

Federal Buy Clean For Cement And Steel

Policy Design And Impact On Industrial Emissions And Competitiveness



Ali Hasanbeigi, Dinah Shi and Harshvardhan Khutal



**Global
Efficiency
Intelligence**

Acknowledgements

This report was made possible with support from the Third Way. The authors would like to thank John Milko and Ryan Fitzpatrick of Third Way, Mengjue Zhu, and Aaditee Kudrimoti of Global Efficiency Intelligence, Matt Bright of The Global CCS Institute, and Renilde Becque for their valuable input to this study and/or their insightful comments on the earlier version of this document.

Disclaimer

Global Efficiency Intelligence, LLC has provided the information in this publication for informational purposes only. Although great care has been taken to maintain the accuracy of the information collected and presented, Global Efficiency Intelligence, LLC does not make any express or implied warranty concerning such information. Any estimates contained in the publication reflect Global Efficiency Intelligence, LLC's current analyses and expectations based on available data and information. Any reference to a specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply an endorsement, recommendation, or favoring by Global Efficiency Intelligence, LLC.

This document may be freely quoted or reprinted, but acknowledgment is requested.

Suggested citation format: Hasanbeigi, Ali; Shi, Dinah; Khutal, Harshvardhan. 2021. Federal Buy Clean for Cement and Steel - Policy Design and Impact on Industrial Emissions and Competitiveness. Global Efficiency Intelligence, LLC. Tampa Bay Area, U.S.

<https://www.globalefficiencyintel.com>

Executive Summary

The United States spends billions of dollars each year on government procurement. In 2018, the United States spent \$110 billion in federal non-defense investments in physical capital that among other things, result in the development of infrastructure like highways, bridges, etc. which support the overall long-term growth of the U.S. economy. President Joe Biden's proposed American Jobs Plan aims to invest around \$2.3 trillion this decade with \$1.3 trillion going toward infrastructure spending. That means substantial amount of construction materials including cement and steel will be used in government-funded projects.

The cement and steel industry combined account for around 15% of global anthropogenic greenhouse gas (GHG) emissions in the world. The United States is the 4th largest producer and consumer of cement and steel in the world. Total cement consumption in the U.S. was 98.5 million tonne (Mt) in 2018. From that, around 45 Mt was used in public constructions, which is 46% of total cement used in the U.S. Total steel consumption in the U.S. was 101 Mt in 2018. Slightly less than half of the steel used in the U.S. is for construction, and roughly 18% of total steel use in the U.S. is for public construction.

Both federal and state government should leverage their large-scale purchasing power by buying goods and services with a lower carbon footprint, and help drive markets in the direction of sustainability, reduce the negative impacts of their use of goods, and produce positive environmental and social benefits. Many governments around the world have already recognized the value of green public procurement (GPP) - otherwise often referred to in the U.S. as Buy Clean - as a policy instrument and are trying to leverage the money they invest in large contracts to achieve decarbonization goals.

There are some new positive developments in the United States related to Buy Clean – a policy that requires the government to consider embodied carbon in its procurement decisions and reward producers and contractors with lower embodied carbon footprints. In January 2021, President Biden issued an Executive Order to consider additional regulatory steps the federal government can make to promote increased contractor attention on supply chain emissions. The House of Representatives also introduced a bill in March 2021 – the Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act – containing provisions establishing a Buy Clean framework for federal procurement. There are also Buy Clean policies at the state level. California led the way by passing a Buy Clean Act in 2017, and several other states such as Washington, Oregon, Minnesota, Colorado, New York and New Jersey are considering ways to implement their own state-level Buy Clean policy as well.

Buy Clean could help American manufacturing become more competitive in a growing global market of green construction products; maintain the domestic competitive advantage of energy-intensive, trade-exposed industries; reduce the price of green products; and induce green innovation. Public procurement for large infrastructure projects can have a significant effect on the market by stimulating demand. Buy Clean can directly bolster manufacturing competitiveness by increasing demand for green products, which leads to two direct outcomes. The first is reducing costs through economies of scale. The second is reduced prices through increased competition. An increase in demand for green products encourages new suppliers to enter the green market, raising supply and lowering the price of green products. Increased competition in the market can stimulate innovation. Green public

procurement programs establish demand certainty and build confidence in the existence of future markets for low-carbon materials, which enables suppliers to justify high switching costs and research and development (R&D) expenditures.

Buy Clean would reward domestic U.S. steel producers for having lower CO₂ intensity than most of their foreign competitors and encourage the production of steel in the U.S. using lower carbon-intensive production processes using EAF. This will save and even create new high-paying jobs in the steel industry, especially in key steel-producing states such as Indiana, Ohio, Michigan, and Pennsylvania. Continuous efficiency improvement, supply of low-cost domestic natural gas, and decarbonization of the U.S. electric grid by the deployment of more renewable energy will help U.S. steel producers to keep their competitive advantage in the near- and medium-term.

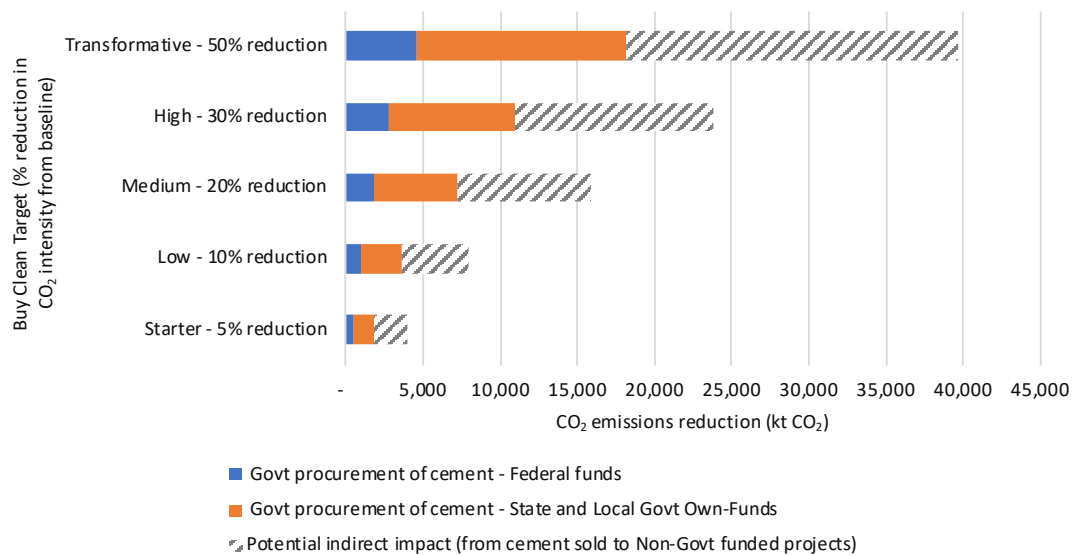
The federal and state governments procurement should reward domestic U.S. steel producers for their competitive carbon advantage over countries the U.S. is importing steel from.

In this study, we estimated the CO₂ emissions associated with cement and steel used in public construction projects and the potential impact of Buy Clean to reduce those emissions. Approximately half of the annual CO₂ emissions associated with cement consumption is associated with public construction which was around 36 Mt CO₂ in 2018. Of this, around 25% is associated with government-funded projects using federal funds and the remaining is related to public projects using states and local governments-own funds.

Around 18% of the annual CO₂ emissions associated with steel consumption is associated with public construction which was around 21 Mt CO₂ in 2018. Of this, about 27% is associated with government-funded projects using federal funds and the remaining is related to public projects using states and local governments-own funds.

Figure ES1 shows the annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the U.S. in 2018. We also made similar estimates for selected states as well as Buy Clean for steel in the U.S. (see chapter 3).

For the United States to meet its climate change mitigation commitment and stay in course to meet its Paris Agreement goals, it is crucial to address the carbon emissions embodied in public construction, especially for carbon-intensive materials such as cement and steel. While state-level Buy Clean policies are great to get started in the U.S., a federal Buy Clean policy is needed to have a larger impact especially in view of proposed infrastructure spending. Despite the existence of several barriers to federal Buy Clean, policymakers can take advantage of international best practices to set up federal Buy Clean for construction materials, especially cement and steel. In this study, we looked at several international best practices on Buy Clean in other countries and made recommendation for the U.S. federal Buy Clean policy.



Note: Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded construction projects.

Figure ES-1. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the U.S. in 2018 under different Buy Clean targets.

Some of the key aspects of international best practices of green public procurement policies that can be adopted in the U.S. for successful design and implementation of federal Buy Clean for construction materials are:

- Design criteria at the national level and implement at the national, state, and local levels by an individual entity and enforced by law
- Establish standardized reporting and evaluation. Standardized reporting could entail mandatory life cycle analysis for entire project bids and/or use of environmental product declaration (EPD) for materials and products.
- Make tools and databases created to support Buy Clean publicly available.
- Establish programs and funds to help bidders adopt these new practices and help them in Life cycle assessment (LCA) and EPD preparation, which can be an expensive and complex process.
- Include policy elements that promote innovation. Increase standards over time to account for technological improvements and encourage continued emissions reduction.

Industry support is one the key drivers of success in Buy Clean programs. Businesses need to be willing to participate in Buy Clean to make manufacturing more sustainable and spur innovation. Thoughtful policy design that promotes stakeholder engagement, transformation support, and protection against the unfair competition can increase support for Buy Clean from businesses, trade associations, and other key stakeholders.

Table of Contents

Executive Summary	2
1. Introduction	7
2. Scale of Government Procurement of Construction Materials in the U.S.	9
2.1. Cement used in public construction and associated GHG emissions	11
2.2. Steel used in public construction and associated GHG emissions	14
3. Potential Impact of Federal Buy Clean on Industrial GHG Emissions	17
3.1. Potential impact of federal Buy Clean on cement industry's emissions	17
3.2. Potential impact of federal Buy Clean on steel industry's	22
4. How Does Buy Clean Help American Manufacturing Competitiveness?	27
5. Current and Proposed Buy Clean policies in the U.S.	31
5.1. Federal-level Buy Clean programs	31
5.2. State-level Buy Clean programs	36
6. Barriers to Federal Buy Clean for the Construction Materials in the U.S.	39
7. Recommendations for Federal Buy Clean for construction Materials Based on International Best Practice	41
7.1. International best practices	41
7.2. Adoptable best practices for U.S. federal Buy Clean	42
7.3. Policy design to encourage industry support for Buy Clean	43
8. Conclusions	46
References	48
Appendices	53
Appendix 1. Methodology and assumptions	53



Public procurement accounts for an average of 12 percent of gross domestic product (GDP) in Organization for Economic Cooperation and Development (OECD) countries, and up to 30 percent of GDP in many developing countries. When public entities leverage their large-scale purchasing power by buying goods and services with a lower carbon footprint, they help drive markets in the direction of sustainability, reduce the negative impacts of their use of goods, and produce positive environmental and social benefits (UNEP, 2017).

The United States spends billions of dollars each year on government procurement. In 2018, the United States spent \$110 billion in federal non-defense investments in physical capital that among other things, result in the development of infrastructure like highways, bridges, etc. which support the overall long-term growth of the U.S. economy (Campbell & Tawil, 2019). The next chapter presents more detailed information on the scale of government procurement of construction materials in the U.S.

The European Commission, in its communication entitled “public procurement for a better environment,” defines green public procurement (GPP) as “...a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured” (Interreg Europe 2018). GPP’s potential has been increasingly recognized both nationally and internationally. The United Nations (UN) also highlighted the importance of public procurement in its sustainable development goals.

In the United States, green public procurement (GPP) is often referred to as “Buy Clean”.

Many governments around the world have already recognized the value of GPP as a policy instrument and are trying to leverage the money they invest in large contracts to achieve green goals. Hasanbeigi et al. (2019) studied 30 such programs, 22 of which are in countries in Asia, Europe, North and South America, Africa, and Oceania, five case studies at the city and regional level, as well as GPP programs of three multi-lateral banks and the UN to promote sustainable production and consumption (Hasanbeigi, et al. 2019).

President Joe Biden’s proposed American Jobs Plan aims to invest around \$2.3 trillion this decade with \$1.3 trillion going toward infrastructure spending (Probasco 2021). In the United States, 55% of GHG emissions attributed to public institutions are a result of government-purchased goods and products. There is little federal, state, or local regulatory framework to address these emissions, but several voluntary national programs (e.g., Leadership in Energy and Environmental Design (LEED) and Living Building Challenge) have evolved to strengthen the focus on embodied carbon reduction. Some cities and states view procurement-based policies as a key opportunity to reduce carbon emissions. Implementation of the Buy Clean California procurement policy may act as a model for other jurisdictions considering embodied carbon policies (Simonen, Huang, & Huang, 2018).

Buy Clean

There are some new positive developments in the United States related to Buy Clean. In January 2021, President Biden issued Executive Order 14008 to consider additional regulatory steps the federal government can make to promote increased contractor attention on supply chain emissions. (White House 2021). Two bills were proposed in March 2021 to realize these goals: the Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act and the Better Utilizing Investments to Leverage Development and Generating Renewable Energy to Electrify the Nation's (BUILD GREEN) Infrastructure and Jobs Act.

The CLEAN Future Act is a comprehensive bill from the House Energy and Commerce Committee that proposes both sector-specific and economy-wide policies to achieve net-zero GHG emissions by 2050. In the industrial sector, the bill proposes to reduce embodied emissions in projects involving federal funds by increasing transparency of embodied emissions in construction products, establishing a Federal Buy Clean program, and creating a Climate Star program (E&C 2021).

The BUILD GREEN Act focuses on electrification of the transportation sector, which accounts for 29% of U.S. emissions, and upgrading infrastructure (EPA 2019). Modeled after the Department of Transportation's (DOT) BUILD grant program, it proposes to invest \$500 billion in grant funding for states and local governments to electrify public transit systems and modernize roads, bridges, and rail. Eligible projects are required to add renewable energy generation to cover the energy consumed by the project (Warren 2021).

These pieces of the legislature would greatly augment the scope of federal Buy Clean in the United States and increase public awareness of embodied emissions. However, it remains to be seen whether the bills will be passed in their current forms.

This report aims to investigate the scale of public procurement of construction materials in the U.S., estimate the potential the impact of federal Buy Clean on GHG emissions from the cement and steel industry, the impact of federal Buy Clean on U.S. manufacturing competitiveness, and how policy design could help to gain support from industry for a federal Buy Clean program. It also reviews the current and proposed Buy Clean policies in the U.S. and makes recommendations for federal Buy Clean for construction materials based on international best practices.

The main focus of this report is Buy Clean for construction materials, especially cement, concrete, and steel.



2

Scale of Government Procurement of Construction Materials in the U.S.

Earlier in 2021, we published a report titled [“Scale of Government Procurement of Carbon-Intensive Materials in the United States”](#) (Hasanbeigi and Khutal, 2021). This report analyzed the scale of government procurement of carbon-intensive materials (in particular, concrete, cement, steel, aluminum, and glass), both at the federal and state-levels, for the development of infrastructure in the U.S. It analyzed the scale of federal funds provided to state and local governments for the development of physical capital, the amount of federal spending on imported and domestic materials for infrastructure projects, and specific states where federal funds are used to purchase significant amounts of materials for infrastructure projects.

Figures 1 and 2 below provide a quick overview of the distribution and scale of federal spending and procurement. Figure 1 provides a breakdown of total federal outlays on investment based on 2018 data (Campbell & Tawil, 2019). Figure 2 provides an estimate of the scale of federal spending on construction and procurement of certain construction materials, based on BEA’s 2012 Use table data – the most recent available input-output data in the U.S. (U.S. BEA, 2020a). The two figures are linked since the federal spending on construction is a subset of federal investment in physical capital.

Figure 3 shows that funding for transportation dominates the overall federal non-defense spending on physical capital, accounting for around 58% (\$63.9 billion) of the total. Of the \$63.9 billion in transportation funding, almost 92% (\$58.8 billion) was issued through grants to state and local governments, whereas, the remaining 8% represented direct spending by the federal government. These grants to state and local governments concentrate on the development of highways, mass transportation, and airports. (Campbell & Tawil, 2019).

