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Global anthropogenic methane mitigation -technical potentials

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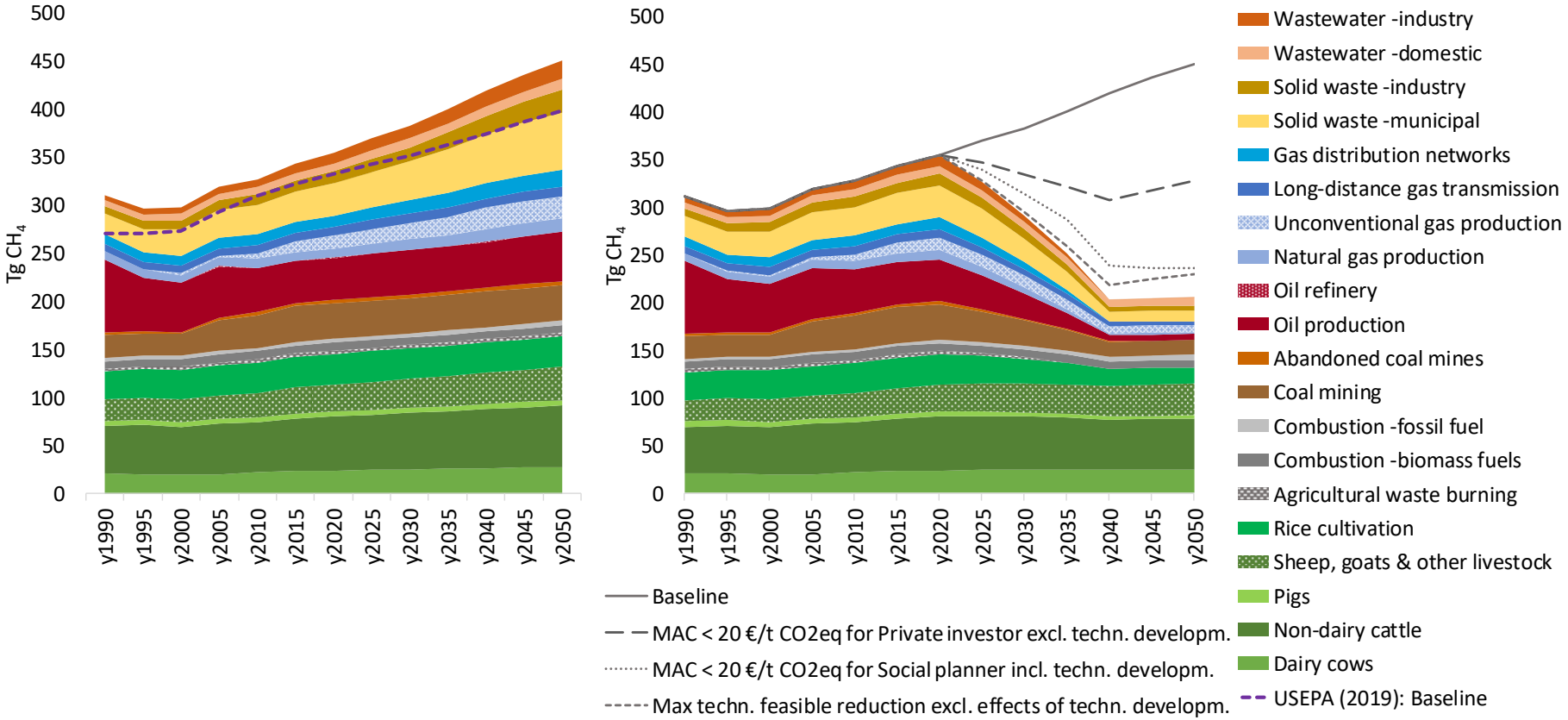
Global anthropogenic CH_4 emissions 1990-2050

Baseline 2050: 450 Tg CH_4 (=13 Gt CO_2eq)

