Imperial College London

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Methane emissions from global natural gas supply chains

Quantifying emissions and assessing the risk of emissions

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Concurrent session 64: Gas and the environment

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Presentation outline

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- Why CH_4?
- Methods
  - Quantifying emissions
  - Assessing emissions risk
- Results
- Summary and conclusions

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Why CH_4?

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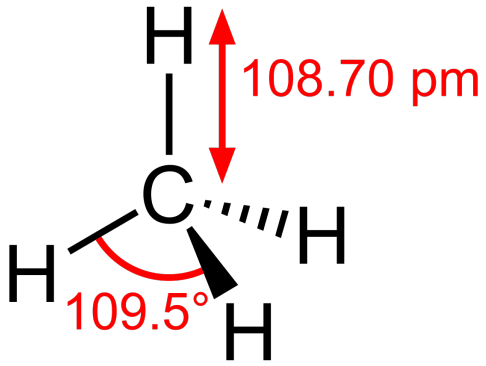

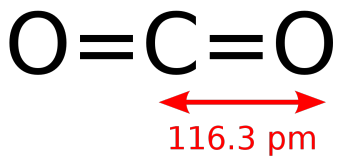

Global warming potential (100 years)	34	1
Global warming potential (20 years)	86	1
Contribution to global warming since 1750	20%	76%

Myers et al., 2013. Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
Ciais et al., 2013. Carbon and Other Biogeochemical Cycles. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Record methane levels pose new threat to Paris climate accord

Rising atmospheric concentrations have power to hasten glo

Global Methane Emissions Reach a Record High

Scientists expect emissions, driven by fossil fuels and agriculture, to continue rising rapidly.

Soaring methane emissions threaten to put climate change goals out of reach

Global emissions of methane, a potent greenhouse gas, have soared over the past decade, according to two new studies that tracked growing sources of the odorless, colorless gas.

Forbes

Sep 4, 2020, 11:48am EDT

Big Oil Methane Emission Limits In Line With Paris Climate Pact Goals

The Seneca Resources shale gas well in St. Mary's, Pa. Eighty percent of North America's rise in methane emissions was from fossil fuels. Keith Srakocic/Associated Press

Methods

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The supply chain

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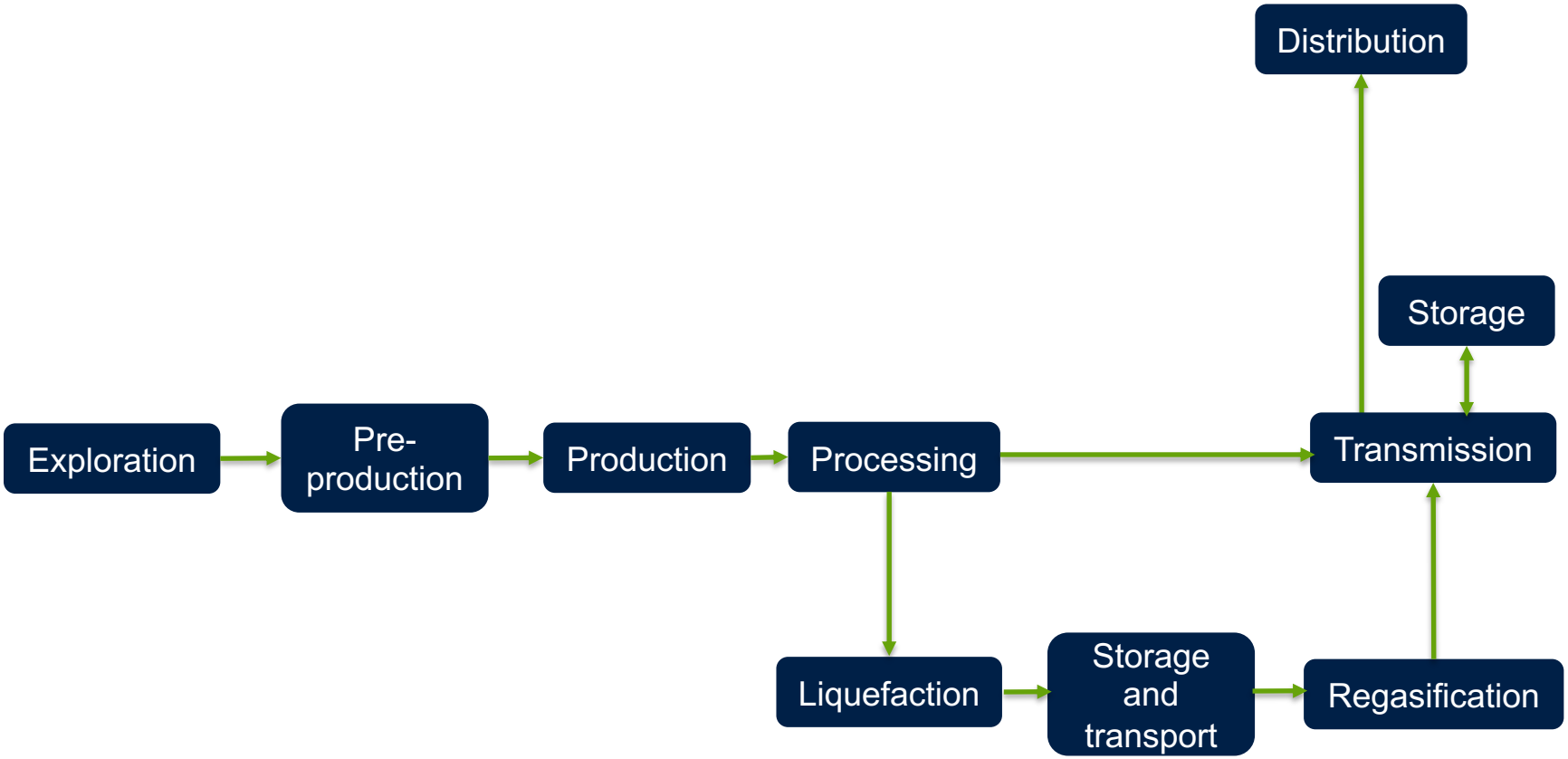