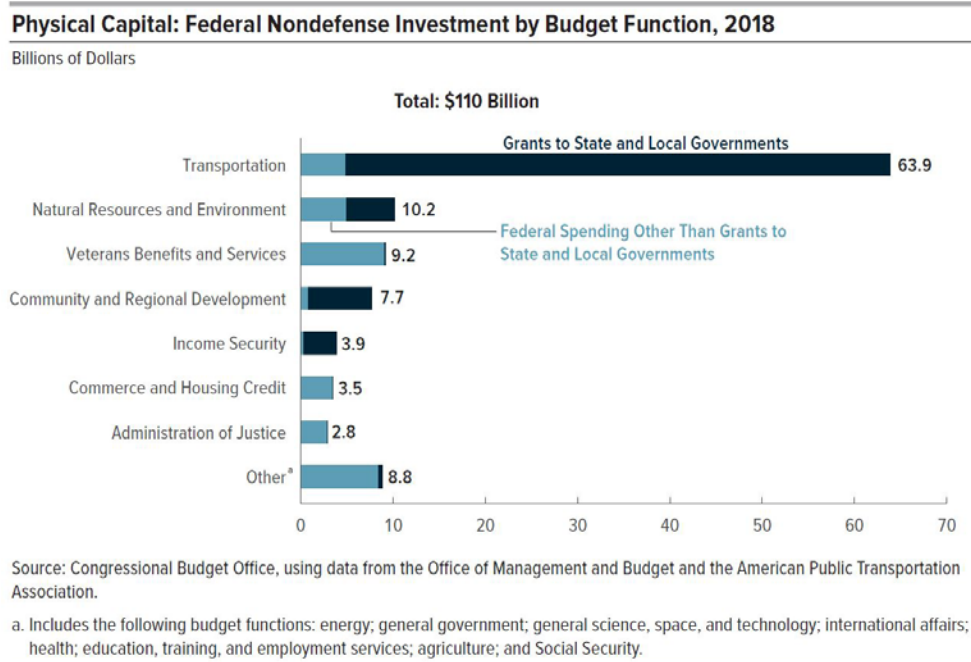


Figure 3. Breakdown of federal non-defense expenditure in physical capital (Campbell & Tawil, 2019)

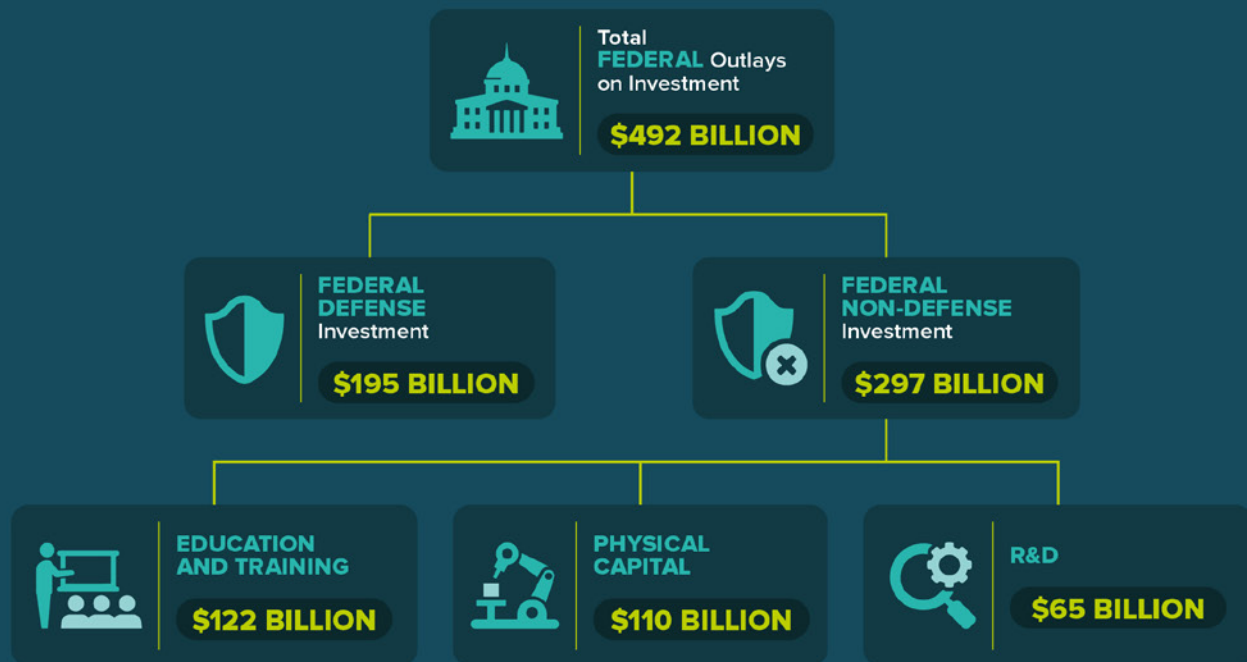


Figure 1: Distribution of Federal Outlays on Investment in 2018 (Campbell & Tawil, 2019)

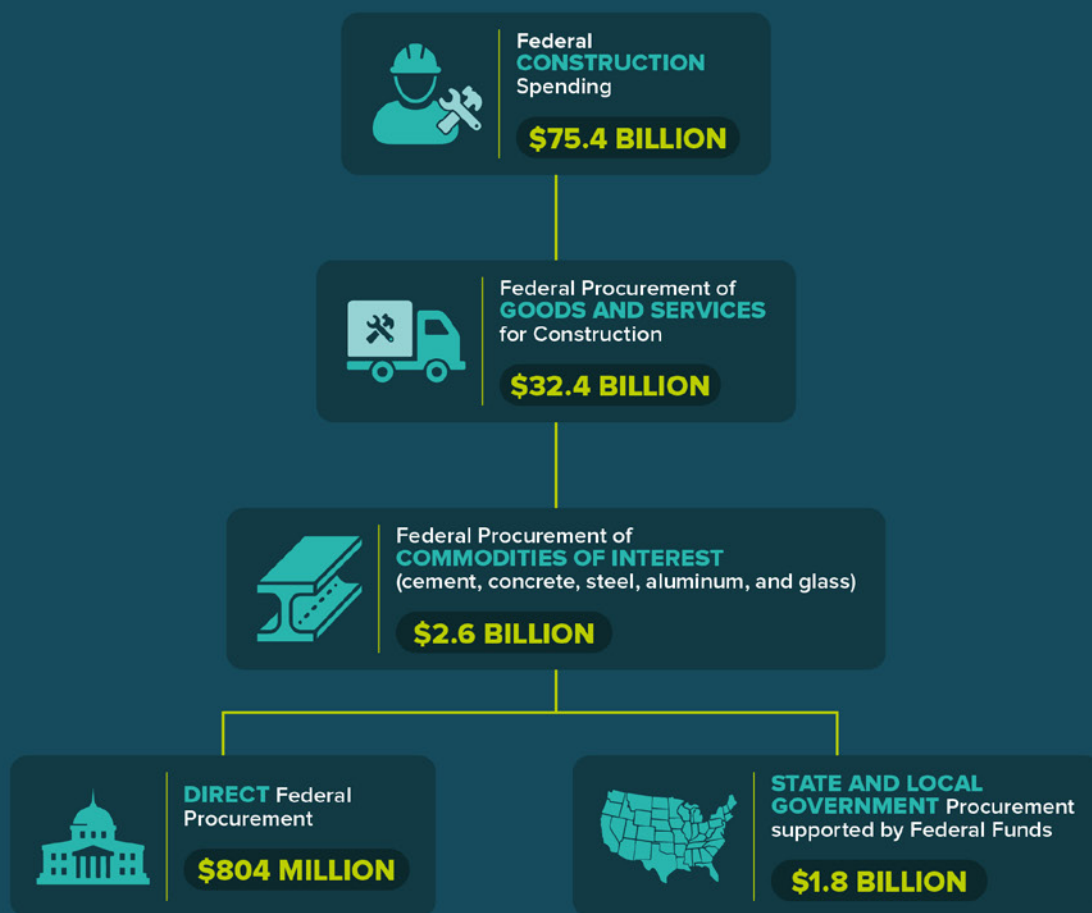


Figure 2: Scale of Federal Construction Spending and Procurement of Commodities in 2012 (U.S. BEA, 2020a) (Note: the latest input-output data available from BEA and used in this analysis was for 2012)

The main focus of this report is the cement and steel industry. Therefore, we looked into the consumption of cement and steel for public construction projects.

2.1. Cement used in public construction and associated GHG emissions

The United States produced 86 million metric tonnes (Mt) of Portland cement and masonry cement in 2018. The United States is the 4th largest producer and consumer of cement in the world. Cement was produced at 96 plants in 34 states in 2018. Of those, 86 plants employed the dry kiln process, and 9 used the wet kiln process. Sales of cement in 2018 were around \$12.7 billion. Texas, California, Missouri, Florida, Alabama, Michigan, and Pennsylvania have the highest cement production, in that order, and they account for about 60% of U.S. cement production (USGS 2020a).

Total cement consumption in the U.S. was 98.5 Mt in 2018 (USGS 2020a). From that, around 45 Mt was used in public construction projects, which is 46% of total cement used in the U.S. (Figure 4) (PCA 2016). Table 1 shows the detailed breakdown of cement consumption by market segment in the U.S.

It should be noted that in the majority of cases, the government or its contractors do not purchase cement and instead purchase concrete (mainly ready-mix concrete) which is the final product used in construction projects. The values shown in this chapter include the cement used in concrete that is used in construction projects.

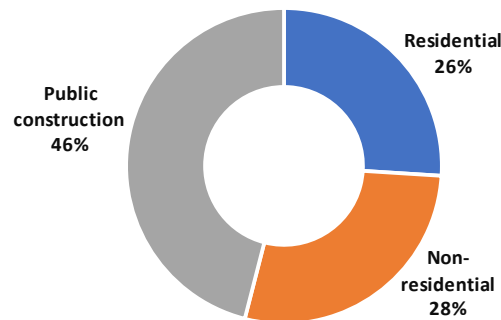


Figure 4. Apparent use of Portland cement by the market in the U.S. (PCA 2016)

Table 1. Cement consumption in the U.S. in 2018 (USGS 2020a, PCA 2016)

Market	Cement use (kt)
Total cement consumption	98,500
Public construction	45,136
Building	2,520
Highways and streets	31,084
Public safety	195
Conservation	3,066
Sewage & Waste Disposal	4,698
Water Supply Systems	3,572

Note: 1) public construction values for 2018 are estimated based on 2016 values given by PCA (2016)
 2) The values shown in the table include the cement used in concrete that is used in construction projects.

Figure 5 below shows the total cement consumption in selected states, as obtained from PCA (2019). Texas accounts for the highest cement consumption followed by California and Florida. Most of the selected states are among the top cement consuming states in the U.S.

We used the share of cement used in public construction from total cement used in the U.S. (46%) as a proxy for estimating the cement used for public construction in each state. Around 25% of total cement and concrete procured by the government in the U.S. is by means of federal funds and the remaining through the use of state and local government-own funds (Hasanbeigi and Khutal 2021). We used this 25:75 ratio to estimate the government procurement of cement using federal funds, and state and local government-own funds in each state (Figure 6).

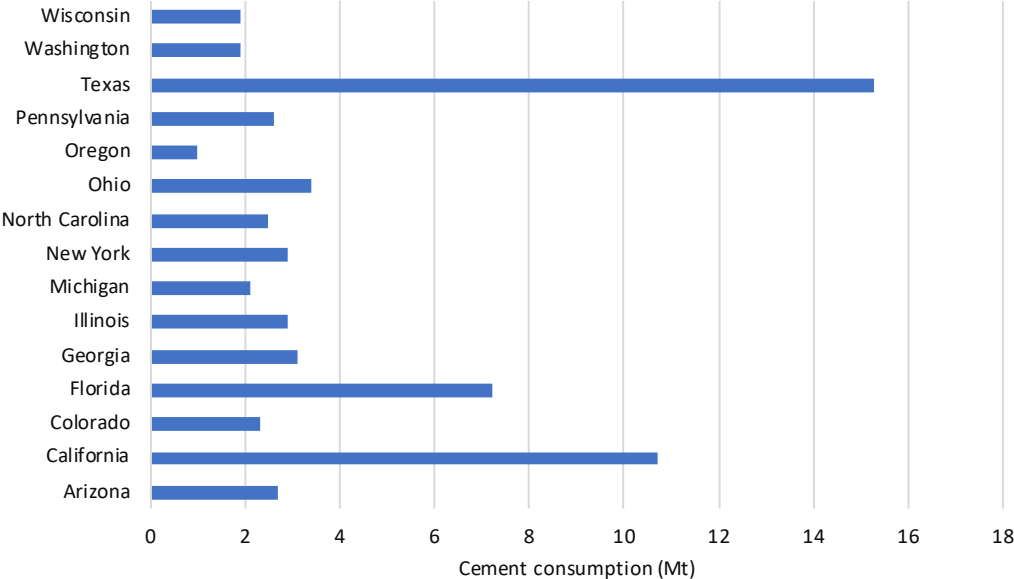


Figure 5. Total cement consumption in selected states in 2018 (PCA 2019)

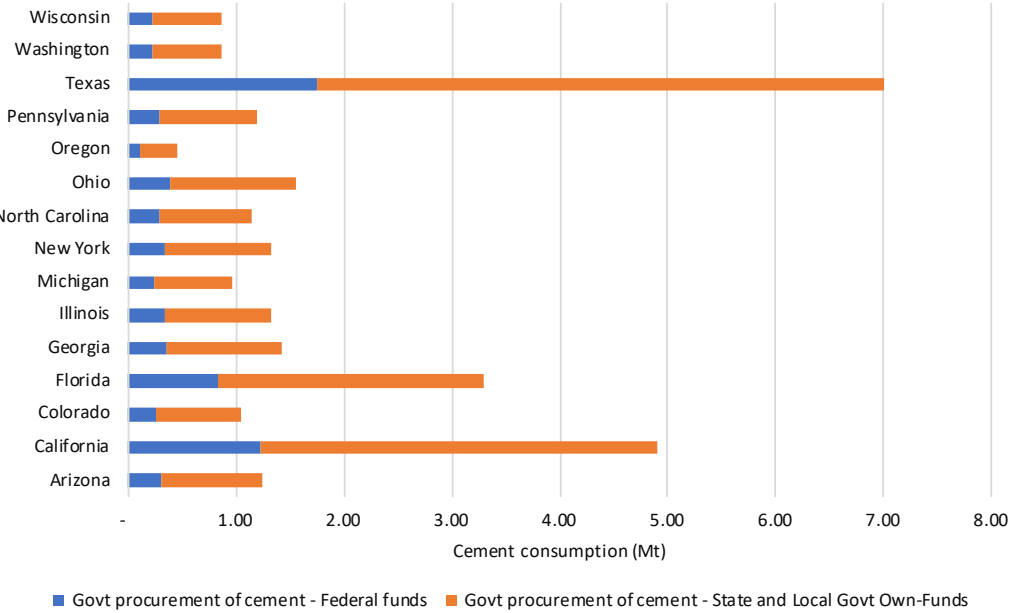


Figure 6. Total cement consumption in Public Construction in 2018 in selected states

Figure 7 and Figure 8 show annual CO₂ emissions associated with cement used in the U.S. and selected states in 2018. We used the weighted average CO₂ intensity of cement produced in the U.S. and net imported cement to calculate annual CO₂ emissions associated with cement consumption. Around half of the annual CO₂ emissions linked with cement consumption are associated with public construction which was around 36 Mt CO₂ in 2018. Therefore, government procurement has significant leverage in incentivizing decarbonization of the cement production.