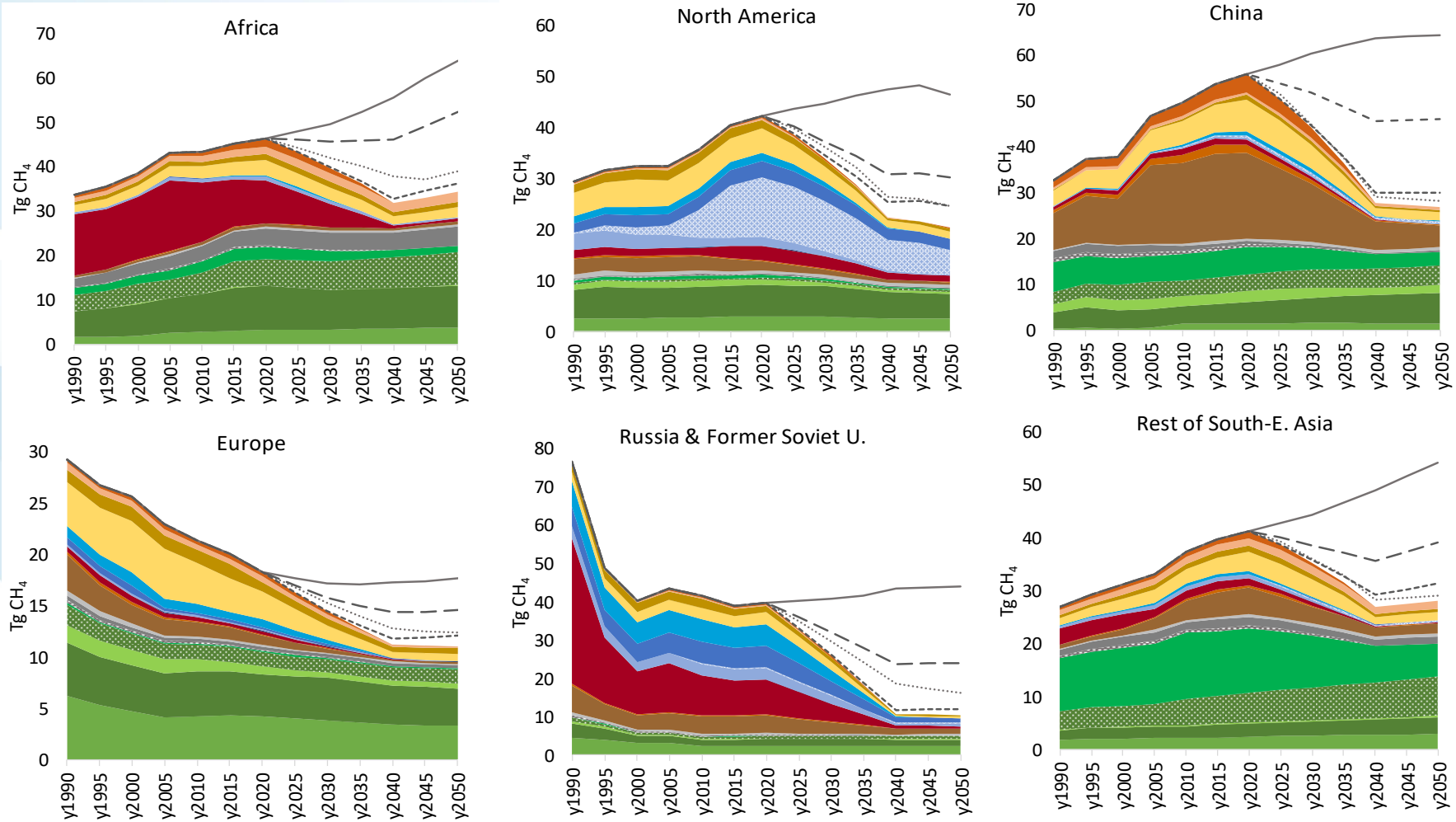
Max technical feasible reduction: 205 Tg CH_4 (=6 Gt CO_2eq)



Cumulative emissions 2020-2050:	Gt CH_4	Gt CO_2eq	% reduction
Baseline	12	349	0%
Private MACC < 20€/t CO2eq	10	285	-18%
Social MACC < 20€/t CO2eq	9	248	-29%
Max technically feasible reduction (MFR)	8	217	-38%

