Targeting the Global Methane Pledge through Key Pathways in Inter-country Production and Consumption Networks with Feasible Technologies and Minimum Cost (Special Session: Sustainable Strategies for Reducing COâ,, and Non-COâ,, Greenhouse Gas Emissions)

Topic: Sustainable Strategies for Reducing COâ,, and non-COâ,, Greenhouse Gas Emissions (I)
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(1) The research question
Unclear pathways of methane emissions resulting from economic activities and trade flows and their mitigation costs pose obstacles to international cooperation in efforts to reduce methane emissions.
(2) The method used
In this paper, we integrated annual inter-country input-output (ICIO) tables with sector-level methane inventories, we developed an environmental double filtering method (EDFM) based on the double filtering method (DFM) developed by Liu (2018), to quantify the key pathways for embedded methane emissions. We distinguished emissions into those embedded in domestic intermediate input (DOE) and versus those in imported intermediate inputs (IME). We analyzed the change in network characteristics of the key pathways over four distinct sub-period since 1995 with complex network analysis, and estimated the sources of these changes in embedded emissions with a structural decomposition analysis (SDA). Finally, we developed two methane emissions reduction scenarios based on an analysis of key mitigation pathways. We formulated and solved an optimization model to identify cost-effective, coordinated strategies across countries and sectors that can achieve the goals of the Global Methane Pledge by 2030 using feasible technologies at minimum cost.
(3) The data used
The data utilized here come from widely-used databases â€“ the Inter-Country Input-Output (ICIO) Tables from OECD and emissions from EDGAR GHG. We constructed a correspondence for embedded methane emissions from sector i in region r to sector j in region s and form environmental ICIO (EICIO) tables across 76 economies and 14 industries. These sources provide comprehensive and reliable information for conducting our analysis and generate insights into the complex interplay of economic activities, trade networks, and their embedded methane emissions.
(4) The novelty of the research
Unlike previous work, we identified the key pathways of the flow of embodied methane emissions resulting from global production and consumption activities, which was ever a major obstacle in international collaboration to mitigate climate change. These pathways, just 0.3% of 1,132,096 total linkages, accounted for around 60% of global methane emissions. It's a relatively systematic and sector-resolved quantitative analysis on global methane emissions, taking into account the inter-industry correlations. Furthermore, we found the driving factors for DOE and IME changes at each key linkage. Our analysis revealed that emission intensity, per capita GDP, and technical coefficients significantly yet variably influenced these pathways' emissions. We estimated the DOE and IME reduction volume of each key linkage with applicable technologies, providing a potential way to realize the Global Methane Pledge in 2030 at the lowest cost. We presented specific linkages through which global methane emissions could be reduced by 30.7% from 2020 levels by 2030, with the lowest cost estimated at US$20.6 billion. Finally, we discussed how our results can be integrated into existing climate policies and initiatives, forming broader and coordinated efforts to hit the Global Methane Pledge.

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