Institutional Emissions and Energy Planning:

A Practical Guide for Administrators, Managers and Decision-Makers on the Interactions Between Carbon Accounting, Institutional Goal Setting and Energy Procurement

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1. EXECUTIVE SUMMARY

Institutions are increasingly developing emissions and energy plans with the aim of reducing both greenhouse gas emissions and energy consumption. To create a consistent energy and emissions plan that benefits the institution and society, institutions require an awareness and knowledge of several interlinked components. This document provides an overview of these key components and their interactions. The components identified in this report are: Goal Setting, Action and Energy Procurement, and Emissions Accounting.

Institutions will find that many of the questions that arise when developing an energy emission plan will not have clear answers. Therefore, this document strongly recommends that institutions set principles that reflect their fundamental values and the motivation for developing an emissions and energy plan at the planning process. Importantly, these principles need to reflect the values and motivation of all stakeholders, as various stakeholders across an institution may have different goals and values. Once institutional principles are established, each component and its respective interactions may be analyzed under this guiding framework, which will more consistently direct decisions.

For goal setting, this document summarizes the decisions needed to characterize an institutional footprint, such as determining institutional boundaries and emission scopes, and provides examples of institutional principles. For emissions accounting, several methods to quantify emissions are introduced. Selecting a transparent and credible accounting framework is strongly recommended. For action and energy procurement, it is recommended that institutions evaluate different options for emissions reduction based on their institutional principles.

Consider the connections between goal setting, energy procurement, and emissions accounting when making decisions. Many of the interactions between the components discussed in this document may not be apparent. Challenges and uncertainties will arise in developing and implementing a plan associated with the long time scales involved, complex and potentially changing system boundaries, and secondary effects of an institution's actions—these should be planned for.

The aim of this document is not to anticipate all of the challenges and complexities that will arise, but to introduce a structured way to approach plan development, and to highlight the types of issues that can be expected. Therefore, several other useful resources are cited throughout the document. Lastly, several case studies of energy and emissions plans deployed by institutions are presented, highlighting both leading efforts and the types of challenges that can arise.

While each institution is unique in purpose, geography, structure, and financial resources, a baseline knowledge of these fundamental components is necessary to ensure effective planning and communication between all stakeholders, and to limit unintended consequences. Most importantly, this baseline knowledge allows institutions to create an energy and emissions plan that is credible, transparent, self-consistent, and impactful. Together, these considerations will allow institutions to establish a coherent narrative that can be clearly and effectively communicated to stakeholders and society more broadly.

2. GLOSSARY

Cap-and-Trade: A type of emissions reduction policy where emitters must hold tradable permits for each unit of emissions that they emit. The markets for these permits form a price on emissions.

Emissions Intensity: The quantity of emissions per unit of energy produced, either by an individual energy producer or averaged across a whole sector (for example, the electricity grid of a particular state or country).

Greenhouse Gas: A gas that absorbs infrared radiation and therefore has a warming effect in the atmosphere. The main greenhouse gases emitted by human activities that are causing global warming are carbon dioxide from fossil fuel burning, followed by methane, nitrous oxide, and various fluorinated gases.

GHG Protocol: Greenhouse Gas Protocol. A standardized framework for accounting greenhouse gas emissions used by major companies, universities, and other institutions setting emissions targets.

Paris Agreement: The 2015 international climate agreement that set a target to limit global warming to below 2 degrees Celsius.

PPA: Power Purchase Agreement. A contract to purchase a certain amount of electricity from an power generator. Usually a long-term contract of more than five years.

REC: Renewable Energy Certificate. A REC certifies that a MWh of electricity was generated from an eligible renewable energy source, such as solar or wind.

Societal Emissions: The sum of all greenhouse gas emissions across the globe, which is the controlling factor for climate change. An institution and its energy procurement actions affect societal emissions both directly and indirectly.

Watt: a unit of power, or rate of flow of energy. Electrical energy at institution-scale is typically on the scale of millions of watts (Megawatts, **MW**).

Watt-hour: a unit of energy equal to the cumulative energy of 1 watt acting constantly for 1 hour. Electrical energy at institutional-scale is typically on the scale of millions of watt-hours (Megawatt-hours, **MWh**) to billions of watt-hours (Gigawatt-hours, **GWh**).

3. OVERVIEW

Universities, municipalities, corporations, and other institutions are increasingly addressing the challenge of climate change by setting voluntary greenhouse gas reduction targets and taking actions to minimize their environmental impact. These trends are being driven by a growing awareness and acceptance of climate change, the increasing importance of sustainability in corporate responsibility, and the increasing availability and affordability of low-emission energy sources and energy-saving technologies.

This is powerfully illustrated by the rapid growth in corporate renewable energy procurement and steady growth in university procurement (see Figure 3.1).

> "Nearly two-thirds of Fortune 100 and nearly half of Fortune 500 companies have set ambitious renewable energy or related sustainability targets. Renewable energy procurement by universities recently passed 1 gigawatt" *Rocky Mountain Institute*

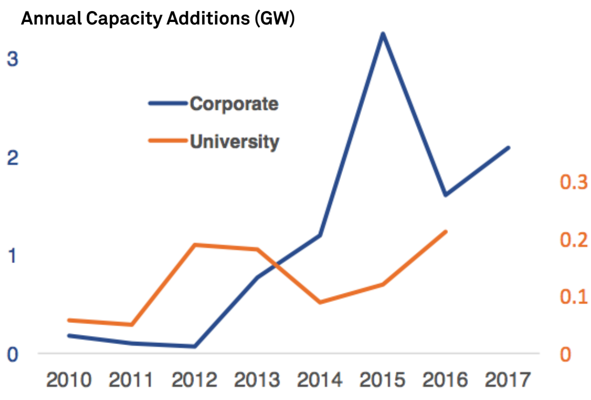


Figure 3.1 New corporate and university renewable energy procurement in the United States for each year from 2010 to 2017 (data from RMI).

3.1 Components of an Emissions and Energy Plan

Before embarking on a program to reduce emissions, institutions need to be able to understand, justify, and explain three key components of their emissions and energy plan. These are:

1. Their emissions goals and why these specific goals were set.
2. Actions they take to achieve their emissions goals.
3. The methods they use to quantify their progress toward these goals.

In this document, these three components are referred to as "institutional goal setting", "action and energy procurement", and "carbon accounting," respectively (Figure 3.2). While these three components are distinct, they are inherently interdependent and must be considered together throughout the decision making process. Failure to fully consider the interactions between the components, or failure to involve all stakeholders, may lead to poor outcomes. Examples of such outcomes include setting targets that cannot be met, spending more money than necessary to meet a target, or claiming institutional emission reductions that are higher than their true impact.

Decisions within each of the components have feedbacks throughout the entire framework, therefore several iterations may be necessary to arrive at a coherent plan. A set of fundamental principles that clearly define an institution's values is necessary to guide the development process. These principles should drive decisions in all three individual components so that all policies and actions consistently reflect the institution's intentions.

This overall framework is illustrated in Figure 3.2. In this section, each of the three components are briefly introduced. Several questions are posed for each component to assist the reader in understanding the overarching concepts, followed by a discussion of the interactions between components. The three following sections discuss each of the components in more detail.

