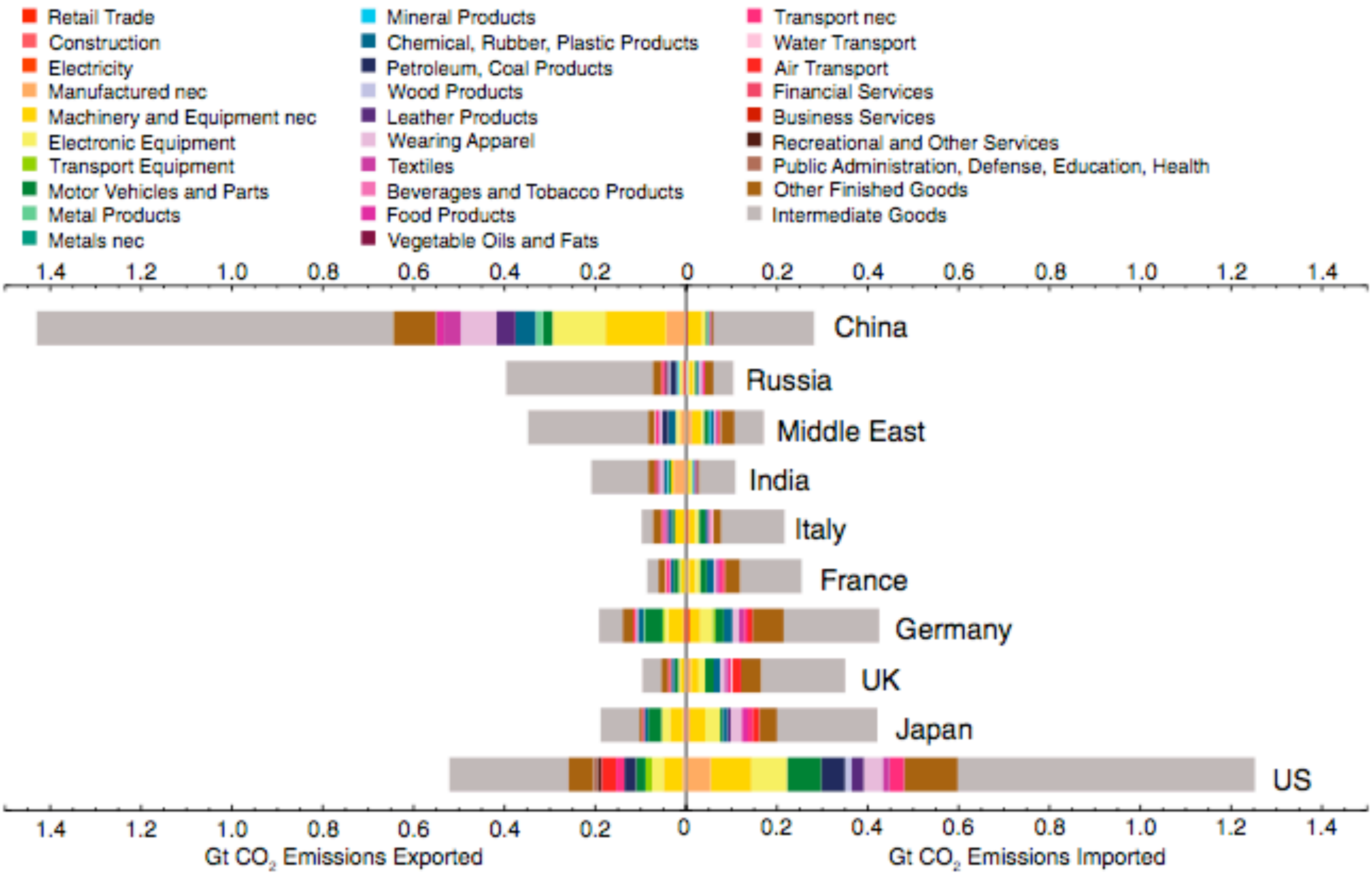
Consumption

Transport energy & emissions difficult to quantify at global scale.

Cooking: 8% of energy use & ~2/3 of BC emissions

Role of trade



S.J. Davis, et. al. *PNAS* (2010).

How do we calculate?

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Two main methods:

(1) **Life-cycle analysis (LCA)**

- Bottom-up approach
- Count all inputs at all steps
- Very precise
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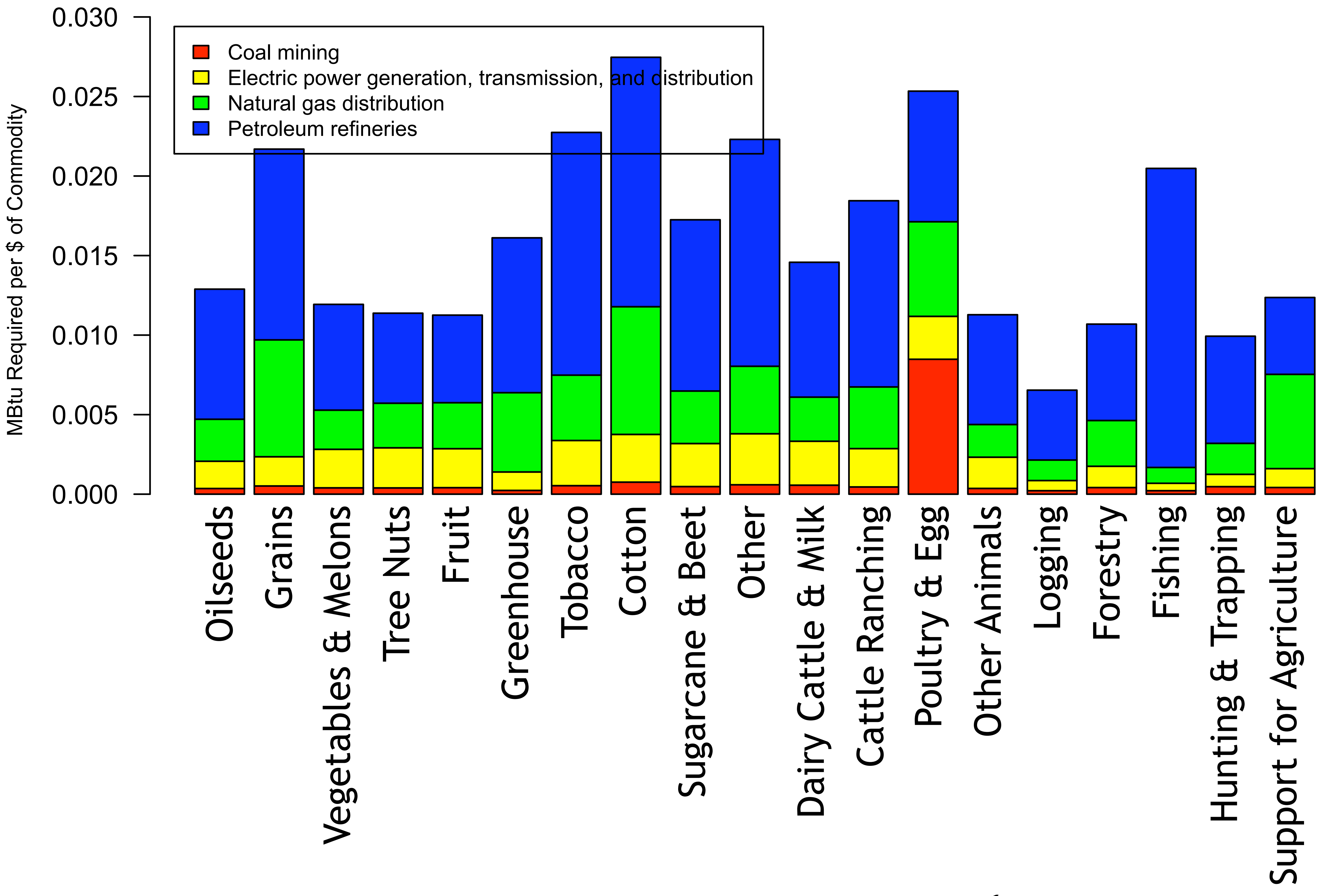
(2) **Input-output (IO) accounting**