Quantifying emissions

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- CH_4 emission factors derived from emissions data reported in national greenhouse gas inventories collected for largest gas supply chains
  - 17 major gas producing and consuming countries
    - *Argentina, Australia, Bolivia, Canada, China, Egypt, Germany, Iran, Italy, Japan, Malaysia, Netherlands, Norway, Qatar, Russia, UK, USA*
  - 63 countries who import/export gas to the 17 major countries
  - 80 countries and 252 supply chains in total
- Natural gas production, trade and consumption data collected
  - All supply chains considered: domestic production, pipeline trade, LNG trade and domestic consumption.
- Methane emissions calculated from emission factors and activity data
- Year 2017 considered

Assessing emissions risk

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- Bootstrapping resampling run on emission factor data to determine impact of Tier 1 data
- Risk assessment carried out based on emissions and emission quantification methodology used per country
  - Likelihood: occurrence of inaccurate emission factors based on IPCC tier
  - Consequence: emission rate, relative to 0.2% benchmark

		Consequence			
		Minor (1)	Moderate (2)	Major (3)	Extreme (4)
Likelihood	Very high (4)	Low-risk	Moderate-risk	High-risk	High-risk
	High (3)	Low-risk	Moderate-risk	High-risk	High-risk
	Moderate (2)	No-risk	Low-risk	Moderate-risk	Moderate-risk
	Low (1)	No-risk	No-risk	Low-risk	Low-risk

