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# Unlocking Solutions: The Social Benefits of Reducing Methane Emissions from South Korea's Energy Imports

# Unlocking Solutions

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# I. Introduction: How Can South Korea Contribute to Global Methane Reduction Through Fossil Fuel Imports?

South Korea consumes large amounts of coal, oil, and gas for district heating and electricity, in addition to demand from industrial sectors such as steel and petrochemicals. Most of this fossil fuel demand is met through imports, making Korea the fifth-largest fossil fuel importer globally. In other words, for Korea to consume fossil fuels domestically, other countries must produce them— and through its steady consumption, South Korea plays a significant role in driving fossil fuel flows globally.

However, while Korea accounts for carbon dioxide and methane emissions from domestic fossil fuel use, it has largely overlooked methane released during production in exporting countries. This is a critical gap, given that methane is up to 80 times more potent than carbon dioxide in terms of global warming potential. It is also important to highlight that methane emissions from fossil fuel extraction and production are several times higher than emissions released during consumption. For example, while methane emissions from South Korea's domestic energy sector amounted to only about 5 million tonnes of $CO_2e$ in 2022, the methane emissions associated with production in exporting countries reached approximately 50 million tonnes of $CO_2e$—ten times higher.

As the climate crisis affects countries around the world, South Korea, as a major importer, has the potential to leverage its market position to drive methane reductions in producing countries.

## EU Methane Import Standards and Policy Opportunities for South Korea

A methane import standard is a policy tool that regulates methane emissions linked to imported fossil fuels. By targeting methane released during fuel production and transportation—often outside a country's borders—this tool can be particularly meaningful for countries like South Korea, which imports 98% of its fossil fuels. Last year, the European Union took the lead in adopting a policy to regulate methane emissions beyond its borders. As a signatory to the Global Methane Pledge, South Korea can consider similar measures.

The methane mitigation policy options proposed by Solutions for Our Climate and Carbon Limits can be broadly classified into four types:

1. **Information-based approach** – Requires exporters to monitor, report, and verify methane emissions associated with exported fuels.
2. **Prescriptive approach** – Mandates the use of specific methane reduction technologies or practices.
3. **Performance-based approach** – Sets an upper limit on methane emission intensity for imported fuels.
4. **Market-based approach** – Introduces a methane fee or tax to impose a cost on methane emissions.

These policies may have different impacts on different energy exporters, depending on the cost burden and mitigation potential. However, if major energy importers such as South Korea, China, Japan, and the EU adopt and coordinate these regulations together, they could have a significant impact on global methane reductions.

## II. What Are the Benefits of Importing Low-Methane Fossil Fuels?

Methane import standards are expected to generate both benefits and costs across various sectors. The potential global benefits that South Korea could gain from implementing such a policy are summarized below.

Table 1. Estimated Economic and Social Benefits of Methane Regulation on Fossil Fuel Imports

| Type of Benefit | Effect | Description |
|---|---|---|
| 1. Reduced climate damage due to GHG (methane) reduction | A. Direct abatement effect | • Methane has a global warming potential approximately 80 times greater than $CO_2$ over a 20-year period (IPCC, 2021). Its atmospheric lifetime is around 12 years, making short-term reductions highly effective.<br>• Regulating methane in imported energy reduces methane leakage from oil and gas production, mitigating climate change damages in the long term. |
| | B. Indirect mitigation effect | • Methane contributes to the formation of tropospheric ozone. Reducing methane also reduces ozone, creating additional benefits such as increased crop yields (UNEP, CCAC 2021). |
| 2. Contribution to climate goals from GHG (methane) reduction | A. Cost-effective reduction | • Methane reduction is a cost-effective climate strategy, contributing to the achievement of climate goals (2030 NDC, 2050 carbon neutrality, etc.) |
| | B. Acceleration of low-carbon energy transition | • Regulating the methane intensity of imported energy naturally encourages a shift to cleaner energy sources, accelerating the energy transition. |
| 3. Co-benefits | A. Improved air quality (WHO, 2021). | • Methane is an ozone precursor; reducing it helps lower smog levels.<br>• Prevention of respiratory diseases due to reduced emissions of harmful substances such as VOCs (volatile organic compounds). |
| | B. Public health benefits | • Can reduce air pollution-related premature mortality by up to 10%. |
| 4. Enhanced international standing | A. Positioning as a climate change leader | • By becoming a leader in methane reduction, South Korea can increase its influence in international climate negotiations and raise its global profile.<br>• Increase national brand value through green leadership |
| | B. Fulfillment of the Global Methane Pledge | • Korea joined the Global Methane Pledge in 2021 (aiming to reduce methane emissions by 30% by 2030). Implementing concrete policies would strengthen its credibility on the global stage. |
| | C. Economic Benefits of Being a Fast-actor | • Early leadership in methane regulation can give Korea influence in setting technical and certification standards.<br>• Establishing systems for monitoring, reporting, and verification (MRV) opens opportunities for technology exports.<br>• Early mover advantage in the clean energy market. |