- Top-down approach
- Calculate economy-wide activity for output in one area
- Get all direct and indirect requirements, nothing missed
- Requires very good data, lose precision with aggregation

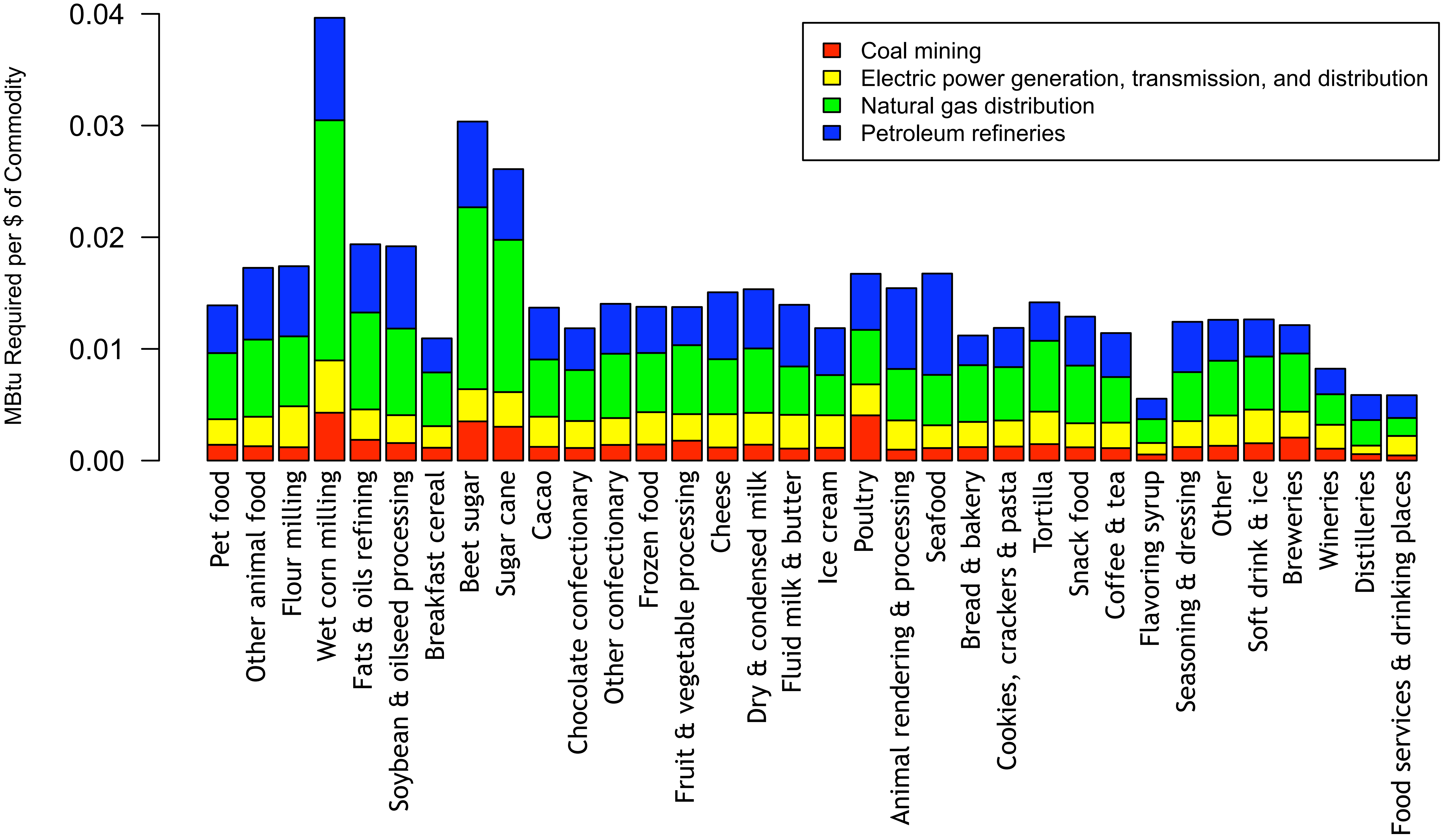
Energy used in US production (bottom-up)

