April 2023

Green Public Procurement of Steel in India, Japan, and South Korea

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Global Efficiency Intelligence

Acknowledgements

This report was made possible with support from the Climate Catalyst and the Rockefeller Foundation. The authors would like to thank Naomi Ages, Reecha Upadhyay, Sakshi Balani, Suresh Kotla, Emma Richardson, Madeleine Hill, and Tierney Smith of Climate Catalyst, Rachel Eun Ko of the NEXT Group in South Korea, Taro Sonobe of Kyoto University, Roger Smith of Steel Watch, Dinah Shi and Adam Sibal of Global Efficiency Intelligence for their valuable input to this study and/or their insightful comments on the earlier version of this document.

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Recommended citation: Hasanbeigi, A., Bhadbhade, N. 2023. Green Public Procurement of Steel in India, Japan, and South Korea. Global Efficiency Intelligence. Florida, United States.

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Executive Summary

The global steel industry accounts for around 7% of global greenhouse gas (GHG) emissions and 11% of global CO_2 emissions. Substantial cuts in energy demand and CO_2 emissions of the global steel industry will be needed by 2030 and thereafter for the world to reach the target of the Paris Climate Agreement: to limit global warming to “well below” 2 ℃.

Governments in India, Japan, and South Korea spend billions of dollars each year on public procurement: the purchase of goods and services by public authorities such as government departments. This large-scale purchasing power gives governments leverage in driving markets toward the development of low-carbon products such as steel used in construction projects.

Green public procurement (GPP) is a policy instrument where public entities seek to procure goods with a reduced environmental impact throughout their lifecycle relative to similar goods that provide the same function. GPP adoption is increasing around the world as national governments, sub-national governments, and multilateral entities develop policies to reduce their carbon footprints and create new low-carbon markets.

This report focuses on three case studies of green public procurement of steel in India, Japan, and South Korea. India, Japan, and South Korea are the 2nd, 3rd, and 6th largest steel-producing countries, respectively. These three countries are among the nations with some of the highest CO_2 emissions intensity for their steel industry. This is mainly driven by low share of scrap-based electric arc furnace (EAF) steel production in these countries.

Total steel consumption in Japan and South Korea has remained almost flat in the past decade, while the total steel consumption in India has increased by 63% between 2010 and 2021. It is estimated that steel consumption in India could increase by over four times to around 500 million tonnes (Mt) by 2050. Government-funded construction and infrastructure projects accounted for around 27%, 13%, and 11% of total steel demand in India, Japan, and South Korea in 2019, respectively. The government in these countries can use this purchasing power to stimulate demand for green steel products, especially in India where the share of public procurement of steel is higher.

We estimated the CO_2 emissions associated with steel used in public construction projects and the potential impact of a GPP policy to reduce those emissions. Public procurement of steel in India, Japan, and South Korea accounted for approximately 55 Mt CO_2, 15 Mt CO_2, and 10 Mt CO_2 emissions in 2019, respectively. Figure ES1 shows the annual CO_2 emissions reduction potential resulting from GPP of steel in these three countries.

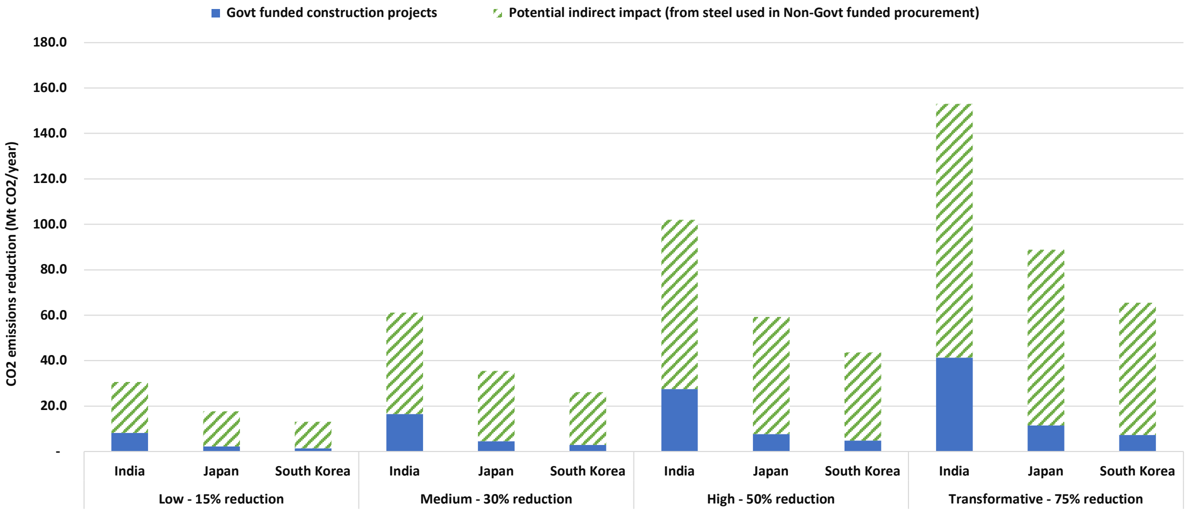

Figure ES1. Annual CO_2 emissions reduction potential resulted from GPP of steel in India, Japan, and South Korea

Note: Potential indirect impact assumes that changes in steel plants to reduce CO_2 emissions would impact the CO_2 intensity of all steel products produced and sold, even to non-government-funded projects.

While GPP has political support in these three countries, the pace of implementation could be improved. Japan and South Korea already have well-established GPP programs, but they do not include carbon criteria for steel products. India, however, is further behind and needs to further develop and deploy a coherent national GPP policy which also includes carbon criteria for steel products. Some of the challenges include consistent emissions reporting standards, establishing feasible quantitative limits on embodied carbon, decentralized procurement, carbon leakage.

Applying learnings from international best practices, we make the following recommendations for a GPP policy for steel in India, Japan, and South Korea:

- Accelerate the creation of the life cycle emissions inventory. This is a crucial step to enable reliable reporting of emissions data and the use of environmental impact in bid evaluation.
- The central government should examine international best practices and evaluate different models to promote or ensure the uptake of GPP at the sub-national level, including creating a mandatory federal backstop program similar to carbon pricing; developing robust national GPP program; and encouraging states/provinces and municipalities to adopt GPP through funds or incentives aimed to top-up spending on infrastructure investments that use green steel products.
- National GPP policy should move quickly to prevent fragmented GPP policies across provinces/states and municipalities. It is easier to build a harmonized framework now than in a few years when more sub-national governments will have their own GPP programs.
- Targets should use a two-tiered approach to promote innovation while maintaining feasibility. Targets should be performance-based, preferring whole-project over product-level analysis where possible. Standards should be adjusted at regular intervals to reflect changes in technology to incentivize innovation continually.

- Build a national team to help national and sub-national agencies implement green steel procurement. This team should build expertise on embodied carbon, lifecycle analysis, and tender creation, publish online resources, and act as consultants to public agencies.
- Invest in tools and capacity-building programs that can be used by sub-national governments and private entities that have low administrative capacity. Many provinces/states and cities with smaller bureaucracies do not have the time and resources to invest in training for GPP procurement. This, paired with the significant amount of procurement that happens at the sub-national level, underscores the importance of the national GPP program investing in tools that auto mate and simplify the implementation of the GPP policy.
- Build out a portfolio of policies that support industrial decarbonization. A carbon border adjustment mechanism (CBAM) can protect green steel manufacturers from competitors whose prices do not reflect negative environmental externalities. Carbon contracts-for-differences (CCfD) can remove uncertainty over future carbon prices. With GPP creating a demand signal for green steel products, loans and grants for manufacturers can close the loop by helping the supply side pay upfront costs for retrofitting and retraining.

GPP can catalyze significant carbon emissions reductions in the steel industry by acting as a signal of durable demand. This complements ongoing industrial decarbonization policies in India, Japan, and South Korea by demonstrating demand for the growing supply of green steel. Together, these policies can make the steel industry in these countries more globally competitive in the growing market of green steel products. This is especially important and timely as other jurisdictions such as the European Union and U.S. adopt and strengthen their green public procurement policies.

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1 Introduction

The global steel industry emitted around 3.6 billion tons of carbon dioxide (CO_2) in 2019. This accounts for around 7% of global greenhouse gas (GHG) emissions and 11% of global CO_2 emissions. Substantial cuts in energy demand and CO_2 emissions of the global steel industry will be needed by 2030 and thereafter for the world to reach the target of the Paris Climate Agreement: to limit global warming to "well below" 2 ℃. India, Japan, and South Korea are the 2^{nd}, 3^{rd}, and 6^{th} largest steel-production countries (Worldsteel 2022).

The products that governments procure for large infrastructure projects such as roads, buildings, and railways account for a large percentage of CO_2 emissions. These projects heavily use construction materials such as steel. When governments leverage their large-scale purchasing power by buying steel with lower CO_2 emissions intensity for their construction projects, they help drive markets towards sustainability, reduce the emissions footprint of their constructions, and create new markets for innovative green steel products. Green public procurement (GPP) is a policy mechanism that can facilitate this change.

This report focuses on GPP of steel products in India, Japan, and South Korea. India, Japan, and South Korea ranked 2^{nd}, 3^{rd}, and 6^{th} steel producing countries in 2021, respectively. The transition to net-zero by 2050 is challenging for the steel industry. This means that conventional energy efficiency and fuel-switching measures will not be enough to produce net-zero steel. Technology shift and investment in near-zero steel production technologies such as green hydrogen direct reduced iron (H_2-DRI) production are needed to move the steel industry towards the net-zero target.

The steel industry is relevant to public agencies since steel is heavily used in the construction of roads, buildings, and other public infrastructure. By putting limits on the embodied carbon of steel and granting incentives to projects with low carbon footprints, the government can catalyze the growth of green steel production.

This report investigates the scale of public procurement of steel products in India, Japan, and South Korea to evaluate the potential impact of a GPP policy on greenhouse gas (GHG) emissions from the steel industry. We also analyzed the state of the steel industry in these three countries and the CO_2 emissions intensity of steel production by both primary and secondary steel production routes in these countries and compared them with other major steel-producing countries. We reviewed existing national and sub-national policies related to the decarbonization of the steel industry in these three countries. We identify common challenges to GPP implementation for steel, as well as challenges unique to these countries. We close by surveying international best practices and making recommendations.

2 Steel production, consumption, and trade

2.1. Steel production and consumption

World steel production has more than doubled between 2000 and 2021. China is the largest steel-producing country and accounted for around 53% of global steel production in 2021. India, Japan, and South Korea are the 2nd, 3rd, and 6th largest steel-production countries and accounted for around 6%, 5%, and 4% of global steel production in 2021 (Worldsteel 2022) (Figure 1). In 2021, the top six steel-producing countries accounted for 76% of world steel production (Worldsteel 2022).

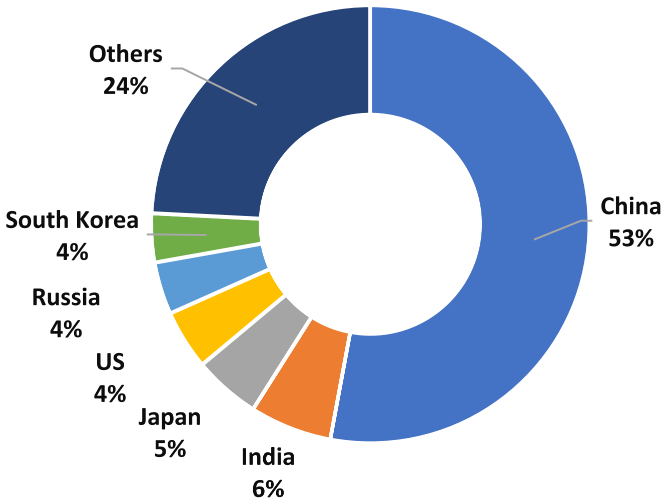


Figure 1. Share of crude steel production in top steel-producing countries in 2021 (Worldsteel 2022)

While the crude steel production in Japan and Korea has been relatively flat, with a slightly decreasing trend in Japan in the past decade, the crude steel production in India has increased substantially between 2010 and 2021 (Figure 2) and is expected to increase in the coming years and decades. There was sudden decline in crude steel production in 2020, which was the result of the COVID-19 pandemic.

Steel can be produced in a basic oxygen furnace (BOF) or electric arc furnace (EAF). The EAF steel production has substantially lower energy and carbon intensity compared to that of BOF steelmaking, especially when steel scrap is used as the feedstock to EAFs. Figure 3 shows the share of EAF steelmaking from total crude steel production in India, Japan, and South Korea since 2010. The share of EAF steelmaking in India has been around 55% for most of the last decade. However, it should be noted that a high amount of coal-based, highly carbon-intensive direct reduced iron (DRI) is used in EAFs in India, resulting in a significantly higher energy and CO_2 emissions intensity for the steel produced by EAFs in India as opposed to scrap-based EAF steel which has a substantially lower CO_2 emissions intensity.

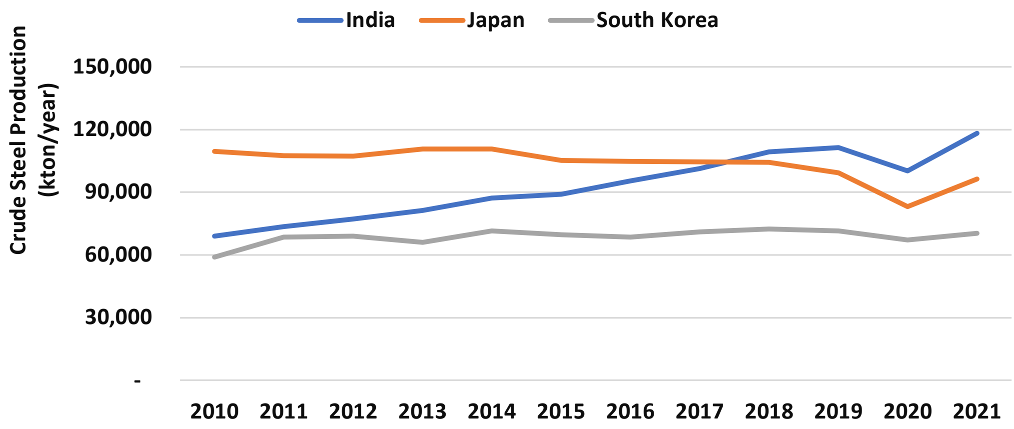


Figure 2. Crude steel production in India, Japan, and South Korea in 2010-2021 (Worldsteel 2021, 2022)

The share of EAF steelmaking in Japan has been under 25% for the last decade. This results in the higher CO_2 emissions intensity of the overall steel production in Japan. The share of EAF steelmaking in South Korea has decreased from 42% in 2010 to 33% in 2021 (Figure 3). This is due to an increase in BF-BOF production capacity in South Korea during this period (Worldsteel 2021).

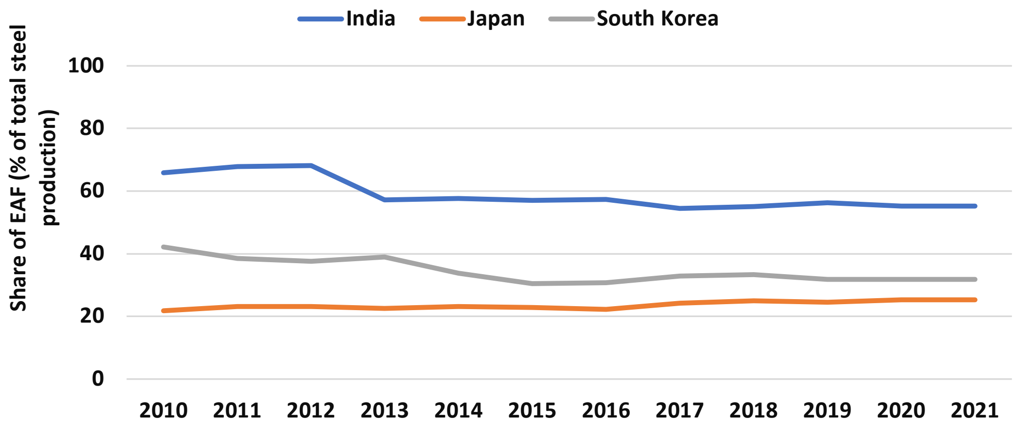


Figure 3. Share of EAF steelmaking from total crude steel production in India, Japan, and South Korea in 2010-2021 (Worldsteel 2021, 2022)

Total steel consumption in Japan and South Korea has remained almost flat in the past decade, while the total steel consumption in India has increased by 63% between 2010 and 2021 (Figure 4). It is estimated that steel consumption in India could increase by over four times to around 500 million tonnes (Mt) by 2050 (Hall et al. 2022).