For options 2 (prescriptive approach) and 3 (performance-based approach), South Korea may not see significant direct benefits from these policies, as it produces little oil or gas domestically. These policies are primarily effective in reducing methane leakage in the transportation of fossil fuels, which may have limited direct effects because South Korea imports most of its fossil fuels. That said, there is a possibility that methane reductions achieved abroad could be recognized as part of Korea's own mitigation achievements.

As for option 4 (market-based approach), the benefits may not be immediately tangible (e.g., cost savings), but rather intangible (e.g., improved international image), making it difficult to calculate the exact value of this approach.

Therefore, this study focuses on Approach 1 (Information-based), particularly the direct benefits of reducing climate damages through methane mitigation, and aims to estimate the resulting domestic and global benefits.

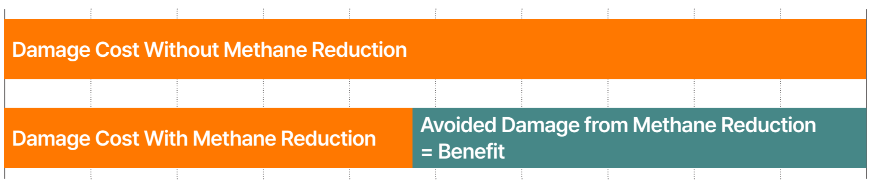
## III. Assumptions on the Economic and Social Benefits of Importing Low-Methane Fossil Fuels

Greenhouse gases (GHGs), including methane, accumulate in the atmosphere and cause the greenhouse effect. In terms of climate impact, these emissions have global consequences regardless of where they are released. In other words, since GHGs are global pollutants, the benefits of reducing them are shared worldwide. These benefits — or the avoided damages from climate change — may vary by region and over time. For example, areas more severely affected by climate change tend to experience greater benefits from emission reductions. Similarly, regions with faster rates of climate change and greater concentrations of socioeconomically vulnerable populations or assets are expected to see higher future benefits.

In the case of methane, its relatively short atmospheric lifetime — about 12 years — means that the climate damage it causes occurs over a shorter time frame. As a result, the benefits of reducing methane emissions can also be realized more quickly.

Reflecting these spatial and temporal dynamics, the academic community defines the Social Cost of Carbon (SCC) as the long-term economic damage caused by emitting one ton of greenhouse gases today. Accordingly, the benefits of emission reductions can be estimated by the extent to which they reduce this social cost. When applied to methane reduction, this can be illustrated as follows: even with maximum mitigation efforts, some methane emissions are inevitable and will incur damage costs. Thus, the benefits of methane reduction can be understood as the avoided damage costs — i.e., the difference between the costs of damage in a no-mitigation scenario and the costs incurred under a mitigation effort.

Figure 1. Relationship Between Damage Costs and Benefits




*Source: Author's illustration*

Starting in 2010, the Obama administration in the United States established an Interagency Working Group—comprising the White House, EPA, DOE, DOT, and other government agencies—to officially estimate and publish the Social Cost of Carbon (SCC). In the early stages, the social cost of greenhouse gases was estimated primarily based on carbon dioxide, which is why the term "Social Cost of Carbon" was used. However, since 2017, the group has incorporated scientific characteristics of various greenhouse gases—such as atmospheric circulation and lifetime—and has begun estimating the social cost of each substance individually, including SC-$CO_2$ (carbon dioxide), SC-$CH_4$ (methane), and SC-$N_2O$ (nitrous oxide).