	Energy use per acre	Energy use for US crop	Fertilizers Production	Pesticides Production	Irrigation	Tillage
	MBtu/acre	1e6 MBtu	%	%	%	%
Corn	8.13	647.17	0.63	0.03	0.32	0.02
Wheat	8.3	413.92	0.78	0.02	0.18	0.02
Soybeans	0.96	73.36	0.31	0.16	0.43	0.1
Potatoes	15.2	15.88	0.62	0.04	0.32	0.02

Energy used in US production (top-down)

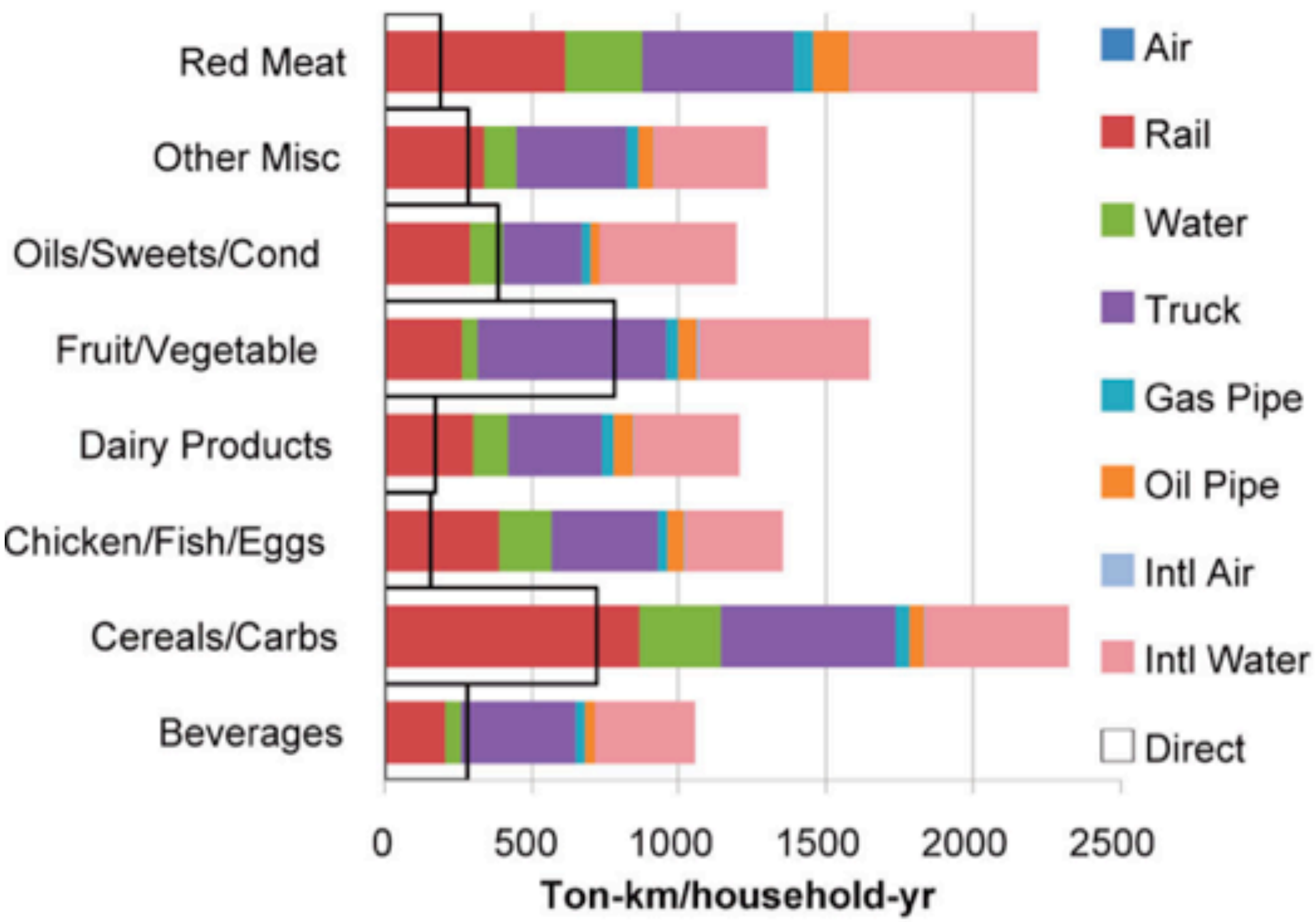


Energy used in US processing

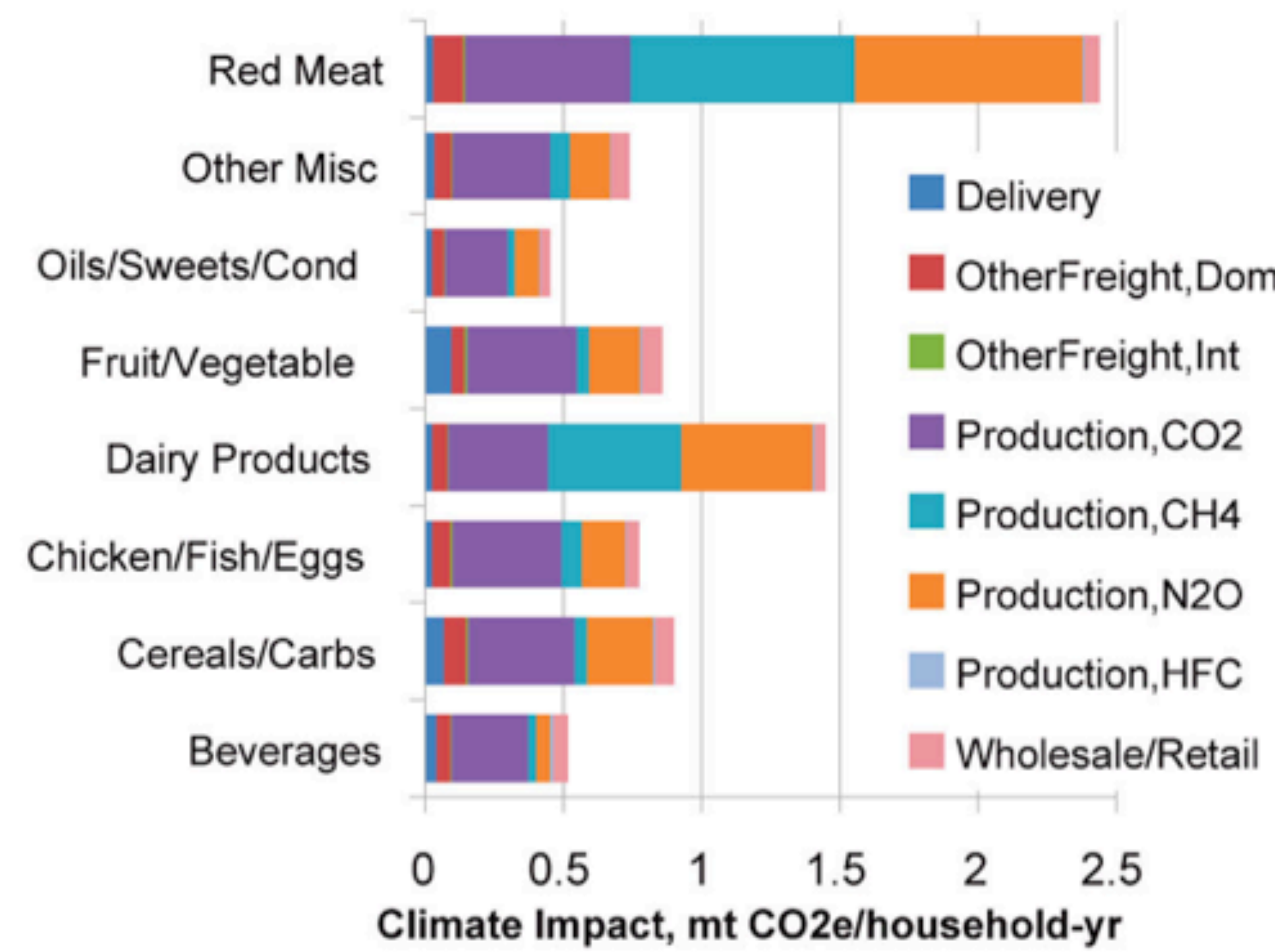