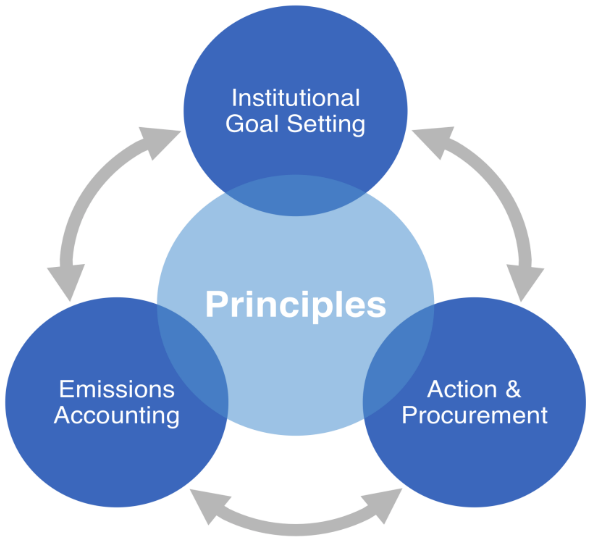


Figure 3.2. Relationships between the overarching principles and key components of an emissions and energy plan.

Principles: What are your principles and what is the basis behind them? How do your principles guide decisions within the components of your plan?

An institution needs a set of principles that guide its goals, actions, and accounting. Principles can be applied to decisions in each of these emissions and energy plan components to ensure a consistent, defensible plan. Some common principles adopted by institutions include demonstrating leadership, additionality, and prioritizing local actions, which are further discussed in Section 4.

Institutional Goal Setting: What are your emissions goals and why? What is the scientific or other basis for the goals?

To establish goals, an institution needs to first identify why they are setting an emissions and energy goal. Often, institutional principles guide the establishment of these goals. There are a variety of goals an institution can set, such as emissions reduction targets, emissions neutrality goals, clean energy targets, or other sustainability goals.

The types and magnitudes of the goals will be influenced by many factors. Some key considerations include the feasibility and costs of meeting the goals, the actions of peer institutions, scientific guidance, and state and national government policies.

Action and Procurement: What actions can you take to meet your emissions goals? What infrastructure options do you have? Can you procure low-emissions energy?

The actions and energy procurement options available to an institution depend strongly upon the size and financial position of the institution, its geographical location(s) and existing infrastructure, government policies, and the costs and benefits of actions, both monetary and non-monetary (e.g. public and community relations). The principles set by an institution may also prioritize certain actions over others.

Emissions Accounting: What method(s) will you use to calculate your emissions? What are your institution's emissions quantities and sources? What emissions will you include in your targets?

Precisely quantifying an institution's emissions and the impact of its actions on the complex, global energy system is incredibly challenging. Therefore, simplified yet credible carbon accounting is required. However, simplification of a complex and interconnected system necessarily excludes information. This can introduce perverse accounting incentives that may lead to unintended behaviors and outcomes, such as accounted emissions reductions that do not correspond to true societal emissions reductions.

3.2 Interactions Between Components

In this section, an overview of some of the interactions between the three components of an emissions and energy plan is provided. Examples of feedbacks that should be considered when making an emissions and energy plan are highlighted. This should act as an introduction to the rest of the document, where interactions between components are explored in greater depth.

Institutional Goal Setting and Action and Energy Procurement: Do your goals eliminate or incentivize particular actions and energy procurement options? Can you afford the actions and procurement needed to achieve your goals?

There is a close link between the goals an institution sets and the action and procurement options available to achieve those goals. Many institutions will want to set goals with an understanding of how they can be achieved. Some institutions may choose to set goals that they know will be difficult to achieve in order to incentivize innovation, particularly for longer-term goals.

Emissions Accounting and Institutional Goal Setting: Is it possible to achieve the emissions goal under the chosen accounting method?

The choice of accounting methods and which emissions to include in your accounting has major implications for both how and by how much those emissions can be reduced. It is critical to develop emissions targets with knowledge of the accounting methods and accounting boundaries that the institution is intending to set. Otherwise, there is a risk that unachievable targets may be set.

Emissions Accounting and Action and Energy Procurement: Will the accounting framework incentivize actions that are feasible and consistent with your principles?

Accounting choices will influence the types and sizes of actions required to meet emissions targets. The exclusion of particular categories of emissions, for example air travel, could exclude cost-effective reductions. Furthermore, energy procurement options that have identical accounted emissions reductions may have different societal emissions impact.

Each of the three components introduced above is discussed individually in the following sections. Uncertainties that should be considered when developing and institutional emissions and energy plan are then discussed. Lastly, several case studies are provided as examples. Ultimately, this document seeks to aid institutions in developing emissions and energy plans that are credible, consistent, and impactful.

4. SETTING INSTITUTIONAL GOALS

To develop an emissions reduction and energy procurement plan, institutions should first undertake three interrelated efforts: set principles for action and understand the implications of those principles; characterize their emissions footprint; and set institutional goals. These components will require review and modification as they are developed and the relationships between them are better understood. However, as a first step it is helpful to consider each action individually. This section highlights some of the key considerations for developing a coherent understanding in each of these areas.

Every institution has a unique energy consumption and emissions footprint, along with a range of financial, institutional and physical constraints. Recognizing that the ability to successfully reduce emissions is based on these factors, a one size fits all approach is not possible. Here, a general framework is introduced to aid development of an institution-specific plan to tackle emissions reductions. Once these points are addressed, an institution will: have identified the key principles that will guide their emissions reduction actions, understand their current emissions, and have defined goals for emissions reductions.

4.1 Setting Institutional Principles and Understanding Their Implications

It is important to realize that any emissions reduction plan, and the associated targets and emissions accounting, may be imperfect, especially in the early stages of their development and implementation. Therefore, it is critical that institutions are transparent in setting their goals and present a clear and logical narrative for any decisions made on an emissions reduction and energy plan. A multitude of difficult and complex decisions are to be expected, with grey areas that have the potential for negative perception if they are not carefully considered. Institutional principles are especially important, since they can provide a basis for making consistent decisions and presenting a clear set of values externally.

> The guiding principles serve as the foundation for the emissions targets and reduction plan. Institutions will find themselves revisiting these principles on a frequent basis in order to assess the extent to which the emissions targets and plan reflect the institution's guiding principles.

What Are Principles, and Why Are They Important?

While targets are key components of an emissions reduction plan, they do not necessarily identify acceptable actions that an institution can take to meet these targets. A set of guiding principles helps to outline an institution's fundamental values and its motivation for developing an emissions and energy plan. There will likely be various options available to reduce or offset emissions, however these may not all be consistent with an institution's values. For example, if one of the institution's key principles is to support solutions that are local, this may produce the purchase of renewable energy from distant and unconnected electric grids or carbon offsets from international programs. However, these may be acceptable solutions for an institution whose primary goal is to maximize the overall societal CO_2 reductions of its actions.

Examples of Principles

The table below outlines key principles that an institution may wish to consider before developing an energy and emissions plan. This is not an exhaustive list, and there may be additional principles specific to your institution. Many of these principles are interrelated.