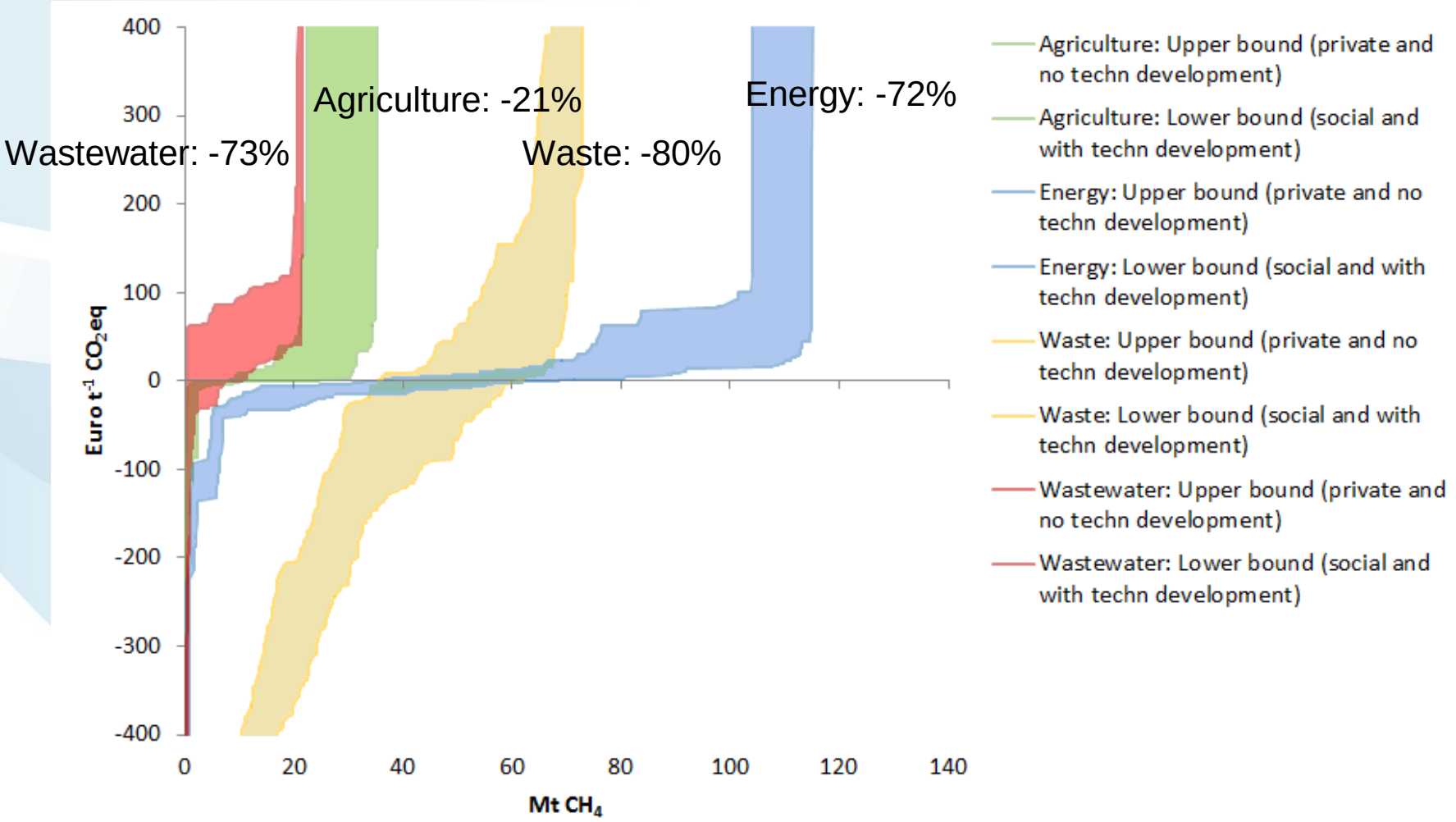
Source: GAINSv4; Höglund-Isaksson et al., 2020