Transport & "food miles" in the US

Ton-km per household



mt CO2e per household



Delivery: ~5% of climate impact in US
Transport as a whole: ~11% of climate impact

Weber & Matthews, *ES&T* (2008)

Consumption in the US and globally

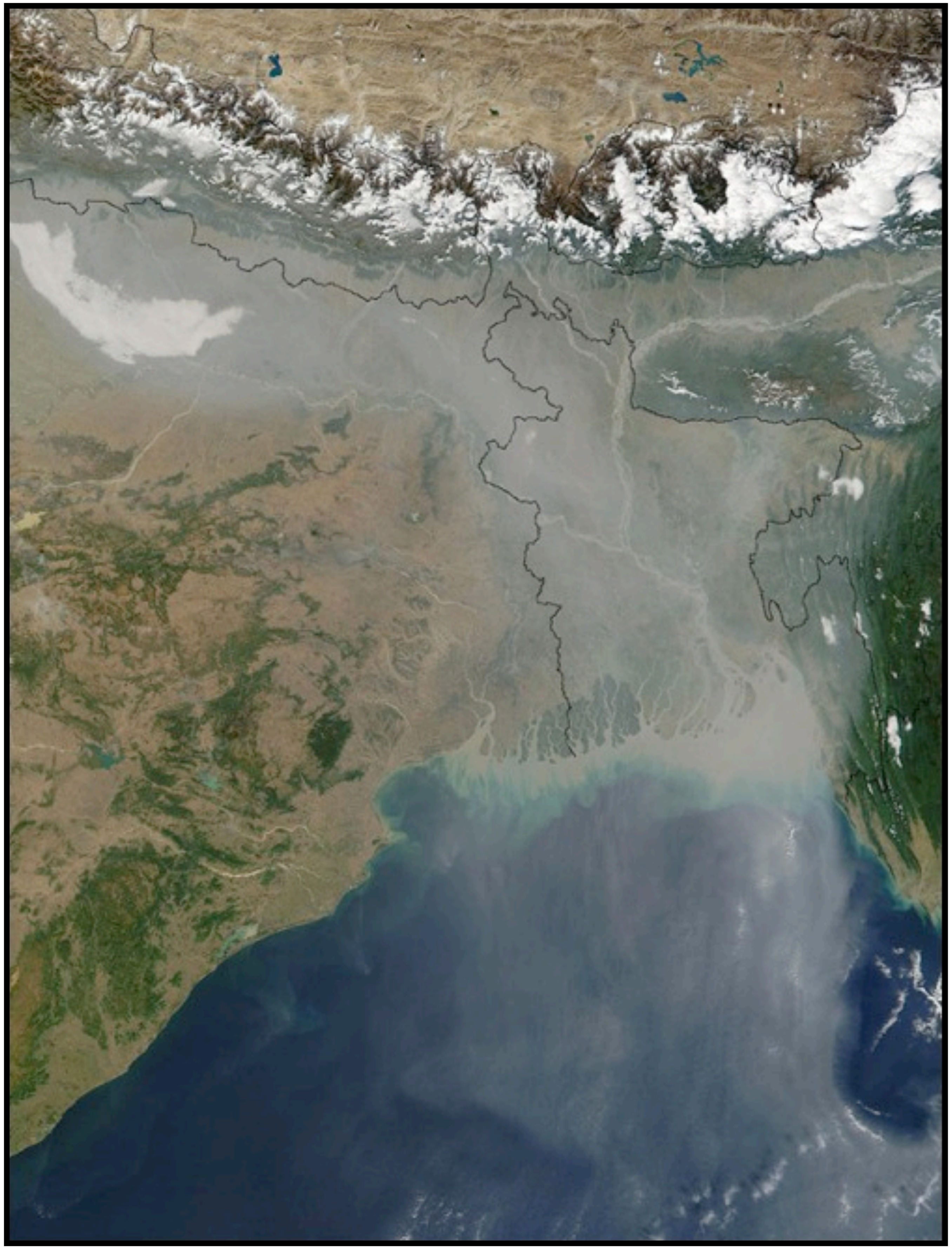
US Residential Energy Use:

2/3 of electricity to appliances (~4 Quad)
<10% of NG to appliances (~5 Quad)

Global Energy Use:

8% of energy use to cooking
2/3 is biomass, in developing world
(much higher climate impact)

A note on biomass-based cooking



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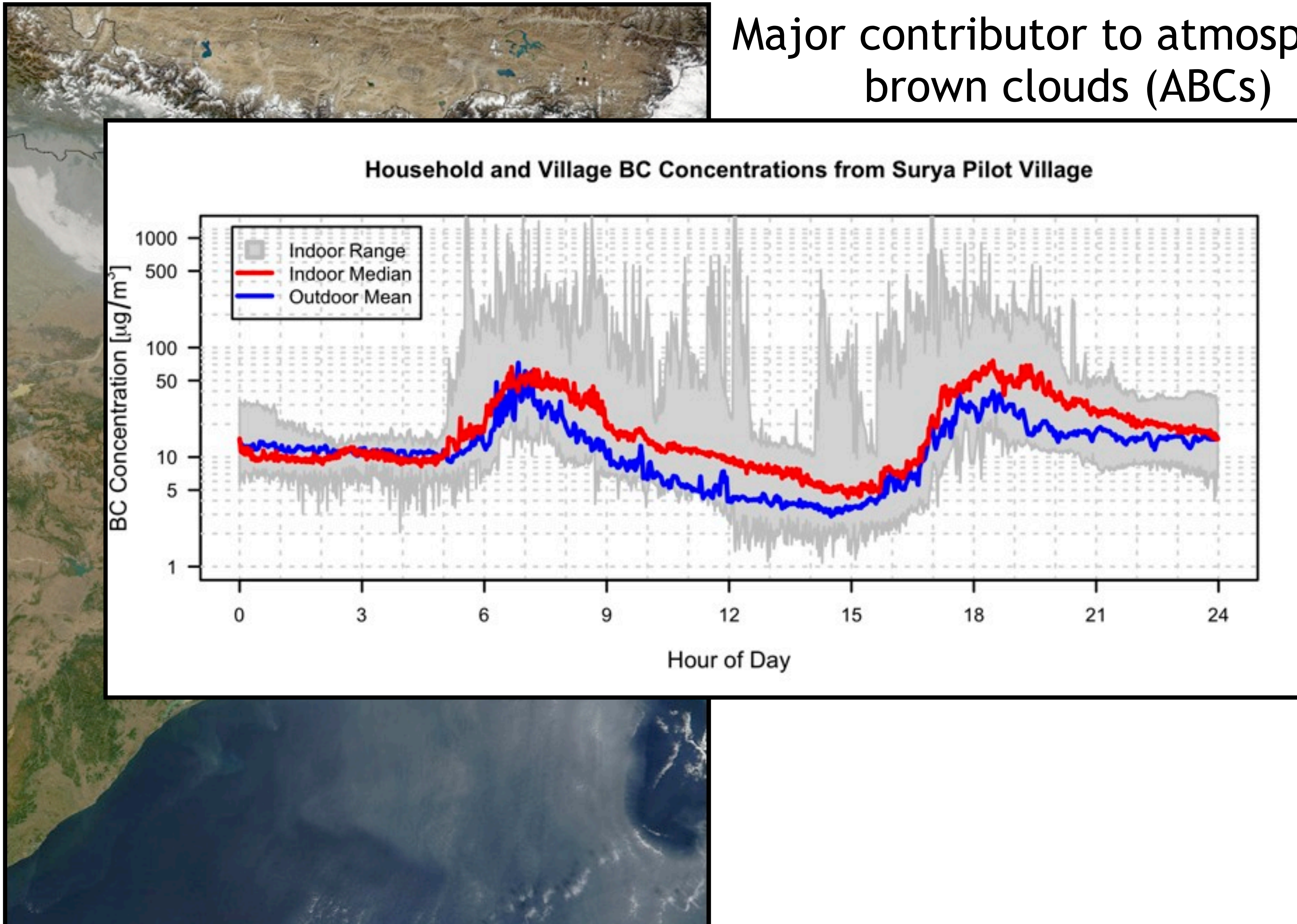

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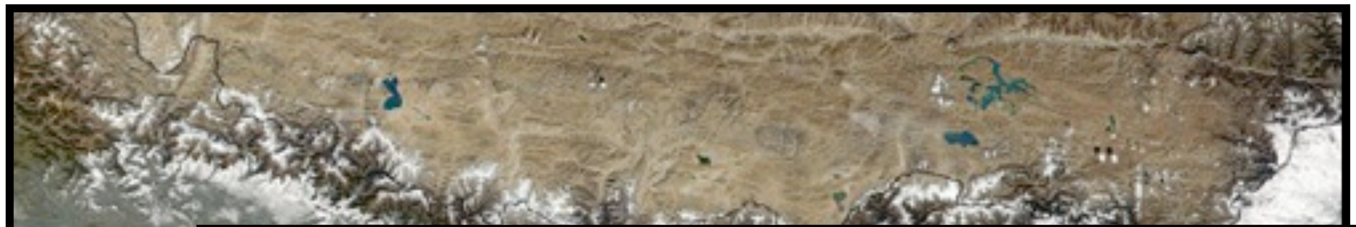