Results

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Methane emissions

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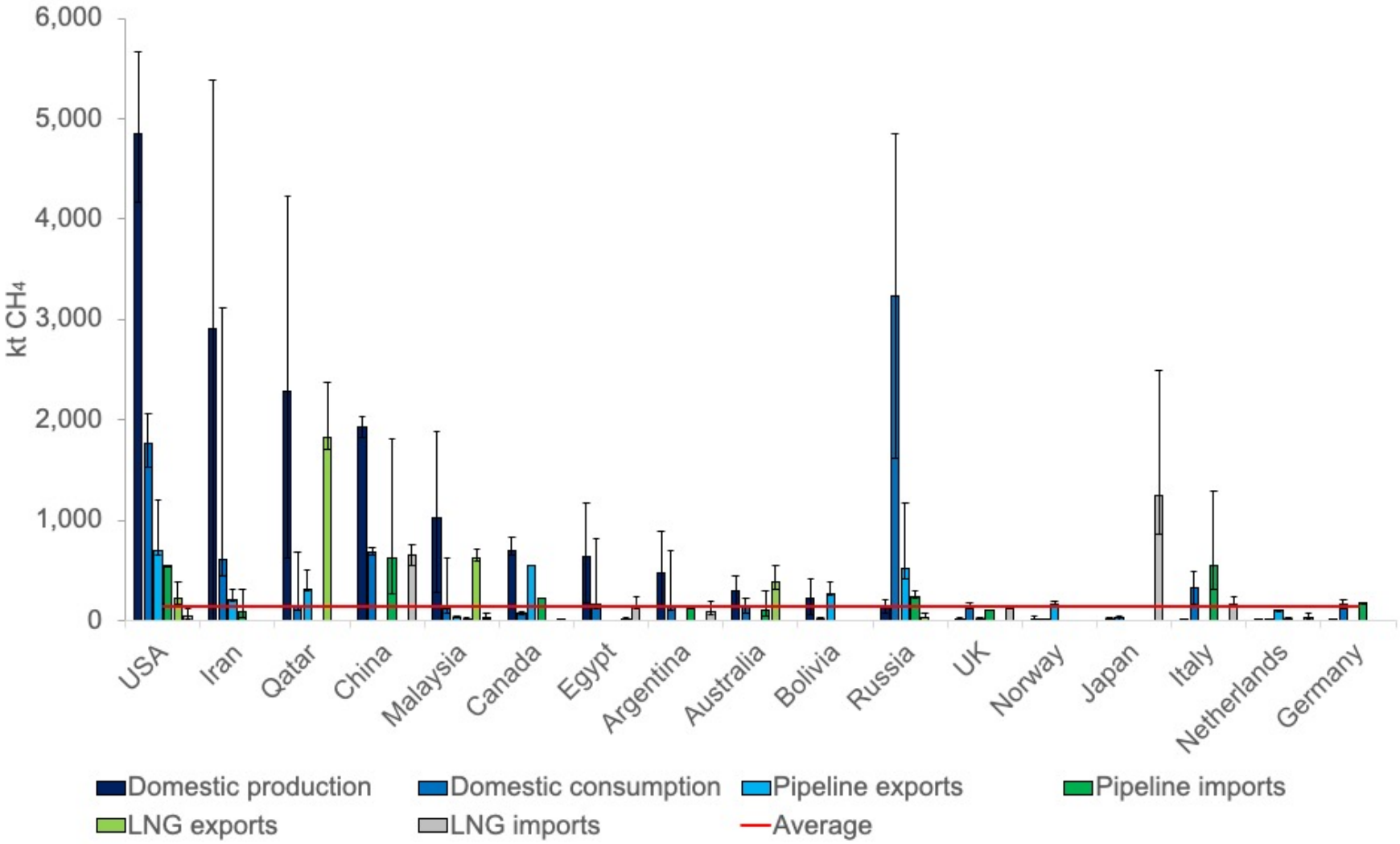