Large regional variation in sector emissions and mitigation potentials



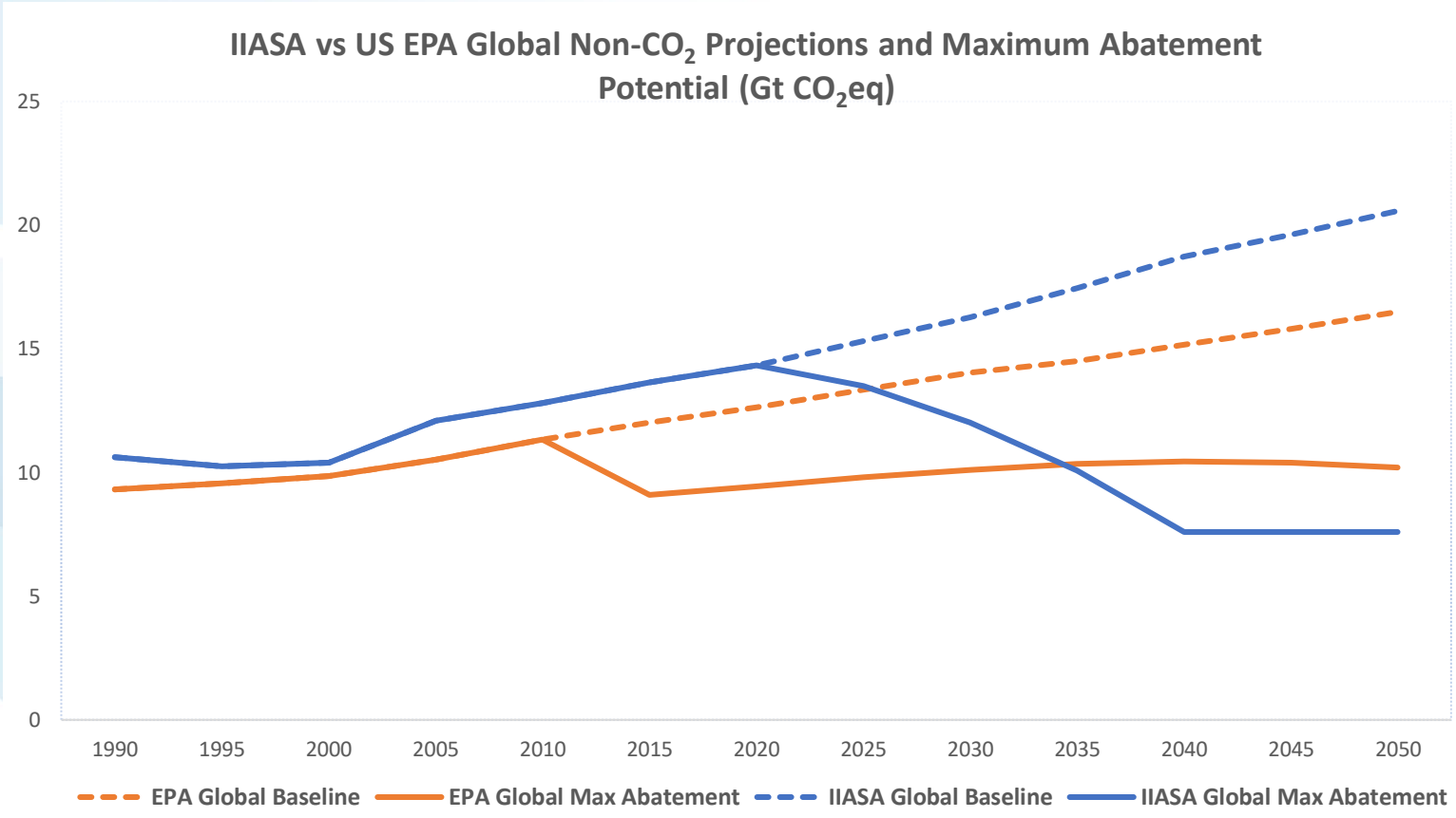
Source: GAINSv4; Höglund-Isaksson et al., 2020