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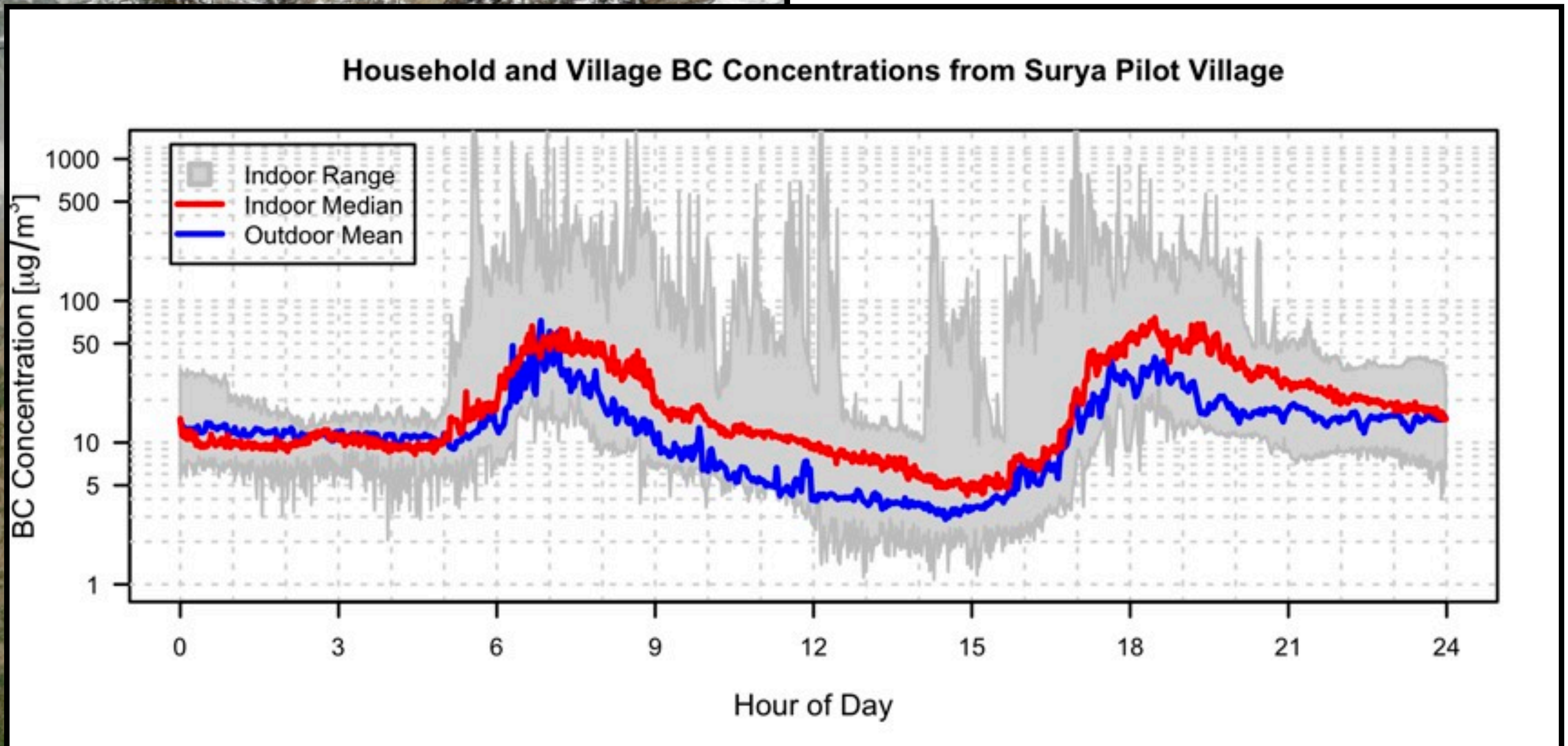

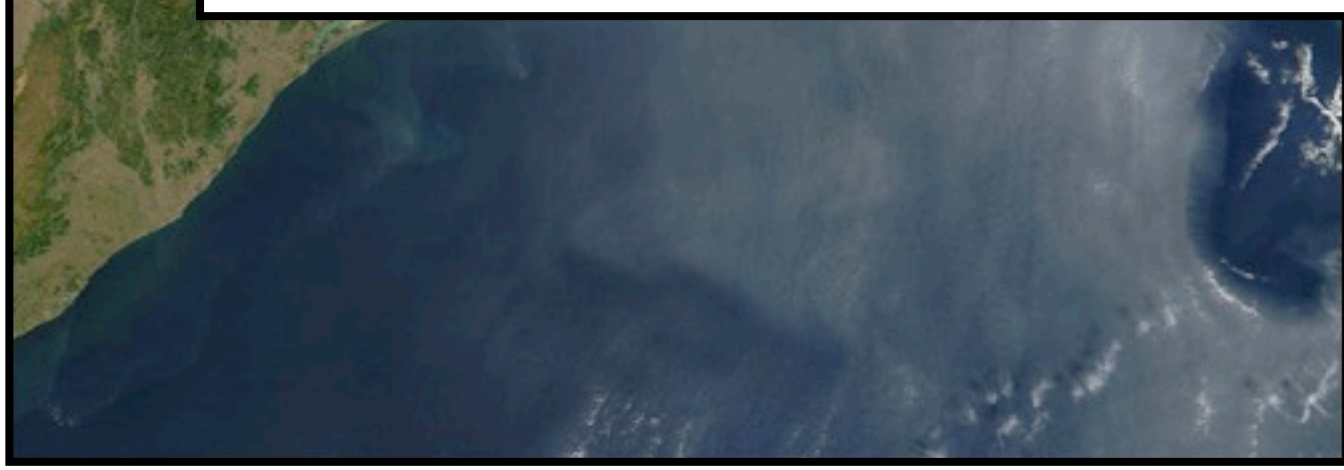

Traditional/unimproved cookstoves:

- Not just indoor pollution problem (chimneys don't help)
- Need strategies that sustainably address black carbon emissions