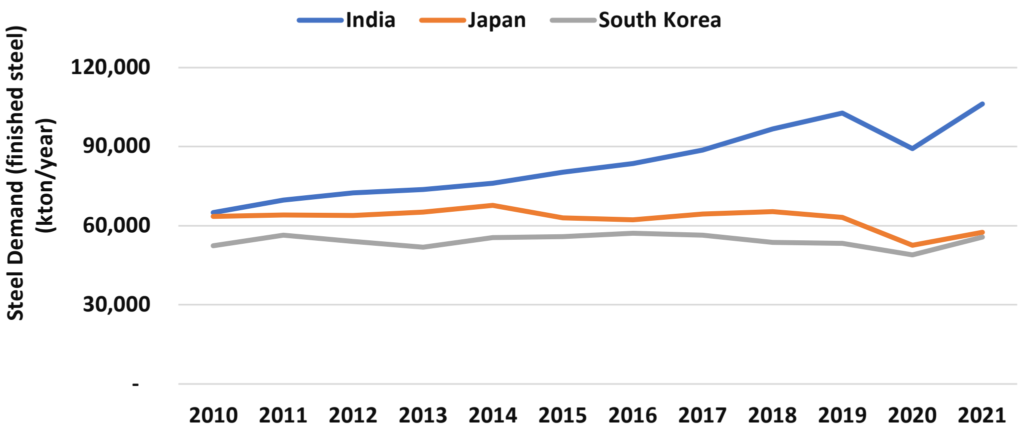


Figure 4. Steel consumption (finished steel products) in India, Japan, and South Korea in 2010-2021 (Worldsteel 2021, 2022)

2.2. Steel trade

Figure 5 shows the import of semi-finished and finished steel products in India, Japan, and South Korea. While the steel import in Japan and India was at the relatively same level, with a short-term increase in India during 2013-2015, the steel import in South Korea decreased substantially during 2010-2019. Figure 6 shows the share of steel imports from total steel consumption in India, Japan, and South Korea in the same period. The steel imports account for around 10% of total steel used in India and Japan, but have a much higher share (31%) in South Korea.

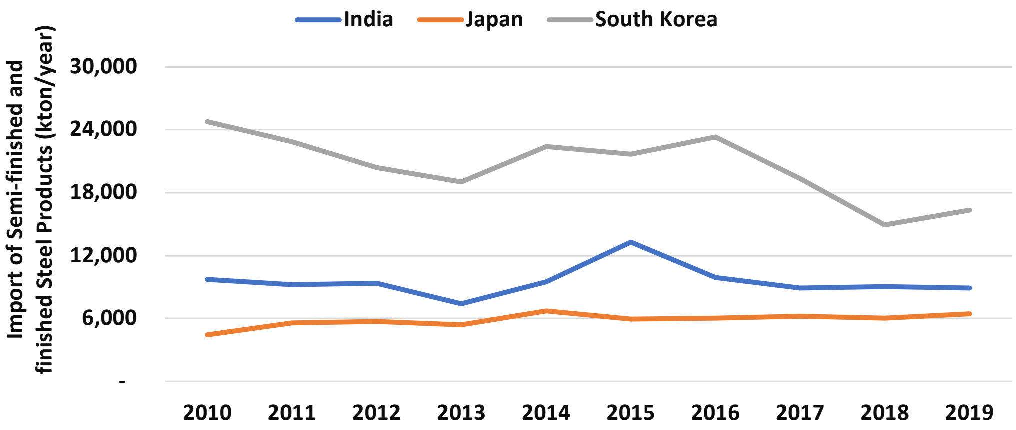


Figure 5. Import of semi-finished and finished steel products in India, Japan, and South Korea in 2010-2019 (Worldsteel 2021)

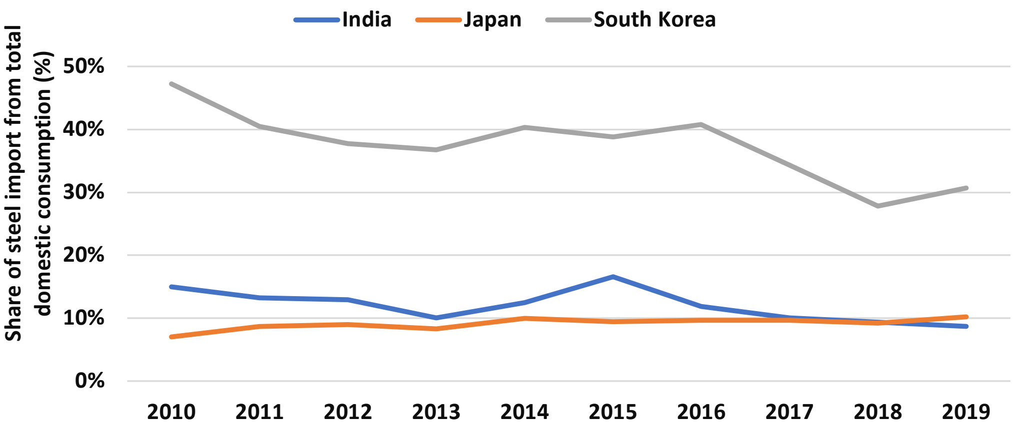


Figure 6. Share of steel import from total steel consumption in India, Japan, and South Korea in 2010-2019 (Worldsteel 2021)

The export of semi-finished and finished steel products was relatively flat in India and South Korea, but the export has dropped in Japan since 2016 (Figure 7). Figure 8 shows the share of steel export from total steel production in India, Japan, and South Korea. It is clear that steel export accounted for a small share of total steel production in India (12%) in 2019, while this share was much higher in Japan (33%) and South Korea (42%). Therefore, the export markets have much more influence on the steel industry in Japan and South Korea than in India.

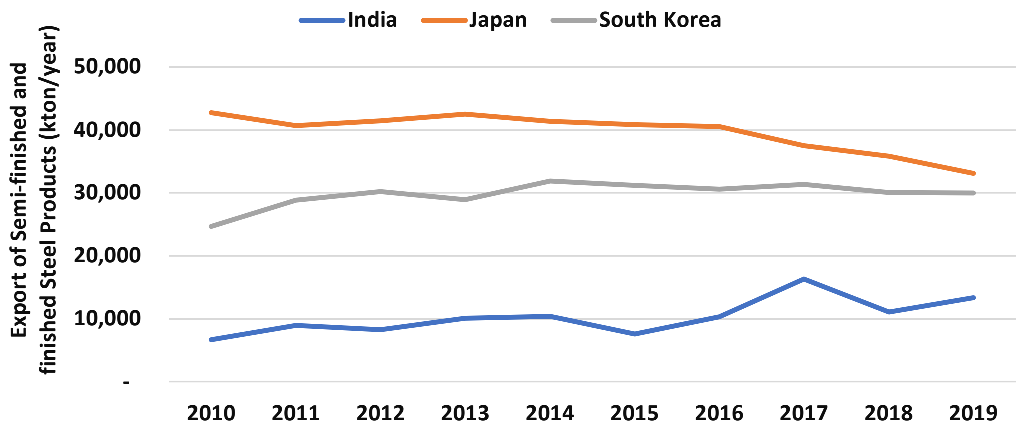


Figure 7. Export of semi-finished and finished steel products in India, Japan, and South Korea in 2010-2019 (Worldsteel 2021)

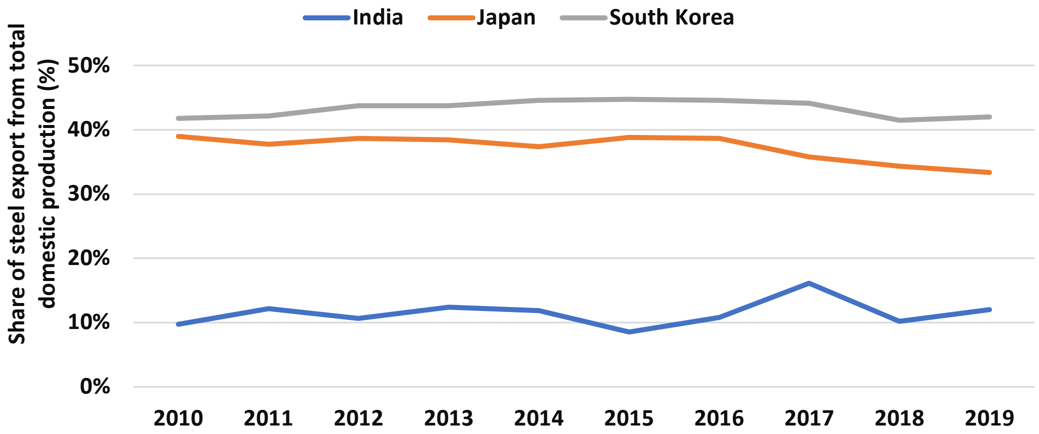


Figure 8. Share of steel export from total steel production in India, Japan, and South Korea in 2010-2019 (Worldsteel 2021)

3 The CO_2 emissions intensity of the steel industry in India, Japan, and South Korea

International benchmarking of CO_2 emissions intensity can provide a comparison point against which a company or industry's performance can be measured to that of the same type of company or industry in other countries. Benchmarking can also be used for assessing the emissions reduction potential that could be achieved by the implementation of CO_2 reduction measures. Also, at a national level, policymakers can use benchmarking to prioritize decarbonization options and to design policies to reduce CO_2 emissions.

Figure 9 below shows the ranking of the CO_2 emissions intensity of the steel industry in major steel-producing countries. India, Japan, and South Korea are among the nations with some of the highest CO_2 emissions intensity for their steel industry.

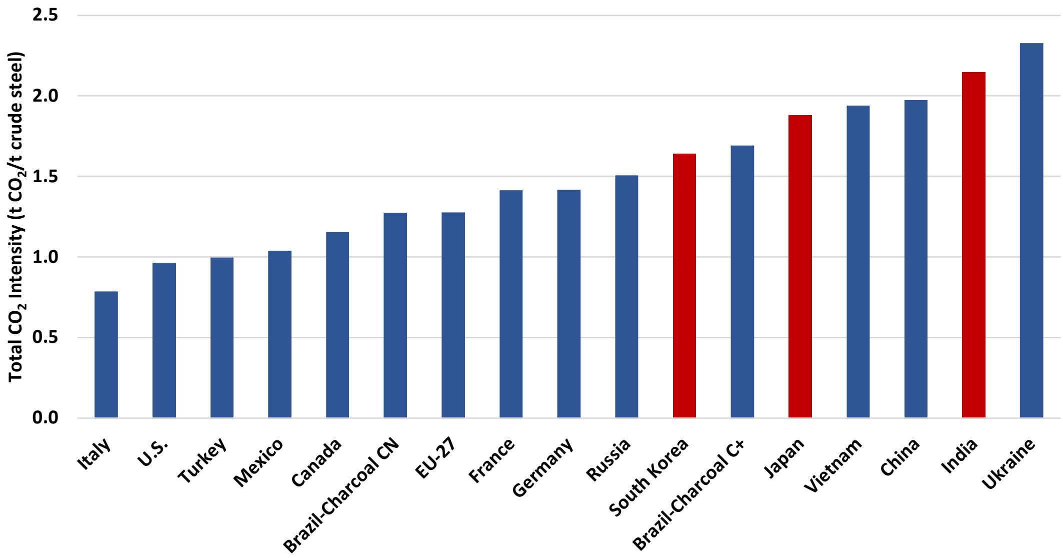


Figure 9. Total CO_2 emissions intensity of the steel industry in 2019 (Hasanbeigi 2022)

Note: Brazil-Charcoal CN refers to when charcoal is considered carbon neutral. Brazil-Charcoal C+ refers to when charcoal is not considered carbon neutral because of questions and concerns regarding the sustainability of biomass used in the steel industry in Brazil.

Italy, the U.S., and Turkey have the lowest CO_2 emissions intensity. This is primarily because of a significantly high share of electric arc furnace (EAF) steel production in total steel production in these countries (Figure 10). EAF is a secondary steel production process that primarily uses steel scrap and therefore uses less energy to produce a tonne of steel compared to primary steelmaking using blast furnace-basic oxygen furnace (BF-BOF). In other words, a higher share of scrap-based EAF production helps reduce the overall CO_2 emissions intensity of the steel industry in a country. It should be noted that EAF can also use direct reduced iron (DRI) or even pig iron (which is produced by blast furnaces) which are energy and carbon-intensive feedstock to EAF. In some countries like India, a high amount of DRI is used in EAFs, and in China, a large amount of pig iron is used in EAFs, both resulting in significantly higher energy and emissions intensity for the steel produced by EAFs in those countries. Other factors also impact the energy and CO_2 emissions intensity of the steel industry, as discussed in Hasanbeigi (2022).

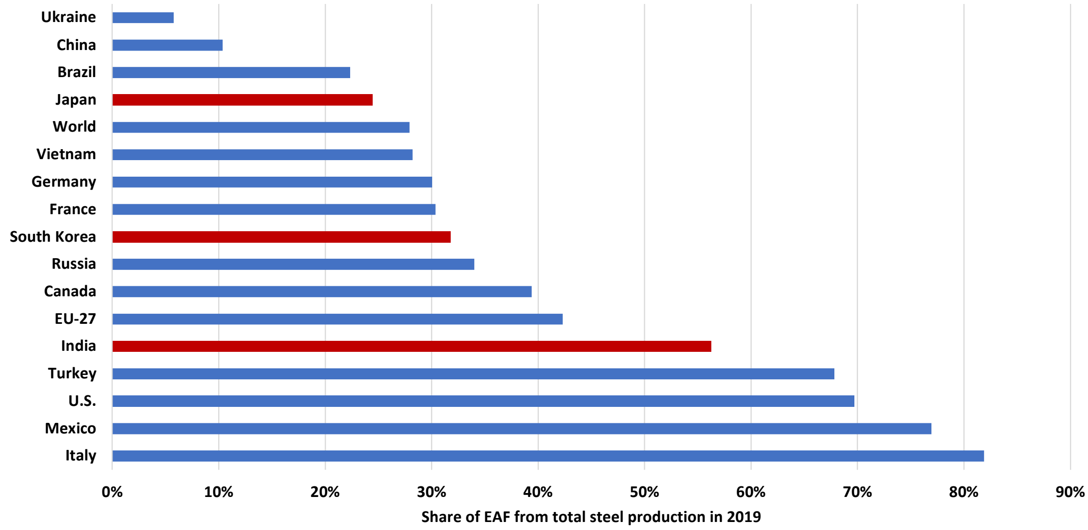


Figure 10. The share of EAF from total steel production in 2019 (Hasanbeigi 2022)

On the other hand, Ukraine, India, and China have the highest CO_2 emissions intensity of the steel industry among the countries studied. Ukraine, China, and Brazil also have the lowest share of EAF steel production. While India's steel industry has a high share of EAF steel production (56% in 2019), its CO_2 emissions intensity is relatively high. This is mainly because, unlike in many other countries, a substantial amount of DRI is used as the feedstock for EAFs in India (around 50% of total EAF feedstock). Unlike recycled steel scrap, DRI is produced from iron ore using the direct reduction process, which is an energy- and carbon-intensive process. In addition, India is one of the few countries in the world that uses coal-based DRI technology instead of the natural gas-based DRI used in most other countries around the world. This contributes to higher energy intensity and CO_2 emissions for DRI-EAF steel produced in India.