Marginal abatement cost curves (ranges) for global CH_4 mitigation in 2050

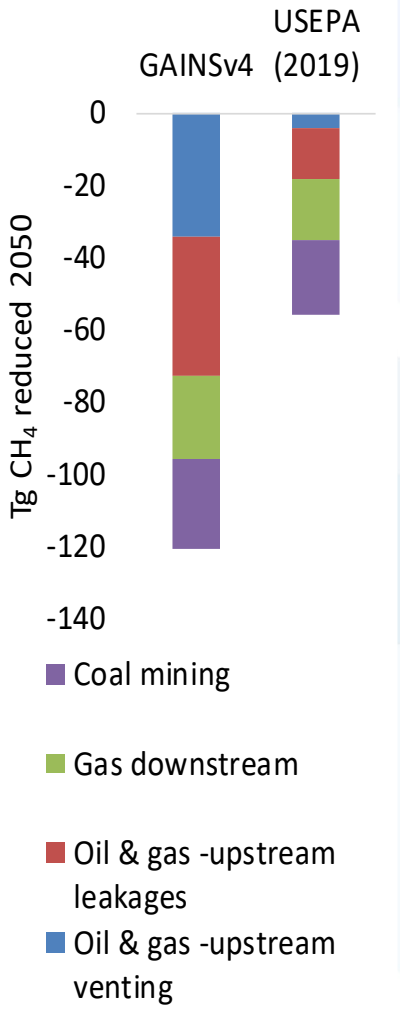


Source: GAINSv4; Höglund-Isaksson et al., 2020

Comparison GAINSv4 vs USEPA (2019): Non-CO_2 Maximum Technically Feasible Reduction

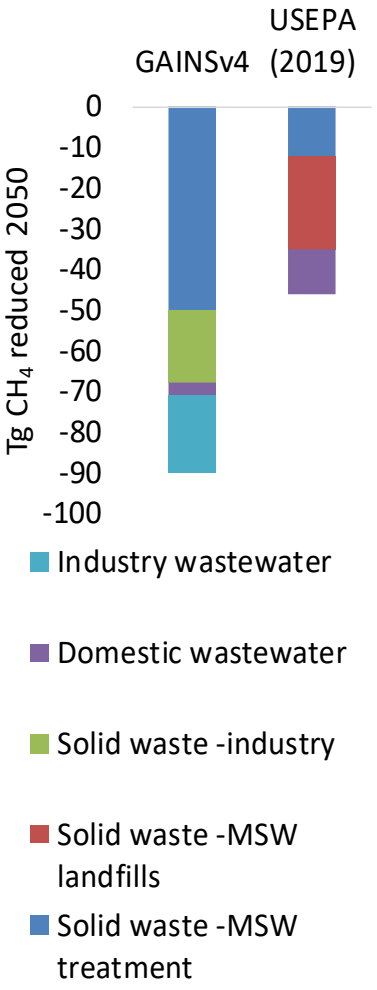


Energy:
Global CH_4 mitigation potentials 2050



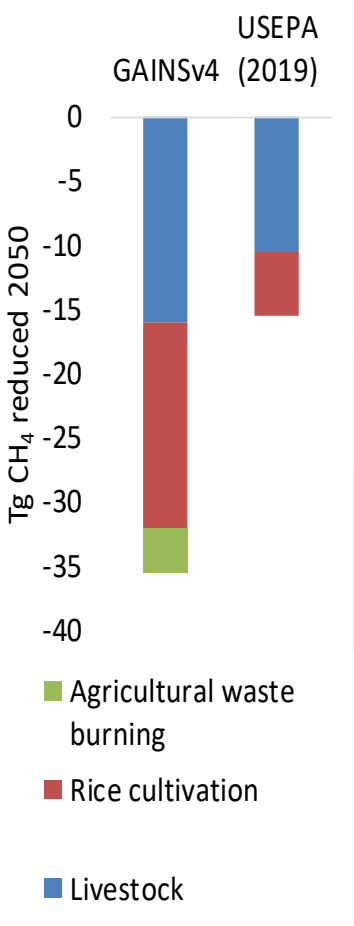
	GAINSv4 options & mitigation potential 2050		USEPA (2019) options & mitigation potential 2050 (approximate from total non-CO2)	
CH_4 source:		Tg CH_4		Tg CH_4
Oil & Gas -Upstream handling of associated gas	Recovery of associated petroleum gas, control of flare shut-downs	34	Flaring instead of venting	4
Oil & Gas -Upstream unintended leakages	Leak Detection & Repair (LDAR) programs	39	Direct Inspection and Maintenance, Conversion of gas pneumatic controls to instrument air, Early replacement Reciprocating Compressor Rod Packing Rings, Vapor Recovery Units on Oil Storage Tanks etc.	14
Gas downstream	LDAR programs & Replacement of cast iron pipes	23	Direct Inspection & Maintenance of compressors, Replace Cast Iron Pipeline, Portable Evacuation Compressor for Pipeline Blowdowns etc.	17
Coal mining	Degasification	9	Degasification	4
	VAM	12	VAM	16
	Flooding of abandoned coal mines	4	Open flare etc.	1
Sum Maximum technically feasible mitigation		**121**		**~ 57**
% below Baseline 2050 for the Energy sector		**72%**		**~ 50%**