Table 2. Global Social Cost of GHGs by Gas Type[1]

| | Social Cost of Carbon Dioxide (SC-CO2) Unit: USD / tonCO$_2$ (KRW 1,000 / tonCO2) | | | Social Cost of Methane (SC-CH4) Unit: USD / tonCH4 (KRW 1,000 / tonCH4) | | | Social Cost of Nitrous Oxide (SC-N2O) Unit: USD / tonN2O (KRW 1,000 / tonN2O) | | |
|---|---|---|---|---|---|---|---|---|---|
| Discount Rate | 2.50% | 2% | 1.50% | 2.50% | 2% | 1.50% | 2.50% | 2% | 1.50% |
| 2020 | **0.12** (142) | **0.19** (225) | **0.34** (403) | **1.30** (1,539) | **1.61** (1,894) | **2.31** (2,723) | **35.12** (41,442) | **54.19** (63,939) | **87.30** (103,013) |
| 2030 | **0.14** (166) | **0.23** (272) | **0.38** (450) | **1.91** (2,250) | **2.41** (2,842) | **3.21** (3,789) | **45.16** (53,283) | **66.23** (78,148) | **100.34** (118,406) |
| 2040 | **0.17** (201) | **0.27** (320) | **0.43** (509) | **2.71** (3,197) | **3.31** (3,907) | **4.21** (4,973) | **55.19** (65,123) | **79.27** (93,541) | **120.41** (142,087) |
| 2050 | **0.20** (237) | **0.31** (367) | **0.48** (568) | **3.51** (4,144) | **4.21** (4,973) | **5.32** (6,276) | **66.23** (78,148) | **93.32** (110,118) | **140.48** (165,768) |
| 2060 | **0.23** (272) | **0.35** (414) | **0.53** (628) | **4.31** (5,091) | **5.12** (6,039) | **6.32** (7,460) | **76.26** (89,989) | **110.38** (130,247) | **150.52** (177,609) |
| 2070 | **0.26** (308) | **0.38** (450) | **0.57** (675) | **5.02** (5,920) | **5.92** (6,986) | **7.23** (8,525) | **85.21** (100,645) | **120.41** (142,087) | **170.59** (201,290) |
| 2080 | **0.28** (332) | **0.41** (485) | **0.60** (710) | **5.82** (6,868) | **6.82** (8,052) | **8.23** (9,709) | **95.33** (112,486) | **130.45** (153,928) | **180.61** (213,131) |

*Source: EPA (2023)*

According to another study (Yoo Jonghyun et al., 2025), the present value of climate change damages incurred by South Korea accounts for approximately 0.9% of global climate change damage costs. Based on this proportion, when applied to the values in Table 2, the social cost of methane (SC-CH$_4$) specific to South Korea can be estimated as shown below. In this study, a 2% discount rate was applied for the annual social cost estimates.

1 All monetary values in this study are presented in U.S. dollars at 2020 constant prices. Where applicable, values have been converted to Korean won using the average 2020 exchange rate of KRW 1,180 per USD. The discount rate applied refers to the Ramsey formula and represents the short-term social discount rate.

Table 3. Social Cost of Methane in Korea

| | Social Cost of Methane in Korea (SC-CH4) Unit: USD / tonCH4 (KRW 1,000 / tonCH4) | | |
|---|---|---|---|
| Discount Rate | 2.50% | 2% | 1.50% |
| 2020 | **0.01** (13.9) | **0.01** (17.0) | **0.02** (24.5) |
| 2030 | **0.02** (20.3) | **0.02** (25.6) | **0.03** (34.1) |
| 2040 | **0.02** (28.8) | **0.03** (35.2) | **0.04** (44.8) |
| 2050 | **0.03** (37.3) | **0.04** (44.8) | **0.05** (56.5) |
| 2060 | **0.04** (45.8) | **0.05** (54.4) | **0.06** (67.1) |
| 2070 | **0.05** (53.3) | **0.05** (62.9) | **0.07** (76.7) |
| 2080 | **0.05** (61.8) | **0.06** (72.5) | **0.07** (87.4) |