Because BF-BOF and EAF steel production routes are quite different and thus their CO_2 emissions intensity are also significantly different from each other, it is also important to look at the steel production in each country for each production route, i.e., primary steelmaking by BF-BOF versus the secondary steelmaking by EAF.

Figure 11 shows the CO_2 intensity of BF-BOF steel production in major steel-producing countries in 2019 (Hasanbeigi, 2022). It is worth highlighting that even though China has the 3rd highest CO_2 intensity for its entire steel industry, its ranking improved for the CO_2 intensity for the BF-BOF steel production route. Although the very low share of EAF steel production in China results in a high total CO_2 intensity for its entire steel industry, more than 80% of the BF-BOF steel production capacity in China was built after the year 2000, with an average age of plants around 15 years. Many of these new plants are using more efficient production technology. In addition, in the past ten years, China has been aggressively shutting down old and inefficient steel plants. It is important that other countries, especially India also shut down really old and inefficient steel plants.

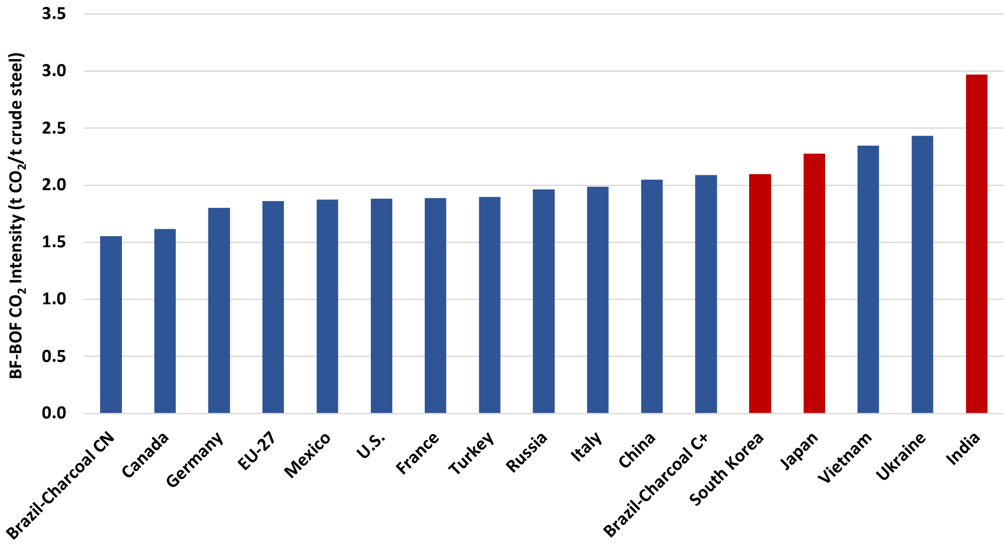


Figure 11. The CO_2 intensity of BF-BOF steel production in 2019 (Hasanbeigi 2022)

Note: Brazil-Charcoal CN refers to when charcoal is considered carbon neutral. Brazil-Charcoal C+ refers to when charcoal is not considered carbon neutral because of questions and concerns regarding the sustainability of biomass used in the steel industry in Brazil.

India has the highest CO_2 intensity of BF-BOF steel production mainly because of many old and inefficient BF-BOF plants still operating in India. It should be noted, however, that some of the newly built steel plants in India are among the world's most efficient.

Figure 12 shows the CO_2 intensity of EAF steel production in the major steel-producing countries (Hasanbeigi, 2022). Brazil and France have the lowest, and India and China have the highest CO_2 intensity of EAF steel production. A key reason why the CO_2 intensity of EAF steel production in India, China, and Mexico is significantly higher than that in other countries is the type of feedstock used in EAF in these countries. In most countries, steel scrap is the primary feedstock for EAF. In India and Mexico, however, a substantial amount of DRI (around 50% in India and 40% in Mexico) is used as feedstock in EAFs (Worldsteel 2021). In China, instead of DRI, a significant amount of pig iron (around 50% of EAF feedstock), which is produced via BF, is used as feedstock in EAFs. Both DRI and pig iron production are highly energy-intensive processes, which result in higher energy and CO_2 intensity of EAF steel production when used as feedstock in EAFs.

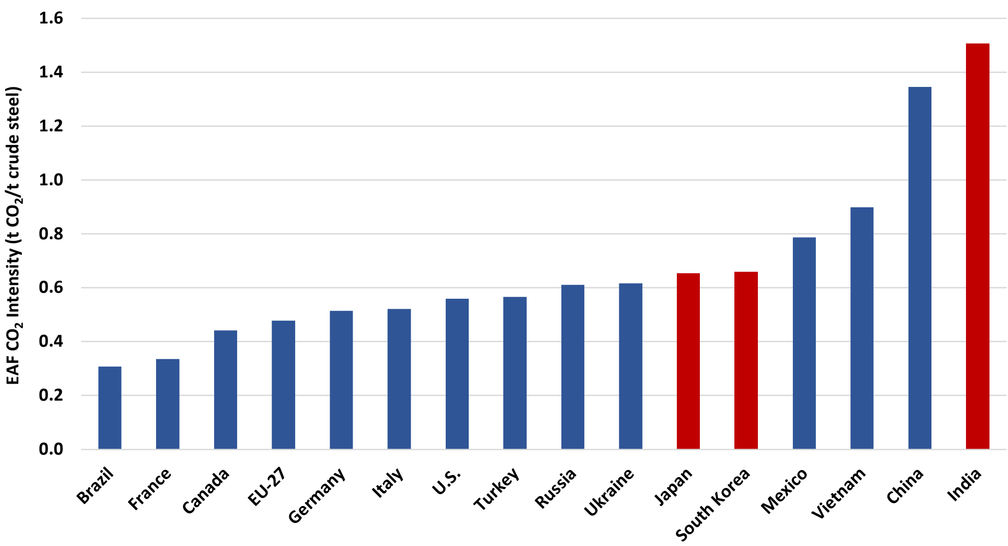


Figure 12. The CO_2 intensity of EAF steel production in 2019 (Hasanbeigi 2022)

Another important factor that influences the CO_2 intensity of EAF steel production is the electricity grid CO_2 emissions factor. France, Brazil, and Canada have the lowest electricity grid CO_2 emissions factors thanks to large nuclear (in France) and hydro (in Brazil and Canada) power generation. Vietnam's high CO_2 intensity of EAF steelmaking can be mainly attributed to its very high electricity grid CO_2 emissions factor (Figure 13). India, South Korea, and Japan all have high grid CO_2 emissions factors due to high share of coal and natural gas used in power generation in these countries.

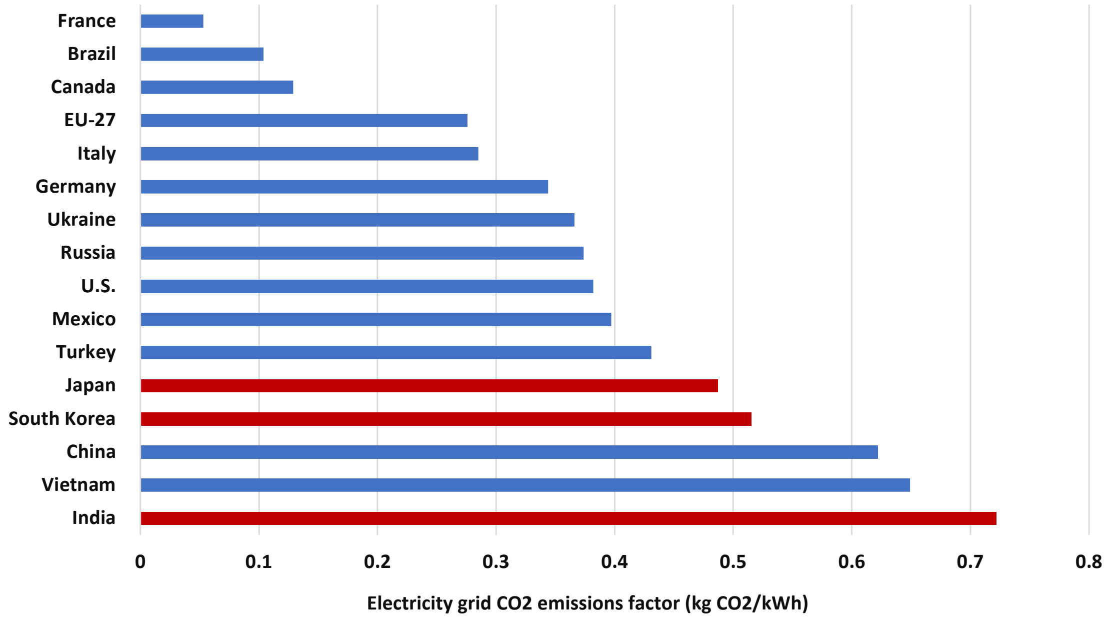
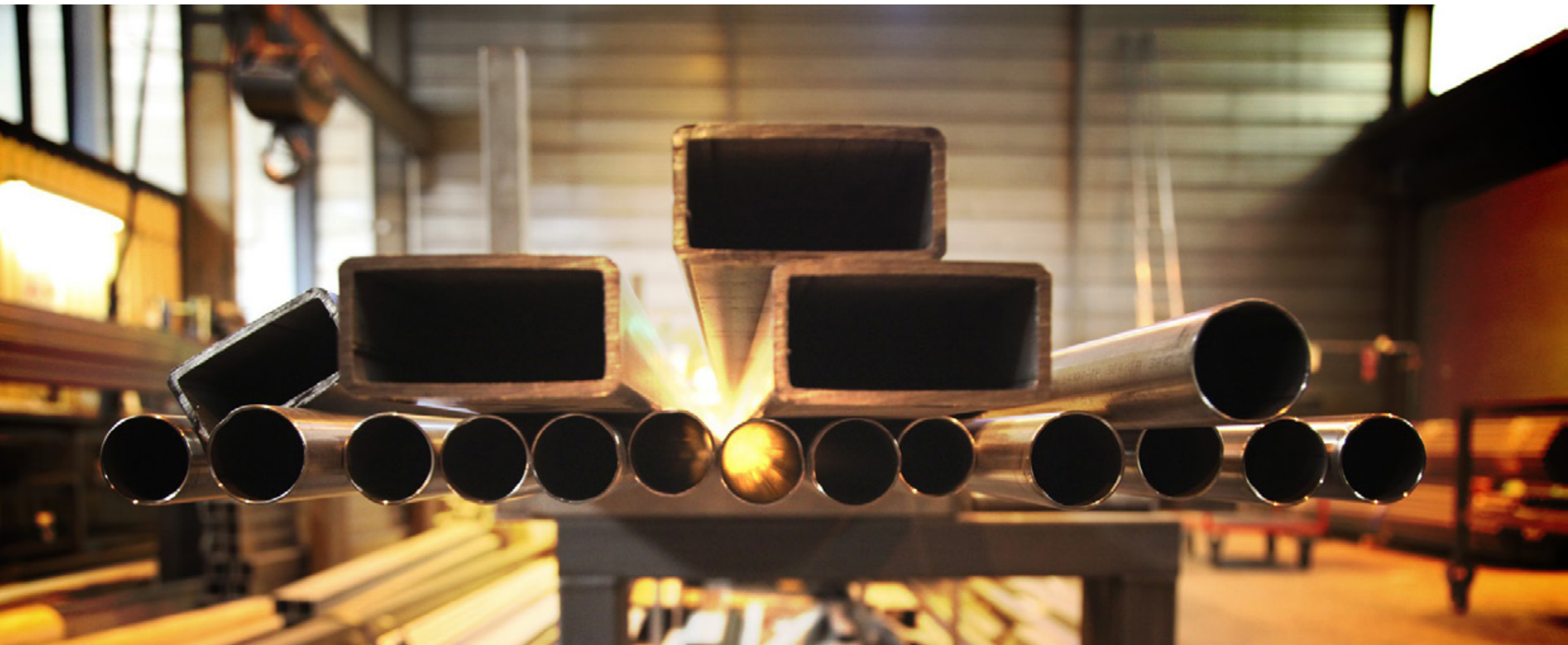


Figure 13. Electricity grid CO_2 emissions factors in the studied countries in 2019 (IEA 2021)

Some of the key factors that could explain why the steel industry's CO_2 emissions intensity values differ among the countries are:

1) The share of EAF steel in total steel production
2) The fuel mix in the iron and steel industry
3) The electricity grid CO_2 emissions factor
4) The type and quality of feedstocks in BF-BOF and EAF
5) The level of penetration of energy-efficient technologies
6) The steel product mix in each country
7) The age of steel manufacturing facilities in each country
8) Capacity utilization
9) Environmental regulations
10) Cost of energy and raw materials



4 Scale of Public Procurement of Construction Materials

The following chapter presents an analysis of the scale of government procurement of steel that is used in publicly funded construction and infrastructure projects for India, Japan, and South Korea. The quantity of steel procured for government-funded construction and infrastructure projects is obtained from national statistics in some cases or estimated based on monetary indicators such as shares of public expenditure on construction and infrastructure projects published in the national accounts of the respective countries.

4.1. Scale of government procurement of steel in India

General government expenditure in India

General government expenditure for India stood at about 31% of the country's GDP in FY 2019-2020[1] (OECD, 2021). Figure 14 presents the shares of overall government non-defense expenditure in various sectors. Transport and communication together (24%) represent the largest share of non-defense public spending in India, followed by power, irrigation and flood control (23%), health care and social services (22%), and other functions such as agriculture, railways, public works, general economic services, and industry and minerals represent the remaining 31% of the total non-defense expenditure.

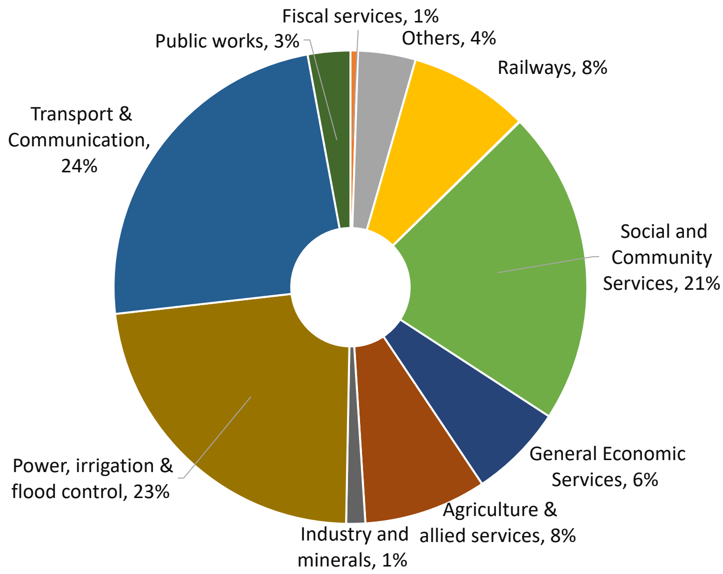


Figure 14. Shares of government spending on various functions in India for fiscal year (FY) 2019-20 (PRS Legislative Research, 2021)

1 In order to avoid skewed shares of government spending, the last pre-pandemic year was chosen as the base year for the analysis where possible. FY 2019-2020 for India refers to period from April 1st 2019 to March 31st 2020.

Public infrastructure spending in India

Based on the analysis of government expenditure reported by union budget statistics, total public infrastructure spending in India accounted for about 52% of total non-defense government expenditure for FY 2019-20 (PRS Legislative Research, 2021). Figure 15 presents the share of public expenditure for various construction and infrastructure sectors in India for FY 2019-20. Construction of roads and bridges (31%) represents the largest share of the government's non-defense infrastructure spending, followed by the spending on irrigation (23%), railways (14%), power sector (11%), housing and urban development (9%) and other infrastructure projects (12%).