Waste & Wastewater: Global CH_4 mitigation potentials 2050



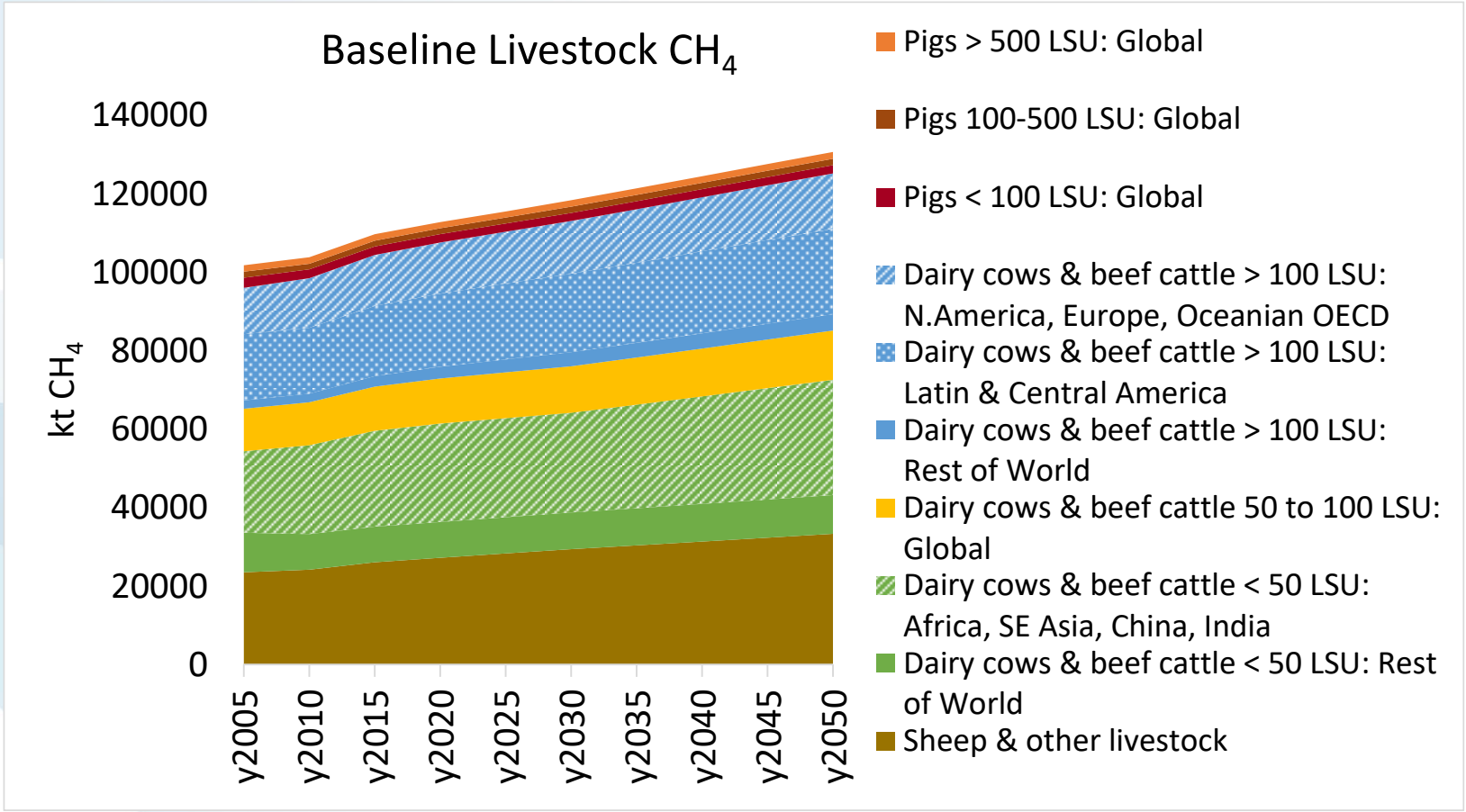
CH_4 source:	GAINSv4 options & mitigation potential 2050	Tg CH_4	USEPA (2019) options & mitigation potential 2050 (approximate from total non-CO2)	Tg CH_4
Solid waste	MSW -Anaerobic digestion	20	Anaerobic digestion or composting	6
	MSW -Paper recycling	15	Paper recycling	3
	MSW -Waste to Energy	15	Waste to Energy	3
	MSW -Landfill gas recovery etc.	0	Flaring of landfill gas	4
	Industrial waste -Food industry AD	13	Landfill -Enhanced oxidation etc.	4
	Industrial waste -Incineration	5	Landfill gas recovery for direct use or electricity generation	15
Wastewater	Domestic wastewater -primary to two-stage anaerobic & aerobic treatment, latrine or septic tank to aerobic treatment	3	Open sewer to aerobic wwtp	4
			Wastewater treatment plant with anaerobic sludge digester with co-gen	1
	Industrial wastewater -primary to two-stage anaerobic & aerobic treatment with biogas recovery	19	Latrine or Septic tank to aerobic wwtp	6
Sum Maximum technically feasible mitigation		**89**		**~ 45**
% below Baseline 2050 for the Waste and Wastewater sectors		**78%**		**~ 60%**