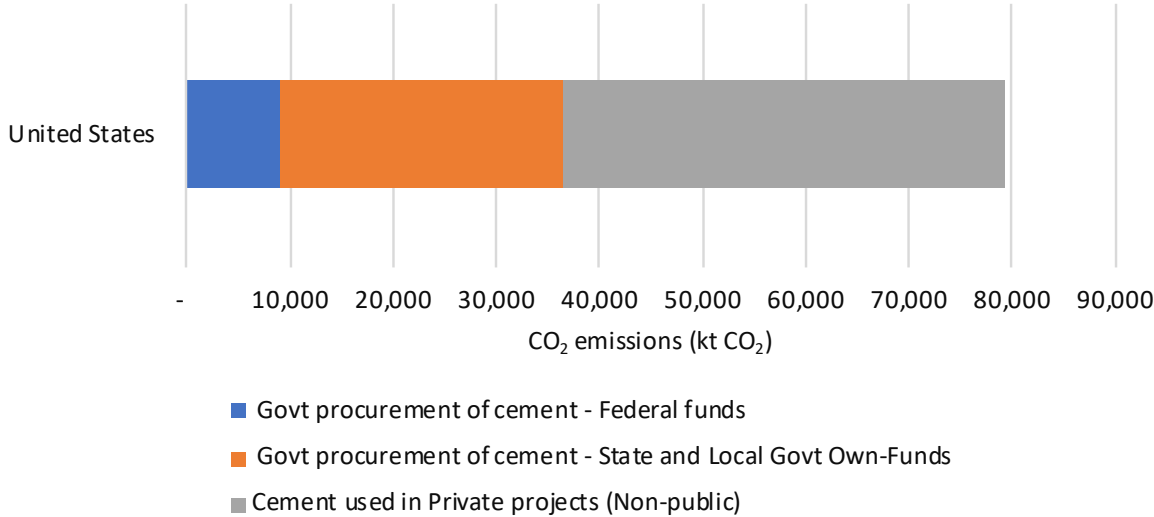


Figure 7. Annual CO₂ emissions associated with cement used in the U.S. in 2018

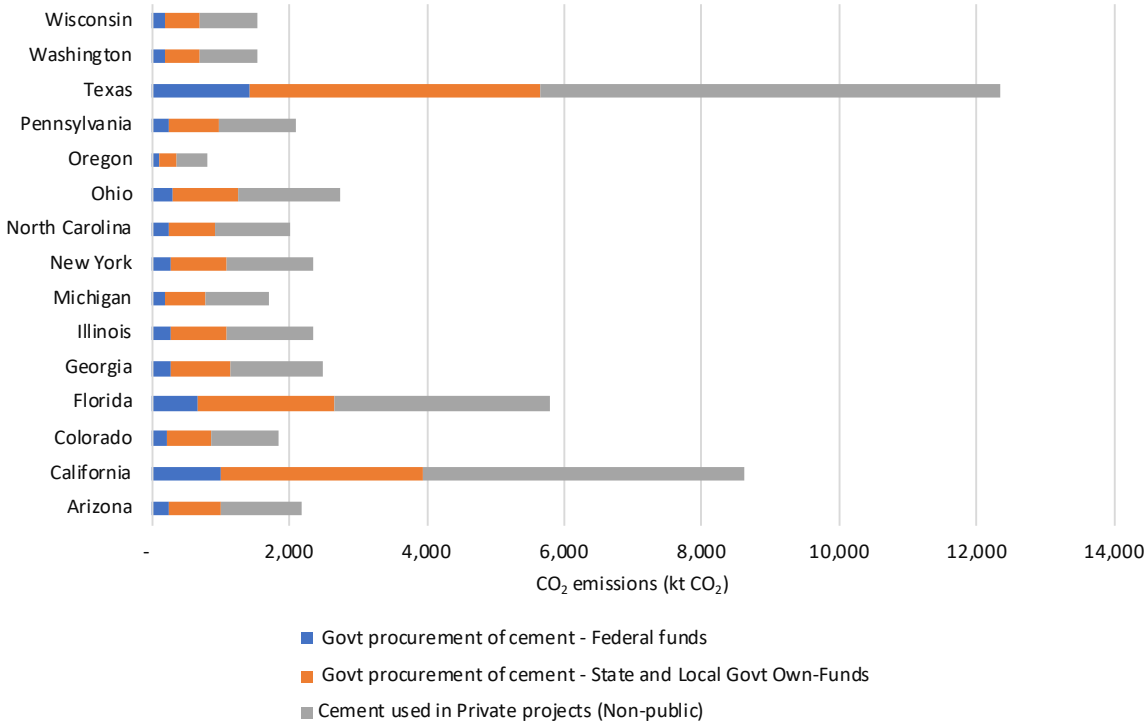


Figure 8. Annual CO₂ emissions associated with cement use in selected states in 2018



2.2. Steel used in public construction and associated GHG emissions

The U.S. steel industry produced 87 Mt of crude steel in 2018, of which 33% was produced by primary steelmaking plants using blast furnace-basic oxygen furnace (BF-BOF) and 67% was produced by the electric arc furnace (EAF) production route, which mainly uses steel scrap but can also use direct reduced iron (DRI). The U.S. also imported 32 Mt and exported 8 Mt of steel mill products in 2018. The United States is the 4th largest producer and consumer of steel in the world. The value of products produced by the U.S. iron and steel industry and ferrous foundries in the United States in 2018 was about \$137 billion. The BF-BOF plants in the United States that produce pig iron and crude steel are operated by three companies that have integrated steel mills in nine locations. The EAF steel plants are owned by 51 companies producing crude steel at 99 minimills. BF-BOF and EAF steel plants together employed around 81,000 people, and iron and steel foundries employed an additional 64,000 people in the United States in 2018. Indiana accounted for 27% of total crude steel production, followed by Ohio (12%), Michigan (6%), and Pennsylvania (6%) (USGS 2020b).

Total steel consumption in the U.S. was 101 Mt in 2018. Around 43% of the steel used in the U.S. is for construction. The second-largest market segment is the transportation, predominantly the automotive sector (USGS 2020b).

Based on the share of steel for construction from the total used in the U.S. (43%) (USGS 2020b) and the share of government spending as a proportion of total construction spending in the U.S. of 41% (US BEA 2020, Hasanbeigi and Khutal 2021), we estimated that around 18% of the total steel used in the U.S. is for public construction. Consequently, around 25% of the total steel used in the U.S. is for private construction. In addition, we estimated that around

27% of total steel procured by the government in the U.S. for construction uses federal funds, and the remaining uses state and local government-own funds (Hasanbeigi and Khutal 2021). Table 2 shows the estimated amount of steel used in government-funded projects in the U.S. in 2018.

It should be noted that the government procures other products that include steel (e.g. vehicles, appliances, etc.). The government procurement of steel presented in this table and analyzed in this report only focuses on steel used in construction.

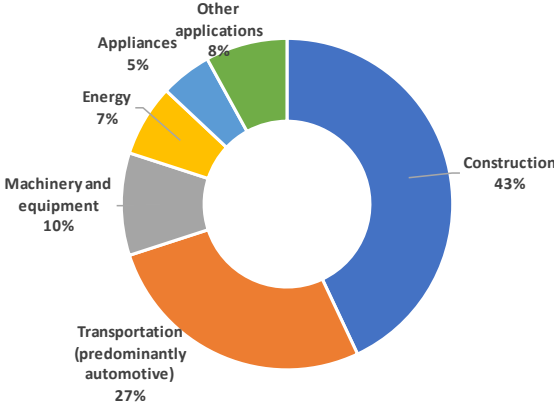


Figure 9. Domestic shipments of steel in the U.S. by market classification in 2018 (USGS 2020b)

Table 2. Steel consumption in the U.S. in 2018 (USGS 2020b; our analysis based on U.S. BEA 2020 and Hasanbeigi and Khutal 2021)

Market	Steel use (Mt)
Total steel consumption in the U.S.	101
Total steel used in public construction	18
Government procurement of steel - federal funds	5
Government procurement of steel - State and local Govt own-funds	13
Total steel used in private construction	26

Note: Government procures other products that include steel (e.g. vehicles, appliances, etc.). The government procurement of steel presented in this table and analyzed in this report only focuses on steel used in construction.

Figure 10 shows annual CO₂ emissions associated with steel used in the U.S. in 2018. We used the weighted average CO₂ intensity of steel produced in the U.S. and net imported steel to calculate annual CO₂ emissions associated with steel consumption. Approximately 18% of the annual CO₂ emissions associated with steel used in the U.S. are associated with public construction. Therefore, government procurement has significant leverage in incentivizing decarbonization of the steel production.

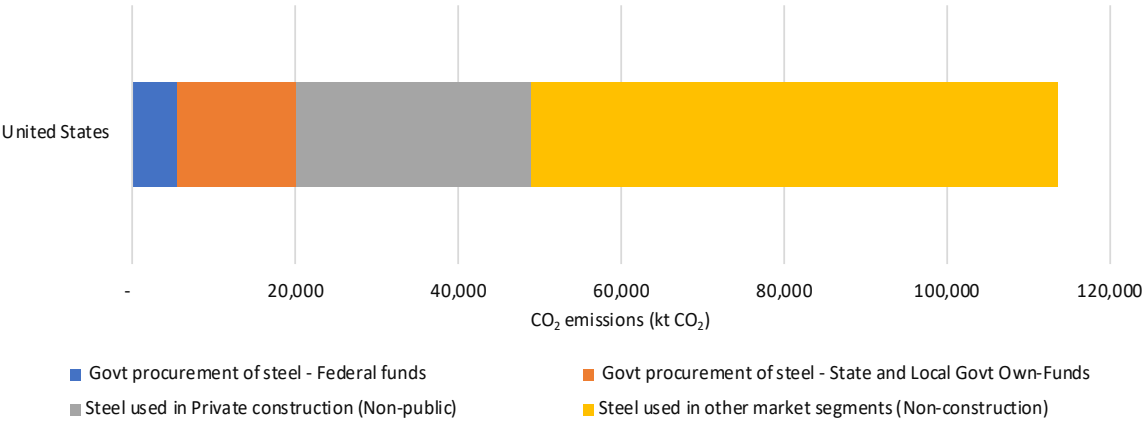


Figure 10. Annual CO₂ emissions associated with steel used in the U.S. in 2018



Potential Impact of Federal Buy Clean on Industrial GHG Emissions

In this section, we present the results of our analysis to estimate the potential impact of federal Buy Clean on the GHG emissions associated with cement and steel used in the U.S.

3.1. Potential impact of federal Buy Clean on cement industry's emissions

To estimate the potential impact of Buy Clean on GHG emission associated with cement used in the U.S., we developed several scenarios with various Buy Clean targets for CO₂ intensity of cement set by a Buy Clean policy (Table 3). It should be noted that the Buy Clean intensity targets shown in the table below are industry-level targets and not for a specific cement product. In reality, a Buy Clean policy is more likely to set product-specific intensity targets rather than industry-level targets like in California's Buy Clean policy (DGS 2021). However, because of the lack of information and also the existence of so many different cement (and concrete) 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 Buy Clean cement.

Table 3. Buy Clean target scenarios for the cement industry

Buy Clean Target	% reduction in cement CO ₂ intensity from baseline	Cement CO ₂ intensity (kgCO ₂ /t cement)*	Potential actions for CO ₂ emissions reduction**
Baseline	-	806	This is the weighted average of CO ₂ intensity for both domestic and imported portland cement. The assumed clinker to cement ratio for both domestic and imported cement is 0.9.
Starter	5%	766	Can be achieved by small effort in energy efficiency improvement, fuel switching to lower carbon fuels, and a small addition of supplementary cementitious materials (SCMs) instead of clinker
Low	10%	725	Can be achieved by low effort in energy efficiency improvement, fuel switching to lower carbon fuels, and the addition of SCMs instead of clinker
Medium	20%	645	Can be achieved by maximizing energy efficiency improvement, more aggressive fuel switching to lower carbon fuels, and higher use of SCMs instead of clinker
High	30%	564	Can be achieved by maximizing energy efficiency improvement, substantial phase-out of coal and pet coke and switching to lower carbon fuels, and substantially higher use of SCMs instead of clinker. CCS can help to achieve it easily
Transformative	50%	403	Will require CCS to achieve this target. This stimulates innovation and adoption of transformative technologies

* The Buy Clean intensity targets show in this table are industry-level targets and not for a specific product.

** More detailed information on potential actions for CO₂ emissions reduction can be found at (IEA 2018, Bataille 2019, Hasanbeigi and Springer 2019c, Friedmann et al. 2019, Material Economics 2019, McKinsey & Company 2018, Sandalow et al. 2019).

Potential activities for emissions reduction

In the U.S. cement industry, process-related CO₂ emissions from calcination accounted for over 50% of total CO₂ emissions related to calcination process. In other words, more than half of the CO₂ emissions from the U.S. cement industry are not associated with energy use. Therefore, deep decarbonization in the cement industry (Transformative scenario) cannot be achieved even by best available energy-efficient technologies or fuel switching alone. Clinker substitution and CCUS are imperative in order to achieve deep decarbonization in the cement industry. Material efficiency and circular economy measures can help to reduce the carbon footprint of cement and concrete use in the demand side. Below we briefly discuss major decarbonization levers for the cement industry (IEA 2018, Bataille 2019, Hasanbeigi and Springer 2019c, Friedmann et al. 2019, Material Economics 2019, McKinsey & Company 2018, Sandalow et al. 2019)

Energy efficiency: Many energy efficiency technologies are already ready to be deployed on a commercial scale. These include waste heat recovery (WHR) technologies, high efficiency clinker cooling and grinding processes, and the use of multistage preheater/precalciner kilns, strategic energy management, smart sensors and advanced analytics, etc.

Fuel switching: Switching away from coal and petroleum coke to lower-carbon fuels such as natural gas or biomass that are available in large quantities and can be easily used in cement plants with current technology is the main fuel switching option in the near-term. In the long-term, no-carbon fuels (e.g. green hydrogen, renewable natural gas, or electrification of process) should be considered.

Clinker substitution: All the fuel use and around 60% of the electricity used in a cement plant is consumed for clinker production (for raw material grinding, fuel preparation, and cement kiln). A higher clinker-to-cement ratio results in higher energy intensity per tonne of cement produced. Replacing clinker with supplementary cementitious materials (SCMs) such as fly ash, blast furnace slag, natural pozzolans, ground limestone, and calcined clay can help to significantly reduce energy intensity per tonne of cement produced.

Carbon capture, utilization, and storage (CCUS): CCUS technologies are emerging for the cement industry that capture and compress CO₂ emissions and permanently store them. The carbon capture technologies are being piloted and demonstrated at several cement plants around the world, while some carbon utilization technologies are fully commercialized and adopted in large scale such as the CarbonCure technology.

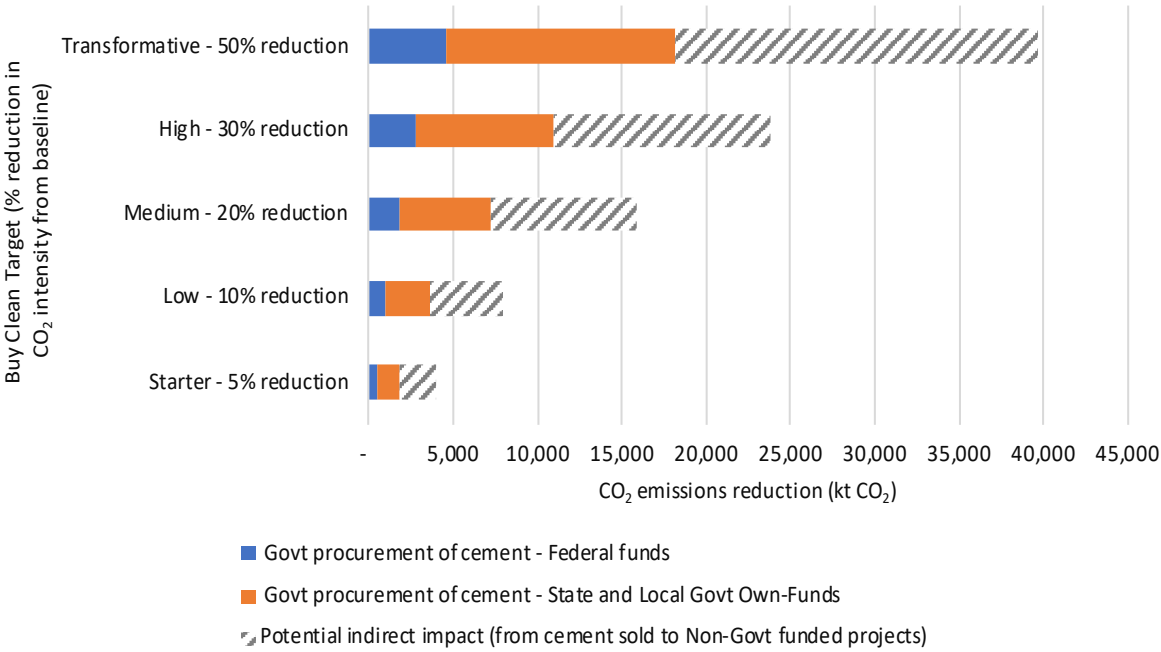
Potential impact of Buy Clean cement

Using the annual CO₂ emissions associated with cement used in the U.S. presented in the previous chapter and the targets set in Table 3, we estimated the annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the U.S. and selected states in 2018 (Figure 11-15).

Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded projects. The scale of such indirect impact is unknown; therefore, it's shown by striped bars on the charts.

Under the Low scenario for Buy Clean target for cement, annual emissions reduction of 3.6 Mt CO₂ can be achieved directly from government procurement of cement for construction. This direct annual CO₂ emissions reduction potential would increase to 11 Mt CO₂ and 18 Mt CO₂ under High and Transformative scenarios, respectively. The potential CO₂ emissions reduction impact of Buy Clean for cement would more than double if we consider the potential indirect impact from the cement sold to non-public construction if we assume the changes that cement plants make for CO₂ emissions reduction applies to all cement they produce.

The annual CO₂ emissions reduction under Low, High, and Transformative Buy Clean cement scenarios are equal to annual emissions from 0.8, 2.3, and 3.9 million cars, respectively.