As seen by comparing Tables 2 and 3, limiting the calculation to South Korea's domestic share of climate damages significantly reduces the estimated social cost. As a result, the estimated domestic benefit from methane reduction also appears relatively small. However, as noted in the introduction, this report focuses only on the climate damage reduction benefits from methane mitigation. Other types of benefits—such as cost savings from mitigation, co-benefits, diplomatic advantages, etc. — were not included in the calculation. Therefore, the actual benefits are likely to exceed the estimates presented in this study.

## IV. Estimating the Economic and Social Benefits of Importing Low-Methane Fuels

To assess the actual scale of benefits that a policy regulating methane emissions from imported oil and gas could deliver, we calculated the quantitative benefits of methane reduction following the steps below:

1. Methane emissions in producing countries linked to South Korea's coal, oil, and gas imports in 2023
2. Estimation of annual methane reduction potential
3. Analysis of the resulting quantitative benefits over time (global benefits and domestic benefits)

First, in 2023, methane emissions generated in producing countries to export coal, oil, and gas to South Korea amounted to approximately 46 million tons $CO_2e$.

Table 4. Annual Methane Emissions from Fossil Fuel Exporting Countries to South Korea (Unit: million tons $CO_2e$)

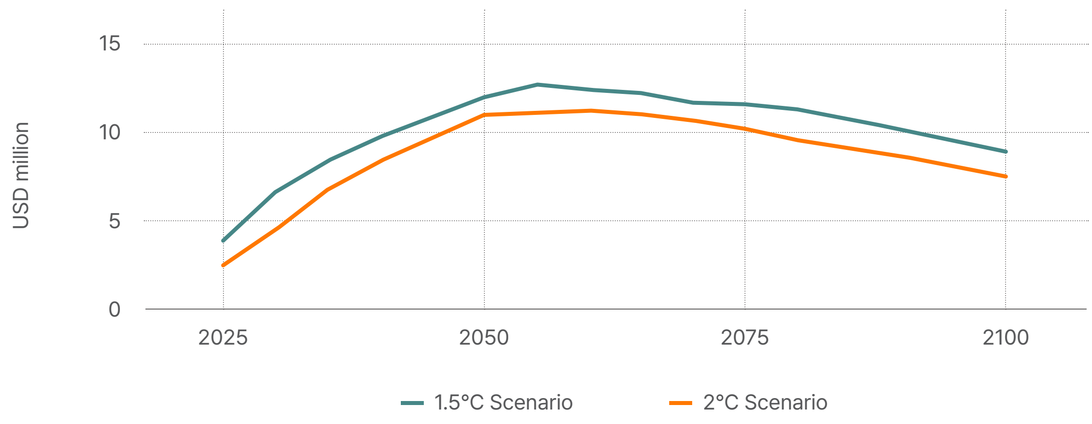
| Category | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|
| Natural Gas | 8.74 | 10.32 | 9.34 | 7.26 |
| Oil | 19.85 | 18.19 | 22.81 | 24.09 |
| Coal | 17 | 16.12 | 18.19 | 15.38 |
| Total | 46 | 44.63 | 50.35 | 46.72 |

*Source: SFOC estimates based on IEA Global Methane Tracker, Korea Energy Statistical Yearbook, KNOC Petronet, etc.*

Next, to estimate methane reduction potential over time, this study applied two reduction pathways based on the IPCC Sixth Assessment Report: the 1.5°C and 2°C global warming scenarios. For each pathway, we applied the corresponding social cost values from Table 2 to calculate the damage costs that would still occur despite strong methane mitigation efforts (see Figure 1). By subtracting these damage costs from a "no action" scenario, we estimated the resulting benefits—summarized in Figure 2[2].