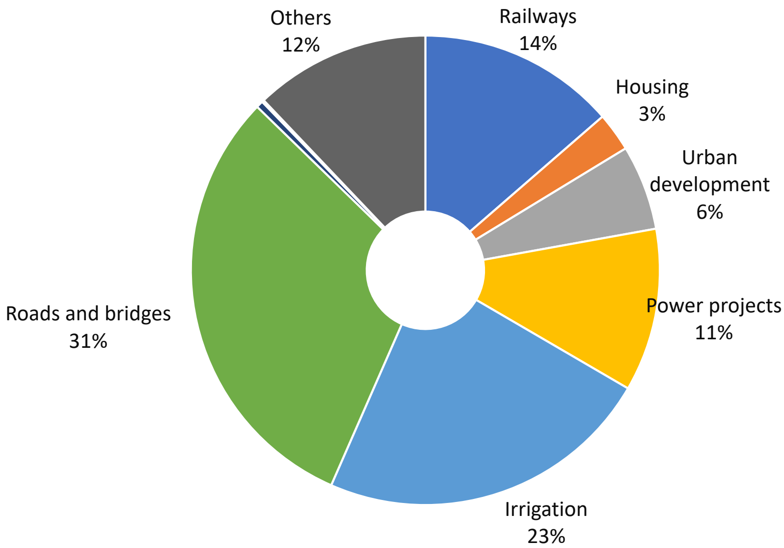


Figure 15. Shares of government expenditure on various infrastructure sectors in India for FY 2019-20 (Public Finance Statistics,2022)

Share of public spending on various infrastructure and construction sectors in India

Analysis of the statistics reported for the union budget for India allows the estimation of scale of public expenditure on various infrastructure and construction sectors, leading to the estimation of shares of public and private expenditures. Figure 16 presents the share of public (central and state governments) and private expenditure on the infrastructure sectors in India for FY 2019-20. The largest share of public spending can be observed for the construction of railways (89%), followed by the construction of roads, highways, and bridges (88%). While the public expenditure on housing represents 2% of total housing expenditure, the public expenditure share represents about 25% of total expenditure on the construction of industrial and commercial infrastructure.

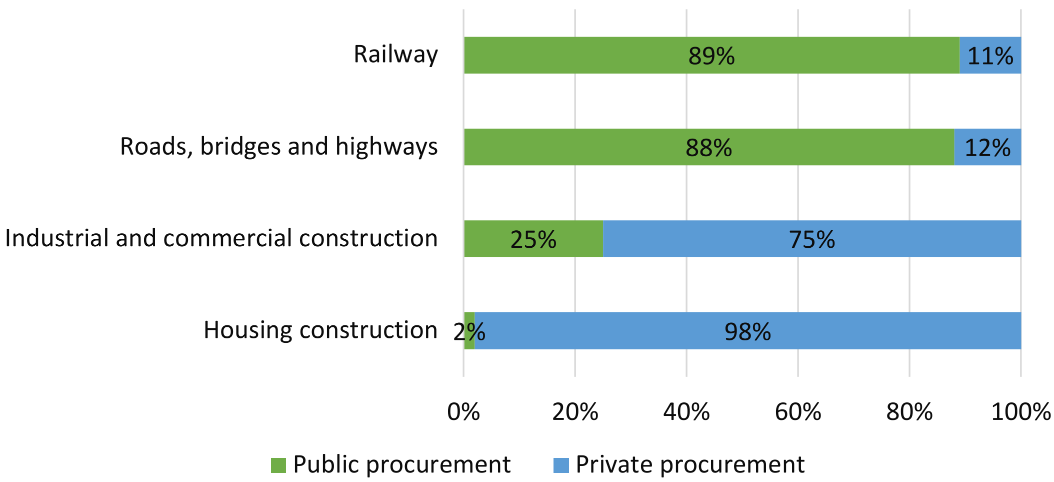


Figure 16. Share of public and private expenditure on various infrastructure and construction sectors for FY 2019-20 (Ministry of Finance, 2022; CRISIL report, 2021; Ministry of Statistics, 2022)

Steel consumption by end-use sectors in India

According to the Steel Ministry of India, the total steel demand for the financial year 2019-20 was about 100 Mt (Steel Ministry of India, 2022). Figure 17 presents the shares of domestic consumption of steel by end-use sectors in India in FY 2019-20. Building and construction (43%) represented the largest share of total steel demand, whereas the infrastructure sector (including the construction of roads, highways, and railways) was the second largest consumer of steel, representing about a quarter of total steel demand. The rest of the steel demand is attributed to the automotive industry (9%), engineering and packaging (22%), and defense (1%). Within the building and construction sector, housing construction accounts for 75% of steel demand, and industrial and commercial construction accounts for the remaining 25% of the steel demand (CRISIL report, 2022).

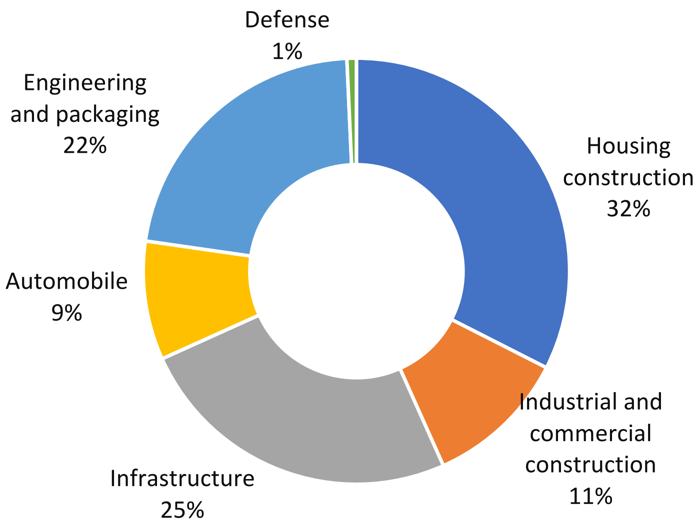


Figure 17. Steel consumption by sector for FY 2019-20 (Steel Ministry of India, 2022)

Steel procurement for government-funded infrastructure projects in India

Shares of government expenditure within the total expenditure for infrastructure sectors at the national level are assumed to represent the shares of steel procured from the total steel consumption reported by the Ministry of Steel for respective sectors. Table 1 presents the total absolute steel demand for construction and infrastructure projects along with the estimates of steel consumed by government-funded construction and infrastructure projects.

Table 1. Absolute steel demand for infrastructure sectors and government-funded infrastructure and construction projects (estimated by this study based on data from Steel Ministry of India 2022, Ministry of Finance 2022; Ministry of Statistics 2022)

Sector	Total Steel demand (million tonnes)	Government procured steel (million tonnes)
Building and Construction	43	3.4
Housing construction	33	0.6
Industrial and commercial construction	10	2.7
Infrastructure	25	22.3

Figure 18 presents the scale of steel procured for government-funded construction and infrastructure projects in India for FY 2019-20. Steel demand for government-funded infrastructure and construction projects is estimated at 25.6 Mt, which accounts for about a quarter of India's total steel demand in FY2019-20. Steel procurement related to government-funded infrastructure projects is estimated at about 22.3 Mt and represents 90% of total infrastructure-related steel demand in India, whereas the government-funded building construction projects is estimated at 3.3 Mt and represents about 8% of total steel consumed for building construction in India for FY 2019-20.

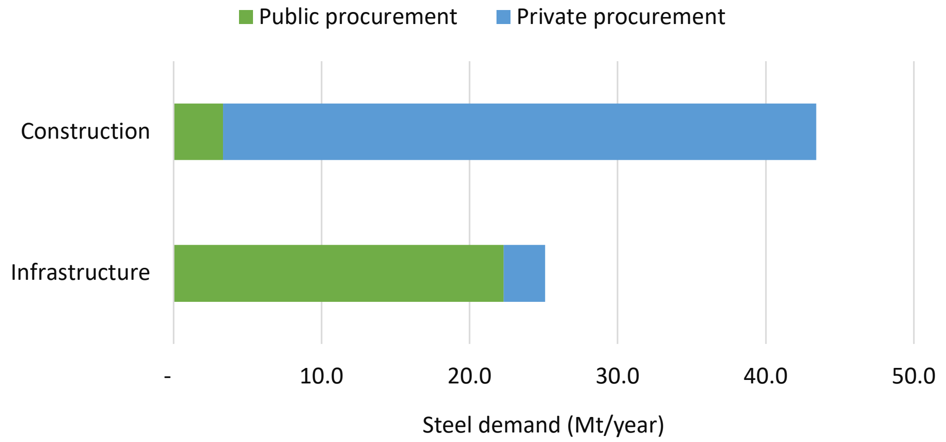


Figure 18. Shares of public and private procurement of steel for infrastructure and construction sector in India in FY 2019-2020.[2]

Figure 19 shows the total steel procurement by both public and private sectors in India in FY 2019-2020. It should be noted that the government also procures other products that contain steel (e.g. vehicles, equipment, etc.). The values on the graphs for "Government-funded construction projects" only contain the steel procured for public infrastructure and construction projects. The "Non-Government-funded procurement" refers to the rest of the steel consumed in India other than those for public construction.

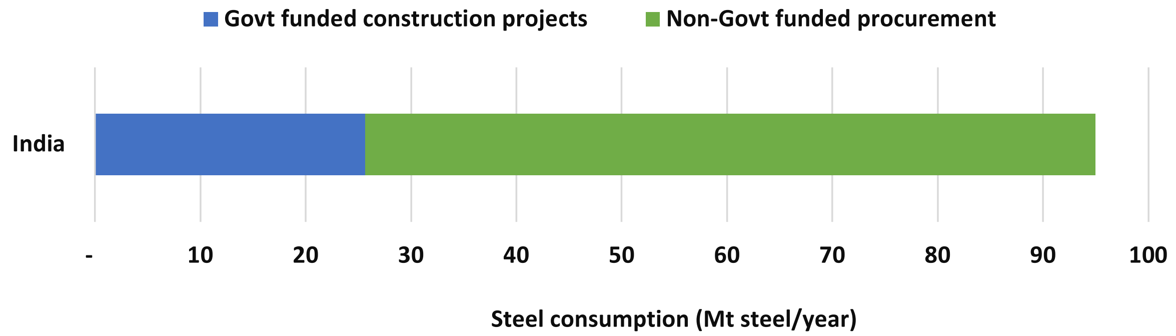


Figure 19. Public and private procurement of steel in India in FY 2019-2020

Figure 20 shows annual CO_2 emissions associated with steel used in India in FY 2019-2020. Because of the small share of imported steel in India, we used the domestic CO_2 intensity of steel produced in India in 2019 (2.15 t CO_2/t steel) (weighted average of both primary steelmaking and EAF steelmaking in India) to calculate annual CO_2 emissions associated with steel consumption in India. Approximately, 27% of the annual CO_2 emissions linked with steel consumption are associated with Government-funded construction projects which were around 55 Mt CO_2 in 2019. Therefore, government procurement can be a strong driver of demand for green steel in India.

2 Construction sector includes housing, commercial and industrial construction. Infrastructure sector includes roads, highways, bridges, and railways.

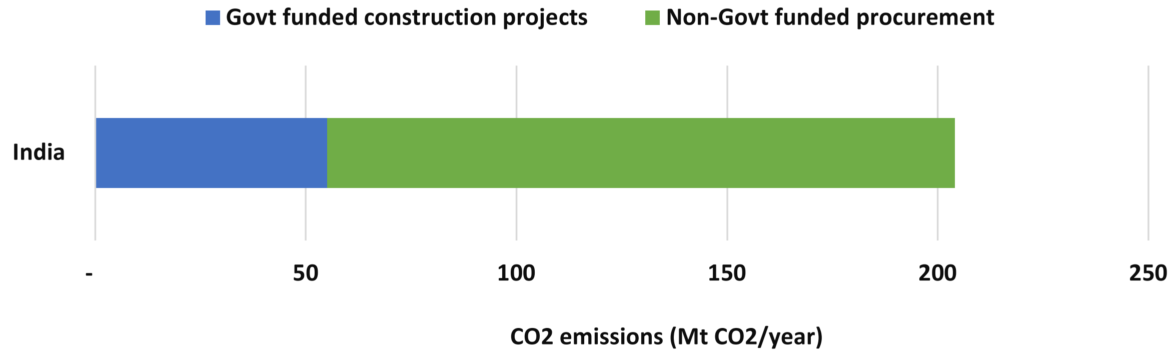


Figure 20. Annual CO_2 emissions associated with steel used in India in FY 2019-2020

4.2. Scale of government procurement of steel in Japan

The following section presents the scale of procurement of steel related to government-funded infrastructure and construction projects along with the shares of general government expenditure on its functions and infrastructure and construction sectors for Japan. Total expenditure on all government functions is estimated at 38.8% of Japan's GDP in 2019.[3] The spending on public procurement accounts for about 42% of total general government expenditure in the same year (OECD, 2021).

General government expenditure on the functions in Japan

Based on the analysis of total general government expenditure by sector published by the Cabinet Office of Japan (Figure 21), the majority of non-defense public spending went to health services (36%), followed by social protection (14%), education (13%), and rest of the general government expenditure can be attributed to the general public and economic services, environmental protection, housing, transport, and agriculture.

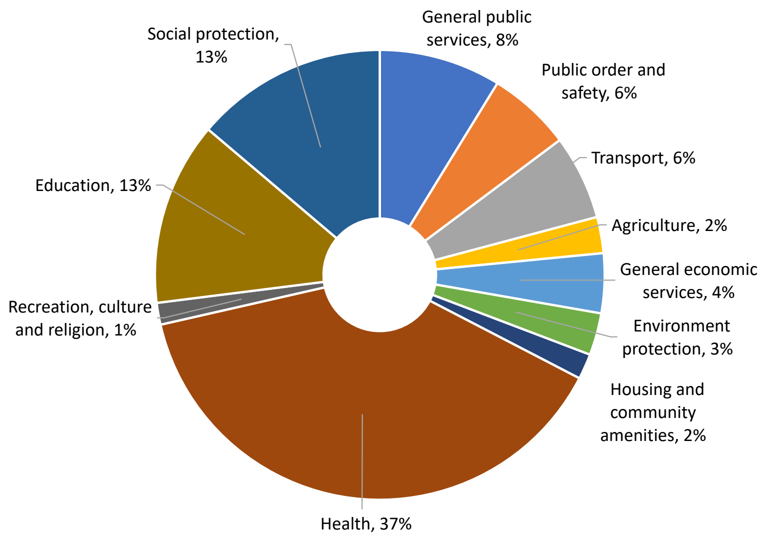


Figure 21. Shares of public expenditure on the functions of government in Japan in FY 2019 (Cabinet Office, 2022)

3 In order to avoid skewed shares of government spending, the last pre-pandemic year was chosen as the base year for the analysis.

Public infrastructure spending in Japan

The statistics published on the infrastructure spending provide the share of government expenditure on infrastructure development for its various functions (Figure 22). The transport sector (28%) represented the largest share of public non-defense spending for infrastructure development in Japan for FY 2019. Other general economic services such as mining, communication, energy, research and development, and other industries were responsible for 14% of total public non-defense infrastructure spending in Japan for FY 2019. While the environmental protection and education sectors were responsible for 12% of total infrastructure spending each, the remaining 34% of the infrastructure spending can be attributed to infrastructure development related to agriculture, housing, health, recreation, culture & religious facilities, and general social protection & public services.