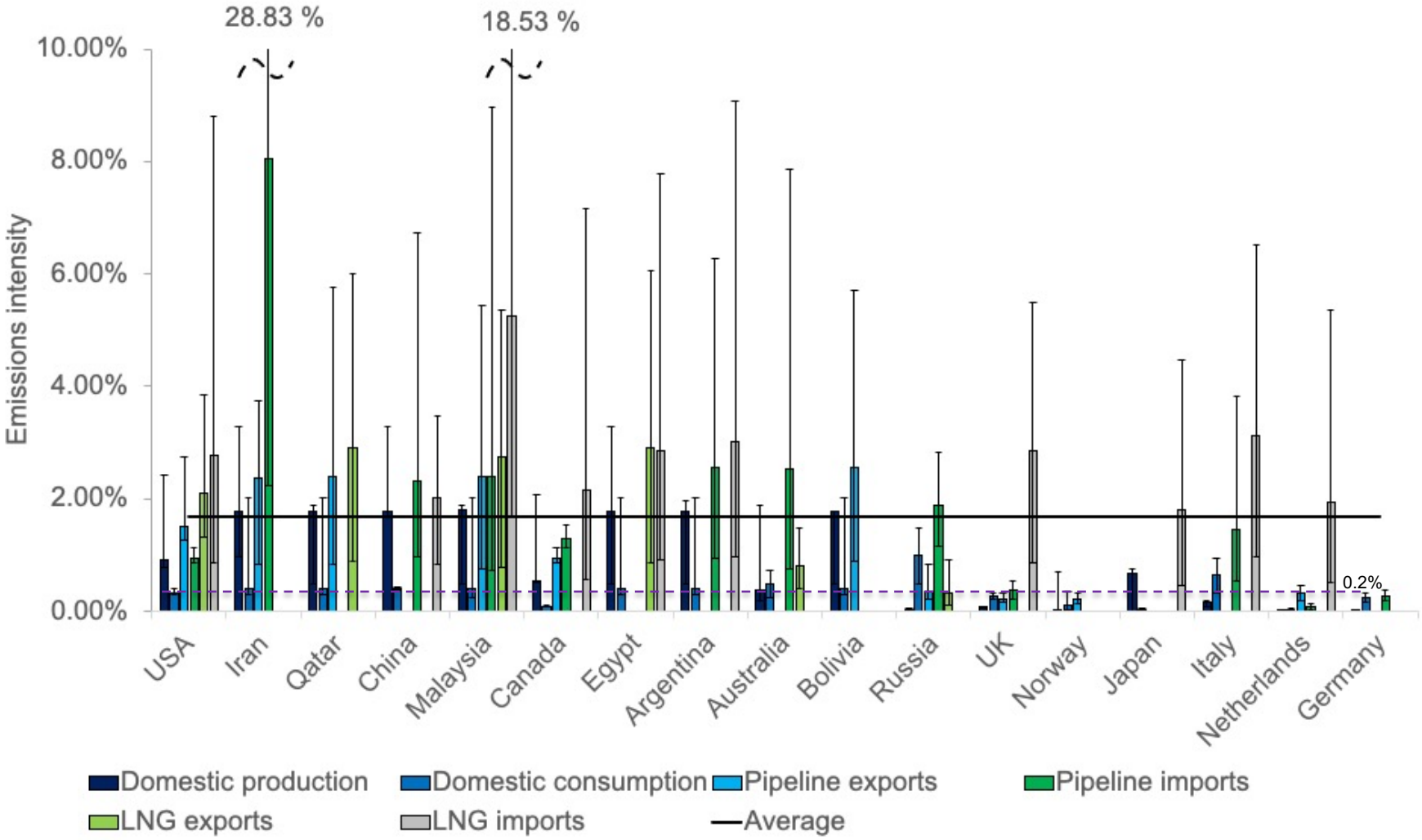
28.83 %
18.53 %
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Emissions intensity
0.2%
USA
Iran
Qatar
China
Malaysia
Canada
Egypt
Argentina
Australia
Bolivia
Russia
UK
Norway
Japan
Italy
Netherlands
Germany
Domestic production
Domestic consumption
Pipeline exports
Pipeline imports
LNG exports
LNG imports
Average