Table 4.1 Institutional Principles and Descriptions

Principle	Guiding Question	Description
Additionality	Does an institution's action contribute to reductions in global CO_2 emissions compared with not taking this action?	Additional actions result in emissions reductions that would not otherwise happen. Quantifying additionality is difficult. Ultimately, it is critical for an institution to have a credible and logical narrative to justify that its actions lower emissions. Counter-example: Emissions reduction by purchase of low-cost RECs from a legacy renewables project purchased from a voluntary REC market. In this case additionality is unlikely, and may not be consistent with an additionality principle.
Co-Benefits	Is it important that actions taken to reduce emissions also have benefits in other areas (environment, health, community etc.)?	There are many potential co-benefits that can be realized from taking climate action, and institutions may want to focus on maximizing opportunities in specific areas. For instance, institutions may wish to undertake opportunities that engage the community or its employees, or which improve local environmental conditions.
Leadership	Does the action taken demonstrate leadership or innovation, and set an example for others?	This includes actions that display leadership in a variety of areas, such as supporting new technologies, setting a sector-leading emissions target, or being a first mover. This is a broad category that may encompass many goals dependent on the institution's focus areas. For example, a technology firm may wish to implement new and innovative energy solutions, while a community organization may wish to undertake projects within the local community.
Locality	Where are the emissions reductions and accompanying actions undertaken?	Local actions are those taken within some defined geographical proximity to the institution. Efforts to maximize locality are often driven by a desire to increase community engagement, improve public relations, or the institution's belief that future solutions will need to be local.

Long-Term Vision	Will our near-term actions enable greater long-term reductions, or make longer-term reduction more difficult?	Some short-term, lower-cost emissions reductions may make longer-term emissions reduction more difficult. Long-term vision is necessary to enable a pathway to deep reductions. For example, near-term reduction may be achieved by switching from oil to gas heating, but a long-term reduction to zero emissions will be more difficult than if heating was electrified.
Public and Community Relations	How will these actions contribute to the engagement of and perception within the local community, country, or business sector?	An institution's actions may foster a positive or negative public image. This may be a significant consideration. For example, a wealthy institution may be seen as "buying its way out" if it takes actions which are much too expensive to be feasible for other institutions.
Scalability	Can the actions be scaled up and applied broadly in a society seeking deep decarbonization?	This is an important but complex principle. The concept is that actions and solutions should be scalable system-wide to help achieve a zero emissions energy system. It is critical to note that a range of solutions will likely be required to achieve significant decarbonization, and each institution will be poised to take different actions. Therefore, actions should not be eliminated solely because they are not applicable in every location. As with the additionality question, it is important for an institution to have a credible and logical narrative for their decisions.
Societal View	What will be the overall impact of the institution's plan on societal emissions?	How do an institution's actions interact and fit within the broader energy system?
Target Basis (Scientific Basis)	On what basis should the institutional emissions reduction targets be made?	An institution may decide that it should base its emission reduction targets or energy plan on particular criteria, such as using a science-based targets method, or remaining

4.2 Characterizing an Institutional Footprint

Two initial and critical steps in developing an institutional target for emissions reductions are to (1) understand the existing overall emissions profile of the institution, and (2) to assign emissions (or energy consumption) to specific end uses. These two will set a *baseline* emissions level and identify the activities responsible for those emissions. This provides a justifiable basis for setting quantifiable emissions reductions targets, and also guides an institution to focus on areas of maximum benefit.

Understanding an Existing Emissions Profile

The most commonly used standard for emissions quantification is the Greenhouse Gas (GHG) Protocol, which provides guidance on emissions classification and accounting. The GHG Protocol provides a transparent, widely accepted accounting framework for institutions. More detailed information on this protocol can be found in Section 6: Emissions Accounting Methods.

The GHG Protocol breaks emissions into three 'scopes', which cover direct and indirect emissions. Guidance is provided within the GHG Protocol for quantifying each of these scopes.

- Scope 1: Direct emissions - emissions for which the institution is directly responsible. For example, on-site fossil fuel combustion for electricity generation or transportation.
- Scope 2: Electricity indirect emissions - emissions for which the institution is responsible through the purchase of electricity from off-site sources.
- Scope 3: Other indirect emissions - emissions that arise as a result of the activities of the organization, but not through consumption of energy on-site. A broad category, it covers items such as employee business travel and transport of purchased goods, among others. The full scope of these emissions can be reviewed in the GHG Scope 3 Calculation Guidance document.

Scope 1 emissions are the most direct form of emissions. For institutions that generate their own electricity, heating and/or cooling from on-site combustion sources, Scope 1 will constitute a significant proportion of total emissions. They may also represent the most challenging sources of emissions to address, as reductions may require significant infrastructure changes.

Scope 2 emissions associated with electricity consumption will account for a substantial proportion of emissions for most institutions. These may be easier to address than Scope 1 emissions. Several options exist for reducing emissions associated with Scope 2 emissions, including purchase of renewable energy, and reduction of electricity demand through efficiency programs, as discussed later.

Scope 3 emissions will require careful analysis to determine which categories should be included in the institutional footprint. Many institutions choose a subset of the categories, such as employee business air-travel. Scope 3 emissions may be more complicated than other categories, as they typically represent another party's Scope 1 or 2 emissions.

Most institutions focus on Scope 1 and 2 emissions, and these are the main focus of this paper. Emissions may shift between scopes as systems or behaviors evolve. For example, if an institution's energy system is converted to an electrified system, emissions may shift from Scope 1 (on-site, direct) into Scope 2 (off-site, indirect). If future employee transport involves electric cars that are charged on-site during the day, formerly Scope 3 emissions will become Scope 2. Some of these associated risks and uncertainties will be discussed later in Section 7: Uncertainties and Challenges.

System Boundaries

The organizational and legal structures of institutions will impact how their system boundaries are defined. Understanding and defining clear boundaries is important both for quantifying the institution's emissions, as well as being able to categorize emissions into the one of the three scopes introduced above. For an institution with a campus, a simple physical boundary will likely be the most logical approach. For an institution with shared operations, boundary definition may become more complex. This is discussed further in Section 6. Readers may also refer to the guidance provided in the GHG Protocol.

Assigning Emissions to End Uses

Actions to reduce institutional emissions will not only focus on shifting to low- or zero-emissions energy sources, but also on increasing efficiency and reducing energy consumption. Therefore, it is important for an institution to understand their energy uses, system efficiencies, and areas of maximum opportunity.

Emissions or energy consumption can be assigned to end uses or locations. This may take a sectoral approach, identifying contributions of cooling, heating, transport, lighting, etc. to total emissions/consumption; a geographical approach, assigning emissions/usage to individual buildings or groups of buildings; or a combination of the two. Following quantification, benchmarking against other institutions and technologies will assist in highlighting areas for improvement and providing insight into the emissions reductions that may be possible.

4.3 Setting Institutional Goals

An institution's emissions reduction goals are quantified by the targets it sets. Targets may take several forms. For example, an institution may set a target to reduce absolute emissions, reduce the intensity of emissions, or alternately require procurement of a particular quantity of clean energy. Which of these targets are appropriate will depend upon each institution's total emissions, energy consumption, and infrastructure.

> Regardless of the types of targets set, targets should be explicitly tied back to an emissions reduction quantity, as greenhouse gas emissions reduction is the underlying purpose of all of these actions.