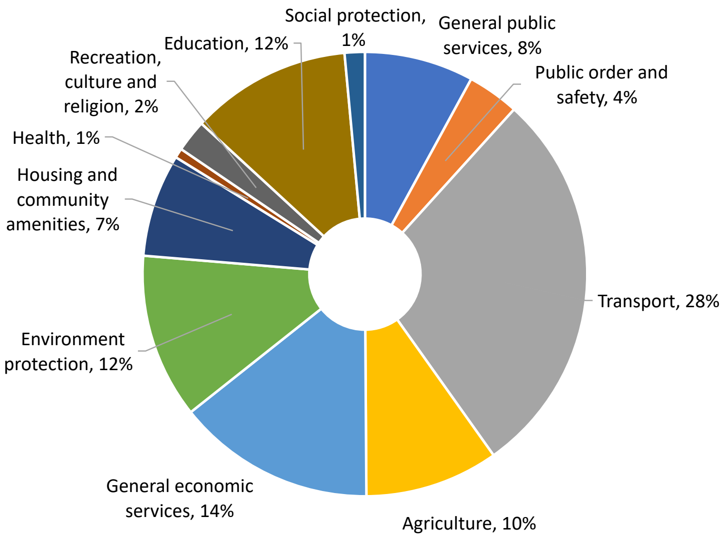


Figure 22. Shares of public expenditure on infrastructure development in Japan in FY 2019 (Cabinet Office, 2022)

Share of public spending on various infrastructure and construction sectors in Japan

Statistics published by the Construction Research and Statistics Office of Japan allow the estimation of public and private shares within the total spending on infrastructure and construction projects. Figure 23 presents shares of public and private spending on infrastructure and construction[4] sectors in Japan in FY 2019. The share of public spending on infrastructure projects accounts for 76% of total infrastructure spending, whereas public spending accounts for about 26% of the total spending on industrial and commercial construction and only 4% of the total housing construction spending in Japan (Construction Research and Statistics Office, 2022b).

4 Public sector infrastructure projects include construction of Roads, Harbors, Fishing ports, Parks, Sewages, Hazard prevention systems and other infrastructure such as agriculture, logging roads etc. Infrastructure spending on railroads, telecommunication, power distribution, and gas companies is included under private sector (Construction Research and Statistics Office, 2022b).

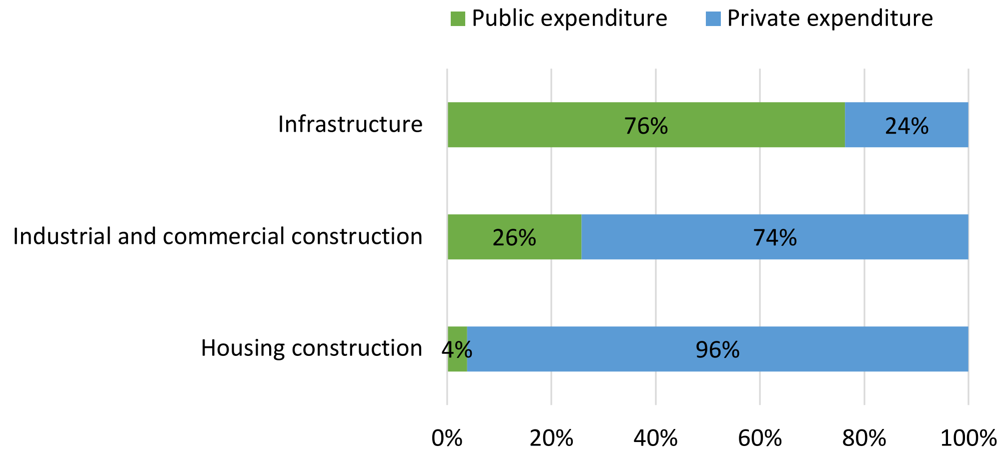


Figure 23. Share of public and private spending on infrastructure and construction sectors in Japan in FY 2019 (Construction Research and Statistical Office, 2021)

Steel consumption by the end-use sector in Japan

According to the World Steel Association, about 57.5 Mt of steel was consumed domestically in Japan in FY 2019. Figure 24 below presents the shares of domestic steel consumption by various sectors of the Japanese economy in FY 2019. The construction and infrastructure industry consumed the largest share of total domestic steel (46%), followed by the automobile industry (21%), shipbuilding (7%), and the remaining domestic steel consumption can be attributed to industrial and electrical machinery & equipment manufacturing, secondary processing and other manufacturing (Statista 2023, Japan Iron and Steel Association 2022).

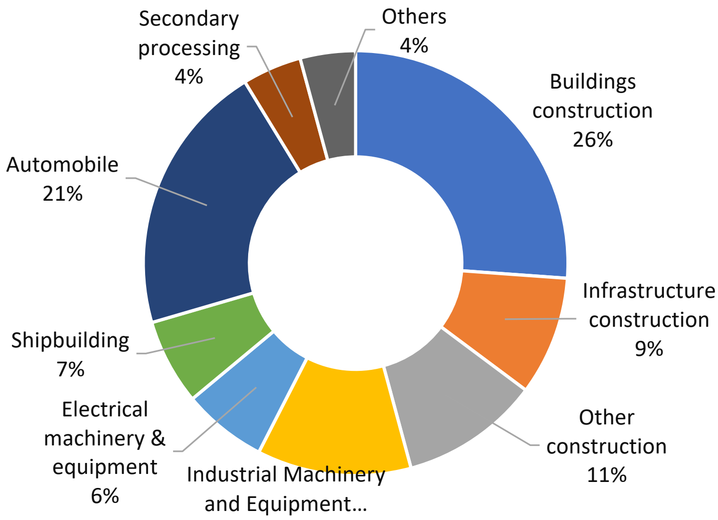


Figure 24. Shares of total domestic steel demand by consumption sectors in Japan for FY 2019 (Statista 2023, Japan Iron and Steel Association 2022)

Steel procurement for government-funded infrastructure and construction projects in Japan

The share of steel consumed for government-funded infrastructure projects and construction is estimated based on the statistics provided by the Japan Iron and Steel Association and shares of public expenditure (Japan Iron and Steel Association 2022, Construction Research and Statistical Office 2021). Figure 25 presents the shares of steel consumption for government-funded infrastructure and construction sectors in Japan for FY 2019. Total steel demand for government-funded infrastructure and construction projects is estimated at 8.2 Mt, which accounts for around 13% of total steel demand in Japan.

Steel demand for government-funded infrastructure projects is estimated at about 4.8 Mt based on the shares of public and private steel consumption provided by the Japan Iron and Steel Association (JISA, 2022), whereas the steel demand for government-funded construction projects is estimated at 3.4 Mt using the shares of public expenditure for construction sector published in the national accounts. Figure 26 shows the total steel procurement by both public and private sectors in Japan in 2019.

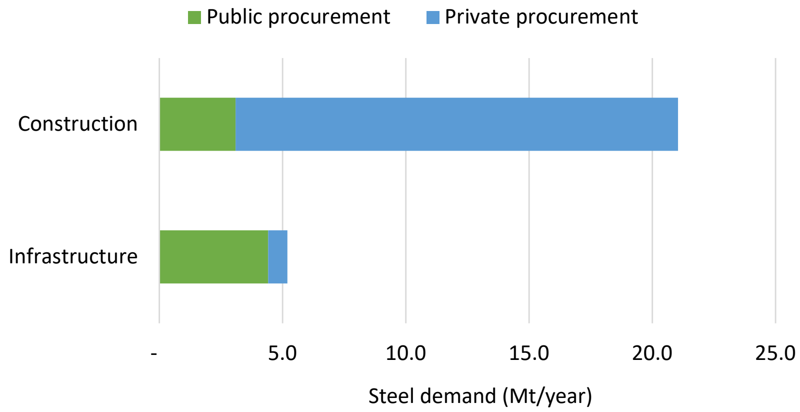


Figure 25. Shares of public and private procurement of steel for infrastructure and construction sector in Japan in 2019 (Source: this study)

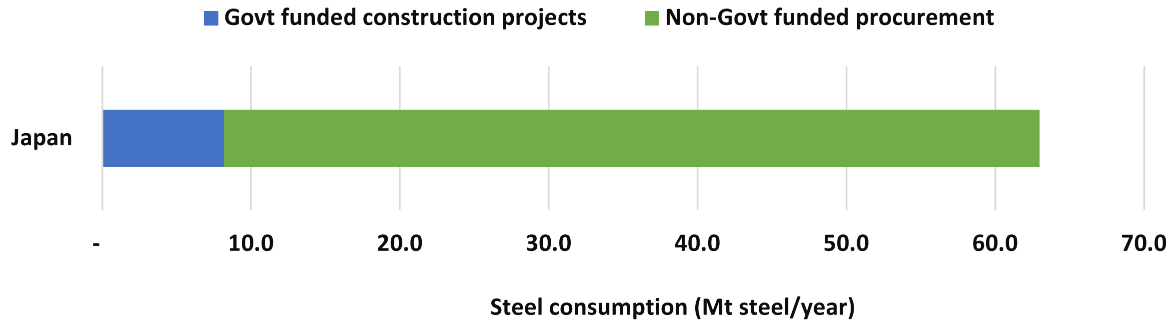


Figure 26. Public and private procurement of steel in Japan in 2019 (Source: this study)

Figure 27 shows annual CO_2 emissions associated with steel used in Japan in 2019. Due to the small share of imported steel in Japan, we used the domestic CO_2 intensity of steel produced in Japan in 2019 (1.88 t CO_2/t steel) (weighted average of both primary steelmaking and EAF steelmaking in Japan) to calculate annual CO_2 emissions associated with steel consumption in Japan. Approximately, 13% of the annual CO_2 emissions linked with steel consumption are associated with Government-funded construction projects which were around 15 Mt CO_2 in 2019. Therefore, government procurement may not be as strong a driver of demand for green steel in Japan as it is in India.

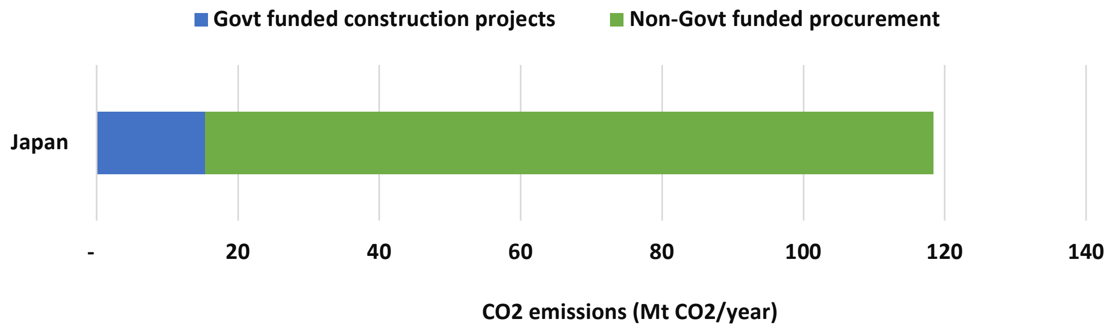


Figure 27. Annual CO_2 emissions associated with steel used in Japan in 2019 (Source: this study)

4.3. Scale of government procurement of steel in South Korea

The following section presents the scale of procurement for the steel consumed in the government-funded infrastructure and construction projects and government-procured vehicles in South Korea, along with the shares of public expenditure on general functions of the government and infrastructure & construction sectors for FY 2019. Total general government expenditure in South Korea stood at about 33% of the country's GDP, whereas public procurement accounts for 41.5% of total general government expenditure (OECD, 2021).

General government expenditure on the functions in South Korea

The Ministry of Economy and Finance provides the analysis of total funds attributed to various functions of the government (figure 28). The largest share of non-defense public expenditure in South Korea is represented by health, welfare, and employment-related spending (39%), followed by education (15%). The economic sectors of agriculture, construction, industry, research & development were responsible for 5% of the overall public spending. Spending related to environment, culture, sports, and tourism represents 8% of total non-defense public expenditure in South Korea. The remaining 23% of the public spending is attributed to other sectors such as public safety, diplomacy reunification, and local governments (including the transfer of funds to local governments).

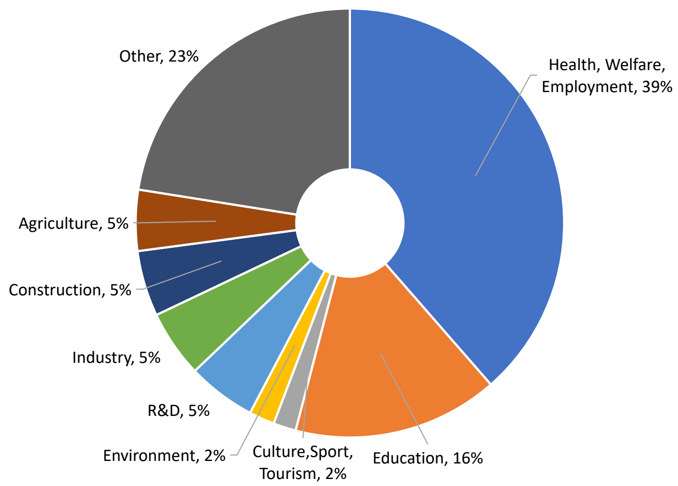


Figure 28. Share of general government expenditure by its functions in South Korea in FY 2019 (Ministry of Economy and Finance, 2020)

Share of public spending on infrastructure and construction sectors in South Korea

Figure 29 below presents the shares of public and private expenditure in infrastructure (i.e., roads, highways, bridges, railways) and building construction (i.e., housing and commercial construction). The value of construction contracts by the type of construction sector provides information about the shares of public and private expenditure within the construction and infrastructure sectors in South Korea. The public expenditure represents about 83% of the total value of construction contracts related to the infrastructure sector, whereas in the construction sector, the public expenditure accounts for 19% of the total value of the construction-related contract in South Korea for FY 2019.

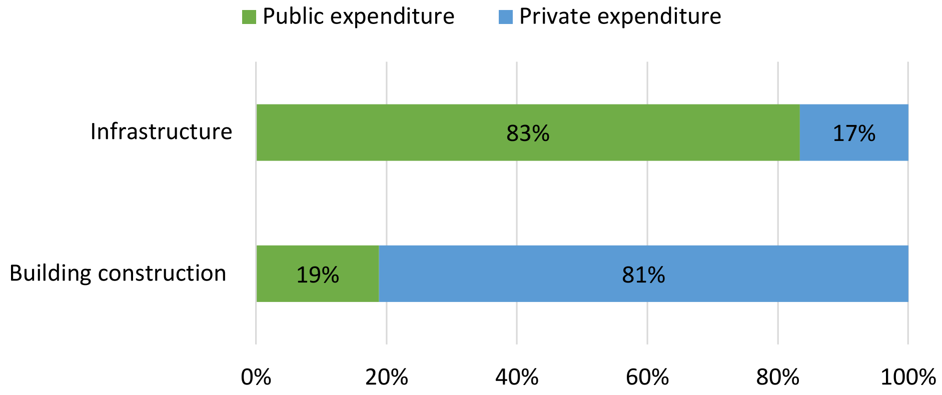


Figure 29. Share of public and private expenditure for infrastructure and construction in South Korea in FY 2019 (Ministry of Land, Infrastructure and Transport, 2021)

Steel consumption by the end-use sector in South Korea

Total steel consumption in South Korea is estimated at 50.3 Mt in 2021 (Next Group, 2021). Figure 30 presents the shares of end-use sectors for steel consumption in South Korea in 2021. The majority of the steel consumed in South Korea for the year 2021 was from the construction sector (35%), which was followed by the steel consumed by the automotive industry (26%), shipbuilding (18%), machinery and electronics (9%) and other applications (12%) (Next Group, 2021).

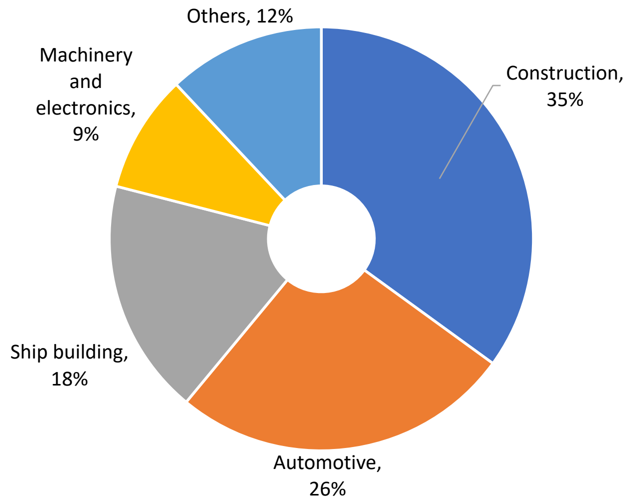


Figure 30. Shares of steel consumption by end-use sectors in South Korea in 2021 (Next Group, 2021)

Steel procurement for government-funded infrastructure and construction projects in South Korea

In the absence of data related to steel used in public infrastructure and construction projects, the share of government expenditure within the infrastructure and construction sector at the national level is used as a proxy. Based on the shares of steel consumption by the end uses and the data of the value of construction contracts published by the Ministry of Land, Infrastructure and Transport in South Korea, the total steel procured for the government-funded infrastructure and construction sector in South Korea is estimated at 5.5 Mt (Figure 31), which accounts for 11% of total steel consumed in South Korea in 2021. Due to data limitations, the steel demand for the construction and infrastructure sector could not be further disaggregated.