Emission methodology

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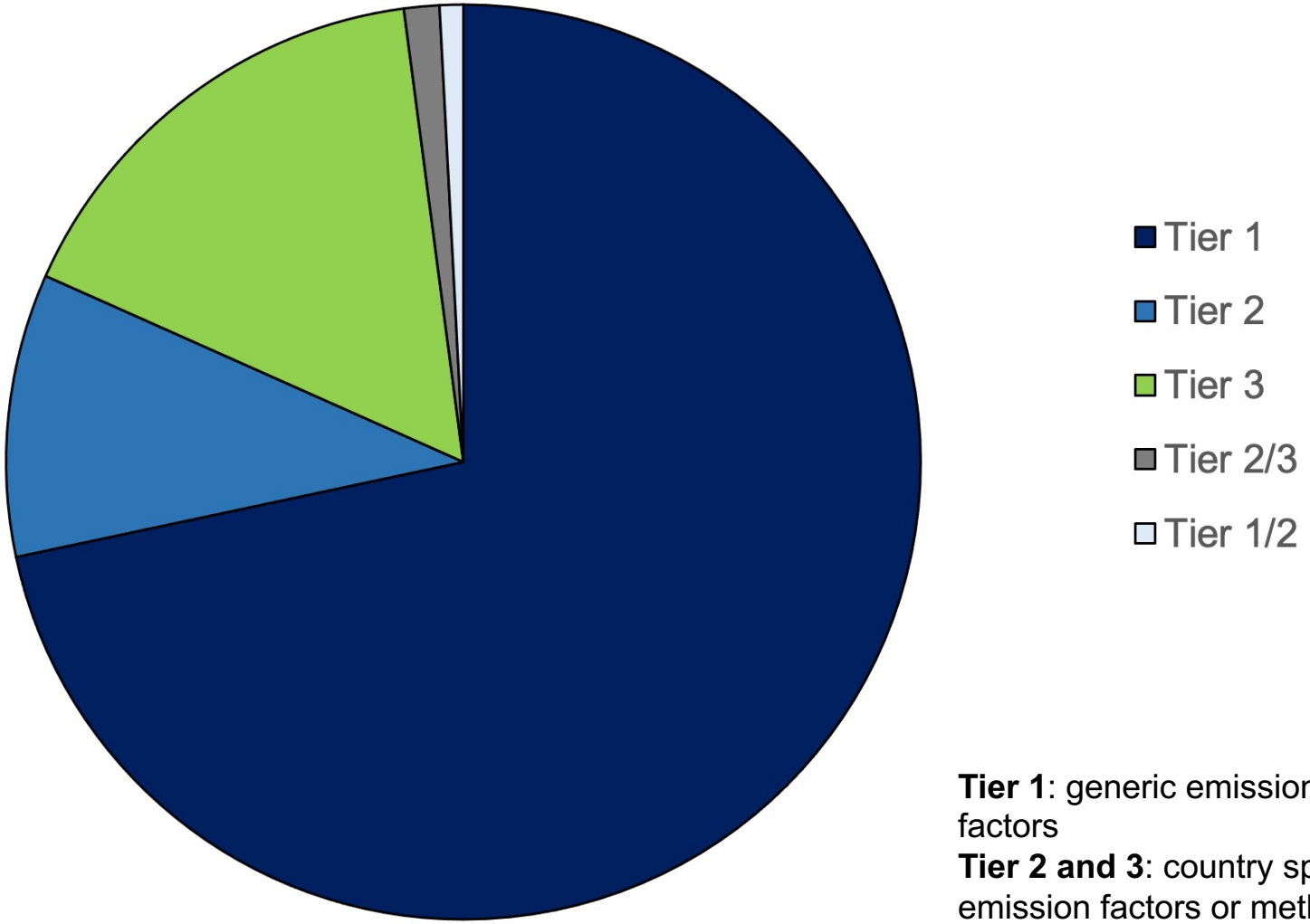

Tier 1: generic emission factors
Tier 2 and 3: country specific emission factors or methods

Uncertainty of emissions data

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- Resampling omitting Tier 1 data reduces emission
- 3.8-fold reduction in upstream emissions and 47% reduction in downstream emissions

		Production	Processing	T&S	Distribution
Mean	Original	0.87%	0.06%	0.07%	0.15%
	Bootstrapped	0.17%	0.02%	0.05%	0.11%
Median	Original	0.82%	0.09%	0.05%	0.14%
	Bootstrapped	0.17%	0.02%	0.05%	0.11%
SD	Original	0.85%	0.05%	0.10%	0.22%
	Bootstrapped	0.04%	0.00%	0.01%	0.02%
5% CI	Original	0.77%	0.06%	0.06%	0.13%
	Bootstrapped	0.25%	0.03%	0.07%	0.14%
95% CI	Original	0.98%	0.07%	0.09%	0.18%
	Bootstrapped	0.27%	0.03%	0.09%	0.14%