Note: Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded projects.

Figure 11. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the U.S. in 2018 under different Buy Clean targets.

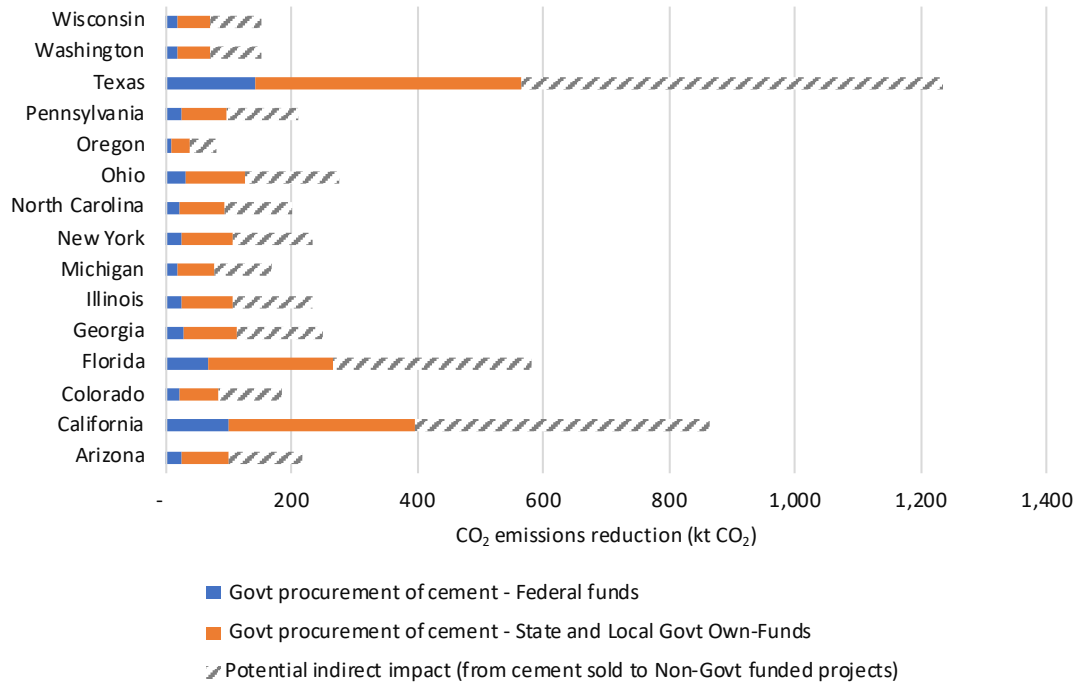
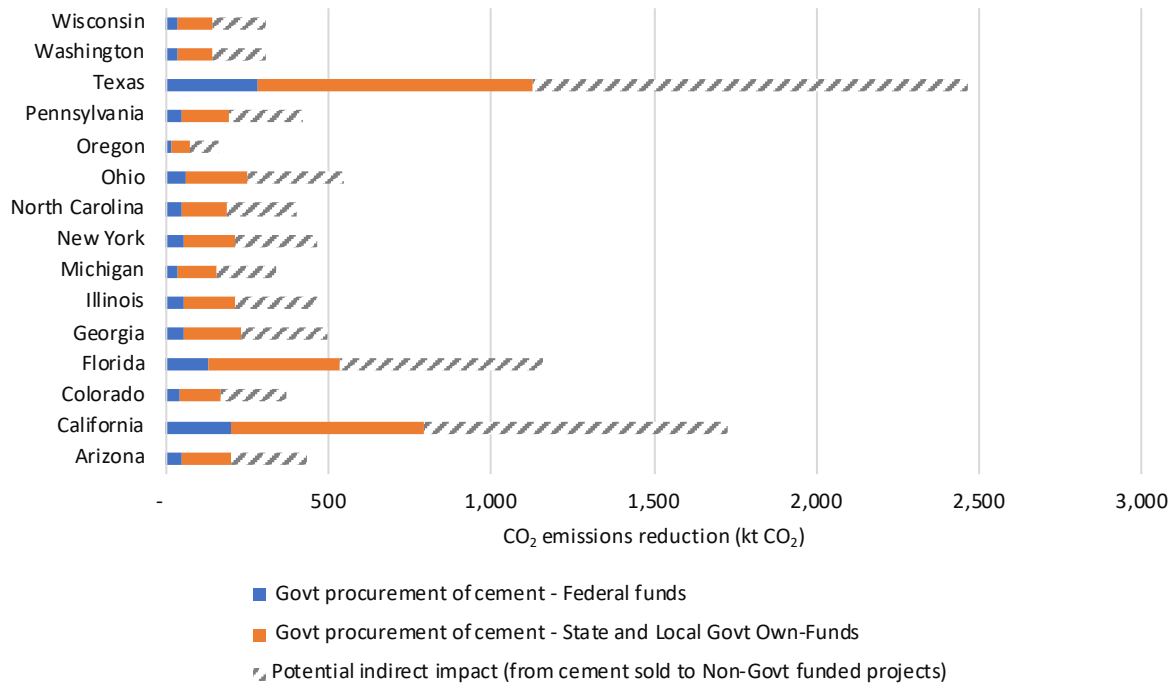
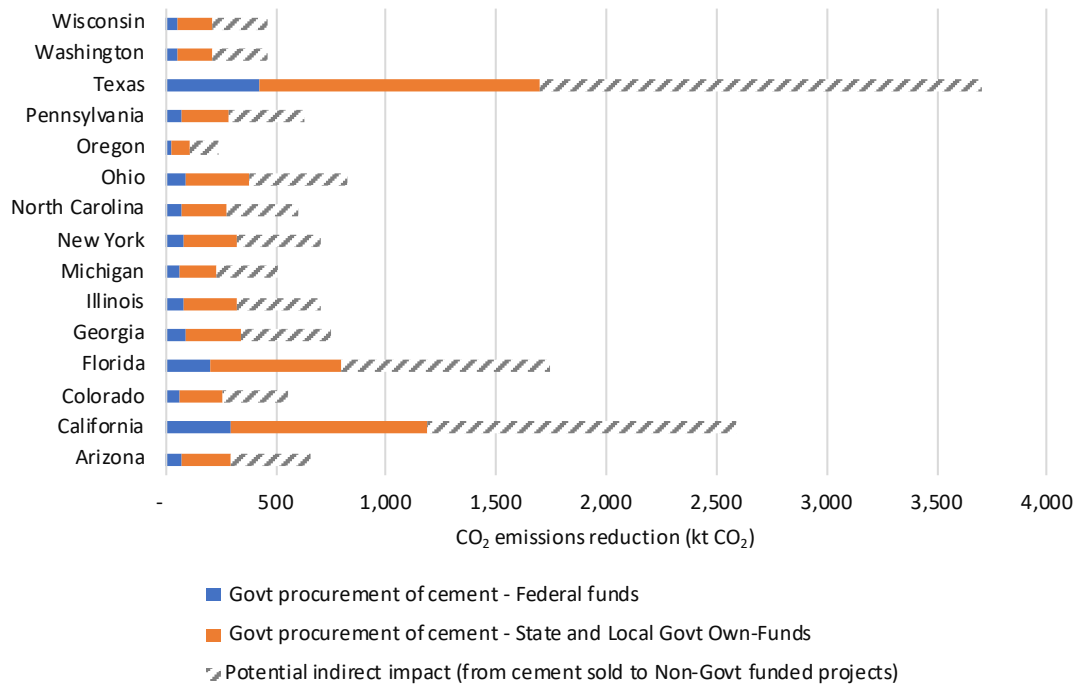


Figure 12. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the selected states in 2018 – Low Target Scenario (10% reduction in CO₂ intensity from baseline)



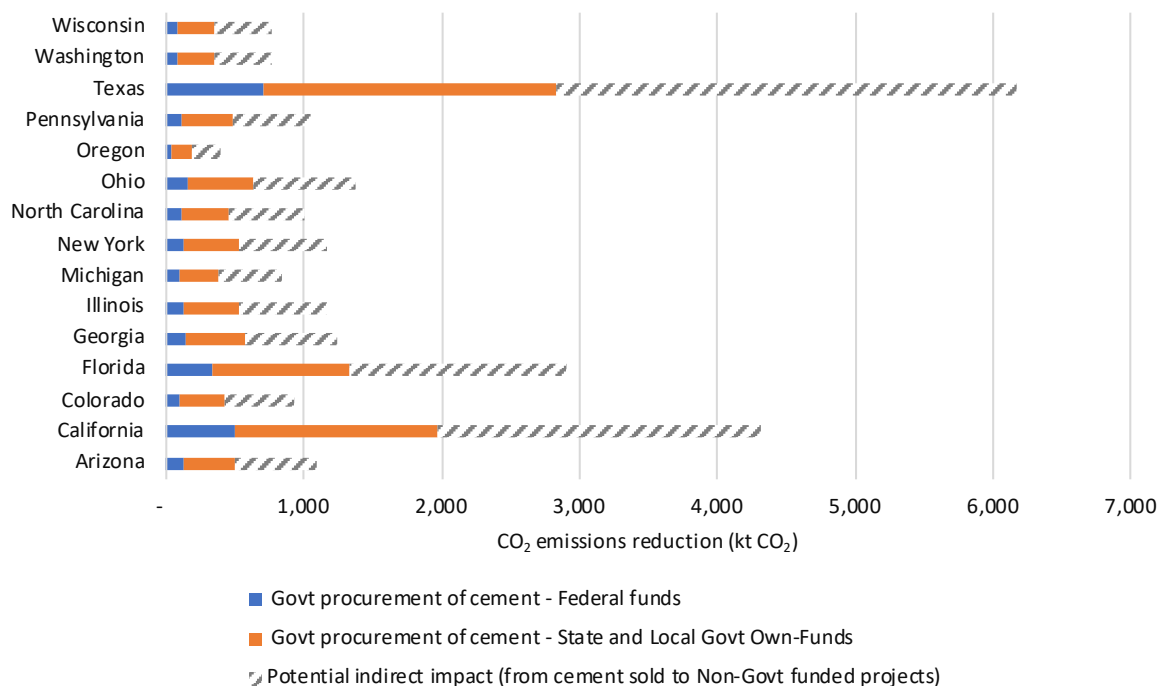
Note: Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded projects.

Figure 13. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the selected states in 2018 –Medium Target Scenario (20% reduction in CO₂ intensity from baseline)



Note: Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded projects.

Figure 14. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the selected states in 2018 – High Target Scenario (30% reduction in CO₂ intensity from baseline)



Note: Potential indirect impact assumes that changes in U.S. cement plants to reduce GHG emissions would impact the CO₂ intensity of all cement produced and sold even to non-government funded projects.

Figure 15. Annual CO₂ emissions reduction potential resulted from Buy Clean for cement in the selected states in 2018 – Transformative Target Scenario (50% reduction in CO₂ intensity from baseline)



3.2. Potential impact of federal Buy Clean on steel industry's emissions

Similarly, to estimate the potential impact of Buy Clean on GHG emission associated with steel used in the U.S., we developed several scenarios with various Buy Clean targets for CO₂ intensity of steel set by a Buy Clean policy (Table 4). It should be noted that the Buy Clean intensity targets shown in the table below are industry-level targets and not for a specific steel product. In reality, a Buy Clean policy is more likely to set product-specific intensity targets rather than industry-level targets. However, because of the lack of information and also 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 Buy Clean steel.

Table 4. Buy Clean target scenarios for the steel industry

Buy Clean Target	% reduction in steel CO ₂ intensity from baseline	Steel CO ₂ intensity (kgCO ₂ /t crude steel) *	Notes and potential actions for CO ₂ emissions reduction **
Baseline	-	1,124	This is the weighted average of CO ₂ intensity for both domestic and imported steel which includes both EAF and BF-BOF. Most countries that the U.S. imports steel from are above this threshold.
Starter	5%	1,068	U.S. steel industry currently meets this intensity threshold. All the countries that the U.S. imports steel from except Mexico and Turkey (only account for 15% of the U.S. import combined) are above this intensity threshold.
Low	10%	1,012	U.S. steel industry intensity currently sits right above this intensity threshold. All the countries that the U.S. imports steel from are above this intensity threshold.
Medium	20%	899	Improvement in energy efficiency and a small amount of fuel switching from coal and coke to natural gas or other lower-carbon fuels will help the U.S. steel industry to meet this intensity threshold. All the countries that the U.S. imports steel from are above this intensity threshold.
High	30%	787	A larger improvement in energy efficiency and fuel switching from coal and coke to lower carbon fuels will help the U.S. steel industry to meet this threshold. All of the countries that the U.S. imports steel from are above this intensity threshold.
Transformative	50%	562	Maximizing in energy efficiency and a substantial amount of fuel switching from fossil fuel to lower carbon fuels and adoption of CCUS in BF-BOF plants will help the U.S. steel industry to meet this threshold.

* The Buy Clean intensity targets show in this table are industry-level targets and not for a specific steel product.

** More detailed information on potential actions for CO₂ emissions reduction can be found at (IEA 2020, Bataille 2019, Friedmann et al. 2019, Material Economics 2019, McKinsey & Company 2018, Sandalow et al. 2019, ETC 2018).

Potential activities for emissions reduction

The major decarbonization levers that can help to reduce GHG emissions from the steel industry are energy efficiency, fuel switching to low/no-carbon fuels and electrification, CCUS, and adoption of transformative technologies. Material efficiency and circular economy measures can help to reduce the carbon footprint of steel use in the demand side. Below we briefly discuss these major decarbonization levers for the steel industry (IEA 2020, Bataille 2019, Friedmann et al. 2019, Material Economics 2019, McKinsey & Company 2018, Sandalow et al. 2019, ETC 2018).

Energy efficiency: There are variety of energy efficiency technologies are already ready to be deployed on a commercial scale in the steel industry. Technologies such as waste heat recovery for different processes, coke dry quenching (CDQ), Top-Pressure Recovery Turbine Plant (TRT), and many others are commercially available for deployment. Also, cutting-edge technologies could assist with energy management systems, drawing from smart manufacturing and the Internet of Things; such technologies include predictive maintenance and machine learning or digital twins to improve process control.

Fuel switching and electrification: Several fuels can replace coal or petroleum coke as a reducing agent in the smelting process. These alternative fuels include natural gas, biomass, or biogas, and on a longer time horizon, hydrogen. Globally, the main pathway to electrification of the steel industry is the use of EAF steel production. In the United States, however, around 70% of the steel is already produced by EAFs and limited opportunity remains for increased use of EAF technology. Another major pathway to electrification is the use of transformative steelmaking technologies such as the ones discussed below. Several different process heating pathways in steel production could be decarbonized by switching to low-carbon electricity. Reheating furnaces could be electrified, and electric induction furnaces could be scaled up. Ladle and tundish heating could be switched to resistance, infrared, or plasma heating.

CCUS: Carbon capture and storage (CCS) could decarbonize different routes of steel production, such as top-gas recycling in blast furnaces with CCS, DRI with post-combustion CCS, oxygen-rich smelt reduction with CCS, etc. These production pathways vary greatly in their commercialization status, with blast furnace CCS being at the pilot stage, DRI with CCS in the development stage, and smelting reduction CCS in the pilot stage. The main challenges for CCS technologies are achieving further reductions in costs and improving operational efficiencies. The captured CO₂ emissions from iron and steel production can be used for chemicals or fuel production.

Transformative technologies: These technologies help to produced steel with substantially lower carbon footprint. Two of such transformative technologies are the use of hydrogen that is produced from renewable energy instead of natural gas in direct reduced iron (DRI) production (HYBRIT 2021) and the electrolysis of iron ore (Boston Metal 2021). More R&D, pilot and demonstration is needed for wide-scale commercialization of these technologies. It should be noted that all the Buy Clean targets assumed in this study for the steel industry (Table 4) can be achieved without the adoption of transformative technologies. However, adoption of CCUS might be needed for the Transformative scenario.