Targets should be developed with an understanding of the institution's principles (discussed above) as well as the opportunities, costs, and feasibility of implementing those targets. Overly ambitious targets may be impractical, while easily attainable targets could be perceived as insufficient and are unlikely to meaningfully reduce the institution's emissions.

A pragmatic approach is advisable, where the perfect is not an enemy of the good. Goals and targets can be staggered, with an institution beginning with small steps to demonstrate commitment, while allowing for learning and tightening of goals as time progresses. Openness and transparency are important, so that stakeholders and the community can understand the trajectory and the decision making process.

Defining Targets:

Targets can be set using either a top-down or bottom-up approach, and should be developed with consideration of the institutional principles and baseline emissions. The interactions between institutional targets and other schemes to regulate emissions, such as carbon taxes or emissions trading schemes (ETS) is not explicitly discussed here, but is addressed in Section 7: Uncertainties and Challenges.

Top-Down

Top-down targets set cumulative institution-wide targets without specifying the actions that will be taken to meet those targets. These may take the form of absolute emissions reductions, emissions intensity reductions, or specific renewable energy procurement targets. An institution may choose to set science-based targets, which, for example, may align with the best scientific research on the level of decarbonization needed worldwide to achieve the Paris Agreement target. Alternatively, an institution may choose to align its targets with a given international, national, or state emissions reduction goal, or simply choose its own goal.

Examples of top down targets:

- Net-zero carbon emissions: Through a combination of efficiency projects, low-emissions electricity purchases, and carbon offsets, an institution can achieve net-zero emissions. An institution seeking net-zero emissions still allows onsite emissions, with offsets purchased to 'zero' these emissions. In setting a net-zero goal, an institution becomes reliant on other actors to help mitigate its emissions, adding to the uncertainties and accounting difficulties discussed in the following sections.

- Total-zero carbon emissions: Through a combination of efficiency projects, infrastructure projects and zero-emission electricity to cover all remaining energy needs, an institution can achieve total-zero emissions. An institution seeking total-zero emissions will allow neither onsite emissions or the purchase of carbon offsets to cover Scope 1 or 2 emissions. A total-zero goal is the most concrete way to ensure that an institution's impacts are minimized and is relatively simple to assess, but can be extraordinarily challenging to meet.

- A percentage reduction in net or total Scope 1 and 2 emission reductions from a set baseline: for example, an institution may seek to reduce Scope 1 and 2 emissions by 30% by 2030, based on baseline emissions in 2018.

- A set quantity of renewable energy purchases: for example, an institution may set out to procure 10 GWh/year of solar and/or wind power by a given target date.

Bottom-Up

Bottom-up targets are based on what can be achieved from a particular set of infrastructure changes, efficiency projects, power purchases, and so on. In these cases, the targets and their implementation are inherently linked. Although this is not a "target" in the true sense, bottom-up targets may be particularly suitable for institutions that have limited capital, or are undertaking significant infrastructure changes and would like to evaluate possible emissions reductions for different development plans.

Table 4.2: Top-Down Versus Bottom-Up Carbon Target Development Examples

	Top-down Targets		**Bottom-up Targets**	
	Science-Based	Policy-Aligned	Financial Constraint	Highest Cost- Benefit
Example Goal	Emissions reduction consistent with IPCC 2° C target.	Emissions reduction consistent with US UNFCCC CO_2 target.	Maximize emissions reduction within a fixed budget.	Choose actions that maximize emissions reductions per $ invested.
Example Target	Institutional 100% decarbonization by 2050.	Reduce institutional emissions by 26-28% by 2025.	Focus on the largest emissions reductions for a given expenditure	Refer to Stanford Case Study (Section 8)

5. ACTION AND ENERGY PROCUREMENT

There are many actions available to institutions wishing to reduce their energy and emissions footprints. Emissions reductions can be achieved by means of energy conservation and improved energy efficiency, procurement of energy from low-carbon sources, or by purchase of carbon offsets. These options may be pursued individually or in combination.

The emission reduction options will vary for each institution based on the availability of low- emission energy resources (e.g. wind or sunlight), the relative costs of each option, and the regulatory environment. This section introduces how an institution's principles also affect the option(s) chosen for decarbonization. In particular, the principles of scalability and additionality are discussed.

The options for emissions reductions depend on the scopes of emissions (Figure 5.1). The options in Figure 5.1 are not equally impactful, and the solutions chosen will depend on an institution's principles and goals. For example, an institution seeking *net-zero* emissions could maintain on-site combustion of fossil fuels by purchasing offsets for the amount of CO_2 emitted. However, an institution seeking total-zero emissions would need to use low-emission fuel sources or switch to an electrified energy system with clean electricity sources.

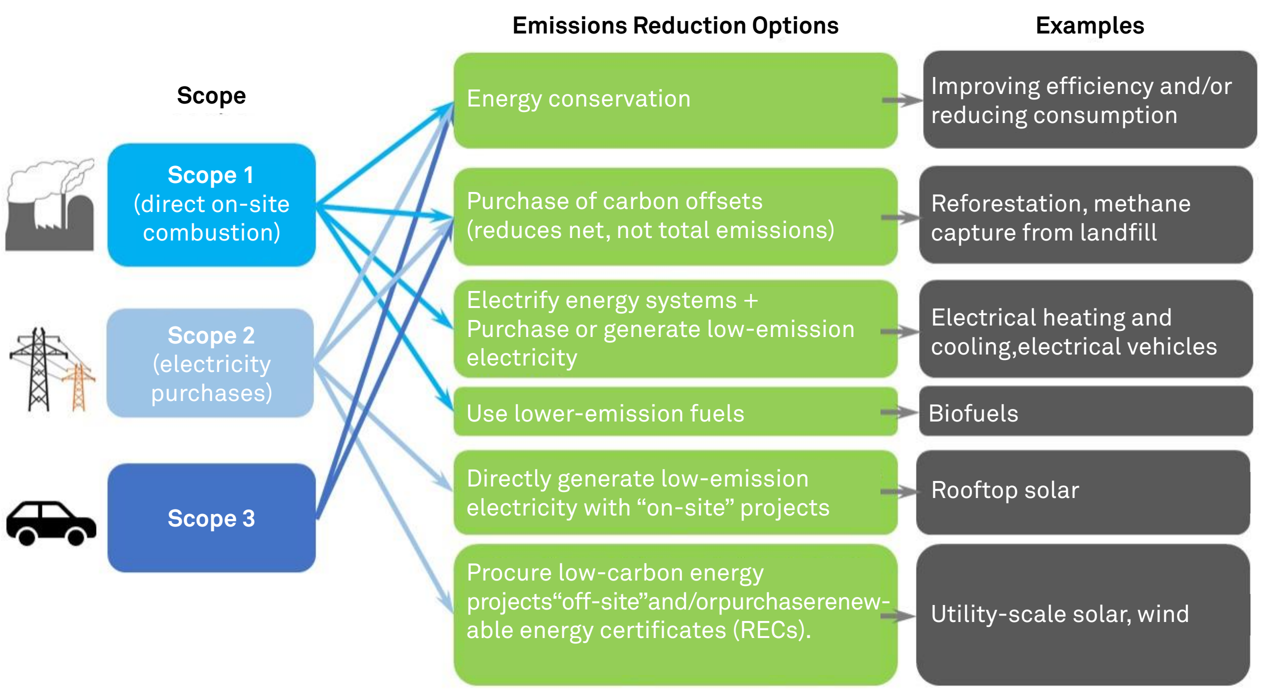


Figure 5.1. Pathways to reduce emissions.

Overall, the major options for reducing emissions involve generating or procuring low-carbon electricity, purchasing carbon offsets, using biofuels, or increasing energy efficiency. Key considerations for each of these options are discussed below.

5.1 Energy Conservation and Efficiency

Improving energy efficiency decreases the amount of energy needed to provide services for an institution. Energy efficiency can directly reduce both Scope 1 (on-site) and 2 (electricity related) emissions. For example, using less energy to heat or cool buildings means either less on-site combustion to produce energy or less electricity purchased from the grid. Common energy efficiency improvements include energy-saving lighting, improved building insulation, green roofs, and geothermal energy storage. Improved energy efficiency directly decreases energy use, and thus immediate reductions in emissions are achieved.

Energy conservation can also be achieved through behavioral change, for example encouraging or mandating increased interior temperatures during summer. This approach can be a powerful and cost effective approach to augment the energy consumption reductions from efficiency projects. It can also be readily applied to mitigation of Scope 3 emissions, for example reduction of commuting emissions by carpooling and reduction of business travel emissions by replacing travel with teleconferencing.

Additionality
When an institution takes voluntary actions to reduce energy consumption or improve on-site energy efficiency, such as using more efficient appliances or vehicles, the action is additional. Increased availability of energy efficient technologies has been largely driven by government policies mandating specific appliance or vehicle efficiency standards.[1] However, if actions are mandatory under government regulation, then additionally can be questionable.

Scalability
Maximal scaling of energy efficiency and conservation projects (i.e. optimizing the energy efficiency of all infrastructure and encouraging appropriate behavioral changes) can reduce total emissions by a substantial fraction. However, some level of energy use and associated emissions will remain. Therefore, energy efficiency needs to be coupled with other carbon mitigation strategies in order to achieve zero emissions.

5.2 Low-Emissions Electricity and Renewable Energy Certificates (RECs):

On-site production of renewable energy directly reduces the amount of electricity purchased from the grid, which typically includes electricity from emissions-generating sources. One disadvantage of this approach is that the total renewable energy generation potential on an institution's property is typically insufficient to meet its energy requirements. Additionally, on-site installations can have high upfront costs, and maintaining these installations is likely outside of the institution's core competencies.

[1] Doris, E. et al. (2009). Energy efficiency policy in the United States. Overview of trends at different levels of government. National Renewable Energy Lab Golden, CO.

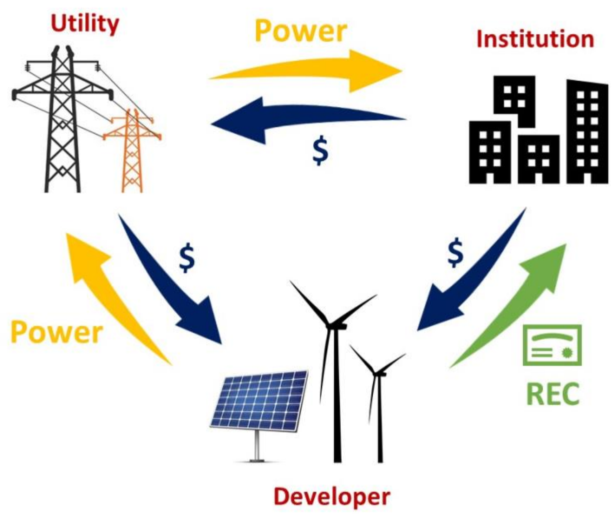
Therefore, procuring energy from off-site renewable sources is one of the most widely used methods to reduce emissions, either to supplement or substitute on-site generation. The primary method for tracking renewable electricity purchases is through renewable energy certificates (RECs). A REC certifies that a MWh of electricity was generated from an eligible renewable energy source, such as solar or wind, and serves as a proxy for the purchase of renewable energy.

The power grid contains a mix of electricity from renewable and traditional sources (i.e. fossil, nuclear). In reality, users draw power from multiple sources and it is impossible to know which users are utilizing which sources. RECs were created to allow users to claim the environmental benefits associated with renewable energy generation. In short, RECs enable the identification of clean electricity users – despite the fact that different sources of electricity cannot be separated or physically traced to specific buyers.

Whenever a renewable power source generates one MWh of electricity, one REC is created. The electricity users that would like to claim the use of clean electricity can pay a renewable power developer for the corresponding REC. Although the institution still gets its power from a grid that has a mixture of electricity sources, by purchasing one REC for every MWh consumed, it purchases the right to claim 100% renewable energy use. However, the reality can be much more complex, as is described in the following paragraphs.

RECs can be traded by utilities that must comply with mandatory renewable energy policies and by institutions that are pursuing voluntary renewable energy targets. As illustrated in Figure 5.2, revenue for renewable energy developers comes from selling both RECs and electricity. Therefore, RECs may allow renewable electricity to be sold at a price low enough to compete with traditional sources, since it is partially subsidized by the purchase the RECs. This provides an added incentive for developers to invest in renewable energy projects.

Figure 5.2. The procurement of low-carbon electricity via Renewable Energy Certificates (RECs).



It is recommended that any RECs that are purchased have undergone a rigorous third-party certification process in order to verify the claimed environmental benefits. Green-e is the most common marketplace for and certifier of RECs. Although all RECs are certified on a MWh basis, large uncertainties exist when converting certificates (MWh) to CO_2 emission reductions. Therefore, the conversion from a certified REC to a reduction in emissions can lead to accounting credibility issues, which are discussed in Section 6.

Even though RECs may comply with certification standards, there are different methods of purchasing RECS that may lead to different levels of emission reduction due to their additionality. In this context, the distinction between RECs bundled with a purchase of electricity (bundled RECs) and those purchased separately from the associated electricity (unbundled RECs) is important.

Unbundled RECs

Once RECs are generated, they can be purchased separately from the associated electricity. The price of unbundled RECs varies considerably depending on the state in which the electricity is generated (< $1/MWh in Texas and > $100/MWh in New Jersey). REC prices tend to be higher in regions with a mandated quantity of renewable energy production, as there is significant demand from utilities in order to meet these requirements. In other regions, RECs are sold on a purely voluntary market, and tend to have lower prices.

Thus, depending on the states in which the electricity is generated, purchasing and retiring unbundled RECs may have a different impact on the development of renewable energy.

Power Purchase Agreements with Bundled RECs

A more direct way to support renewable projects is to "bundle" RECs with an electricity purchase. In a power purchase agreement (PPA) the electricity user agrees to buy a certain amount of electricity and the associated RECs from a specific renewable project at a price that is typically contracted for 7-20 years. A PPA guarantees the developer a predictable revenue stream from the project's generated electricity, which facilitates financing and often enables new projects to be built. Therefore buying bundled RECs with a PPA, especially for new renewable projects, generally has a larger impact than purchasing unbundled RECs. As for unbundled RECs, bundled RECs have to be retired for the electricity user to claim the use of green electricity.

There are two types of PPA contracts: physical and virtual (often structured as a contract-for-differences). While the two types differ in financial structure, the type of contract does not impact the emissions characteristics of the PPA. More information about purchasing renewable energy through a PPA can be found in EPA's 'Guide to Purchasing Green Power' and Rocky Mountain Institute's 'An Introduction to Renewable Energy PPAs'.

Additionality

The "additionality" of RECs is complex and difficult to quantify[2] (Table 5.2). A renewable project bundled with RECs is additional if the renewable energy project would not otherwise be built without revenue from the PPA and RECs. Unbundled RECs are additional if the sale of RECs allows new renewable energy investments that would not have otherwise happened. This may be the case in states with strict renewable energy requirements, and therefore

[2] Gillenwater, M. (2012). What is Additionality? Part 1: A long standing problem. GHG Management Institute,

Table 5.2: The additionality of different electricity procurement options.

On-site Generation	Additionality is unambiguous if the resulting RECs are retired and the institution is solely responsible for the new project.
Bundled RECS with PPA for new renewable projects	Additionality is essentially guaranteed when a long-term contract is r equired to secure project financing.
Bundled RECs with PPA for existing renewable projects	Additionality is weaker than that for RECs that directly enable new project because the projects likely do not require funding from a PPA to continue producing electricity once completed.
Unbundled RECs	Additionality is questionable if unbundled RECs are inexpensive relative to the price of electricity. Unbundled RECs with higher cost (as in mandatory REC markets) are more likely to impact clean energy investments as they contribute a larger revenue stream to development – provided the price does not solely represent additional profit for the sellers.

high REC prices. Additionality tests have been developed to better evaluate the additionality of projects. However, these tests require counterfactual scenarios that can be hard to assess, causing huge uncertainties in additionality.

In the absence of a clear additionality test, it is recommended that an institution be able to communicate a clear narrative that its RECs and/or power purchases have led to increased renewable power generation and reduced emissions.

There are a wide range of additionality characteristics between different types of RECs. It is worth noting that despite the lack of clear additionality associated with inexpensive, unbundled RECs, unbundled RECs as a whole still provide some additional revenue for renewables and may therefore contribute positively to renewable energy adoption. Purchasing unbundled RECs can also be a quick first action by which institutions can demonstrate their intent to reduce emissions while a more thorough plan is developed. Furthermore, purchasing unbundled RECs can motivate behaviors to reduce emissions as there is now a cost associated with an institution's emissions footprint.

Scalability

The scalability of renewable electricity purchases or generation as a societal solution to the energy and climate problem also varies based on how the electricity is generated and/or purchased (Table 5.3).

Table 5.3: The scalability of different electricity procurement options.

On-site Generation	Limited potential due to the generally insufficient on-site resource availability for most institutions. Scalability is good to the extent that resources are available.
RECs (all types)	Sufficient wind, solar, and other renewable energy resources exist to meet global energy demand; thus, off-site electricity production is scalable to a large extent. However, RECs do not account for grid reliability issues that result from increasing levels of intermittent renewable electricity, so this approach, like all others, is not perfectly scalable.

Carbon Offsets
Carbon offsets are created when emissions are reduced, avoided, or sequestered by one party, but the right to claim this reduction is sold to a buyer elsewhere who wishes to offset their emissions. Typically offsets are sold in terms of tons of CO_2-equivalent. Carbon offsets are available from a number of sources, such as reforestation, capture of greenhouse gases such as methane from landfills, or direct CO_2 capture.

When an institution invests in a carbon offset project or purchases carbon offsets, the amount of greenhouse gas removed from the atmosphere as a result of the project can be used to offset an institution's on-site emissions. This indirectly reduces the overall net emissions attributed to the institution (similar to the project-based method introduced in Section 6).

Additionality
The additionality of carbon offsets varies among projects. A thorough explanation of additionality tests (evaluating whether a carbon offset project would have happened without the institution's investment) can be found in "Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards".[3] A limitation of additionality tests is that the impacts of an institution's procurement action are measured against a counterfactual scenario (what would happen without the institution's action), which cannot be proven.

Scalability
Scaling up carbon offset projects alone cannot displace all emissions in the world. For example, the net sequestration of carbon in U.S. forests is estimated to be only 10% of annual carbon emissions from U.S. transportation and energy production.[4] Ultimately, there is a limit to the number of trees that can be planted without broader impacts on land, energy, and water use, and disturbance of ecosystems. Similar scalability problems occur for other forms of carbon offsets.

Biofuels
A key difference between biofuels and fossil fuels is that biofuels are produced from plants grown in the present. The CO_2 absorbed during growth of plants used to produce biofuels results in reduction of atmospheric CO_2, which is later re-emitted when those biofuels are burned. However, not all biofuels are carbon-neutral. Calculating the lifecycle emissions of biofuels is complex, requiring quantification of emissions associated with growing the crops, fertilizer production, and processing the plants into is debatable whether biofuels contain more energy than is required to produce the fuels.

Furthermore, the broad and complex impacts of biofuels on land, energy, and water use, have raised significant criticism against biofuels. For example, there has been significant recent concern regarding the negative effects of biofuels, particularly concerning mass deforestation in the tropical rainforests of Brazil and Indonesia.[5]

In general, second generation biofuels made from biomass have superior energy and environmental characteristics to first generation biofuels made from sugars and oils in purpose-grown crops; however, impacts vary significantly

[3] Kollmuss, A. et al. (2008). Making sense of the voluntary carbon market: A comparison of carbon offset standards.
[4] Wear, D., and Coulston, J. (2015). From sink to source: Regional variation in US forest carbon futures. Scientific Reports, 5, 16518.
[5] https://www.nytimes.com/2018/11/20/magazine/palm-oil-borneo-climate-catastrophe.html

among types of biofuels and must be assessed on a case-by-case basis before implementation. Institutions should carefully consider the sources and impacts of any biofuels purchases, especially when feedstocks are sourced from another country."

Additionality
Determining the additionality of biofuels is also complex. Some biofuel production (e.g. corn ethanol) is driven by the Renewable Fuel Standard (RFS), which requires a certain amount of biofuel to be produced along with traditional gasoline products sold by refineries and fuel importers. Therefore, the additionality of these fuels is questionable. While other biofuels, such as advanced biodiesel or cellulosic fuels, are also included in the RFS, targets are set such that production is predominantly based on consumer demand. Therefore, it is more likely that purchase of these biofuels is additional.

An important caveat is that the genuine environmental benefits of biofuels differ drastically among types of fuels and production methods. If the lifecycle emissions of a particular biofuel are not significantly lower than those from traditional fuels, it is impossible to argue that using that biofuel leads to any additional emissions reductions.

Scalability
Scaling up the use of biofuels could have broad environmental impacts. For example, massive land requirements, especially for conventional biofuel crops, could lead to deforestation or competition with agricultural land. Strategies for minimizing the unintended impacts of biofuel production can be found in Tilman et al. "Beneficial Biofuels – The Food, Energy, and Environment Trilemma" (2009).[6]

Producing sufficient quantities to replace a significant fraction of the fossil fuels currently used while avoiding these negative impacts would be impossible with present technologies, so the scalability of biofuels as a broad global solution is limited. However, as with additionality, scalability varies widely between different biofuels and must be assessed case-by-case. Also, to achieve overall societal decarbonization, biofuels may be necessary in certain applications that depend strongly on liquid fuels, such as backup electricity generation and long-haul transport, so use of biofuels may be considered more scalable in those limited applications.

Comparison of Options
The relationships between procurement options and the principles of additionality and scalability are summarized schematically in Figure 5.3. None of the procurement options by itself is perfectly scalable. It is also worth noting that a procurement option with limited scalability should necessarily not be ruled out. For example, for institutions generating emissions from air travel and ground transportation, carbon offsets may be a reasonable procurement option. Each decarbonization option plays a role in reducing emissions and several strategies will need to be combined to achieve deep societal decarbonization.

Institutional goals and energy procurement options are interconnected.

[6] Tilman, D. et al. (2009) Beneficial biofuels—the food, energy, and environment trilemma. Science 325(5938), 270-271.

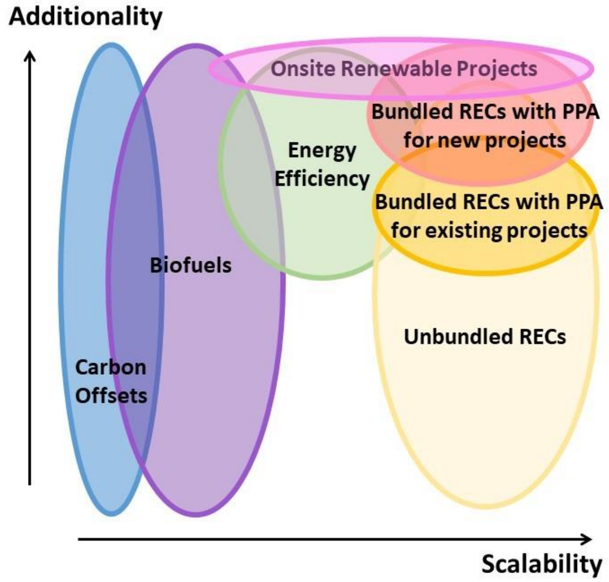


Fig. 5.3: A map of the additionality and scalability for different decarbonization options. This diagram is a qualitative illustration of the relationship between these institutional principles and several emissions reduction options.

For example, an institution could achieve a goal of using 100% renewable energy by purchasing unbundled RECs, while pursuing energy efficiency projects alone could not accomplish this goal. As a further example, an institution could not achieve a total-zero emission goal (see Section 4) if it procures heating and/or cooling from a carbon dioxide emitting source. Major changes to its infrastructure would be required to achieve a total-zero emission goal in that case, such as full electrification of the heating and/or cooling systems along with the purchase of clean electricity.

6. EMISSIONS ACCOUNTING METHODS

Institutions require emissions accounting methods to quantify their emissions and measure progress towards their goals. However, emissions accounting can be complex, particularly for electricity. In addition, the method chosen to account emissions will have a large impact on the feasibility of meeting emissions goals and the procurement options that are incentivized to meet those goals. Therefore, a simple accounting framework that is credible, transparent, and which incentivizes actions consistent with an institution's guiding principles is necessary.

Key decisions for emissions accounting involve which emissions to count within the inventory and the methods used to quantify those emissions. This section introduces some important issues to consider when making these decisions. Different types of emissions and methods by which they can be quantified are briefly described, followed by a more detailed discussion of electricity emissions accounting.

6.1 Boundaries and Scopes: What Emissions Am I Counting?

Institutions need to decide which emissions associated with their activities they include in their institutional footprint and targets. Some decisions are clear, such as including emissions associated with combustion of fossil fuels on-site, but others are open to interpretation, such as emissions resulting from shared buildings or off-site data centers. These choices can be thought of as decisions about what boundaries to set, and what scopes of emissions to include. System boundaries and emission scopes are introduced in Section 4. In this section, we discuss their relevance to emission accounting.

The system boundaries may be physical, such that only emissions within the physical boundary of the institution are counted towards its footprint. Boundaries may also be financial, such that emissions associated with actions financed by the institution, such as air travel, are included. Emission scopes (Section 4) can also be used to define the institutional boundaries, where certain emission scopes are counted and others are not. Lastly, boundaries may be chosen using a combination of these definitions.

Institutions will need to define and justify emissions accounting boundaries consistent with their principles and goals, in addition to communicating these boundaries in a transparent manner to members of the institution and the public. A case study demonstrating difficulties with emissions boundary choices is presented in Section 8. Moreover, technological and societal changes may cause emissions to shift from a scope that is not counted to a scope that is counted. An example is the switch to electric vehicles that are charged at work, which would result in Scope 3 emissions becoming Scope 2 emissions. Such uncertainties are discussed in Section 7 and should be considered when deciding on institutional emissions boundaries.

The choice of accounting boundaries strongly impacts the actions that institutions are incentivized to take and the goals that they can set. In general, the broader the emissions accounting boundaries, the more holistically an institution is incentivized to approach emissions reduction, but the more difficult (and expensive) deep emissions reduction can become. The inclusion of emissions that are difficult for an institution to reduce, such as those associated with employee commuting and air travel, may make more aggressive emissions goals, such as near- term total-zero emissions goals, infeasible. In these cases, there may be a stronger incentive to set net-zero goals and to allow offsets. By including only institutional energy use within accounting boundaries, greater emissions inventory reductions may be possible in the near- term, but the institution will not be incentivized to take other actions that would reduce societal emissions, such as improving mass transit options or encouraging the use of electric cars.

Greenhouse Gas Protocol (GHG Protocol)
The GHG Protocol establishes a standardized framework for measuring institutional emissions that is credible, robust, and relatively straightforward. The GHG Protocol is widely used by Fortune 500 companies and large institutions around the world, such as Microsoft, BP, Ford, and Harvard University.

Further guidance on accounting boundary choices can be found in guidance documents from the GHG Protocol and The Climate Registry.

6.2 How to Quantify Emissions

Scope 1:
Quantifying Scope 1 emissions requires the summation of direct GHG emissions from within the institution's boundaries or from institution-controlled operations. From an accounting methodology perspective, quantifying Scope 1 emissions is relatively straightforward: the amount of fuel combusted is multiplied by an appropriate emissions factor. Complications may arise when quantifying Scope 1 emissions from the use of biofuels. The GHG Protocol states that direct CO_2 emissions from the combustion of biofuels shall not be included in Scope 1 emissions, but will be reported separately. For more information about accounting for Scope 1 and biofuel emissions, please consult the GHG Protocol (see side panel).

Scope 2:
Quantifying Scope 2 emissions is more complex than quantifying Scope 1 emissions. Institutions almost always source electricity from regional grids, where precisely quantifying the emissions impact of an individual customer is difficult. Significant complications arise because many electricity generators, with differing emission rates, feed into the electricity grid, and the mix of generators vary with both geographical location and time. Therefore, precisely determining the

emissions of a unit of electricity taken from the grid or the emissions reduction caused by supplying a unit of clean electricity to the grid, such as through a bundled REC, is challenging.