2 The methodology used for this calculation can be found in the appendix of the report.

Figure 2. for Global benefits of methane reduction efforts in fossil fuel exporting countries




The analysis shows that if South Korea implements methane regulation for its coal, oil, and gas imports, the total global benefit could reach approximately USD 163 billion (KRW 200 trillion) by 2100 under the IPCC 1.5°C pathway. The benefit is projected to peak around 2055, indicating that faster methane reduction by exporting countries before 2050 could significantly increase the total benefit.

Under the less ambitious 2°C pathway, the estimated global benefit would be around USD 140 billion (KRW 160 trillion).

As for the benefits specific to South Korea, the total is estimated at approximately USD 1.5 billion (KRW 1.7 trillion) by 2100 under the 1.5°C scenario. These are tangible, direct benefits arising from avoided climate-related damages—such as natural disasters—due to methane reduction.

Table 5. Estimated Global and Domestic Benefits from Methane Reduction in Fossil Fuel Exporting Countries to Korea (Unit: USD billion (KRW trillion))

| Category | Methane Reduction Scenario | 2025-2050 | 2025-2100 |
|---|---|---|---|
| Global | 1.5°C | **51.7** (61.04) | **163.3** (192.78) |
| Global | 2.0°C | **42.9** (50.71) | **140.2** (165.73) |
| South Korea | 1.5°C | **0.46** (0.54) | **1.46** (1.73) |
| South Korea | 2.0°C | **0.38** (0.45) | **1.19** (1.40) |

## V. Conclusion: Implications and Limitations of the Benefits of Importing Low-Methane Fossil Fuels

To reduce methane emissions by 30% by 2030 under the Global Methane Pledge and achieve carbon neutrality by 2050, South Korea must also address methane emissions from fossil fuel production. In this context, demanding methane reductions from fossil fuel exporting countries can help reduce global climate-related damages—estimated at hundreds of billions of USD—beyond South Korea's domestic social costs. This study shows that methane reduction is not merely a socioeconomic burden but can lead to measurable benefits, which could strengthen both the justification for and acceptance of future methane reduction policies.

The policy approaches for introducing low-methane fossil fuels proposed by Solutions for Our Climate and Carbon Limits could help incentivize voluntary methane reductions by fossil fuel producers. From transparent disclosure of methane emissions in importing countries like the EU to methane intensity standards, such policies not only enhance corporate value for energy companies but also contribute meaningfully to reducing GHGs. For instance, Malaysia's national oil company Petronas has set a target to cut methane emissions by 50% by 2030 compared to 2019 levels. Beyond Malaysia, fossil fuel producers in countries like the United States are also exploring technologies and strategies for methane measurement and reduction.

Among the four methane import standard policy approaches presented earlier, South Korea should begin with the information-based approach. This means introducing an MRV (Monitoring, Reporting, and Verification) framework, similar to the EU's, that requires fossil fuel exporters to report their methane emissions.

Of course, the timing and stages of implementing a methane reduction policy on fossil fuel imports must be carefully considered. As seen during the introduction of South Korea's Emissions Trading Scheme, it is crucial to provide industries with sufficient time to prepare before the policy takes effect. This study aims to analyze the effectiveness of such a policy by focusing on the reduction of climate damage, from a cost-benefit perspective. In doing so, it can help inform appropriate timelines and implementation stages for future policy design.

While past carbon neutrality policy designs have considered the perspectives of various stakeholders—such as industry and local communities—there has been relatively little research examining the social cost benefits of GHG reductions. This study on the social benefits of methane reduction from fossil fuel imports can serve as an objective basis for understanding the need for such policies. At the same time, the macroeconomic effects highlighted in this study may differ significantly at the micro level depending on the industry, company, or region. Potential conflicts with other policy goals (e.g., support for small and medium enterprises or regional economic revitalization) must also be considered. Therefore, it is essential to minimize unintended negative side effects by discussing specific policy details and implementation tools (e.g., regulations, taxes, or tariffs) with a diverse set of stakeholders. These considerations go beyond the scope of this report and should be addressed in future research.