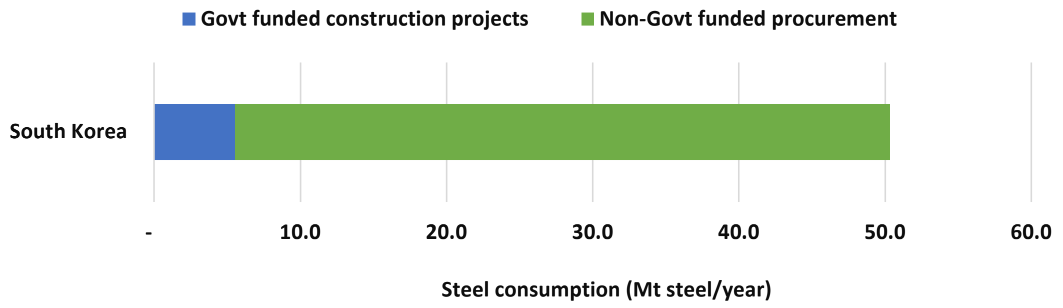


Figure 31. Public and private procurement of steel in South Korea in 2019 (Source: this study)

Figure 32 shows annual CO_2 emissions associated with steel used in South Korea in 2019. Since steel imports accounted for around 33% of the total steel consumed in South Korea in 2019 (Worldsteel 2021), we used the weighted average CO_2 emissions intensity of the Korean steel industry (both primary and EAF steelmaking) and the imported steel (1.73 t CO_2/t steel) to calculate annual CO_2 emissions associated with steel consumption in South Korea. Approximately, 11% of the annual CO_2 emissions linked with steel consumption are associated with Government-funded construction projects which were around 9.6 Mt CO_2 in 2019. Therefore, government procurement may not be as strong a driver of demand for green steel in South Korea as it is in India.

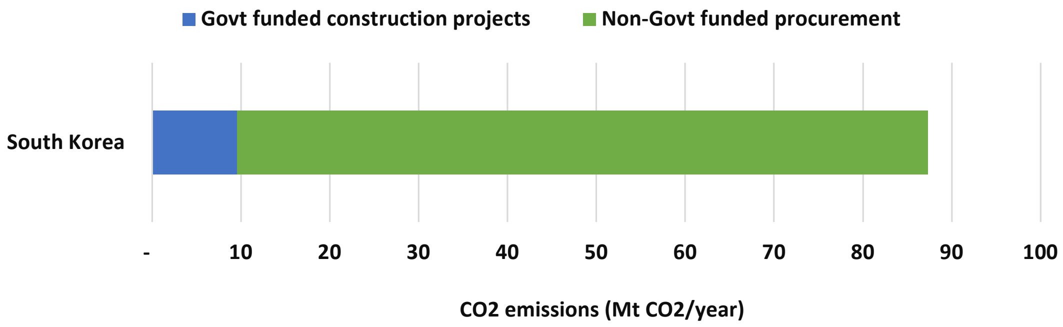


Figure 32. Annual CO_2 emissions associated with steel used in South Korea in 2019 (Source: this study)

5 Potential Impact of Green Public Procurement of Steel on CO_2 Emissions

To estimate the potential impact of GPP on CO_2 emissions associated with steel consumed in India, Japan, and South Korea, we developed several scenarios with various GPP targets for the CO_2 intensity of steel set by a GPP policy (Table 2). Since the amount of steel (in tonnes) imported into India and Japan in 2019 accounts for only 9% and 10% of the total steel consumed in these two countries respectively (Worldsteel 2021), we used the average CO_2 emissions intensity of India's and Japan's domestic steel industry as the baseline for the target setting for steel GPP in these two countries. However, since steel imports accounted for around 33% the total steel consumed in South Korea in 2019 (Worldsteel 2021), we used the weighted average CO_2 emissions intensity of the Korean steel industry (both primary and EAF steelmaking) and the imported steel as the baseline for target setting for steel GPP in South Korea.

The GPP intensity targets for steel shown in the table below are industry-level targets and not for a specific steel product. A GPP policy is likely to set product-specific intensity targets rather than industry-level targets. However, because of the lack of information and the existence of so many different steel products, it is not possible to do such industry-level impact estimation using product-level targets. Therefore, we used industry-level intensity targets to show the potential impact of GPP of steel.

Table 2. GPP target scenarios for the steel industry in India, Japan, and South Korea *

GPP Target	% reduction in steel CO_2 intensity from baseline	Steel CO_2 intensity in India ($kgCO_2$/t crude steel)	Steel CO_2 intensity in Japan ($kgCO_2$/t crude steel)	Steel CO_2 intensity in South Korea ($kgCO_2$/t crude steel)
Baseline	-	2,147**	1,879**	1,735***
Low	15%	1,825	1,597	1,475
Medium	30%	1,503	1,315	1,215
High	50%	1,074	940	868
Transformative	75%	537	470	434

* The GPP intensity targets shown in this table are industry-level targets and not for a specific steel product.

** Since the amount of steel imported in India and Japan in 2019 accounts for only 9% and 10% of the total steel consumed in these two countries respectively, we used the average CO_2 emissions intensity of India's and Japan's domestic steel industry as the baseline for the target setting for steel GPP in these two countries.

*** Since steel imports accounted for around 33% of the total steel consumed in South Korea in 2019, we used the weighted average CO_2 emissions intensity of the Korean steel industry and the imported steel as the baseline for target setting for steel GPP in South Korea.

Using the annual CO_2 emissions associated with steel used in India, Japan, and South Korea presented in the previous chapter and the targets set in Table 2, we estimated the annual CO_2 emissions reduction potential resulting from GPP of steel in these countries (Figure 33-35).

Under the Low scenario for the GPP target for steel, an annual emissions reduction of 8.3, 2.3, and 1.4 Mt CO_2 can be achieved directly from public procurement of steel in India, Japan, and South Korea, respectively. This direct annual CO_2 emissions reduction potential would increase substantially to 28, 8, and 5 Mt CO_2 under the High scenario in India, Japan, and South Korea, and even higher under the Transformative scenario. If we consider potential indirect impacts of GPP, the potential CO_2 emissions reduction impact of GPP of steel could increase by approximately four-fold in India, eight-fold in Japan, and nine-fold in South Korea. This assumes, for example, that the changes steel plants make for CO_2 emissions reduction applies to all steel they produce for market, such as steel sold to private consumers and projects.

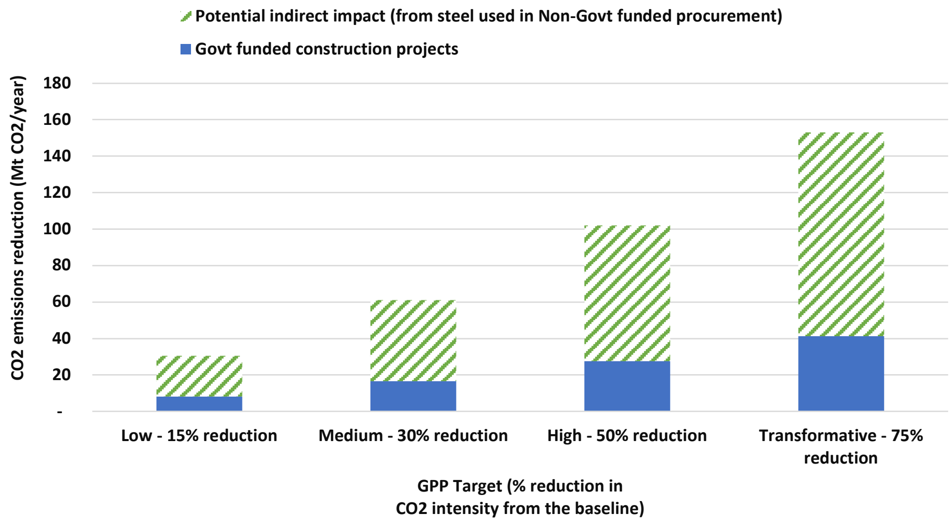


Figure 33. Annual CO_2 emissions reduction potential resulted from GPP of steel in India

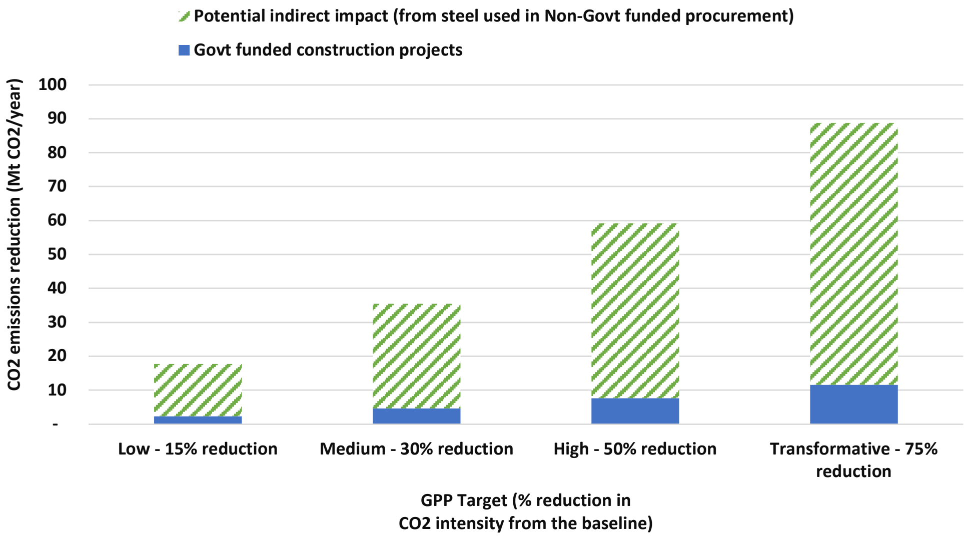


Figure 34. Annual CO_2 emissions reduction potential resulted from GPP of steel in Japan

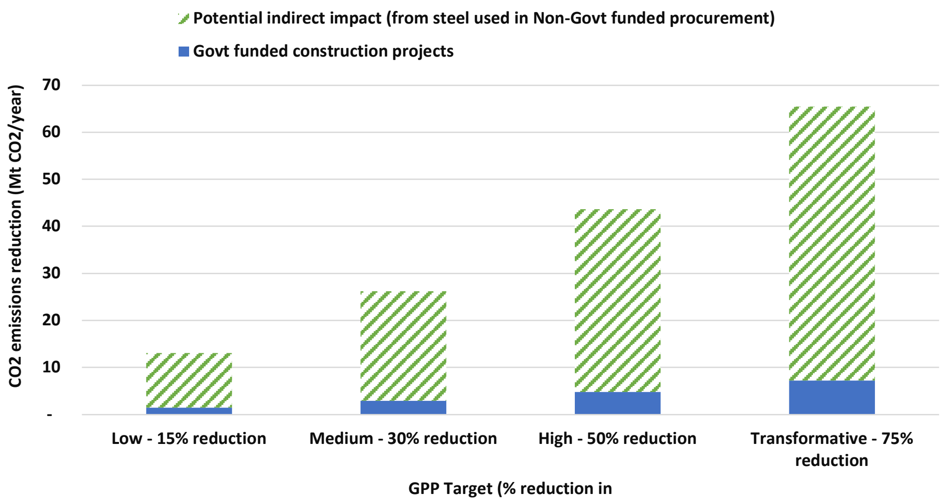


Figure 35. Annual CO_2 emissions reduction potential resulted from GPP of steel in South Korea

6 Industrial Decarbonization Policies and the Steel Industry

Japan and South Korea have set net-zero carbon emissions targets by 2050 and India by 2070. In order to achieve those targets, governments in these countries have introduced national as well as sector-specific policy frameworks. The following section presents a review of some of the national and steel industry-specific decarbonization policies adopted in India, Japan, and South Korea, and the state of GPP policies in these countries.

6.1. Policies in India

India has committed to achieving carbon neutrality by the year 2070, which translates to intermittent reduction target of 33 to 35% reduction in GHG emissions per unit of GDP for entire economy. In order to achieve the climate targets, India currently has 150 individual policy measures in place at the national level influencing the GHG emissions from land use, agriculture, power sector, transportation, residential and industrial sectors (Observe Research Foundation, 2022). Policy measures such as capital subsidies for renewable energy, National Solar Mission, Perform Achieve and Trade Scheme (PAT), national green hydrogen mission, and LED lighting have been some of the most influential in the context of CO_2 emissions reduction. The rest of the policy measures are implemented on voluntary bases and are less likely to have a big impact on GHG emissions (Observe Research Foundation, 2022).

India is the world's second-largest producer of crude steel and is second only to Ukraine with the highest average CO_2 emissions intensity among major steel-producing countries at approximately 2.15 tons of CO_2 per ton of crude steel in 2019 due to its predominant use of coal-based BF and coal-based DRI in the sector, high emissions in the power sector, and a large number of old and inefficient plants. The CO_2 emissions intensity of primary steel production in India is around 3 tons of CO_2 per ton of crude steel (Hasanbeigi, 2022). To comply with India's National Determined Contributions (NDCs) for GHG emissions, the Indian primary steel producers must reduce carbon emissions intensity substantially by 2030 and thereafter (Argus Media, 2022; Green Steel World, 2022).

In line with the national economy-wide target, the Ministry of Steel in India is committed to a Net-Zero target by 2070. In order to achieve this target, the Ministry has planned to emphasize the promotion of various steelmaking technology pathways in three incremental phases. In the first phase, a short-term decarbonization target is set for FY 2030, and it will be achieved through the promotion of energy and resource efficiency improvement. The detailed steps will include introducing steel scrap recycling policy and Motor Vehicle Registration rules to enhance the scrap steel availability, wider adoption of Perform, Achieve, Trade (PAT) scheme, and Best Available Techniques (BATs). For the second phase, the medium-term decarbonization target is set for FY 2030-47 and will be achieved through the use of green hydrogen and carbon capture and storage, whereas for the third phase, the long-term target (2047-2070) is expected to be achieved through the disruptive alternative technological innovations (Indian Ministry of Steel, 2022a). The newly launched National Green Hydrogen Mission in India aims to provide a comprehensive action plan for establishing a Green Hydrogen ecosystem and catalyzing a systemic response to the opportunities and challenges of this sector (MNRE 2023). This will have a great implication in decarbonizing the steel industry as well.

Nationally, India currently does not have a GPP program for steel procurement. India does have general financing rules, which are a set of guiding regulatory principles for public procurement focused on efficiency, economy, transparency, and promotion of competition. In 2011, India's Ministry of Environment and Forests formed a committee to develop GPP guidelines. A year later, the Government of India introduced the Draft Public Procurement Bill-2012, which states that the evaluation criteria for procurement may include: (a) price; (b) the cost of operating, maintaining, and repairing goods or works; and (c) the characteristics of the object being procured, such as the functional and environmental attributes (UNEP 2013, Kumar 2014).

A Task Force in Sustainable Public Procurement was created in 2018 to review other GPP programs internationally, assess India's current GPP status and recommend further action, and steel as one of the six primary industrial targets (Hasanbeigi, 2022; Hasanbeigi et al., 2019).

Despite the lack of national programs or standards, the Indian Steel Association (ISA) has called for the government to support green steel production by (Argus Media, 2022; Green Steel World, 2022; India Ministry of Steel, 2022):

1. Introducing standards for green steel and a percentage of green steel in GPP
2. Establishing a carbon credit mechanism
3. Facilitating Carbon Capture Storage and Utilization (CCUS)
4. A renewable power transmission charges waiver
5. Calling for collaboration on research and development
6. Funding demonstration project of GHG reduction practices and technology in India
7. Calling for an EU Carbon Border Adjustment Mechanism

Given the scale of public procurement of steel in India, a GPP program can potentially contribute substantially towards achieving the net-zero steel industry goal in India.