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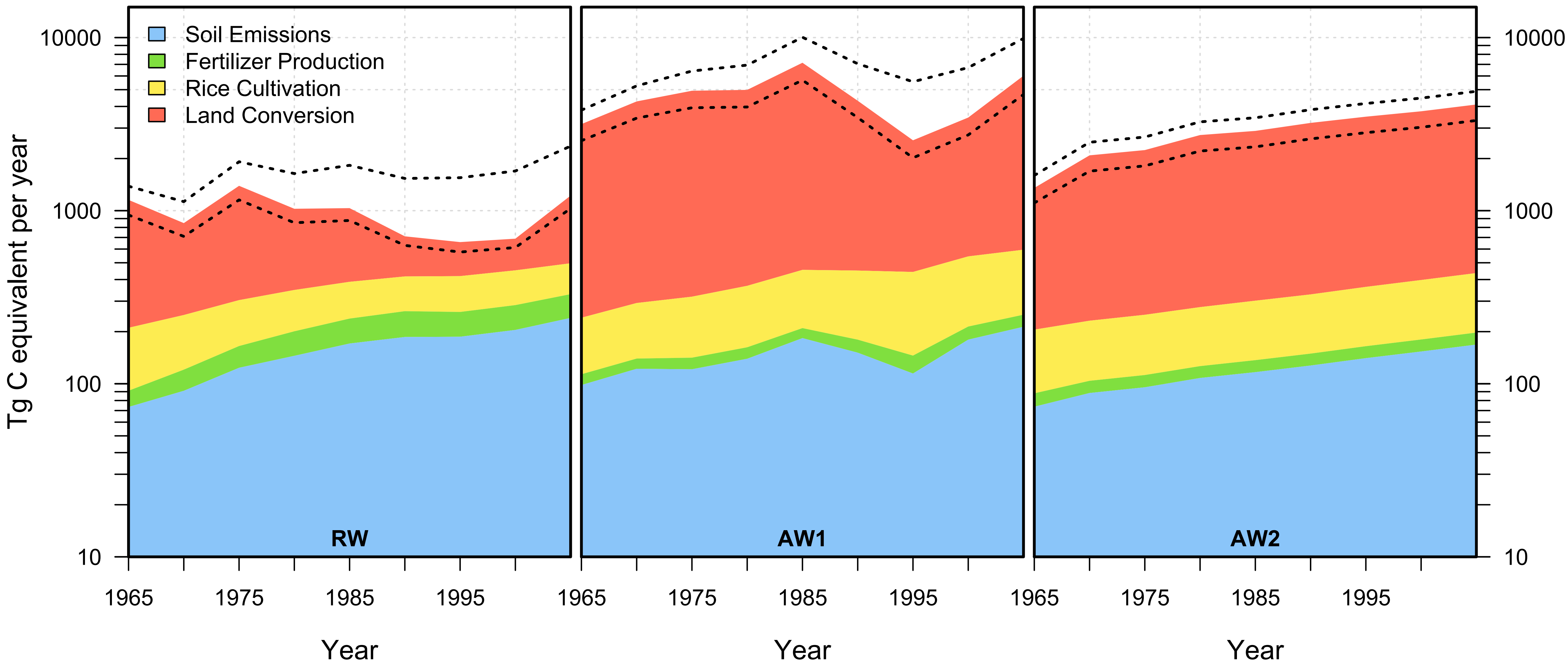
Energy efficient consumption	Reduce personal energy additions	Reduce GHG emissions	Requires planning

Extra slides

Low-input agriculture is a climate loser: yield!!!



RW: Real world

AW1: No yield gains; historical trends in population & living standards

AW2: No yield gains; constant fertility & mortality rates, living standards since 1961

Calories in & calories out

Corn:
56 lbs/bu = 25.45 kg/bu
365 kcal/100g : 92909 kcal/bu

$7.44/bu
$1 = 0.13 bu = 7.53 lb = 3.42 kg = 12487 kcal

Bottom-up estimates (low-bound):
2009: 165.2 bu/acre
15.3 M kcal/acre out

1 kcal = 3.97 Btu
8.13 Mbtu/acre inputs = 2.05 M kcal/acre in

Top-down estimates (high bound):
0.021 Mbtu per $ grain farming output
5290 kcal in per 12487 out

Emissions-free inputs

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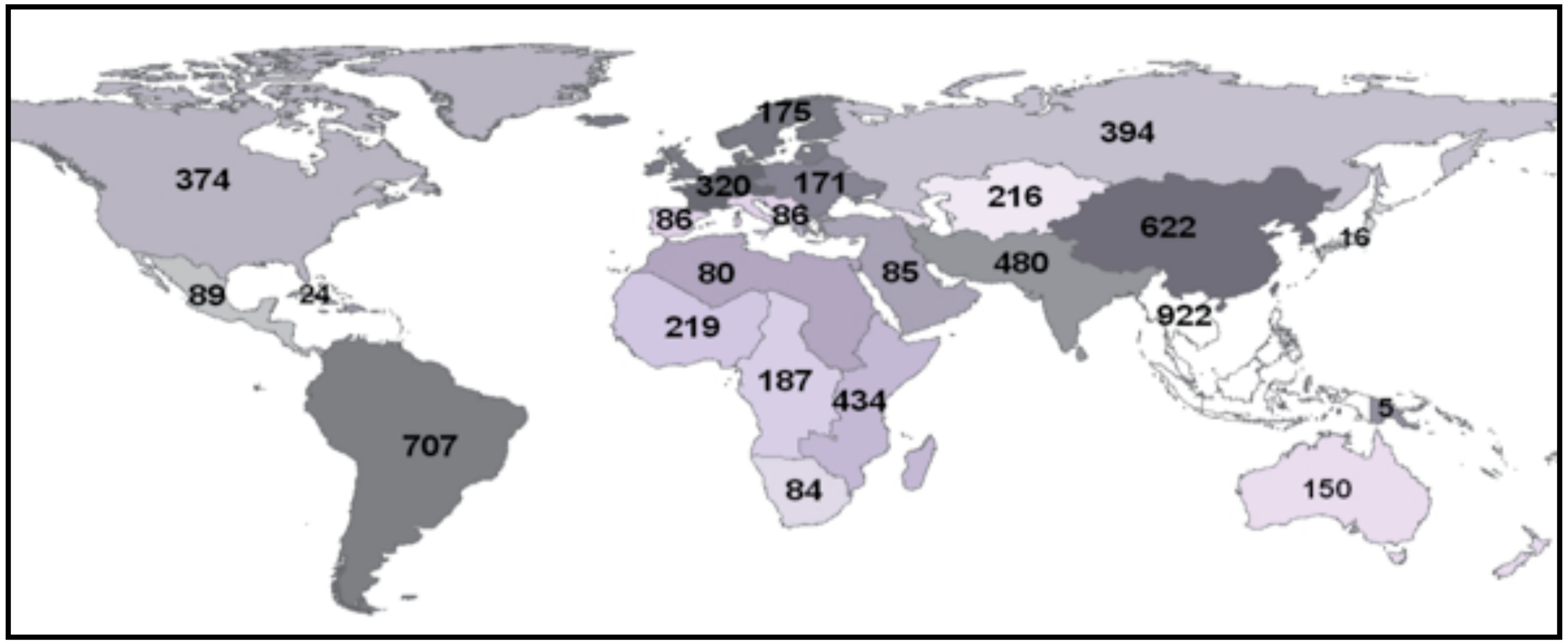
Tillage and residue management