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# Appendix:
# Methodology for Estimating the Benefits of a Low-Methane Fossil Fuel Policy

The Social Cost of Carbon (SCC) is a theoretical concept that represents the long-term socioeconomic damages caused by greenhouse gas (GHG) emissions. These damages include natural disasters, reduced economic growth, public health impacts, agricultural productivity losses, changes in energy demand and supply, and political instability[3]. The social cost of GHGs varies depending on the timing of emissions—generally, emissions released further in the future are expected to incur higher social costs, as atmospheric accumulation increases and climate change worsens over time. In other words, GHG emissions under more severe climate conditions are projected to cause greater socioeconomic damages.

Based on this theoretical framework, the marginal global benefit of regulating methane emissions from imported fossil fuels in Korea can be estimated using the following formula:

$$B_t = SC\_CH4_t * \alpha_t$$

where:

- $SC\_CH4_t$ - Social cost of methane in year $t$ (from Table 2);
- $\alpha_t$ - Estimated methane reduction in year $t$ resulting from the regulation of methane emissions from imported oil and gas;
- $B_t$ - Benefits generated in year $t$. Since the regulation of methane emissions from imported oil and gas is not implemented in a single year but over multiple years, the methane reduction amount ($\alpha_t$) varies by year, and accordingly, the benefit ($B_t$) also occurs on an annual basis. In other words, the benefits are generated over multiple years.

If the effects of this regulation are to be evaluated (or projected) at the present time, all future benefits can be converted into present value using the discount rate mentioned above.

$$PVB_{2020} = \sum_t \frac{B_t}{(1+r)^{t-2020}}$$

For example, in the formula above, $PVB_{2020}$ represents the present value of all benefits generated over multiple years, calculated as of the year 2020—that is, it reflects the overall impact of the policy in today's terms. The variable $r$ denotes the discount rate.

However, the social cost values used in this analysis reflect the global impact of GHG emissions, regardless of who is responsible for the reductions. When applied to Korea's methane regulation on imported oil and gas, the resulting benefits represent global gains, not just those specific to Korea.

3 This can be expressed as the following formula: . In this equation, represents the total socioeconomic damage caused in year by the emission of one ton of greenhouse gas in year $t$. $r$ denotes the discount rate.

This raises an important limitation. While the costs of implementing the policy—such as monitoring or regulatory infrastructure—are borne domestically, the benefits are distributed globally, including to those who do not share in the cost. This mismatch between who bears the cost and who receives the benefit can reduce both the feasibility and political acceptability of the policy. It also reflects the well-documented free-rider problem observed in international climate governance, where some countries benefit from the mitigation efforts of others without contributing themselves.

$$SC\_CH4_t = \sum_n SC\_CH4_{t,n}$$

Under this framework, country-specific social costs can be estimated in several ways. A simple method is to use the proportion of global climate damages attributable to each country as a weighting factor (Nordhaus, 2016). Here, damage refers to the present value of climate impacts, reflecting the applied discount rate ($r$).

$$SC\_CH4_{t,n} = SC\_CH4_t * \frac{PVD_{t,n}}{\sum_n PVD_{t,n}}$$

In this formula:

$PVD_{t,n}$ is the present value of the expected climate change damage costs for country $n$ in year $t$. Ultimately, the assumption is that the share of $SC\_CH4_{t,n}$ in an individual country in the global $SC\_CH4_t$ is equal to the share of $PVD_{t,n}$ in the global $PVD_t$. ($\frac{SC\_CH4_{t,n}}{\sum_n SC\_CH4_{t,n}} = \frac{PVD_{t,n}}{\sum_n PVD_{t,n}}$).

Accordingly, the domestic benefit for Korea resulting from the methane import regulation policy can be calculated as:

$$B_{t,n} = SC\_CH4_{t,n} * \alpha_t$$

Here, $SC\_CH4_{t,n}$ refers to Korea's social cost of methane (from Table 3), and $\alpha_t$ is the same estimated methane reduction as defined earlier.

Finally, the total domestic benefit in present value terms is calculated using the following formula:

$$PVB_{2020,n} = \sum_t \frac{B_{t,n}}{(1+r)^{t-2020}}$$

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Solutions for Our Climate (SFOC) is an independent policy research and advocacy group that aims to make emissions trajectories across Asia compatible with the Paris Agreement 1.5°C warming target.