6.2. Policies in Japan

Japan aims to achieve carbon neutrality by 2050. According to Japan's NDC, it has a short-term target of reducing GHG emissions by 46% by FY 2030 compared to the emission levels in 2013, which translates to an overall 570 Mt of CO_2 in 17 years (UNFCCC, 2022). In order to achieve these targets, Japan has introduced policy packages such as the Ministry of the Environment of in Japan (MOE) initiative to decarbonize infrastructure, Japan Climate Change Agenda 2.0, the Initiative to promote corporate Measurement Reporting and Verification (MRV), and the Climate and Disaster Risk Reduction Initiative (Ministry of Environment, 2021). Table 3below presents the overall and sector-specific targets for CO_2 and other GHG emissions for Japan

Table 3. CO_2 and other GHG emissions reduction targets for Japan until 2030 (UNFCCC, 2022)

Emissions	2013 level (Mt CO_2e)	2030 target (Mt CO_2e)
Energy-related CO_2	1235	577
Industry	463	289
Commercial	238	116
Residential	208	70
Transport	224	147
Non-energy related CO_2	82.3	70
Methane	30	26.7
Other GHG gases	39.1	21.8

The Japan Iron and Steel Federation (JISF) has set a target for the nation's steel industry to reduce production process emissions by 30% by 2030 (The Japan Iron and Steel Federation, 2018). Although there are currently no direct requirements for GPP and no direct target for scrap use or steel emissions intensity set at a national level for the steel industry in Japan, some of the large steel producers in the country have indicated ambitions to achieve carbon neutrality by 2050 (JFE steel, 2022; Nippon Steel, 2021).

Despite the progress in Japan's GPP programs discussed below, the nation's steel industry has one of the highest emissions intensities per ton of steel produced, with approximately 1.8 tons of CO_2e per ton of crude steel (Hasanbeigi, 2022). The JISF adopted the Japanese Industrial Standard "Life Cycle Inventory Calculation Methodology for Steel Products" (JIS Q 20915) in 2019, which mirrors ISO 20915[5] to further support decarbonizing the nation's steel production (The Japan Iron and Steel Federation, 2021).

Japan is the pioneer, both in Asia and the world, in developing a GPP framework. Japan's policies and regulations to promote and implement GPP has been in place since the late 1980s, starting with the Eco Mark environmental labeling program.

The first edition of the "Basic Policy for the Promotion of Procurement of Eco-Friendly Goods and Services" (Basic Policy on Promoting Green Purchasing or Green Purchasing Law) appeared in 2001; the most recent version appeared in 2016. The law requires that government agencies apply green purchasing criteria when procuring products in a wide array of categories.

Japan's "Basic Policy concerning the Promotion of Contracts considering reduction of GHG Emissions by the State and Other Entities" (Basic Policy on Promoting Green Contract or Green Contract Law) was adopted in 2007, with the most recent revision in 2014 and complimented the Act on Promoting Green Purchasing. This law requires government agencies and public institutions to follow green contracting requirements when purchasing electric power, automobiles, energy services, or building design services.

Following the 2001 adoption of the Act on Promoting Green Purchasing, the market share of environmentally friendly products increased in Japan. GPP is estimated to have reduced GHG emissions by 210,000 tons of CO_2 equivalent. Japan's green procurement list includes 246 items in 19 product categories (Hasanbeigi et al., 2019).

Japan's Ministry of Economy, Trade, and Industry (METI) developed a Carbon Neutrality Plan for the Japanese Steel Industry in 2020, which is a multitrack approach to develop ultra-innovative technologies that will help the Japanese steel industry achieve carbon neutrality by 2050. The plan focuses on several key levers, such as expanding the use of scrap, energy efficiency, EAFs, ferro-coke utilization, hydrogen utilization in steel making, and CCUS (JFE Steel Corporation, 2022).

In May 2021, METI worked with the Ministry of Environment (MOE) and Financial Services Agency (FSA) to develop the "Basic Guidelines on Climate Transition Finance" and the Technology Roadmap for Transition Finance in the Iron and Steel industry" in October of 2021 that both promote financing for projects to decarbonize large CO_2 emitting industries in Japan

5 ISO 20915 provides guidelines for conducting Life Cycle Inventory Analysis (LCIA) for steel products focusing on closed loop recycling.

like steel (Ministry of Economy, Trade, and Industry, 2022). Within Japan's steel industry, JFE Steel Corporation (JFE), Japan's 2nd largest steel producer, was a recipient of one of the bonds with funding from Japan's $17.6 billion Green Innovation Fund to support the development of super-innovative steel production processes, energy saving efforts, and efficiency improvement (Ministry of Economy, Trade, and Industry, 2022).

JFE released its Carbon Neutrality Briefing in September of 2022, including a Carbon Neutrality Action Plan in which JFE is introducing low carbon steel processes during its transition period to 2030, reducing emissions by 30% and accelerating its decarbonization efforts through an innovation period to 2050 through R&D and implementation of ultra-innovative technologies (JFE Steel Corporation, 2022).

In 2022, Japan's METI and the Japan Exchange Group (JPX) also announced plans to establish the nation's first market for trading CO_2 emissions that will start in 2023. The plan requires participants to set emission reduction targets by 2030, with surplus reductions being certified as carbon credits. 440 Japanese companies have expressed willingness to participate, including Nippon Steel (Yuasa & Matsumoto, 2022).

Japan maintains an Eco-Products database of information about products (including steel products) and services. The database contains information such as the ratings under the Green Purchasing Guidelines for the products that obtain EcoLeaf label (The Japan Iron and Steel Federation, 2021; Hasanbeigi et al., 2019).

The JISF developed the Product Category Rules (PCRs) for all steel products in order to comply with the EcoLeaf environmental labeling certification Program of the Japan Environmental Management Association for Industry (JEMAI). In 2019 the PCR was approved, covering steel products and secondary steel products for construction and non-Construction use. According to the JISF, for a company to obtain EcoLeaf certification for its steel products, the company will be required to quantify and disclose the environmental impact of recycled steel products through the LCA process (The Japan Iron and Steel Federation, 2021).

Japan's Ministry of Environment (MOE) monitors decentralized GPP activities. Procuring agencies report their purchases to a central body annually. This office compiles the data and estimates the GHG emissions reduction using the share of green products purchased and the difference between the average emissions of a green product and a conventional one.

Individual government agencies and public institutions develop and implement their own procurement policies, evaluate implementation, and report performance to the Minister of the Environment. Certification bodies and non-governmental organizations (NGOs) provide information about certification criteria and environmentally friendly products and services for both consumers and suppliers (Hasanbeigi et al., 2019).

Public procurement in Japan is decentralized, with each ministry or department carrying out its own activities; there is no central procurement agency managing GPP. All central government ministries, 47 prefectural governments, and Japan's 700 cities are subject to GPP policies. GPP is mandatory for all central government and incorporated administrative agencies. It is voluntary for local government and local administrative agencies. Japan has the highest percentage (70%) of agencies implementing GPP policies compared to other countries in the world (Hasanbeigi et al., 2019).

6.3. Policies in South Korea

South Korea has the 7th highest emissions intensity per ton of crude steel produced among the major steel producers at approximately 1.6 tons of CO_2 in 2019 (Hasanbeigi, 2022). Steel production in South Korea accounted for 15% of national GHG emissions in 2019. South Korea has announced targets to cut GHG emissions to 24% below 2017 levels by 2030 overall. To do this, the South Korean government has reported teaming up with the industry to develop and encourage the use of hydrogen fuels to reduce emissions from the steel industry with a goal of demonstrating and developing the technology by 2025 (The Government of the Republic of Korea, 2020).

South Korean steel industry does not have decarbonization targets set in the policy framework. However, in February 2021, some of the largest steel producers in the country made a joint declaration to achieve carbon neutrality by 2050 (Hyundai Steel, 2022). South Korean steel manufacturers aim to achieve carbon neutrality mainly through energy efficiency improvement, low carbon raw materials alternatives, use of hydrogen for reduction, and commercialization of HyRex electric arc furnaces (Fluidized bed reduction with green hydrogen) (POSCO, 2021; Hyundai Steel, 2022). Some steel manufacturers, such as POSCO, also have interim targets of reducing 20% of emissions by 2030 and 50% of emissions by 2040, eventually leading to net carbon neutrality by 2050 (POSCO, 2021).

However, of the 109 items subject to South Korea's Minimum Green Standard Product Purchase Program (MGS) run by the Public Procurement Service (PPS), steel products are not included (Eun Ko and Kim, 2022). There are 17 green steel products, all produced by POSCO, the nation's largest steel producer, under the nation's Low Carbon Product Certification Program. However, the maximum carbon limit in the program is not applicable to steel, and the minimum standard only applies where a steel product must achieve a CO_2 intensity reduction rate of 3.3% over three years to achieve certification, regardless of the absolute intensity of the product. The carbon footprint of the products is also not disclosed for steel products under this program (Eun Ko & Kim, 2022).

Despite the current lack of policy related to green steel in South Korea, the government's Ministry of Trade, Industry, and Energy launched the Green Steel Committee in February of 2021. The committee is made up of industrial, academic, and government representatives discussing the goal of 2050 carbon neutrality in the nation's steel industry agreed upon by South Korea's largest steel producers, POSCO, Hyundai Steel, Dongkuk Steel, KG Dongbu Steel, Seah Steel, and SIMPAC in 2021 (Green Steel, 2021; Min-hee, 2021; Tingyao Lin, 2021). This committee is expected to put out a roadmap for the steel in South Korea this year.

In a September 2022 study by InfluenceMap, POSCO, Hyundai Steel, and the Korean Iron and Steel Association (KOSA) were reported to frequently contribute to policy forums regarding the decarbonization of the steel industry in Korea. POSCO publicly supported the government's 2050 carbon neutrality target and advocated government investment in green hydrogen infrastructure and renewable energy. Hyundai Steel was reported to advocate for transitions from blast furnaces to EAF and hydrogen utilization (InfluenceMap, 2022).

7 Challenges and Policy Recommendations

7.1. Challenges to implementing GPP of steel in India, Japan, and South Korea

There are several challenges shared by all countries seeking to implement green public procurement policies. These include emissions reporting standards, data availability, setting targets, and preventing carbon leakage. Beyond these, there are a set of challenges to implementation that are unique to each country.

Data and standards
The first set of challenges is around establishing common emissions reporting standards. Emissions reporting standards are required to compare products to one another in terms of environmental impact. This requires selecting one format of reporting, typically an environmental product declaration (EPD), and defining the system boundaries (i.e., which stages of production should be counted). Another challenge is ensuring the emissions data used to produce EPDs are reliable and comprehensive. In some cases, data is unavailable if one segment of the supply chain does not report its emissions. Reliability of data can be especially difficult if some stages of production happen in other countries, as regulators cannot always verify the accuracy of reported values.

Target setting
A second challenge is setting feasible yet ambitious targets for emissions reduction. The targets must be ambitious to incentivize low-carbon innovation without being infeasible, which could harm domestic competitiveness. As a result, developing targets requires an iterative process of engagement with the steel industry and stakeholders. Experts in currently available technology and future feasibility may include academics, industry associations, and other researchers.

Carbon loophole
A third common challenge is closing the carbon loophole. The carbon loophole refers to the embodied emissions associated with goods that are traded across borders (Hasanbeigi and Darwili 2022). If an imported good is not subject to climate policy in its country of origin, it may have higher embodied emissions that are not accounted for by the domestic policy. There are two potentially harmful climate outcomes if the green procurement policy does not address the carbon loophole from the outset. The first is that manufacturers may avoid low-carbon innovation by selling to another nation with no embodied emissions policy. The second is a potential loss of market share to imported materials. If domestic manufacturers invest in R&D and facilities transformation to reduce emissions, their costs may go up. This could lead to a competitive disadvantage relative to imported materials which do not face these costs. For green public procurement to drive innovation successfully, it must be paired with policies that address the carbon loophole (Hasanbeigi and Darwili 2022).

Decentralized Procurement
Some countries have a highly decentralized bureaucracy when it comes to public procurement. In 2019, central government spending accounted for around 15% of total government expenditure in Japan, compared to around 50% in India and South Korea (OECD 2021). It can be difficult to build the political momentum to pass GPP policy across all jurisdictions. If select states or provinces and local governments create their own GPP

programs, it can be challenging to harmonize standards across regions after the fact, especially as procurement processes can vary widely between agencies. This can be highly costly if manufacturers need to adjust to a different set of standards and policy frameworks for each jurisdiction. If one state or province has more ambitious embodied carbon standards than its neighbors, the efficacy of this policy instrument can be weakened by a carbon leakage between provinces where heavy polluters sell to the locale with the least regulation. A high degree of decentralization adds significant complexity to GPP.

Lack of Capacity and Competing Priorities

Developing expertise in green procurement is a challenge shared by many countries. This is less of a problem in Japan and South Korea since they already have an advanced GPP although it does not include steel products. In India, however, since there is no well-established GPP policy at the national or sub-national level, this is a bigger problem. Procuring officials need to learn about embodied emissions, EPDs, life cycle analysis, and new frameworks for bid evaluation. This is exacerbated by the problem of bandwidth. In central government agencies and select sub-national agencies, there may be sufficient budget and staffing to support building in-house expertise in green procurement. However, in smaller provinces and municipalities with fewer procurement agents, there will be a lack of bandwidth to learn about green procurement practices. This is especially problematic where a significant scale of procurement that occurs is at the sub-national level.

7.2. International best practices of GPP

Many governments around the world have already recognized the value of green public procurement as a policy instrument and are leveraging the money they invest in large contracts to achieve environmental goals. Hasanbeigi et al. (2019) studied 30 such programs, 22 of which were in countries in Asia, Europe, North and South America, Africa, and Oceania, five case studies at the city and regional level, and three GPP programs at multilateral banks and the UN. Based on this study, they identified the GPP program in The Netherlands as one of the world's best for the reduction of emissions from construction materials (e.g. steel). Below is a summary of international best practices in the GPP programs studied:

A. **Netherlands**: The Dutch GPP program has two kinds of environmental criteria: minimum quality requirements criteria, and preference-based or performance criteria. Tenders that do not meet quality criteria are disqualified from consideration. Performance criteria do not disqualify bids. Rather, they give preference to green materials during the Most Economically Advantageous Tender (MEAT) evaluation.

   The Dutch GPP program uses software called DuboCalc. DuboCalc is a life-cycle analysis-based tool that calculates the environmental impact of proposed designs based on the materials to be used. It calculates 11 environmental impact parameters and combines them into a single value, the Environmental Cost Indicator (ECI). Bids must meet a maximum allowable ECI, and additional reductions in emissions are monetized as a discount applied to the quoted price. The tool is publicly available and can be used by governmental and non-governmental entities. This type of whole-project assessment allows for cross-industry comparison; rather than prescribing technical details, it places the onus on the bidder to consider trade-offs between cost, embodied emissions, and durability of materials.

   The Dutch public procurement expertise center, PIANOo, supports procurement officials in adopting green procurement practices. It maintains a website with information about current GPP targets set by Rijkswaterstaat. It also maintains an online tool for building tender documents with environmental criteria. This simplifies the process for procurement officials and bidders alike.

B. **European Union:** The European Commission has created a set of common GPP criteria which is the basis for GPP in member states. The criteria are divided into selection criteria, technical specifications, award criteria, and contract performance clauses. For each set of criteria, there are two levels: core criteria, which are designed for ease of use while reducing key environmental concerns, and comprehensive criteria, which are more ambitious requirements for agencies that want to go further in supporting environmental and innovation goals.

