Realizing the Global Methane Pledge by 2030 via Key Pathways in Inter-country Production and Consumption Networks

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(1) The research question.
Methane emissions embedded in global production and consumption follow complex, often obscured pathways, offering significant mitigation opportunities and posing substantial research challenges.

(2) The method used.
We applied input-output analysis, complex network analysis, and a double filtering method (DFM), developed an environmental DFM (EDFM) to identify the network of linkages among leading embedded methane-emitting sectors within EICIO tables annually from 2000 to 2020, defining these as key pathways for embedded methane emissions. We distinguished the emissions into those of embedded in domestic intermediate input (DOE) and imported intermediate inputs (IME). We analyzed network characteristics of the key pathways annually and in four phases, and assessed sources of changes in their embedded methane emissions with structure decomposition analysis (SDA) method. Then we made scenario analysis and found practical ways with the lowest cost to reduce methane emissions through the key pathways to achieve the Global Methane Pledge.

(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 2024 GHG published by the IEA. We constructed a correspondence for methane emissions from sector i in region r to sector j in region s and form extended ICIO (EICIO) tables across 76 economies and 14 industries.

(4) The novelty of the research.
We identified the key pathways, just 0.3% of 1,132,096 total linkages, accounted for around 60% of global methane emissions. Our analysis revealed that emission intensity, per capita GDP, and technical coefficients significantly yet variably influenced these pathways' emissions. With scenario analysis, we further identified the specific reduction amounts that can be achieved by 2030 through the selected key linkages by reducing emission intensity with corresponding feasible technologies and estimated their costs US$20.63 billion totally, thereby fulfilling the 2030 Global Methane Reduction Commitment, reducing methane emissions by 30.7% from 2020 levels by 2030.
The emission reduction target under scenario 1 we designed is highly likely to be achieved, for the following reasons. Firstly, the emission intensity of each key linkage's input sector we predicted in 2030 is no less than the corresponding sectorâ€™s smallest emission intensity value among all economies in the EICIO tables in 2020, such as the lowest emission intensity of primary energy sector, agriculture sector and waste sector in 2020 were 0.0003 in Costa Rica, 0.0010 in Singapore, and 0.0001 in Japan, respectively. This indicates that the predicted emission intensity of key linkages in scenario 1 is attainable. Secondly, in scenario 1, the technologies'TA (technical applicability) that we matched to each key linkage is bigger than or equals to 0.7, which means they have high technological feasibility on emission reduction effectiveness. Thirdly, our distinction between the two components DOE and IME facilitates the implementation of emission reduction measures. The technical emission reduction measures for DOE are primarily implemented within the country's own borders, while those for IME are mainly executed in the exporting countries and national cooperations. Fourthly, our results provided feasible technologies for each key linkage with the lowest cost in certain countries and sectors to achieve the Global Methane Plague by 2030, and

incurring either positive or negative costs. This is a practical reference for the financial and technological investments in international cooperation on global methane emissions reduction.
This study, grounded in available scientific data and rigorous analysis, provided a practical strategy for effective and actionable plans for international cooperation in realizing the Global Methane Pledge by 2030. This facilitates the identification of opportunities and challenges at a granular level, aiding nations and industries in the implementation of methane reduction plans and translating climate goals into tangible policy actions. Additionally, the analysis of the DOE and IME key pathways assists major emitting countries in setting methane reduction actions and targets within their upcoming Nationally Determined Contributions (NDCs). Thus, our study serves as a call to action for policymakers, industry stakeholders, the research community, NGOs and the general public to consider these findings and engage in concerted efforts to realize the Global Methane Pledge by 2030.