Emissions before and after bootstrapping. CI; confidence intervals

Areas at risk of emissions

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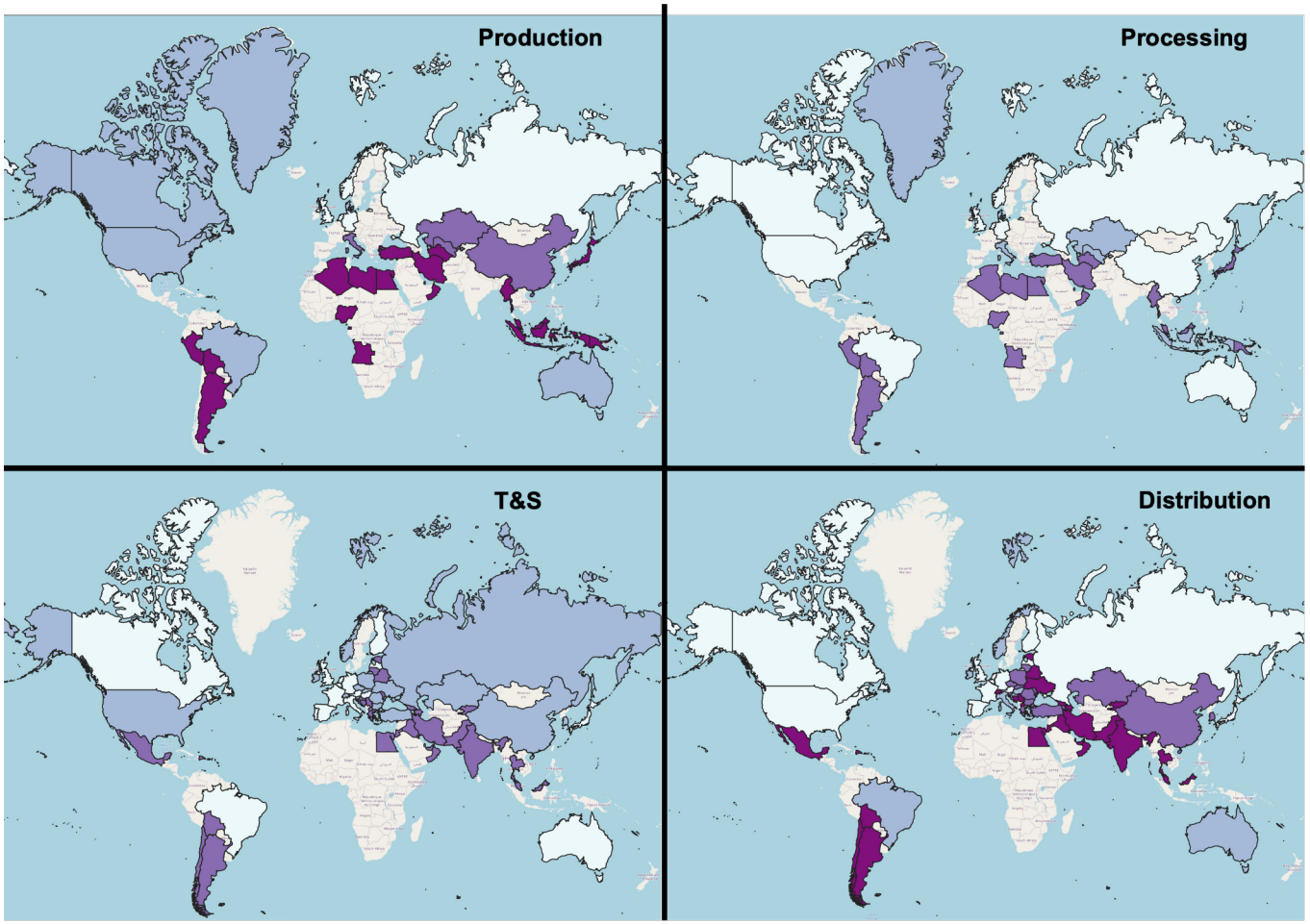

Summary and conclusions

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- 26.4 Mt CH_4 emitted by all 252 supply chains.
  - 15.5 Mt CH_4 from upstream; 7.8 Mt CH_4 from downstream; 3.1 Mt CH_4 from trade.
- Average supply chain emissions is 134 kt CH_4
  - large variation, ranging from >1,000 kt CH_4 to <0.1 kt CH_4
- Average emissions intensity is 1.7%
  - ranges from 0.01% to 8.1%
- Supply chain emissions decreased by 3.8-fold upstream and 47% downstream when bootstrapped.
- Risk assessment found many countries are at high risk of high emissions.
- Unable to deduce whether our emissions estimates are an over or underestimate

Thanks for listening!

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kt CH_4 emissions vs emissions intensity

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