Agriculture: Global CH_4 mitigation potentials 2050



CH_4 source:	GAINSv4 options & mitigation potential 2050	Tg CH_4	USEPA (2019) options & mitigation potential 2050 (approximate from total non-CO2)	Tg CH_4
Livestock -Enteric fermentation	Breeding for enhanced productivity & animal health/fertility, enhanced feed efficiency & feed changes, on farms > 100 LSU	6	Improved feed conversion	1
	Options for large-scale grass-based or feedlot systems; inter-seeding, fodder supplements	7	Intensive grazing	1
			Antimethanogen	3
			Propionate_precursors	2
			Antibiotics & bST	1
Livestock -Manure management	Anaerobic digestion, on farms > 100 LSU	3	Anaerobic digestion & covered lagoon	~2.5
Rice cultivation	Improved water management, soil amendments, alternative hybrids	16	Alternate wetting & drying, Mid-season drainage, Dry-seeding, Ammonium sulphate	~5
Agricultural waste burning	Ban enforcement	4		0
Sum Maximum technically feasible mitigation		**35**		**~ 15**
% below Baseline 2050 for Agricultural sector		**21%**		**~ 8%**

Limited technical abatement for CH_4 in the global livestock sector



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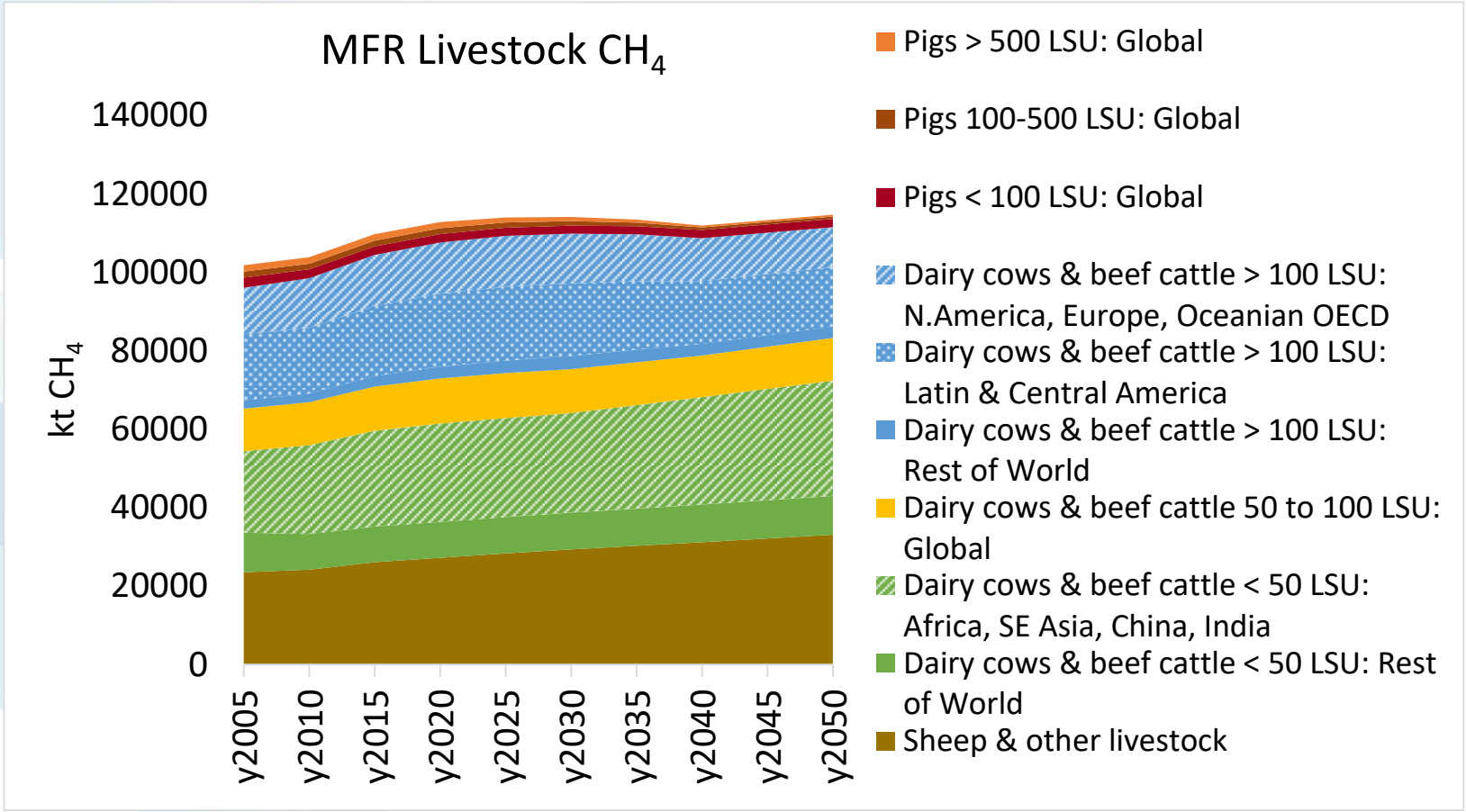

To sum up

- CH_4 added to the atmosphere from global anthropogenic sources 2020-2050:
  - Without further control efforts: ~12 Gt CH_4 (~ 350 Gt CO_2eq)
  - With Max technical mitigation potential: ~ 8 Gt CH_4
  - With options below 20 €/t CO_2eq: 9-10 Gt CH_4

- Also with Max technical potential: ~ 6 CO_2eq still released annually in 2050.
- Too much to offset through land-use change and other measures, hence, behavioural (e.g., human diets, waste reduction) and institutional measures (e.g., alternatives to livestock as risk-management strategy) needed in addition to be on track for Paris Agreement.

- Energy: Large potentials for CH_4 control in the energy sector –oil & gas industry claims technology is there to control close to 100% of CH_4 at very low or even zero cost

- Waste & Wastewater: Recovery of carbon (and other nutrients) for renewable energy and other use increasingly attractive in a world without fossil fuels. Infrastructure and institutional reforms needed to facilitate market access for recovered resources.

- Agriculture: Beyond fossil fuels, agricultural sector will be key to a climate neutral world:
  - What will be the objectives of future agriculture? Food production, human health, guardian of biodiversity and cultural diversity, other ecosystem services.
  - Human diet changes -how much land will be freed up for other purposes?
  - What kind of agriculture do citizens/consumers want/need? Extensive/Intensive?

Thank You!

Höglund-Isaksson et al., 2020. **Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe –results from the GAINS model**
https://iopscience.iop.org/article/10.1088/2515-7620/ab7457

USEPA, 2019. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases