Developing Swarthmore College's Shadow Price on Carbon

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In the summer of 2015, a group of faculty and staff at Swarthmore College formed a reading group focused on carbon pricing. This reading group produced a proposal to the college president that, one year later, turned into the Carbon Charge Program. A central component of that original proposal was a shadow price on emissions integrated into institutional decision-making.[1] In 2016, Swarthmore College implemented an internal carbon levy on college departments and offices as the first phase of the Carbon Charge Program; it convened a Carbon Charge Committee to manage the program. The Carbon Charge Committee recommended—and in 2017 the Ecosphere Executive Committee approved—a pilot that incorporates a shadow price into capital projects involving new construction or renovation. The shadow price complements Swarthmore's internal carbon fee.

This document describes the design and implementation of the shadow price on carbon, including considerations for selecting the shadow price.

Shadow price framework

Activities that result in greenhouse gas emissions exacerbate climate change, with costs distributed across the global population. Under a shadow price, Swarthmore does not pay those costs directly, but considers them (in the form of dollars per metric ton of carbon dioxide equivalent (MTCDE)) as part of a cost-benefit decision-making process. For example, when constructing a new building Swarthmore may consider heating the building with ground source heat pumps or with boilers fueled by natural gas. If the cost of the heating system's carbon production is ignored, it will be less expensive to heat the building with natural gas. However, when carbon production is considered, the smaller carbon impact of the ground source heat pump system would make this the less expensive option over the system's expected lifetime (see Figure 1).

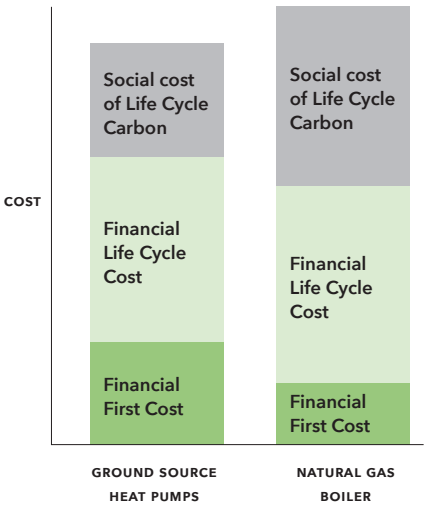

Figure 1 Schematic demonstrating the example considering the financial first costs, financial life-cycle costs, and carbon life-cycle costs of two options for heating a new building.

Evaluated total cost = financial cost + (MTCDE × social cost per MTCDE)

1 To read the full proposal see **bit.ly/SwarthmoreCarbonChargeProposal**.

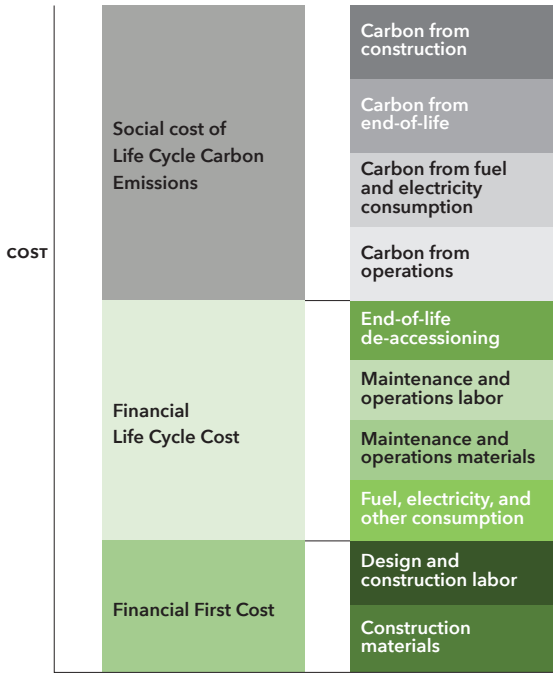

Figure 2 Detailed schematic of some of the costs that are included in each of the categories in Figure 1.

Considerations in setting the shadow price

The Carbon Charge Committee decided on a starting shadow price of $100 per MTCDE. That number was informed by several factors, including:

- the best estimates of the social damages associated with one MTCDE emissions,
- the estimated price that would be necessary to align the global economy with a two-degree Celsius global warming scenario,
- the carbon prices that are used by other institutions, and
- the cost that would be necessary to help Swarthmore take steps to meet its 2035 carbon neutrality commitment.

The following provides more detail on each of these categories.

The social cost of carbon

The most common framework for assessing an appropriate carbon price seeks to estimate the financial costs imposed on the rest of the world as a result of the emission of an additional ton of carbon dioxide equivalent. While theoretically sound, actually estimating and quantifying impacts is extremely difficult. Further, much of the impact will be felt in the fairly distant future, so the cost estimates are extremely sensitive to small fluctuations in the applied discount rate.

The most commonly cited numbers were published in an Environmental Protection Agency (EPA) study that estimated impacts for emissions in 2020 cost $12, $42, or $62 per MTCDE on average, using a 5%, 3%, and 2.5% discount rate, respectively (U.S. EPA, 2017). The EPA's analysis is generally considered an extremely conservative estimate of the social cost of carbon, because it disregards many costs that are difficult to predict, quantify, or monetize. Some of these omitted damages include soil erosion, fires, loss

of ecosystem services, spread of pests and pathogens, violent conflict, mass displacement, and ocean acidification (Howard, 2014).

A paper in *Nature Climate Change* took the same base impact model that the EPA had used and added more detailed considerations for the impact of climate change on GDP growth rates. This study arrived at a much higher cost estimate of $220 per MTCDE (Moore & Diaz, 2015).

Carbon price for a two-degree-scenario

The Paris Agreement presents another framework for determining an appropriate carbon price. In 2015 the Paris Agreement set a goal to keep global warming well below 2°C above pre-industrial temperatures, with an aspirational target of 1.5°C.

A handful of groups have attempted to estimate what carbon price would be necessary to align the global economy with a two-degree scenario. The CDP's Carbon Pricing Corridors report reviewed estimates by the CDP's own expert panel and several other groups. For countries in the Organization for Economic Co-operation and Development (OECD), prices start around $40 per MTCDE and rise to around $100 per MTCDE in 2030, continuing to rise beyond that (CDP, 2017).

The International Energy Agency's modeling indicates that a global emissions trajectory with a 66% chance of keeping warming below 2°C could be reached if all nations instituted carbon prices in alignment with the table below.

	2020	2030	2040	2050
OECD Countries	20	120	170	190
Major emerging economies*	10	90	150	170
Other regions	5	30	60	80

* Includes People's Republic of China, the Russian Federation, Brazil, and South Africa.

Figure 3 Summary of CO2 prices in the 66% 2° (USD/MTCDE), (IEA & IRENA, 2017).

Peer Institutions

In developing Swarthmore's own policy, it was important to consider the policies of other companies and higher education institutions.

Private companies exhibit a tremendous range of internal prices, from a few cents to $890/MTCDE (CDP, 2016). Some prices are part of climate action plans, and others are intended to hedge against regulatory risk. Highly carbon-exposed industries with very long-lasting capital investments often set higher prices (Imperial Oil at $80/MTCDE, ExxonMobil at $80/MTCDE, TransCanada at $61/MTCDE) than companies with less exposure. It is also common to have shadow prices set above any internal carbon charges.

In a memo to the college president, the Carbon Charge Committee outlined some of these considerations in further detail. [2]

2 To read the memo see: **https://docs.google.com/document/d/1dte7orI64rIDls68htiMPd67JGKQ2kMuZhhgFpP1BTE/edit?usp=sharing**

Meeting the 2035 neutrality commitment

Swarthmore signed on to Second Nature's Carbon Commitment, and is intent on achieving carbon neutrality by 2035. Construction and renovations undertaken now will impact operational needs of the college in 2035 and beyond, with decisions today making that target easier or more difficult to achieve. A more expensive shadow price will nudge cost-benefit analysis in favor of decisions that help the college take steps toward neutrality.

There are no data available on the prices necessary to influence decision-making, but Swarthmore's choice was informed by observation of impacts at other institutions. Of the 1,249 companies reporting to the CDP that they have or plan to implement an internal carbon price, only 147 consider the price to be a part of their climate action planning. Of those, only 37 reported an impact on their decision-making. This suggests that the prices that most companies set may not be sufficient to alter cost-benefit calculations and influence decisions, and thus are unlikely to precipitate the impact desired at Swarthmore.

The UN Global Compact calls for companies to implement shadow prices at a minimum of $100 per MTCDE, simply stating that they "believe" it is the "minimum price needed to spur innovation, unlock investment, and shift market signals to ultimately reduce global greenhouse gas emissions in line with the 1.5- to 2-degree Celsius target" (Kingo, 2016).

Policy implementation

The shadow price calculation is applied to all projects and aspects of projects where the systems renovated or constructed are responsible for emitting more than approximately 50 MTCDE annually. Decisions that merit consideration include the building exterior envelope, piping & plumbing, HVAC systems, lighting systems, and electrical power distribution systems.

Design of any major renovation or construction project on Swarthmore's campus includes a life-cycle cost analysis (LCCA) for core elements in the project's scope. This analysis includes both financial costs to the college and carbon costs. Multiple iterations of an LCCA will likely occur for each project; early analyses cover the most impactful systems and elements, while later stages are more detailed and precise. A template for the LCCA is included in requests for proposals and contracts as a required element of design services.[3] Recommendations to the college are thus informed by the long-term impact of carbon production as well as upfront costs and the life-cycle cost of system maintenance.

It is most important to apply the shadow price in areas and projects where there is great potential for carbon reduction with little additional cost.

The shadow price calculation is a key consideration in cost-benefit analysis, but will not, in isolation, influence decision-making. Upfront cost, life-cycle cost, and the shadow cost of carbon all require consideration. Documentation of how options are evaluated helps to inform and educate both the project team and community stakeholders. In addition, requiring this analysis reinforces the college's sustainability goals.

The price, scope of implementation, emissions threshold for consideration, and analytical paradigm will be reviewed by the Carbon Charge Committee in December 2019, and every three years thereafter. Considerations in changing the price of carbon should reflect:

3 To see Swarthmore's LCCA calculator, visit **bit.ly/SwarthmoreLCCA**. Note that construction-, installation-, demolition-, and disposal-related carbon impacts are not included in the LCCA tool, and Swarthmore doesn't currently have means to measure them in most instances. They should be calculated and added manually when data are available.

- Swarthmore's progress towards meeting its 2035 carbon neutrality commitment;
- the latest research on the social cost of carbon as defined by global damage by emissions;
- the latest research on the level of the carbon price needed to contain global warming to 2°C;
- any national or state level carbon prices that cover the college; and
- the consulting costs associated with implementing and performing the LCCA.

References

CDP. (2016). Embedding a carbon price into business strategy. North America: CDP. Retrieved from **https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/001/132/original/CDP_Carbon_Price_report_2016.pdf?1474899276**

CDP. (2017). Carbon pricing corridors: The market view. North America: CDP. Retrieved from **https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/002/112/original/Carbon-Pricing-Corridors-the-market-view.pdf?1495638527**

Howard, Peter. (2014). Omitted damages: What's missing from the social cost of carbon. Environmental Defense Fund, Institute for Policy Integrity, Natural Resources Defense Council. Retrieved from **https://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf**

International Energy Agency & International Renewable Energy Agency. (2017). Perspectives for the energy transition-investment needs for a low-carbon energy system. Retrieved from **https://www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf**

Kingo, L. (2016). Executive update: setting a $100 price on carbon. Huffington Post Blog. Retrieved from **https://www.unglobalcompact.org/news/3361-04-22-2016**

Moore, F. C., Diaz, D. B. (2015). Temperature impacts on economic growth warrant stringent mitigation policy. *Nature Climate Change,* (5), 127–131. **https://doi.org/10.1038/nclimate2481**

U.S. Environmental Protection Agency. (2017). The social cost of carbon. Retrieved from **https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html**