No-Till or Minimum-Till



Global mitigation potential ≈ 1.61Gt C/yr

IPCC, AR4 -- Mitigation: Agriculture, 2007;
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International Biochar Initiative : www.biochar-international.org

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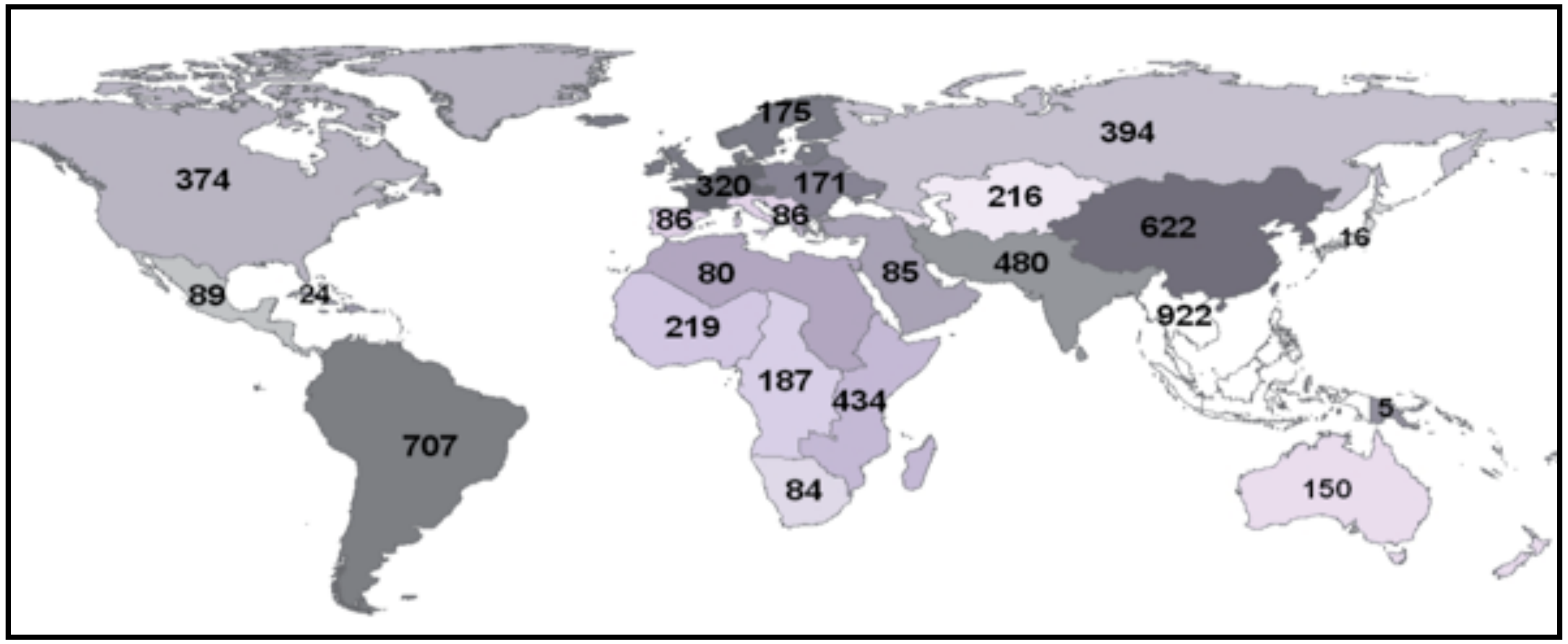

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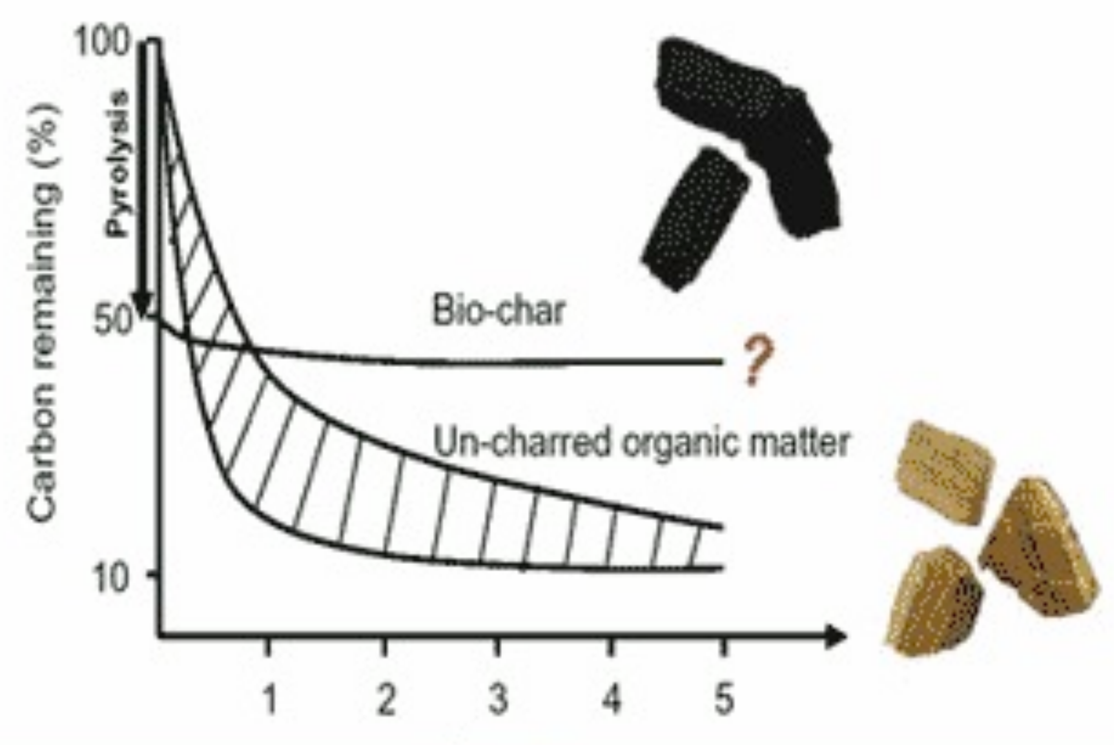

Biochar

International Biochar Initiative: 2.2Gt C/yr

IPCC, AR4 -- Mitigation: Agriculture, 2007;
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