The European Union supports the use of project-level analysis in GPP criteria based on a point system. Points can be awarded based on the improvement of life cycle assessment (LCA) performance in comparison with business as usual or competing designs. A weighting system is applied to combine various LCA indicators, including global warming potential (GWP), depletion potential of the stratospheric ozone layer (ODP), and acidification potential of soil and water (AP), into an overall score. In the absence of an LCA, the GWP from a carbon footprint (CF) assessment can be used. In the absence of both, points can be calculated from proxy data, such as the reduction of CO_2 equivalent emissions from the transportation of materials and recycling of demolition waste (European Commission 2022).

C. **California, United States:** The State of California was the first state to pass the Buy Clean policy in the United States. The Buy Clean California Act requires state-funded projects to consider the GWP of a set of construction materials during procurement. Covered materials include structural steel, concrete reinforcing steel, flat glass, and mineral wool insulation. An amendment to include concrete in this list is underway.

These laws were introduced in two stages. In the first stage, which lasted three years, manufacturers of eligible materials were required to submit facility-specific EPDs in their bids. Using these EPDs, the Department of General Services determined the maximum acceptable GWP limits for each product category. These were set at the industry average for each material. In the second stage, beginning July 1, 2022, compliance with GWP limits will be required to be awarded a state-funded project. The maximum acceptable GWP limits are shown in Table 9. The department must review the maximum threshold for each material every three years. They may adjust the number downward to reflect industry improvements. However, the threshold should not be adjusted upward for any materials (California Department of General Services, 2022).

Also, in September 2022, the Biden-Harris Administration announced new actions under its Federal Buy Clean Initiative to spur the development of low-carbon construction materials (The White House 2022). the Inflation Reduction Act was signed into law. It allocates over US$250 million to support the development, standardization, transparency, and reporting criteria for EPDs; US$100 million to support the development of a low-embodied carbon label for construction materials; and US$5 billion to purchase low-carbon materials for the construction of federal buildings, roads, bridges, and homes. On top of the federal Buy Clean policy, in addition to California, several other states have also adopted Buy Clean policies such as Washington, New York, Colorado, Oregon, and New Jersey.

Table 4. The maximum acceptable GWP limits in California Buy Clean (California Department of General Services 2022)

Eligible material	Maximum acceptable GWP limit (unfabricated)*
Hot-rolled structural steel sections	1.01 MT CO_2 eq./MT
Hollow structural sections	1.71 MT CO_2 eq./MT
Steel plate	1.49 MT CO_2 eq./MT
Concrete reinforcing steel	0.89 MT CO_2 eq./MT
Flat glass	1.43 MT CO_2 eq./MT
Light-density mineral wool board insulation	3.33 kg CO_2 eq./1 m^2
Heavy-density mineral wool board insulation	8.16 kg CO_2 eq./1 m^2

7.3. Recommendations for steel GPP policy in India, Japan, and South Korea

Below we list some of the key aspects of international best practices of GPP that can be adopted in India, Japan, and South Korea for the successful design and implementation of GPP of steel.

- **Accelerate the development of emissions reporting standards and industry-wide EPDs.** Reliable data is central to the successful implementation of GPP. Embodied emissions reporting must be rooted in accurate, supply-chain-specific data. To compare products against one another and prior years' products, this data must be reported in a clear and standardized format. These are key building blocks for GPP. Given the central role of this data in the GPP policy, these efforts should be prioritized higher through adequate resources. From the perspective of sequencing, this is the first step in GPP; without life cycle emissions data, it is impossible to set quantitative embodied emission limits. Therefore, it is the highest priority task at present.

- **GPP should evaluate international best practices to find novel ways to encourage the adoption of GPP at subnational levels**. Because of the high share of sub-national level public procurement, GPP programs in these three countries must be designed with sub-national governments in mind.

  These countries may benefit from replicating the EU GPP criteria. The EU GPP core criteria establish a common baseline: countries without the administrative capacity to invest in creating targets can use the core criteria as is, while more ambitious countries can extend the framework to establish even more ambitious targets. This creates the conditions for policy experimentation as countries find the best GPP implementation for their specific governance context. Similarly, the national governments in India, Japan, and South Korea could lay the groundwork by creating a common set of embodied carbon reduction targets for steel. This could replicate the policy framework behind the carbon price: the federal standards serve as a backstop for provinces/states that do not have their own embodied carbon policies. This significantly reduces the administrative burden of program setup for sub-national agencies. Provinces and municipalities should be able to experiment with even more ambitious GPP targets; this experimentation in different provinces may lead to novel programs that can then be incorporated into the national GPP.

Operationally, for example, the first set of requirements may be that all bids are submitted with product-level EPDs for eligible materials, including steel. If some provinces/states or municipalities have more strict GPP policies, they may require materials with embodied carbon under some maximum value. This would be permissible. However, no projects funded by national/federal fund transfers can be contracted to bidders that have not submitted EPDs. To support sub-national governments to purchase green steel or adopt GPP policies, the central government could provide additional financial incentives (e.g., the US Inflation Reduction Act includes a 2% incentive to cover the incremental costs of using low-carbon materials in federal transportation projects).

- **Get ahead of subnational GPP policies to avoid fragmentation.** Local governments may already be making moves to design their own GPP policies. National/Federal GPP should move quickly to establish common reporting standards to ensure harmonization across regions. This will significantly simplify the bidding process for suppliers and avoid repeated work ; it is unnecessary for each state/province to conduct a unique study to identify reasonable limits on embodied carbon for every steel product class.

- **Use a two-tiered approach to promote innovation while maintaining feasibility.** Procurement programs that only set a minimum environmental standard may reinforce current best practices and eliminate negligent actors from the competition. However, they do not lead to breakthrough innovation. Conversely, GPP targets that are too ambitious may be infeasible, potentially harming the competitiveness of the domestic industry. A two-tiered system like the EU GPP criteria can achieve both: the minimum criteria can be set at the industry average to ensure it is realistic, while a second tier can be set at the 90th percentile to reward innovative low-carbon materials. In practice, this ambitious tier can be applied to a percentage of public pro curements. For example, the policy can require 10% of total public procurement of steel to meet the higher, ambitious standards. It is then up to the procuring agency which projects they choose to apply the higher standards. Alternatively, the first tier can be a required minimum standard while the ambitious tier is rewarded through a discount applied to the project price, giving these projects a competitive advantage.

- **Prefer performance-based standards over prescriptive standards.** Taking learnings from the Dutch green public procurement program, GPP standards should use whole-project life-cycle assessment over product-level standards where possible. This allows for comparison across materials rather than prescribing technical details and gives the bidder the flexibility to consider trade-offs between cost, embodied emissions, and durability of materials.

- **Ratchet up standards over time.** As technological advancements are made over time, GPP targets should be adjusted to reflect new industry capabilities. This ensures that GPP continues to promote green development and innovation. Maximum GWP standards can be lowered at two- or three-year intervals. The Carbon Leadership Forum proposes two models for the rate of change. The first is a percentage reduction using the initial value as a baseline to reach nationally determined contributions, such as zero carbon by 2050. The second is to reduce the value based on the new industry average such that the maximum GWP continuously reflects the 80th percentile of industry performance (Carbon Leadership Forum 2020). Figure 36 shows how these pathways would change the GWP limit over time.

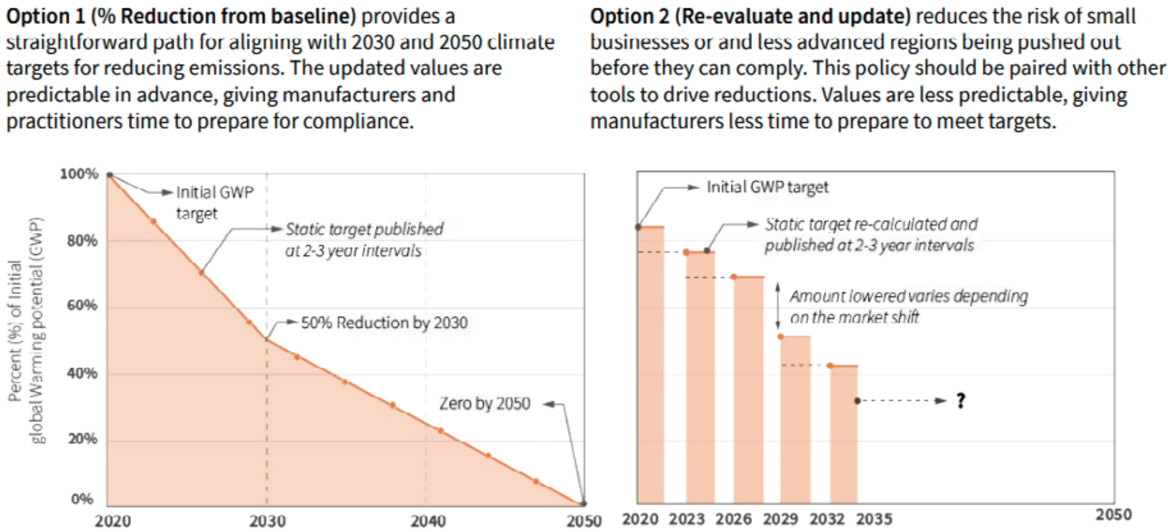


Figure 36. Two options for reducing maximum global warming potential (GWP) limits over time (Carbon Leadership Forum 2020)

- **Invest in programs to build capacity.** The use of EPDs and whole-project life cycle analysis will require a change in long-standing construction and procurement practices. It will take training for engineers to become familiar with the appropriate use of new materials, for construction workers to update processes such as concrete curing, and for procurement officers to adapt to evaluation criteria that go beyond the least cost. National GPP should invest in creating training materials and programs to build this capacity. It would be valuable to create a team to assist sub-national governments and private entities in the implementation of green procurement, similar to the support offered by PIANOo in the Netherlands. This team could build expertise on embodied carbon, life cycle analysis, and tender creation; this could translate into online resources and acting as consultants to other public agencies.

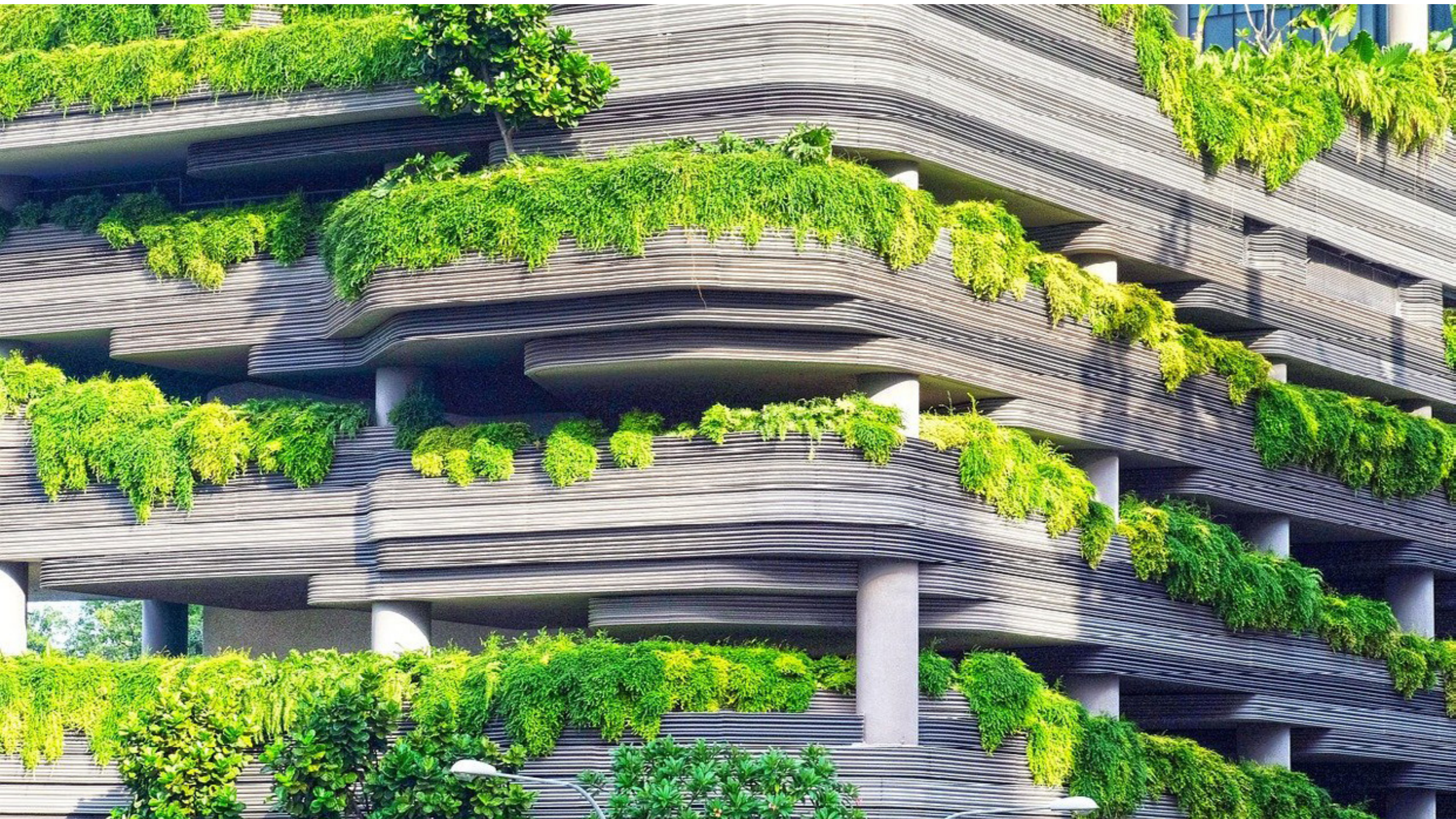
- **Create tools that can automate and simplify the implementation of the GPP policy.** Many states/provinces and cities with smaller bureaucracies do not have the time and resources to invest in green procurement. The national government should invest in software tools that simplify creating tender documents with environmental criteria, evaluating bids that reward emissions reductions, and monitoring during construction. Creating this suite of tools simplifies the implementation of GPP, making it easier for procurement officials at all levels of government to prioritize environmental objectives. If the tools are open-sourced, they may even be adopted by the private sector. An example of this is the Dutch DuboCalc: an LCA-based tool developed by the Rijkswaterstaat (Department of Public Works of the Dutch Ministry of Infrastructure and the Environment) to calculate and compare the environmental impact of procurement. This tool is open to the public and can be used by the private sector as well as the public sector, lowering the barrier to the adoption of green procurement practices economy-wide.

- **Protection against offshoring through a carbon border adjustment mechanism (CBAM).** For the trade-exposed steel industry where public procurement is not a significant portion of the total market share, it may not be economical for manufacturers to invest in retrofitting or adopt sustainable practices. This is because companies that invest in low-carbon technology may need to charge a price premium on their products, causing consumers to search for cheaper options abroad. To mitigate these risks, assurances should be made that action will be taken to prevent emissions leakage in the private sector if necessary. This may be in the form of a carbon border adjustment mechanism (CBAM). The details of this measure are complex as they should be harmonized with major trade partners and complement the carbon price.

- **Continue to invest in industrial transformation.** The government should provide loans, grants, and financial support programs to help steel companies pay the upfront costs required for retrofitting industrial facilities, building new facilities, and retraining workforces.

- **Collaborative program design.** Businesses and stakeholders should be engaged in the process of setting standards for the GPP program. This ensures that the program is designed with the idiosyncrasies of each sector in mind. Where the steel industry has already developed voluntary standards for reporting environmental impact, these should be factored into evaluation criteria. Prior practices benefit from existing adoption and industry experience in measurement and reporting. These can help speed up GPP implementation and makes the program more likely to be successful. Stakeholder engagement also allows the steel industry to voice concerns early and often.

- **Investment in manufacturing dependencies.** Decarbonizing the steel sector is a challenging task that companies will not be able to achieve alone. Policies that invest in making manufacturing dependencies more sustainable will have positive downstream impacts on these companies. Public investment in clean energy supply chains, deployment of renewables, green hydrogen, improved energy stor age, and grid modernization will help steel manufacturers in India, Japan, and South Korea reduce embodied emissions.



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