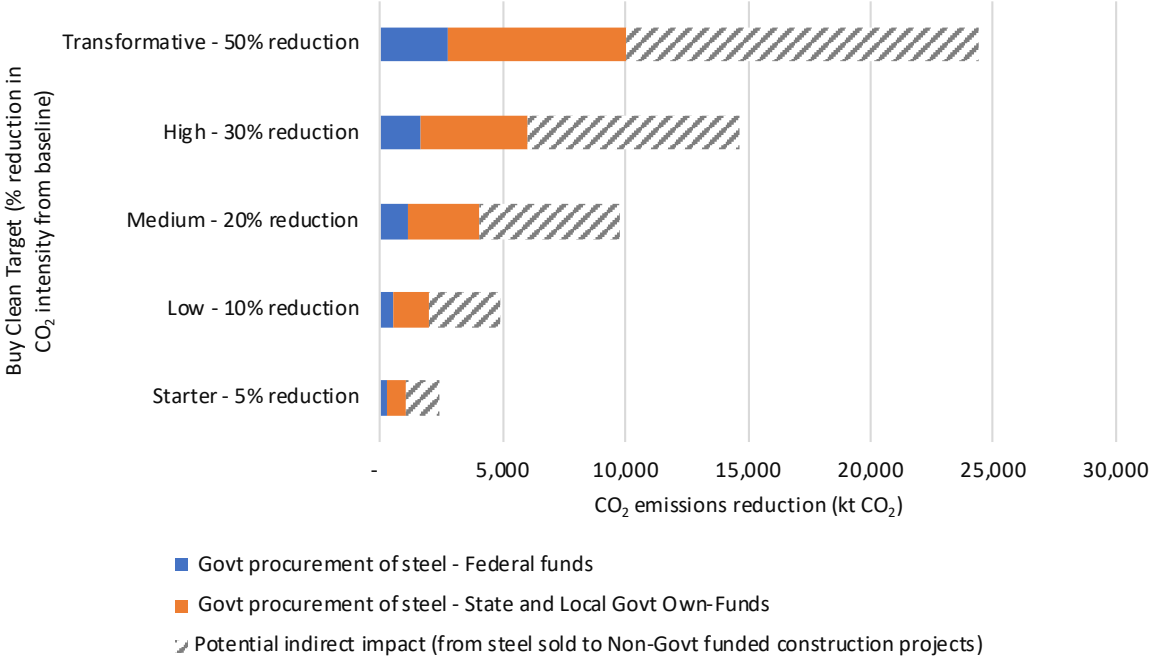
Potential impact of Buy Clean steel

Using the annual CO₂ emissions associated with steel used in the U.S. presented in the previous chapter and the targets set in Table 4, we estimated the annual CO₂ emissions reduction potential resulted from Buy Clean for steel in the U.S. in 2018 (Figure 16). Unfortunately, we did not have sufficient data to estimate the Buy Clean steel impact at the state level.

Potential indirect impact assumption for the steel industry is different from that of the cement industry. It assumes that changes in U.S. steel plants to reduce GHG emissions would impact the CO₂ intensity of all steel produced and sold to non-public construction projects (not all other steel applications). The scale of such indirect impact is unknown; therefore, it's shown by striped bars on the charts.

Under the Low scenario for Buy Clean target for steel, annual emissions reduction of 2 Mt CO₂ can be achieved directly from government procurement of steel for construction. This direct annual CO₂ emissions reduction potential would increase to 6 Mt CO₂ and 10 Mt CO₂ under High and Transformative scenarios, respectively. The potential CO₂ emissions reduction impact of Buy Clean for steel could increase by over two-fold if we consider the potential indirect impact from the steel sold to non-public construction projects if we assume the changes that steel plants make for CO₂ emissions reduction applies to all steel they produced for construction market. One may also assume a larger impact in longer term as the result of spillover effect which could result in lower carbon intensity for steel produced for other market segments (non-construction) as well.

The annual CO₂ emissions reduction under Low, High, and Transformative Buy Clean steel scenarios are equal to annual emissions from 0.4, 1.3, and 2.2 million cars, respectively.



Note: Potential indirect impact assumes that changes in U.S. steel plants to reduce GHG emissions would impact the CO₂ intensity of all steel produced and sold to non-public construction projects (not all other steel applications).

Figure 16. Annual CO₂ emissions reduction potential resulted from Buy Clean for steel in the U.S. in 2018 under different Buy Clean targets.



4

How Does Buy Clean Help American Manufacturing Competitiveness?

Buy Clean has the opportunity to bolster American competitiveness among global manufacturers. U.S. firms are unable to compete with the cost advantages of low-wage competitors like China, Brazil, and Mexico (Jarsulic 2021). The Buy Clean policy can help bolster manufacturing competitiveness, reduce prices, and induce innovation.

As more countries commit to carbon neutrality, policies requiring industrial inputs to meet low-carbon standards are soon to follow. The European Union, the largest importer of natural gas in the world, is well on its way to implementing low methane standards on natural gas imports (Krupnick 2020a, European Commission 2020). The effects are already being felt by American exporters. For example, in 2020, France halted a \$7 billion deal between a French utility company and a U.S. liquefied natural gas (LNG) provider reportedly due to concerns that suppliers would leak too much methane; the deal was dissolved a month later (Politico 2020, Wall Street Journal 2020). For American firms to remain competitive, they must develop low-carbon products. Buy Clean can encourage this development. While LNG is not under the scope of Buy Clean, it provides an example for how U.S. efforts to reduce emissions in industrial products opens markets in the global economy (Krupnick 2020b).

Beyond maintaining existing competitiveness, Buy Clean can encourage development in the emerging market of low-carbon construction products. There is increasing international demand for green construction products and manufacturing processes. The global solar photovoltaic (PV) market, valued at over \$160 billion in 2019, is an example of how valuable these markets can become (Fortune Business Insights 2020). Chinese companies that entered the PV market in the early 2000s now account for more than half of all PVs produced in the world (Jarsulic 2021). No country has dominated green construction products yet. The government can use its purchasing power to encourage American companies to capture this opportunity.

Buy Clean can also protect energy-intensive, trade-exposed industries that produce materials such as steel and cement from offshoring therefore protecting American jobs. Policies such as carbon pricing or direct regulation of domestic facility emissions can lead to a competitive disadvantage if imports are not subject to the same measures. By focusing on market creation, Buy Clean promotes low-carbon development while allowing American manufacturing companies to retain domestic advantages such as lower transportation costs, easier access to markets, and Buy American policies, and thereby securing American jobs (Dell 2021).

Public procurement for large infrastructure projects can have a significant effect on the market by stimulating demand. Buy Clean can directly bolster manufacturing competitiveness by increasing demand for green products, which leads to two direct outcomes. The first is reducing costs. This may be through economies of scale: as the market increases in size, the cost of production can fall as firms can invest in more efficient equipment, benefit from bulk orders, and spread fixed costs over a larger amount of goods. Costs can also be reduced as firms become more specialized and develop more efficient production practices. Another direct outcome is reduced prices through increased competition. An increase in demand for green products encourages new suppliers to enter the green market, raising supply and lowering the price of green products (Krupnick 2020b).

Increased competition in the market can stimulate innovation. A large body of literature examines public procurement as a key element of demand-oriented innovation policy. Elder and Georghiou (2007) note that innovation often entails high learning and switching costs, which prevents suppliers from investing in the research and development required for innovation. Private corporations may be hesitant to make large initial investments even when the profitability of a new product is reasonably clear due to their inability to capture all the benefits of innovations (Jarsulic 2021). This is certainly the case for manufacturing and construction suppliers, where the upfront cost of upgrading facilities can be very high. In the cement industry, retrofitting facilities to improve energy efficiency or fuel switching can cost anywhere from hundreds of thousands to millions of dollars depending on the technology employed (EPA 2010).

Green public procurement programs establish demand certainty and build confidence in the existence of future markets for low-carbon materials, which enables suppliers to justify high switching costs. Unlike R&D subsidies, state demand induces not only proof-of-concept technological innovation, but also manufacturing innovation and commercialization of new technologies (Elder and Georghiou 2007). In the solar industry, government subsidies for solar power adoption in Japan and Germany helped to spur innovation. New entrants and increased competition to meet rising demand led to technical and manufacturing innovation that allowed the cost of solar to fall dramatically and become competitive with fossil fuel-generated electricity (Jarsulic 2021). One study of manufacturing firms in the European Union, Switzerland, and the United States has shown that firms were more likely to adopt innovative green technologies after receiving public procurement funds (Ghisetti 2017).

Buy Clean may also lead to several positive spillover effects. Measurement protocols and certification programs need to be established before green procurement as procuring agencies need to be able to evaluate options. Standardizing this information and making it publicly accessible allows private businesses and consumers to distinguish low-carbon products from alternatives (Krupnick 2020b). The success of the ENERGY STAR program, which promotes products with superior performance in energy use through a label, demonstrates this mechanism in action. These programs can promote private demand for green products, which may have even larger market impacts than public purchases.

Another positive indirect effect is workforce development. As more domestic suppliers enter the green materials market, local workforces develop expertise in green manufacturing processes. This provides industry with skilled workers with process knowledge of green manufacturing who can move between firms leading to diffusion of new standards. A study of local governments in California showed that green building procurement policies led to increased private-sector adoption of LEED certification in those jurisdictions and neighboring areas (Simcoe and Toffel 2014). The authors also found that GPP stimulated investment in green building expertise, as measured by the number of LEED-accredited professionals. They suggested that these professionals were a key transmission mechanism for geographic spillover effects.

Buy Clean could help American manufacturing become more competitive in a growing global market of green construction products; maintain the domestic competitive advantage of energy-intensive, trade-exposed industries; reduce the price of green products; and induce green innovation. Whether or not it achieves these goals depends on the specifics of implementation. Procurement standards that target industry average may promote existing best practices without creating incentives for breakthrough innovations in very low-emission materials. To combat this, the House Select Committee on the Climate Crisis report (2020)

proposes a two-tiered approach where a small percentage of procurement is required to meet higher standards that push the state of the art in low-emissions technology. Effective enforcement is also critical to ensuring Buy Clean can induce the desired benefits (Dell 2021).

More specifically, Buy Clean for the federal and state government procurement will reward domestic U.S. steel producers for their competitive carbon advantage over countries the U.S. is importing steel from. Around 90% of the steel imported to the United States is from countries with higher CO₂ intensity for the steel industry than U.S. steel industry. A recent international benchmarking study for the steel industry shows the U.S. steel industry's carbon advantage over the majority of its steel trading partners (Figure 17) (Hasanbeigi 2021).

Buy Clean would reward domestic U.S. steel producers for having lower CO₂ intensity and encourage the production of steel in the U.S. using lower carbon-intensive production processes using EAF. This will save and even create new jobs in the steel industry, especially in key steel-producing states such as Indiana, Ohio, Michigan, and Pennsylvania.

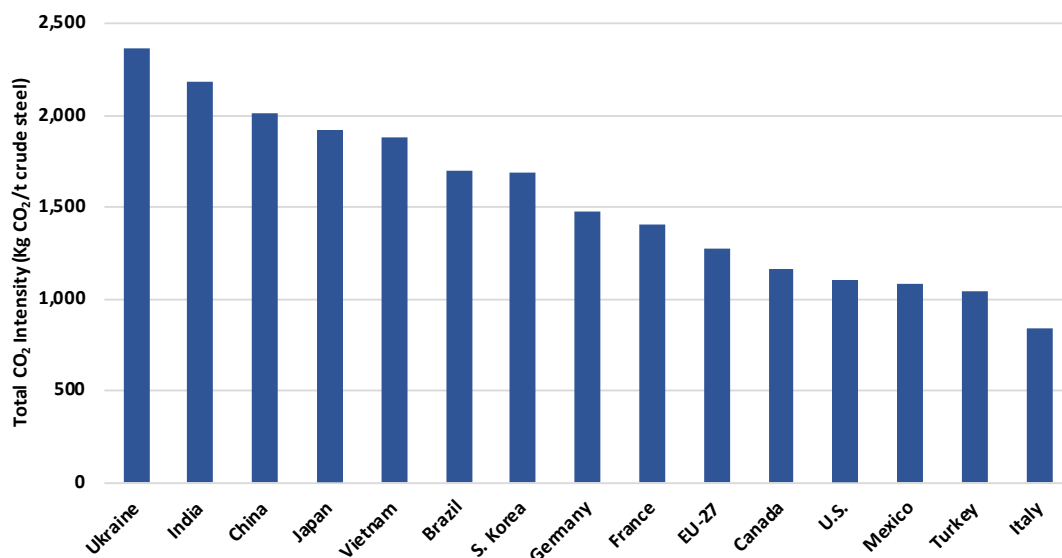


Figure 17. Total CO₂ emissions intensity of the steel industry in major steel-producing countries in 2019 (Hasanbeigi 2021)

Continuous improvement, supply of low-cost domestic natural gas, and decarbonization of the U.S. electric grid by the deployment of more renewable energy will help U.S. steel producers to keep their competitive advantage in the near- and medium-term.

In the medium and long-term, more strict Buy Clean criteria with lower CO₂ intensity threshold will incentivize domestic steel producers to lower their CO₂ intensity even further by the adoption of decarbonization measures such as energy efficiency and fuel switching to low/ no-carbon fuels and electrification and also encourages R&D and demonstration of transformative technologies such as carbon capture, utilization, and storage (CCUS), Hydrogen Direct Reduced Iron EAF (H₂-DRI EAF) steelmaking and electrolysis of iron ore.

Some of the key factors influencing energy and CO₂ emissions intensity of the steel industry include (Hasanbeigi and Springer 2019a):

- The share of EAF steel in total steel production,
- The fuel shares in the iron and steel industry,
- The electric grid CO₂ emissions factor,
- The type of feedstocks in BF-BOF and EAF,
- The level of penetration of energy-efficient and low-carbon technologies,
- The steel product mix in each country,
- The age of steel manufacturing facilities in each country,

- Capacity utilization,
- Environmental regulations,
- Cost of energy and raw materials,
- Boundary definition for the steel industry (i.e., which inputs and intermediary products are included in the analysis and whether or not the embodied energy and carbon in those products are included in the analysis).



5.1. Federal-level Buy Clean programs

Laws, Regulations, and Policies

U.S. federal government procurement of green products began in 1993 with Executive Order 128733 by President Clinton. The order promoted recycling and environmental procurement. The order required agencies to align procurement policies with Section 6002 of the Resource Conservation and Recovery Act (RCRA) to use recycled products to the extent practicable and competitive. It also directed the United States Environmental Protection Agency (EPA) to establish Comprehensive Procurement Guidelines (CPGs) for recycled content in products and instructed federal agencies to adjust their procurement programs to comply with these EPA standards to the maximum extent practicable (Ganley 2013).

The Bush Administration revoked President Clinton's Executive Orders on procurement, replacing them with other purchasing provisions. By 2007, President Bush had adopted a comprehensive policy that included GHG emissions reductions as a goal. In 2001, Executive Order 13212 required agencies to increase energy conservation. Based on this order, the Federal Energy Commission developed best practices to promote federal purchases of U.S. EPA-designated energy-efficient electronic equipment (OECD 2015).

The Bush Administration later issued Executive Order 13221 requiring federal agencies to purchase electronic products that consumed no more than one watt of standby power. Congress also expanded procurement of green products by extending federal buying preferences to include "bio-based" products. Under a United States Department of Agriculture (USDA) program in the 2002 Farm Security and Rural Investment Act, and by adopting the Energy Policy Act of 2005 (EPACT). EPACT added a provision for federal procurement of energy-efficient products to the National Energy Conservation Policy Act (NECPA) (Fischer 2010).

In 2007, Executive Order 13423 articulated a comprehensive sustainability policy that remains largely in place today. Regarding procurement, the order requires agencies to purchase paper made with a minimum of 30 percent recycled content and to meet 95 percent of their electronic equipment requirements using products that have the Electronic Product Environmental Assessment Tool (EPEAT) voluntary certification. To implement this mandate, the Office of the Federal Environmental Executive (OFEE) instructed agencies to procure green products in several categories and required that each agency give preference in procurement and acquisition to the purchase of "environmentally friendly" products. Those are defined as products that contain recycled content, are ENERGY STAR labeled, are water- and/or energy-efficient, are "bio-based," and do not contain toxic materials or ozone-depleting substances (Ganley 2013).

In his October 2009 Executive Order 13514, President Obama broadened the mandate to address GHG emissions in federal operations. The order laid out numerous environmental goals, from reducing the use of toxic chemicals to promoting integrated energy planning. The order also contained wide mandates for federal green procurement, requiring agencies to increase energy efficiency, conserve water, and reduce waste in operations and supply chains through federal procurement and building management (Fischer 2010; Ganley 2013; OECD 2015).

All sustainability mandates have also been incorporated into the Federal Acquisition Regulation (FAR) which covers all procurement requirements for federal purchases. For micro-purchases that fall below the FPDS reporting threshold, FAR coverage still mandates sustainable acquisition compliance (OECD 2015; ICLG 2019).

In the US, 55% of GHG emissions attributed to public institutions are a result of government-purchased goods and products. There is little federal, state, and local regulatory policy to address these emissions, but several voluntary national programs (e.g., Leadership in Energy and Environmental Design [LEED] and Living Building Challenge) have evolved to strengthen the focus on embodied carbon reduction. Some cities and states view procurement-based policy as a key opportunity to reduce carbon emissions. Implementation of the Buy Clean California procurement policy (see text box) may provide a model for other jurisdictions considering embodied carbon regulations (Simonen et al. 2018).

In January 2021, President Biden issued Executive Order 14008 to consider additional regulatory steps the federal government can make to promote increased contractor attention on supply chain emissions (White House 2021). Two bills were proposed in March 2021 to realize these goals: the Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act and the Better Utilizing Investments to Leverage Development and Generating Renewable Energy to Electrify the Nation's (BUILD GREEN) Infrastructure and Jobs Act.

The CLEAN Future Act is a comprehensive bill from the House Energy and Commerce Committee that proposes both sector-specific and economy-wide policies to achieve net-zero GHG emissions by 2050. In the industrial sector, the bill proposes to reduce embodied emissions in projects involving federal funds by increasing transparency of embodied emissions in construction products, establishing a federal Buy Clean program, and creating a Climate Star program (E&C 2021).

The CLEAN Future Act aims to increase the transparency of embodied emissions in products made primarily of eligible materials by establishing a publicly accessible National Environmental Product Declaration Database. The initial list of eligible materials will consist of aluminum, iron, steel, concrete, and cement. Products made primarily of these materials, including imported products, will receive a product category rule that defines guidelines for developing EPDs. Both the eligible materials list and product category rules will be maintained by the U.S EPA and may be modified in response to a petition (E&C 2021).

The bill also directs the U.S. EPA and U.S. Department of Energy (U.S. DOE) to develop a federal Buy Clean policy to reduce the quantity of embodied emissions of construction materials and promote the use of low-emissions materials in projects supported by federal funds. The program will establish buy clean standards for infrastructure projects while considering the inclusion of materials and product categories, the diversity of sectors, the complexities associated with manufacturing, and more (E&C 2021).

Building on the success of the ENERGY STAR label, the CLEAN Future Act will create a Climate Star program to establish a voluntary label to identify and promote products with significantly lower embodied emissions the comparable products. It will also amend the NECPA to add a provision for the public procurement of Climate Star products (E&C 2021).

The BUILD GREEN Act focuses on electrification of the transportation sector, which accounts for 29% of U.S. emissions, and upgrading infrastructure (EPA 2019). Modeled after the Department of Transportation's (DOT) BUILD grant program, it proposes to invest \$500 billion in grant funding for states and local governments to electrify public transit systems and modernize roads, bridges, and rail. Eligible projects are required to add renewable energy

generation to cover the energy consumed by the project (Warren 2021). These pieces of the legislature would greatly augment the scope of federal GPP in the United States and increase public awareness of embodied emissions. However, it remains to be seen whether the bills will be passed in their current forms.

Government Agencies and Authorities in Charge of Green Public Procurement Programs

The Office of Management and Budget (OMB) provides broad guidance on GPP through various policy documents, as does the Office of the Federal Environmental Executive (OFEE), which is housed at the U.S. EPA. Some procurement criteria are set by specific agencies. U.S. EPA, the General Services Administration (GSA), OFEE, and other agencies have databases that identify green products. OMB requires agencies to have green procurement plans and report annually on their GPP activities. Those reporting requirements appear to be largely qualitative, but quantitative reports are available for recycled content and alternative-fuel products (Fischer 2010). Aside from U.S. EPA, two other agencies, the U.S. Department of Energy and the U.S. Department of Agriculture take the lead in designating products and providing purchasing recommendations, and have designated environmental criteria for more than 300 product categories (OECD 2015).

Program Goals and Targets

The goals of Executive Order 13514 are (Ganley 2013, OECD 2015):

- By 2020, the federal government will reduce Scope 1 and 2 GHG emissions by 28% compared to a 2008 baseline.
- By 2020, the federal government will reduce identified Scope 3 GHG emissions by 13% compared to a 2008 baseline.
- By 2015, the federal government will reduce its energy intensity in targeted facilities by 30% compared to a 2003 baseline.
- By 2020, the federal government will reduce its potable water intensity by 26% compared to a 2007 baseline.
- By 2015, the federal government will reduce its fleet petroleum use by 20% compared to a 2005 baseline.

Section 2(h) of President Obama's 2009 Executive Order 13514 reinforces compliance with all sustainable acquisition standards and mandates that "...the head of each (federal) agency shall: ...ensure that 95 percent of new contract actions...are energy-efficient (ENERGY STAR or Federal Energy Management Program [FEMP] designated), water-efficient, bio-based, environmentally preferable (e.g., Electronic Product Environmental Assessment Tool [EPEAT] certified), non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives..." (Fischer 2010, Ganley 2013, OECD 2015).

Environmental Concerns Addressed by Policy

The environmental benefits currently targeted by GPP in the U.S. are:

- Reducing toxicity – prioritizing products using fewer toxic ingredients to minimize the hazardous health impacts on water and air and reduce damage from accidental spills and improper disposal
- Promoting energy efficiency – prioritizing products that limit energy consumption and minimize carbon footprint

- Prioritizing recycled content
- Fostering renewable energy and clean technologies – prioritizing technologies that reduce U.S. dependency on foreign petroleum, stimulate economic development for innovative technologies, reduce GHG emissions, and meet clean energy production goals (NASPO 2019).

Products and Categories included in Program

Currently, sustainable acquisition requirements apply to products that are supplied or used as part of services contracts and fall into the following categories: electricity, design and/or construction, operations and maintenance, janitorial products/services, office supplies, furniture, cafeteria ware/services, fleet management, hospitality (uniforms/bedding/linens, meetings and conference services), and information technology (OECD 2015).

The CLEAN Future Act’s National Environmental Product Declaration Database will apply to products made primarily of aluminum, iron, steel, concrete, and cement. A secondary list consisting of flat glass, insulation, unit masonry, and wood products is provided for consideration at the discretion of the U.S. EPA Administrator, who will be responsible for maintaining the eligible materials list. The list can be modified in response to the petition (E&C 2021).

Product / Service Eligibility for Green Public Procurement

U.S. GPP relies on ENERGY STAR ratings of products. ENERGY STAR is the government-backed symbol for energy efficiency. ENERGY STAR provides simple, credible, unbiased information to enable consumers and businesses to make informed decisions about the energy consumption of labeled products.

High-performance, green buildings (2007) - The building has an ENERGY STAR rating of 75 or higher, or Energy use is 20% below the Fiscal Year 2015 energy use baseline, or Energy use is 30% below the Fiscal Year energy use baseline, or Energy efficiency is 30% better than the current ASHRAE 90.1 standard (OECD 2015).

The U.S. Green Building Council (USGBC) manages the LEED green building rating program, which provides multi-level, point-based certifications. Since its establishment in 1993 as a single standard, LEED has evolved to become the most widely adopted and recognized green building rating system in the world. In LEED v4, USGBC introduced Building Product Disclosure and Optimization (BPDO) credits to encourage transparency and use of products that disclose and optimize whole life-cycle impacts (Carbon Leadership Forum 2018).

Three new credits were established under BPDO:

- EPD credit
- Sourcing of raw materials credit
- Material ingredients credit, as well as a low-emitting materials credit established under the indoor environmental quality rating category

The EPD credit is widely used by industry and has helped move the market toward understanding and addressing embodied carbon. LEED v4 also offers credit for conducting a whole-building life-cycle assessment that demonstrates environmental improvements compared to a baseline building. These credits are intended to encourage manufacturers to disclose the full life-cycle environmental impacts of building products (Carbon Washington 2018).

The CLEAN Future Act proposes a new Climate Star program. Similar to the ENERGY STAR label, the program would create a voluntary labeling program to identify products with significantly lower embodied carbon emissions than comparable products. The label would aid consumers and businesses looking to reduce the carbon footprint of their purchases (E&C 2021).

Monitoring / Measures of Program Success

As noted above, OMB requires agencies to report annually on their GPP activities. The federal government reports to the U.S. Congress every two years on the results of its green procurement monitoring. Additionally, the CLEAN Future Act proposes the EPA produce two reports to congress. The first, on federal procurement, will quantify and evaluate the level of spending and volume of eligible materials procured by the federal government. The second, on material efficiency, will review current research and policy recommendations for improving the material efficiency of eligible materials (E&C 2021).

Tools to Aid Green Public Procurement

The U.S. federal government is developing new and improved ways to integrate green products into acquisition systems. Some agencies have found innovative ways to lead. For example, in addition to reporting per EO 13514 goals and mandates, the U.S. DOE Green Buy Program provides U.S. DOE sites around the country with recognition for reporting on purchases of 40 priority products that go beyond minimum compliance in terms of their sustainability. The priority products list represents optional stretch goals for sustainable acquisition. Sites can tailor this list to meet their specific circumstances, allowing them to select categories and products of most value for their local situations. Facilities may report additional green products and are encouraged to nominate new candidates for the list. This list also assists sites in engaging with the suppliers and informing contract language and related reviews. The recognition program rewards effective procurement programs by giving incentives to procure and report on products whose use demonstrates exceptional commitment to sustainability (OECD 2015).

U.S. EPA collaborated with the General Services Administration (GSA) to integrate U.S. EPA's Recommendations of Specifications, Standards, and Eco-labels into major federal procurement vehicles, which help federal purchasers identify credible, effective standards and eco-labels that have been established by the private sector for products and services (EPA 2017).

The Federal Procurement Data System (FPDS) continues to be refined and improved as a tool to help agencies accurately report compliance with the sustainable acquisition mandates (OECD 2015).

Architecture 2030 recently launched the Carbon Smart Materials Palette, a decision-making tool that provides designers with attribute-based guidelines for (1) designing buildings with low or zero embodied carbon, and (2) specifying construction materials with low or no embodied carbon. The tool is designed to support and complement life-cycle assessment and EPDs (Simonen et al. 2018).



5.2. State-level Buy Clean programs

Buy Clean California

California is a leader in establishing state green building regulations and standards. The 2012 amendment of the California Green Building Standards Code (CALGreen) includes an optional life-cycle assessment pathway that requires emissions reduction against a baseline along with several performance measures related to energy efficiency. This pathway is an alternative to prescriptive requirements for materials selection. Building projects can use CALGreen to pursue other sustainability initiatives such as LEED (Simonen et al. 2018).

In October 2017, California passed Assembly Bill (AB) 262, the Buy Clean California Act, a new law requiring state-funded building projects to consider the global warming potential (GWP) of certain construction materials during procurement. The bill had two components: manufacturers of eligible materials had to submit facility-specific EPDs, and eligible materials had to demonstrate (through submitted EPDs) GWP below the product-specific compliance limits defined by the state Department of General Services (DGS), which regulates policy implementation. The eligible materials include structural steel, concrete reinforcing steel, flat glass, and mineral wool insulation. In January 2021, the DGS published maximum acceptable GWP limits for each product category set at the industry average of facility-specific GWP for each material. Beginning July 1, 2021, awarding authorities will be required to verify GWP compliance for all eligible materials.

Product market representatives pointed out that excluding carbon-intensive materials such as cement and concrete from the program was not congruent with the state's policy goal of cutting GHG emissions. In February 2021, AB 1365 was introduced to include concrete in the list of eligible materials. If passed, it will require bidders to submit supply chain specific EPDs by January 1, 2022. It will also require the DGS to publish maximum acceptable GWP for concrete products by January 1, 2024. Beginning January 1, 2023, procuring agencies would be required to apply a performance discount rate not exceeding 5% to bids with a GWP below the 20th percentile of the range of global GWP collected from submitted EPDs.

The USGBC-LA is also administering a Buy Clean Incentive Program to assist manufacturers from affected product markets in developing facility-specific EPDs.

StopWaste is a public agency in Alameda County, California that focuses on reducing waste in homes, at schools, and work. StopWaste also focuses on embodied carbon in the built environment. A collaborative project of StopWaste and nearby Marin County to increase demand for low-carbon concrete through policy was recently funded by the Bay Area Air Quality Management District (BAAQMD). The project consortium will produce model code language to enable local governments to adopt low-embodied-carbon concrete specifications for residential and non-residential applications. The project will also provide technical assistance to four pilot projects to apply the specifications and will form a Bay Area Materials Working Group (StopWaste, 2018).

Before the adoption of the Buy Clean California Act, the California Department of Transportation (Caltrans) had been evaluating the use of life-cycle assessment and EPDs in evaluating materials. In parallel with the Buy Clean California Act, Caltrans established the Caltrans EPD Implementation Project to begin collecting EPDs for construction materials. In addition to the materials specified in Buy Clean California Act (noted above), the Caltrans project includes materials used extensively in transportation (concrete, asphalt, and aggregate). Before the adoption of the Buy Clean California Act, the California High-Speed Rail project had begun using EPDs as part of its procurement process. The High-Speed Rail Sustainability Report states that the construction projects will: 1) require EPDs for construction materials including steel products and concrete mix designs, and 2) require "optimized life-cycle scores for major materials" and include additional strategies to reduce impacts across the life cycle of the project (Simonen et al. 2018).

Building on the success of the Buy Clean California Act, Washington, Minnesota, Oregon, Colorado, New York and New Jersey all have legislature underway to enact green procurement programs.

Buy Clean and Buy Fair Washington

Several laws and executive orders require Washington state agencies to increase environmentally preferred purchasing. This includes reducing the purchase of products containing persistent toxic chemicals, requiring at least 30% of new vehicles purchased to be clean-fuel vehicles and green building criteria such as LEED certification on new state-funded facilities (Washington State Department of Ecology 2021).

A bill modeled after the Buy Clean California Act was introduced in Washington state's 2021 legislative session to establish reporting on the embodied emissions of structural materials. If passed, the Buy Clean and Buy Fair Washington Act (HB 1033) will require state-funded construction projects larger than 25,000 square feet to submit EPDs for structural concrete,

reinforcing steel, structural steel, and engineered wood products. The bill also directs the University of Washington College of Built Environment to create a publicly accessible database of the collected data with projects anonymized. The bill differs from the Buy Clean California Act in that it requires EPDs to be supply chain-specific and includes consideration of working conditions such as average hourly wage and share of employees covered by a collective bargaining agreement. Supply chain specific EPDs differ from the facility specific EPDs required by California as they must include all processes that contribute to 80% or more of a product's cradle-to-gate environmental impacts (Washington State Legislature 2021).

Buy Clean Minnesota

In 2019, the Buy Clean Minnesota Act (HF 2203) was introduced to incorporate embodied emissions into public procurement decisions. If passed, it will establish a maximum acceptable global warming potential (GWP) at the industry average for each category of eligible materials. The maximum acceptable GWP will be reviewed every three years for downward adjustment. The eligible materials list consists of carbon steel rebar, flat glass, mineral wood board insulation, structural steel, cement, structural timber, solar panels, refrigerants, aluminum, gypsum, and concrete (State of Minnesota Legislature 2019).

Buy Clean New York & New Jersey

New York and New Jersey governments are the single largest purchasers of concrete in their respective states (OpenAir 2021). A new piece of legislature called the Low Embodied Carbon Concrete Leadership Act (LECCLA) leverages this buying power to promote low carbon concrete development. LECCLA will require state agencies to factor climate impact into the procurement of concrete. It proposes to increase competition between concrete suppliers by asking suppliers to supply EPDs with their bids for state-funded projects. A discounting rate not exceeding 5% will be applied based on the GWP: a lower GWP will lead to a higher discount rate, making the bid more competitive. An additional discount not exceeding 3% will be applied for bids incorporating carbon capture, utilization, and storage (CCUS) technology (New York State Senate 2020). This Buy Clean legislature differs from those of other states as it uses price discounting as a bid incentive without establishing a maximum acceptable GWP limit.

Barriers to Federal Buy Clean for the Construction Materials in the U.S.

Although Buy Clean is considered an effective policy instrument to reduce GHG emissions from the industry sector including the cement and steel industry, countries face obstacles in implementing Buy Clean policies (Renda et al. 2012; Van der Zwan 2018). Below we briefly discuss some of the major barriers that have hindered building and instituting federal Buy Clean in the U.S. It should be noted that there are solutions and policy designs that can help to overcome these barriers. Some of these policy designs are discussed in the subsequent sections

Institutional Barriers: Changing policies, changing central standard-setting authority

The United States has many different government entities that design policy, set standards, and design criteria for enforcement. Agencies span from the EPA to the USDA. Different offices within the aforementioned agencies manage GPP, i.e. the Office of Management and Budget and the Office of the Federal Environmental Office, both of which fall under the EPA. Provisions for GPP are often added to different policies and programs that are managed and enforced by different agencies. Such policies and programs include Leadership in Energy and Environmental Design [LEED] and Living Building Challenge, FEMP, as well as the Federal Acquisition Regulation. DOE has its own GPP program that is entitled the GREEN Buy Program and also maintains Energy Star rating which is perhaps the best known GPP tool in the United States. While some might explain that the decentralized approach is useful because every sector and industry has different decarbonization trajectories, monitoring overall progress on GPP is often difficult and uncoordinated because different entities are in charge of different programs and policies all related to GPP.

Standardized and Reliable Measurement Protocols

Environmental product declarations (EPDs) have become a common method to evaluate the environmental impact of construction materials and products. These reports are based on life cycle analysis and include information such as product components, global warming potential, and energy consumption. However, heterogeneity of EPDs makes comparison difficult. A study of EPDs for cement products revealed inconsistent estimation methods, a lack of transparency into methods used, and errors in data (Anderson and Moncaster 2020). This is especially concerning for imported products as there may be lower confidence in data integrity and auditing may be more difficult.

Standardized Planning Tool

There does not seem to be a standardized planning tool that is used for GPP. If entities use different planning tools, it is often difficult to meet a national goal because stakeholders are not coordinated in their approach to ensure decarbonization across industries. The Federal Data Procurement System is designed to report compliance to sustainable acquisition mandates but does not assist the planning process. It is more used as a monitoring tool to help agencies track and report their progress on GPP. While other countries that have more successful GPP programs mandate tools that incorporate life cycle analysis, the U.S. does not.

Defining Program Scope

A challenge common to green procurement programs around the world is defining scope. The standards applied to domestic products should also be applied to imported products to ensure no loophole leads to offshoring environmental harms. When creating a list of eligible materials, it is important to consider substitute materials. For example, only applying GPP standards to cement products would give steel and wood substitutes an unfair advantage, even though they may contain higher embodied emissions. Care should also be given to the creation of product category rules to ensure that heterogeneity within an industry is considered. Another implementation detail that may lead to unfair evaluation is the type of LCA required. “Cradle-to-gate” assessment, which covers resource extraction to the factory gate, does not take into account the impact of transportation or end-of-life disposal. This can be significant when comparing materials that can be recycled with alternatives that cannot. Finally, durability should be considered as substitute materials that require more frequent replacement may result in higher embodied emissions over time.



Recommendations for Federal Buy Clean for Construction Materials Based on International Best Practice

7.1. International best practices

Many governments around the world have already recognized the value of green public procurement as a policy instrument and are trying to leverage the money they invest in large contracts to achieve green goals. Hasanbeigi et al. (2019) studied 30 such programs, 22 of which are in countries in Asia, Europe, North and South America, Africa, and Oceania, five case studies at the city and regional level, as well as GPP programs of three multi-lateral banks and the UN to promote sustainable production and consumption. Based on this study, they identified the GPP program in The Netherlands as one of the world's best practices especially related to GHG reduction from construction materials (cement, steel, etc.). Other GPP best practices are represented by the European Commission's voluntary GPP program, the Flemish government's GPP program, and Japan's GPP program. Below a brief explanation of GPP in these countries are presented (Hasanbeigi et al. 2019):

- A. **Netherlands:** The Netherlands' most significant success in GPP is a result of its robust planning tools and approach, nationally enforced policy, specific guidelines for GPP set by The Directorate-General for Public Works and Water Management (Dutch: Rijkswaterstaat), publicly available data for monitoring, government bodies specifically designed to enforce and evaluate policies, and annual reevaluation of goals. The program uses software called DuboCalc to calculate life cycle environmental impacts for proposed designs and generate an environmental cost indicator (ECI). 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 as the onus is on the bidder to consider trade-offs between cost, embodied emissions, and durability of materials. Bids must meet a maximum allowable ECI and additional reductions in emissions are monetized as a discount applied to the quoted price. The Netherlands also has a voluntary CO₂ Performance Ladder scheme that certifies suppliers on a level scale of 1 to 5. Proposals that use suppliers with higher CO₂ Performance Ladder levels have further discounts applied. The specifications for the levels increase over time, encouraging the companies at the highest levels to continue to innovate. PIANOo, the Dutch public procurement expertise center, exists to support procurers in adopting these new practices and accelerate the uptake of GPP standards. The U.S. can benefit from developing and adopting tools and platforms like the ones mentioned above to support coordination on GPP.
- B. **Japan:** Japan, like California, instituted a broad policy that applies to a diversity of sectors called the Basic Policy for the Promotion of Procurement of Eco-Friendly Goods and Services. This policy outlines a specific green purchasing criterion for procuring products in a wide array of categories. Despite being called a policy, this is a law that all prefectures must follow. Being a law makes it strictly enforceable and makes the repercussions more stringent if the law is not abided by. Individual government agencies can decide plans to meet conditions set by the law and must report their progress to a central entity-the Minister of the Environment. Monitoring exists at both the national local levels. Like the US, Japan also utilizes eco-labeling schemes.

- C. **Belgium:** It has a mandatory GPP criteria for product groups including paper, textiles, vehicles, electricity, information technology, and cleaning products. For other product groups, voluntary criteria are provided. One of the product groups is “materials for building renovation”. They utilize life cycle analysis tools in all of their GPP projects. Belgium provides a case study in balancing voluntary criteria and mandatory criteria. Mandatory criteria exist for more pressing GPP programs, while voluntary criteria can exist to surpass GPP program goals. Belgium continues to use GPP programs for upgrade of outdated infrastructure, something that should be adopted by the U.S.
- D. **European Union (EU):** The EU established a common and a successful voluntary GPP systems that the U.S. could benefit from given the constraints of the federalist system. The voluntary criteria promote innovation and competition for GPP projects. It “enhances EU-wide competition, and triggers new markets, stimulates the development of new environmental technologies, and greener products and services, and reduces administrative burden”. It also utilizes life-cycle analysis and offers two levels of stringency: 1) a core criterion designed for easy application of GPP, 2) comprehensive criteria that encompasses more ambitious requirements and/or a greater number of facets of environmental performance than are addressed by core criteria (much like Belgium) (Hasanbeigi et al. 2019).

7.2. Adoptable best practices for U.S. federal Buy Clean

Below we list some of the key aspects of international best practices of Buy Clean that can be adopted in the U.S. for successful design and implementation of federal Buy Clean for construction materials in the U.S.

- Criteria designed at the national level and implemented at the national, state, and local levels by an individual entity; enforced by law like the criteria in the Netherlands and Japan.
- Establish standardized reporting and evaluation. Standardized reporting could entail mandatory life cycle analysis for entire project bids and/or use of environmental product declaration (EPD) for materials and products. Eco-labeling schemes could be expanded beyond the energy sector, as in Japan. Standardized evaluation should be flexible to be used across different materials and account for the heterogeneity of products within an industry. Coordination between criteria, planning, and project evaluation, like the DuboCalc tool in the Netherlands, can help eliminate concerns in implementation details that lead to unfair advantages for substitute materials.
- Make tools and databases created to support GPP publicly available. As seen in Japan, creating a database of products and materials that is accessible to the public makes the evaluation of products easier for procurers at all levels of government and enables spillover into the private sector. Making the tools used to calculate environmental impact publicly available lowers the barrier to entry for bidders, encourages uptake, and enables private procurers to perform similar assessments. The Dutch DuboCalc program is a prime example of this.
- Establish programs and funds to help bidders adopt these new practices. LCA can be an expensive and complex process with high demand for expertise, especially for

smaller businesses that lack expertise in conducting environmental assessments. The U.S. could establish a body similar to PIANOo in the Netherlands to provide information on sustainable procurement and help suppliers adopt new guidelines.

- Policy elements that promote innovation. Procurement programs that only set a minimum environmental standard may reinforce current best practices and eliminate negligent actors from the competition. However, it does not necessarily lead to innovation. A two-tiered system like those used in the European Union may remedy this concern. In the case of the Netherlands, a minimum standard is required for bidders to be considered and further improvements in sustainability are rewarded through a discount applied to the project price, giving these projects a competitive advantage.
- Increase standards over time to account for technological improvements and encourage continued emissions reduction. As new technology and efficient manufacturing processes become more widespread, GPP standards should be raised to account for this. A model of this is the CO₂ Performance Ladder program in the Netherlands which raises its standards over time, encouraging the entire industry to continue to innovate (Hasanbeigi et al. 2019).

The international best practices could significantly contribute towards a robust federal Buy Clean policy in the U.S. and help to remove some of the barriers such as institutional, administrative, and technological barriers.

7.3. Policy design to encourage industry support for Buy Clean

Industry support is one of the main drivers of success in green public procurement programs. Businesses need to be willing to participate in Buy Clean to make manufacturing more sustainable and spur innovation. Thoughtful policy design that promotes stakeholder engagement, transformation support, and protection against the unfair competition can increase support for Buy Clean from businesses, trade associations, and other key stakeholders.

Collaborative program design

Businesses and stakeholders should be engaged in the process of setting standards for the Buy Clean program. This ensures that the program is designed with the idiosyncrasies of each sector in mind. For example, there is a high heterogeneity within cementitious materials so product categories rules must be highly product-specific to allow for reasonable comparison (Krupnick 2020b). Where the 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 Buy Clean implementation and makes the program more likely to be successful.

Stakeholder engagement also allows the industry to voice concerns early and often. Advocates of ambitious Buy Clean standards have raised concerns about using industry average as a minimum standard, citing that this may lead to incremental improvements on existing best practices but is unlikely to spur breakthrough innovation. However, industry stakeholders point out that this precludes half of the industry from even bidding and is already a high standard for suppliers to meet (Franklin 2020). In interviews with representatives of the

Portland Cement Association (PCA), Krupnick (2020b) found support for performance-based standards over technology-based standards. Trade association leaders have stated the importance of taking a phased approach with the first phase focused on data collection and transparency. This would allow companies to see how clean their products are relative to domestic and foreign competitors. For industries that are not internationally competitive, this information can direct federal investment to aid those industries in their transition (Brown 2021).

Industry leaders have also raised concerns about how procuring agencies will evaluate bids with these new criteria. The scope of the program should include substitute products to ensure that substitutes do not gain an unfair advantage even though they may result in higher embodied emissions. Durability, use in the built environment, and end-of-life disposal should all be considered in the evaluation. Whole-project life cycle analysis is preferred by some industries to account for these factors (Franklin 2020).

Other concerns raised include harmonization of Buy Clean policies across state and federal jurisdictions to avoid uneven results and confusion and enforcement mechanisms to ensure that bidders meet their reported emissions reductions (Dell 2021, Krupnick 2020b, Perciasepe 2021). These nuances should all be considered in the setting of standards and evaluation criteria. Buy Clean should be designed collaboratively with stakeholders from industry and trade associations to ensure that procurement standards are reasonable and appropriate.

Support for industrial transformation

The industrial transformation will require retrofitting industrial facilities, building new facilities, and retraining workforces. These can all incur high costs that are difficult for capital-constrained companies to shoulder, especially small and medium-sized enterprises (SMEs). Buy Clean should be paired with loans, grants, and financial support programs that help manufacturers obtain the necessary capital to cover these upfront costs.

Aside from financial support, a body should be established to help steward industrial transformation. This could be an office within the Department of Energy, the Environmental Protection Agency, or in the Executive Office of the President. This office could help businesses find loan and grant programs available to them, navigate new requirements in environmental reporting, and provide information on green industrial practices. It could also create technology to help companies measure their environmental performance. Precedence for this type of office can be found in the Dutch Public Procurement Expertise Centre, PIANOo.

Investment in manufacturing dependencies

Decarbonizing the industrial 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. Most of these sectors are energy-intensive. Public investment in clean energy supply chains, deployment of renewables, improved energy storage, and grid modernization will help American manufacturers reduce embodied emissions (Brown 2021).

However, energy efficiency alone cannot decarbonize the industrial sector. In the case of concrete, over 50% of emissions produced during manufacturing are a result of the calcination of limestone and would not be reduced by the use of clean energy (Hasanbeigi and Springer 2019b). Public funding should be directed towards research and development in carbon capture, utilization, and sequestration (CCUS) and direct air capture (DAC) technologies to

enable innovations. Funding should also be allocated for the commercialization of these technologies in industrial applications to ensure that the benefits of innovation can be captured by American businesses. These investments would support domestic manufacturers by laying the groundwork for the theoretical and process knowledge required in industrial decarbonization.

Protection against offshoring

Perhaps the most common criticism of Buy Clean is that it can lead to emissions leakage through manufacturing offshoring. If American companies are required to meet strict environmental regulations that suppliers in other countries can avoid, their products may come at a price premium that causes consumers to search for cheaper options abroad. Buy Clean standards must apply to both domestic and imported products. There should be mechanisms to audit the EPDs of imports as there may be low confidence in the credibility of reported data. While these policies would keep American manufacturers competitive in public project bidding, they would not protect them from offshoring in the private sector. For trade-exposed industries where public procurement is not a significant portion of total market share, it may not be economical for manufacturers to invest in retrofitting or adopt sustainable practices. 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 tariff or similar. The United States can also advocate for international adoption of programs like Buy Clean to help build the international market for green construction products.

Buy Clean could be a driver of innovation in manufacturing and set the U.S. up to dominate the emerging international market for green industrial products. To ensure industry support, policy should be designed in collaboration with stakeholders; direct funding should be provided to assist businesses in industrial transformation, especially SMEs; investment should be allocated towards manufacturing dependencies and R&D, and measures should be taken to protect against offshoring.



Public procurement accounts for a significant share of the international economy. More and more governments are using their purchasing power to drive industry towards more sustainable products and materials through green public procurement programs. In the United States, \$110 billion were spent on federal non-defense investments in 2018 alone. Substantial amount of this public fund is used to procure cement and steel for construction projects, which is the scope of this report. GPP, often called Buy Clean in the United States, has the potential to significantly reduce GHG emissions from the production of cement and steel products.

In this report, we quantified the scale and emissions impact of federal, state, and local government procurement of cement and steel in the United States. Total cement consumption in the U.S. was 98.5 million metric tonne (Mt) in 2018. 46%, or about 45 Mt, went towards public constructions. 25% of this was procured using federal funds with the remaining using state and local government funds. An estimated 36 Mt CO₂ emissions were produced by publicly-funded cement consumption. Total steel consumption in the U.S. was 101 Mt in 2018. Around 18% of the steel used in the U.S. is for public construction. An estimated 21 Mt CO₂ emissions were produced by publicly-funded steel consumption.

We also quantified the annual CO₂ emissions reduction potential for Buy Clean in cement and steel for five target scenarios. These findings are summarized in Table 5. Under a Low scenario of 10% reduction in cement CO₂ intensity, Buy Clean can achieve an annual emissions reduction of 3.6 Mt CO₂ from direct public procurement of cement for construction. This emissions reduction potential would increase to 11 Mt CO₂ and 18 Mt CO₂ under the High and Transformative scenarios, respectively. The potential CO₂ emissions reduction impact would more than double if we consider the potential indirect impact on cement sold to non-public construction, assuming the changes that cement plants make for CO₂ emissions reduction applies to all cement they produce.

Table 5. CO₂ Emissions Reductions Potential for Buy Clean Cement and Steel

Buy Clean Target	% reduction in commodity CO ₂ intensity from baseline	Annual CO ₂ Emissions Reduction Potential from Buy Clean (Mt CO ₂)	
		Cement *	Steel **
Starter	5%	1.8	1
Low	10%	3.6	2
Medium	20%	7.2	4
High	30%	11	6
Transformative	50%	18	10

* The potential CO₂ emissions reduction impact of Buy Clean for cement would more than double if we consider the potential indirect impact on cement sold to non-public construction.

** The potential CO₂ emissions reduction impact of Buy Clean for steel could increase by over two-fold if we consider the potential indirect impact from the steel sold to non-public construction projects.

Under the Low scenario of 10% reduction in steel CO₂ intensity, Buy Clean can achieve an annual emissions reduction of 2 Mt CO₂ from direct public procurement of steel for construction. This emissions reduction potential would increase to 6 Mt CO₂ and 10 Mt CO₂ under the High and Transformative scenarios, respectively. The potential CO₂ emissions reduction impact of Buy Clean for steel could increase by over two-fold if we consider the potential indirect impact from the steel sold to non-public construction projects, assuming that changes in U.S. steel plants to reduce GHG emissions would impact the CO₂ intensity of all steel produced and sold to non-public construction projects (not all other steel applications).

Recent developments in federal and state Buy Clean legislature are promising. The federal CLEAN Future Act proposed in March 2021 is especially relevant as it would aim require transparency and potential reduction of embodied emissions in construction materials. At the state level, California remains the only state with a Buy Clean bill passed in 2017. Washington, Minnesota, New York, and New Jersey all have similar Buy Clean bills proposed in legislature.

We find that Buy Clean can help American manufacturing become more competitive in the growing international market of green construction products; protect the competitiveness of domestic energy-intensive, trade-exposed industries; reduce the price of green products; induce innovation; and lead to positive spillover effects in the private sector. Buy Clean would immediately benefit U.S. steel manufacturing as their products already have a lower average carbon intensity than imported products. This will save and even create new high-paying jobs in the steel industry, especially in key steel-producing states such as Indiana, Ohio, Michigan, and Pennsylvania.

Buy Clean faces barriers in unstable political support, public perception, institutional barriers, and establishing measurement protocols, program scope, and implementation guidelines. To overcome these barriers, we make the following recommendations:

- Criteria designed at the national level and implemented at the national, state, and local levels by an individual entity and enforced by law
- Establish standardized reporting and evaluation. Standardized reporting could entail mandatory life cycle analysis for entire project bids and/or use of environmental product declaration (EPD) for materials and products.
- Make tools and databases created to support Buy Clean publicly available.
- Establish programs and funds to help bidders adopt these new practices and help them in Life cycle assessment (LCA) and EPD preparation, which can be an expensive process.
- Include policy elements that promote innovation. Increase standards over time to account for technological improvements and encourage continued emissions reduction.
- Policy design that promotes stakeholder engagement, financial and institutional support for industrial transformation, investment in manufacturing dependencies, and protection against offshoring.

Buy Clean can lead to significant carbon emissions reductions in the production of cement and steel products. It can also make American manufacturing more globally competitive and create high-paying jobs. Thoughtful policy design ensure that the United States captures all the positive co-benefits that green public procurement can provide.

References

- Anderson, J., & Moncaster, A. (2020). Embodied carbon of concrete in buildings, Part 1: analysis of published EPD. *Buildings and Cities*, 1(1), 198–217. DOI: <http://doi.org/10.5334/bc.59>
- Bataille, Chris. 2019. “Low and Zero Emissions in the Steel and Cement Industries: Barriers, Technologies, and Policies.” OECD Green Growth and Sustainable Development Forum.
- Boston Metal. 2021. The Molten Oxide Electrolysis. Available at <https://www.bostonmetal.com/>
- Brown, R. 2021. Testimony of Roxanne Brown, International Vice President at Large of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW) for the Subcommittee on Energy & Water of the Committee on Appropriations hearing on Domestic Manufacturing for a Clean Energy Future. <https://www.usw.org/news/media-center/articles/2021/march/21-03-17-Testimony-of-Roxanne-Brown-on-Domestic-Manufacturing-for-a-Clean-Energy-Future2.pdf>
- Campbell, S., & Tawil, N. (2019). Federal Investment, 1962 to 2018. Congressional Budget Office.
- Carbon Leadership Forum 2018. Buy Clean Washington. <http://www.carbonleadershipforum.org/resources/buy-clean-washington/>
- Carbon Washington 2018. Moving Washington State toward zero carbon emissions
- Committee on Energy and Commerce (E&C) 2021. Climate Leadership and Environmental Action for our Nation’s Future Act. <https://energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/documents/CFA%20Bill%20Text%202021.pdf>
- Dell, R. 2021. Testimony for U.S. House of Representatives Committee on Energy and Commerce Subcommittee on Environment and Climate Change Hearing on the CLEAN Future Act: Industrial Climate Policies to Create Jobs and Support Working Families. <https://docs.house.gov/meetings/IF/IF18/20210318/111348/HHRG-117-IF18-Wstate-DellR-20210318.pdf>
- Dell, R. 2021. Testimony for U.S. House of Representatives Committee on Energy and Commerce Subcommittee on Environment and Climate Change Hearing on the CLEAN Future Act: Industrial Climate Policies to Create Jobs and Support Working Families. <https://docs.house.gov/meetings/IF/IF18/20210318/111348/HHRG-117-IF18-Wstate-DellR-20210318.pdf>
- Department of General Services, California. 2021. Buy Clean California Act. Available at <https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act>
- Elder, J. and Georghiou, L. 2007. Public procurement and innovation—Resurrecting the demand side. http://dimetic.dime-eu.org/dimetic_files/EdlerGeorghiou2007.pdf
- Environmental Protection Agency (EPA) 2010. Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Portland Cement Industry. <https://www.epa.gov/sites/production/files/2015-12/documents/cement.pdf>

Environmental Protection Agency (EPA) 2019. Sources of Greenhouse Gas Emissions. <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

Energy Transitions Commission (ETC). 2018. “Mission Possible: Achieving Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century”

European Commission 2020. Communication from the Commission to the European Parliament, the Council, the European Economic, and Social Committee, and the Committee of the Regions on an EU strategy to reduce methane emissions. https://ec.europa.eu/energy/sites/ener/files/eu_methane_strategy.pdf

Fischer, E. 2010. Green Procurement: Overview and Issues for Congress

Fortune Business Insights 2020. Solar Photovoltaic (PV) Market Report. <https://www.fortunebusinessinsights.com/industry-reports/solar-pv-market-100263>

Friedmann, J., Fan, Z., and Tang, K. 2019. “Low-Carbon Heat Solutions for Heavy Industry: Sources, Options, and Costs Today.” Columbia University Center on Global Energy Policy.

Franklin, C. 2020. Comments at Going Greener: Green Public Procurement for Natural Gas, Cement, and Steel. <https://www.rff.org/events/rff-live/going-greener-green-public-procurement-natural-gas-cement-and-steel/>

Ganley, S. 2013. Federal Green Product Procurement Policy in the United States

Ghisetti, C. 2017. Demand-pull and environmental innovations: Estimating the effects of innovative public procurement. <https://www.sciencedirect.com/science/article/pii/S0040162517300872>

Hasanbeigi, A. 2021. Steel Climate Impact - An International Benchmarking of Energy and CO₂ Intensities. Global Efficiency Intelligence, LLC (forthcoming report)

Hasanbeigi, A. and Khutal, H. 2021. Scale of Government Procurement of Carbon-Intensive Materials in the United States. Global Efficiency Intelligence, LLC.

Hasanbeigi, A. and Springer, C. 2019a. How Clean is the U.S. Steel Industry? An International Benchmarking of Energy and CO₂ Intensities. Global Efficiency Intelligence, LLC.

Hasanbeigi, A. and Springer, C. 2019b. California’s Cement Industry: Failing the Climate Challenge. Global Efficiency Intelligence, LLC.

Hasanbeigi, A. and Springer, C. 2019c. Deep decarbonization roadmap for California’s Cement Industry. Global Efficiency Intelligence, LLC.

Hasanbeigi, A., Becque, R., & Springer, C. (2019). Curbing Carbon from Consumption: The Role of Green Public Procurement. Global Efficiency Intelligence, LLC.

Hasanbeigi, A., Arens, M. Price, L. 2013. Emerging Energy Efficiency and CO₂ Emissions Reduction Technologies for the Iron and Steel Industry. Berkeley, CA: Lawrence Berkeley National Laboratory BNL-6106E.

House Select Committee on the Climate Crisis 2020. Solving the Climate Crisis: the Congressional Action Plan for a Clean Energy Economy and a Healthy, Resilient, and Just America. <https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Crisis%20Action%20Plan.pdf>

HYBRIT. 2021. Fossil-free steel using Hydrogen-DRI process. Available at <https://www.hybritdevelopment.se/en/>

IEC. 2013. Evaluation of the Environmentally Preferable Procurement Program, EPA 100-K-13-014. <https://www.epa.gov/sites/production/files/2015-09/documents/eval-epp-program.pdf>

International Energy Agency (IEA). 2020. Iron and steel technology roadmap.

International Energy Agency (IEA). 2018. “Technology Roadmap: Low-Carbon Transition in the Cement Industry.”

International Comparative Legal Guides (ICLG) 2019. USA: Public Procurement 2019

Interreg Europe 2018. Role of Green Public Procurement in improving resource efficiency.

Jarsulic, M. 2021. Building U.S. Manufacturing Competitiveness and Capacity. <https://www.americanprogress.org/issues/economy/reports/2021/03/11/496920/building-u-s-manufacturing-competitiveness-capacity/>

Krupnick, A. 2020a. Europe Moves toward Requiring Low-Methane Natural Gas. <https://www.resources.org/common-resources/europe-moves-toward-requiring-low-methane-natural-gas/>

Krupnick, A. 2020b. Green Public Procurement for Natural Gas, Cement, and Steel. <https://www.rff.org/publications/reports/green-public-procurement-natural-gas-cement-and-steel/>

Material Economics, 2019. Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry

McKinsey & Company. 2018. “Decarbonization of Industrial Sectors: The Next Frontier.”

National Association of State Procurement Officials (NASPO) 2019. NASPO Green Purchasing Guide

New York State Senate. 2020. Senate Bill S8965: The New York State Low Embodied Carbon Concrete Leadership Act. <https://www.nysenate.gov/legislation/bills/2019/s8965>

OpenAir 2021. The New York and New Jersey Low Embodied Carbon Concrete Leadership Act. <https://openaircollective.cc/leccla>

Organization for Economic Co-operation and Development (OECD) 2015. Going green: best practices for green procurement. https://www.oecd.org/gov/ethics/Going_Green_Best_Practices_for_Sustainable_Procurement.pdf

Perciasepe, B. 2021. Testimony of Bob Perciasepe, President of the Center for Climate and Energy Solutions (C2ES) on behalf of the Renewable Thermal Collaborative (RTC) Before the House Energy and Commerce Committee and Subcommittee on Environment and Climate Change.

https://energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/documents/Witness%20Testimony_Perciasepe_ECC_2021.03.18.pdf

Politico 2020. French government blocks U.S. LNG deal as too dirty. <https://www.politico.com/news/2020/10/21/french-government-blocks-lng-deal-431028>

Portland Cement Association (PCA). 2016. U.S. cement industry annual yearbook 2016.

Portland Cement Association (PCA). 2019. Cement and concrete industry factseets - various states.

Probasco, J. 2021. What's in Joe Biden's \$2.3 Trillion American Jobs Plan?

PwC Sustainability. 2009. Collection of statistical information on Green Public Procurement in the EU. https://ec.europa.eu/environment/gpp/pdf/statistical_information.pdf

Renda, A., Pelkmans, J., Egenhofer, C., Schrefler, L., Luchetta, G., Selçuki, C., & Zirnheld, A.C. 2012. The uptake of green public procurement in the EU27. Brussels, Centre for European Studies (CEPS), College of Europe, 51

Sandalow, D., Friedmann, J., Aines, R., McCormick, C., McCoy, S., and Stolaroff J. 2019. "Industrial Heat Decarbonization Roadmap." Innovation for Cool Earth Forum.

Simcoe, T. and Toffel, M. W. 2014. Government Green Procurement Spillovers: Evidence from Municipal Building Policies in California. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2142085

Simonon, K., Huang, T., Huang, M., 2018. Draft Buy Clean Washington Study State of Minnesota Legislature 2019. Buy Clean Minnesota Act. <https://trackbill.com/bill/minnesota-house-file-2203-buy-clean-minnesota-act-created/1719218/>

StopWaste 2018. Local Government Climate Planning. <http://www.stopwaste.org/preventing-waste/business/built-environment/climate/local-government>

U.S. BEA. (2020). Data Files - Use Tables - 2012: 405 Industries. Retrieved from Input-Output Accounts Data: <https://www.bea.gov/industry/input-output-accounts-data>

US Green Building Council (USGBC) 2018. Buy Clean California. <https://usgbc-la.org/programs/buy-clean-california/>

USGS. 2021. Mineral Yearbook – Iron and Steel.

USGS. 2020a. Mineral Commodity Summaries - Cement.

USGS. 2020b. Mineral Commodity Summaries - Steel.

Van der Zwan Judith 2018. Green Public Procurement as environmental policy tool: A theoretical framework. http://www.a-id.org/wp-content/uploads/2018/05/Green_rpcurement_May_2018.pdf

Wall Street Journal 2020. France's Engie Backs Out of U.S. LNG Deal. <https://www.wsj.com/articles/frances-engie-backs-out-of-u-s-lng-deal-11604435609>

Warren 2021. Warren, Andy Levin, Markey, and Ocasio-Cortez Unveil the BUILD GREEN Infrastructure and Jobs Act to Jumpstart the Transition to Electric Transportation and Modernize Infrastructure.

Washington State Department of Ecology 2021. Environmentally preferable purchasing laws, rules & directives. <https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Environmentally-preferable-purchasing>

Washington State Legislature 2021. Buy clean and buy fair Washington act. <http://lawfilesexternal.wa.gov/biennium/2021-22/Pdf/Bills/House%20Bills/1103.pdf?q=20210328090744>

White House 2021. Executive Order on Tackling the Climate Crisis at Home and Abroad. <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/>

Appendices

Appendix 1. Methodology and assumptions

Cement industry assumptions

Total cement consumption in the U.S. was 98.5 Mt in 2018 (USGS 2020a). From that, around 45 Mt was used in public constructions, which is 46% of total cement used in the U.S. (Figure 4) (PCA 2016). Table 1 shows the detail of cement consumption by market segment in the U.S.

It should be noted that in the majority of cases, the government or its contractors do not purchase cement and instead purchase concrete (mainly ready-mix concrete) which is the final product used in construction projects. The values shown in this chapter do include the cement used in concrete that is used in construction projects.

We used the share of cement used in public construction from total cement used in the U.S. (46%) to estimate the cement used in public construction from total cement used in each state. Around 25% of total cement and concrete procured by government in the U.S. uses federal funds and remaining uses state and local government-owned funds (Hasanbeigi and Khutal 2021). We used this 25% ratio to estimate the government procurement of cement using federal fund and state and local government-owned funds in each state.

The Baseline CO₂ intensity value for cement (806 kgCO₂/t cement) is the weighted average of CO₂ intensity for both domestic and imported cement and it assumes clinker to cement ratio of 0.9 for both domestic and imported cement. It assumes an average CO₂ intensity of 815 kgCO₂/t cement for the U.S. cement production and an average CO₂ intensity of 753 kgCO₂/t cement for the imported cement (Hasanbeigi and Springer 2019b). It should be noted that the cement intensity values for other countries were calibrated to reflect the intensity for a cement with clinker to cement ratio of 0.9. Share of the imported cement from total cement consumption was around 15% in the U.S. in 2018 (USGS 2020a).

Steel industry assumptions

Total steel consumption in the U.S. was 101 Mt in 2018. Around 43% of the steel used in the U.S. is for construction. The second-largest market segment is the transportation predominantly automotive sector (USGS 2020b).

From the share of construction from the total used in the U.S. of 43% (USGS 2020b) and the share of government spending from total construction spending in the U.S. of 41% (US BEA 2020, Hasanbeigi and Khutal 2021), we estimated that around 18% of the total steel used in the U.S. is for public construction. That will mean around 25% of the total steel used in the U.S. is for private construction. Besides, we estimated that around 27% of total steel procured by the government in the U.S. uses federal funds, and the remaining uses state and local government-owned funds (Hasanbeigi and Khutal 2021).

It should be noted that the government procures other products that include steel (e.g. vehicles, appliances, etc.). The government procurement of steel presented in this table and analyzed in this report only focuses on steel used in construction.

The Baseline CO₂ intensity value for steel (1,124 kgCO₂/t crude steel) is the weighted

average of CO₂ intensity for both domestic and imported steel which includes both EAF and BF-BOF. Most countries that the U.S. imports steel from are above this threshold. It assumes an average CO₂ intensity of 614 kgCO₂/t crude steel for the U.S. EAF steel production and an average CO₂ intensity of 1,828 kgCO₂/t crude steel for the U.S. BF-BOF steel production (Hasanbeigi and Springer 2019a). The share of EAF from total U.S. steel production in 2018 was 68%. Using that ratio, we calculated the CO₂ intensity of steel production in U.S. equal to 1,002 kgCO₂/t crude steel in 2018.

Share of the imported steel from total steel consumption was around 30% in the U.S. in 2018 (USGS 2020b). We obtained the list of countries with the amount of steel the U.S. imported from each country in 2018 from USGS mineral yearbook for steel (USGS 2021). To calculate the weighted average CO₂ intensity of imported steel, we used the CO₂ intensity of steel provided in the steel CO₂ intensity benchmarking study by Hasanbeigi and Springer (2019a). The weighted average CO₂ intensity of imported steel to the U.S. in 2018 was about 1,408 kgCO₂/t crude steel.

Using the CO₂ intensity of steel production in U.S., weighted average CO₂ intensity of imported steel to the U.S. and the share of the imported steel from total steel consumption in 2018, we calculated the weighted average CO₂ intensity of steel consumed in the U.S. in 2018 equal to 1,124 kgCO₂/t crude steel. This value was used as the Baseline CO₂ intensity value for Buy Clean steel (Table 4).