The GHG Protocol provides two methods to quantify Scope 2 emissions: the Location-Based (Grid) Method, and the Market-Based (Contract) Method. A third method to quantify societal emission changes, including Scope 2 emissions, is the Project-Based (Offset) Method. Each method answers a different question about an institution's Scope 2 emissions and incentivizes different emissions reduction actions (Table 6.1). The Location-Based Method accounts for electricity emissions using the average emissions rate of the electricity grid in the region in which an institution is located. The Market-Based Method accounts for electricity emissions using the specific emissions rate of electricity generation that an institution has procured, and is usually applied to account for renewable energy procurement. The Project-Based Method accounts for the change in total societal emissions from an institution's energy

Table 6.1: Comparison of Scope 2 emission accounting methods.

Method	Location-Based (Grid)	Market-Based (Contract)	Project-Based (Offset)
Question	What are the emissions inherent in the electricity purchased from the grid?	What are the emissions inherent in the electricity procurement contracts?	What is the change in societal emissions caused by electricity procurement actions?
Accounting Mechanism	Purchased electricity is multiplied by local grid emission rate.	Electricity procured by individual contracts are multiplied by the contract emission rate. Remainder of electricity consumed from electricity grid is multiplied by the grid rate.	The net emissions change resulting from each energy procurement activity is calculated. This requires calculation of emissions associated with the the energy procurement compared with emissions under a baseline scenario without that procurement.
Characteristics	· Uses grid average emissions rate · Simple methodology with little information requirement.	· Uses contracted Emissions Rates (e.g. utility rates and bundled RECs) · Simple methodology with little information requirement	· Baseline scenarios must be formulated. · Large information and effort requirement. · Significant uncertainty.
Implications	· No method to offset Scope 1 emissions through energy procurement actions. · Does not account for off-site renewable procurement or for emissions offset quantity. · Emissions only reduce when grid emissions intensity drops.	· No method to offset Scope 1 emissions through electricity procurement actions · Incentivizes procuring the cheapest low-emissions energy · Renewable energy procurement actions are offset in energy units (MWh), not emissions mass units, and thus may not reflect societal emission reductions caused	· Could be used to offset Scope 1 emissions through energy procurement actions that displace emissions · Incentivizes procuring energy where largest societal emissions reduction are generated per dollar. · Not a standard inventory *GHG Protocol* accounting method by procurement actions.

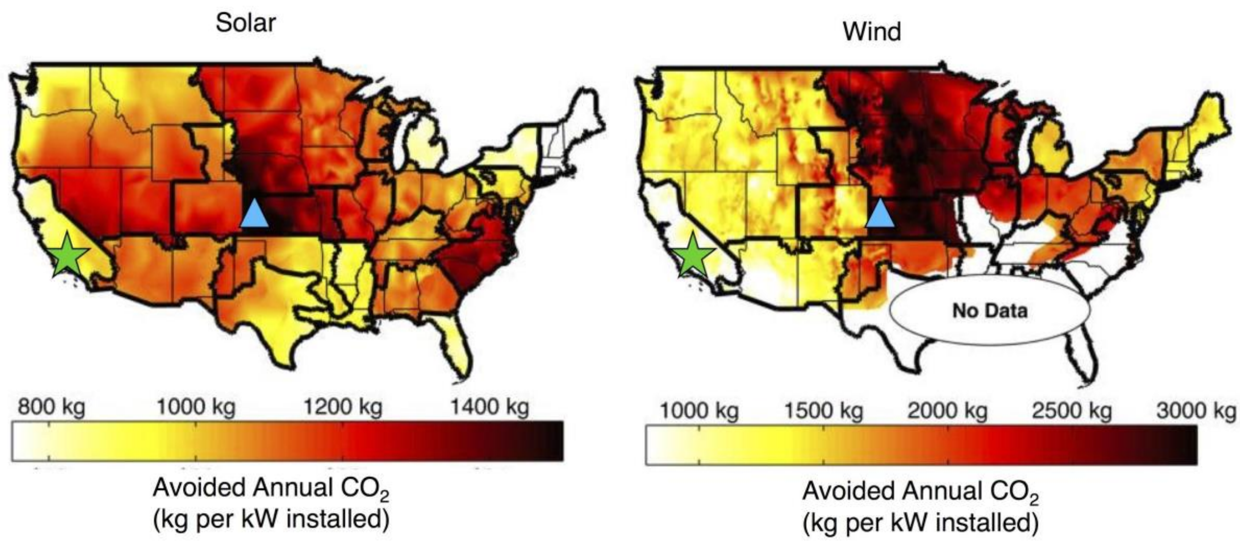
procurement actions: for example, by calculating the emissions avoided due to a new solar farm.

For a complete assessment of emissions, the GHG Protocol Scope 2 Guidance recommends reporting Scope 2 emissions by both the Location-Based and Market-Based methods. These guidelines aim to promote transparency and simplicity, while providing strategies to reduce emissions using low-emission energy procurement. However, using the Project-Based Method may be a more accurate and informative measure of influence on societal emission changes if enough information is available. Institutions sometimes choose to set additional emissions targets based on the Project-Based Method and internally report emissions calculated using this method.

Each accounting method offers advantages and disadvantages in terms of accuracy, effort, and transparency. The characteristics of the chosen accounting method need to align with institutional guiding principles and be made explicit during reporting. The differences between the methods become most apparent when accounting for off-site low-emissions electricity procurement actions.

Scope 3:
Given the diversity of activities that fall into the Scope 3 emission category, methodologies for accounting each separate activity vary. These emissions are often the most uncertain and are also often difficult to eliminate. Therefore, they are commonly excluded from institutional emissions inventories despite being a significant proportion of emissions for most institutions. One exception is air travel, which can be calculated by tracking air travel paid for by the institution. For more information, consult the GHG Protocol Scope 3 Guidance.

Figure 6.1: Overview of avoided CO_2 (kg) that would result from the installation of 1 kW of renewable energy capacity across the United States, considering local grid emission intensities and renewable capacity factors.[7] The blue triangle (Oklahoma) and green star (California) represent two locations where equal renewable energy procurement will result in different amounts of avoided emissions.



[7] Siler-Evans, K. et al. (2013) Regional variations in the health, environmental, and climate benefits of wind and solar generation. Proceedings of the *National Academy of Sciences of the United States of America,* 110(29), 11768-73.

6.3 Scope 2 Accounting: Opportunities and Complexities

The different Scope 2 accounting methodologies can result in different emission values for the same electricity procurement action. This inconsistency arises because each method is asking a different accounting question (Table 6.1). Institutions should recognize that each accounting methodology will not always reflect the true impact on societal emissions. After considering all three accounting methods, institutions can decide which method will result in actions consistent with their principles and goals. The importance of method selection for Scope 2 emissions accounting and accurate estimation of societal emissions reduction is illustrated in Table 6.2 with an example analyzing the impacts of electricity projects in different geographical locations across the continental United States.

Embodied Emissions of Renewable Technologies:
While renewable energy sources are assigned a zero emission rate in emission accounting standards, the building of renewable energy facilities (such as wind and solar farms) does use energy, which may result in greenhouse gas emissions. This energy is often referred to as "embodied energy." The embodied energy and emissions are relatively insignificant compared to the life-cycle emissions from fossil fuel power plant generators[8]

The Market-Based Method is recommended by the GHG Protocol to account for renewable energy procurement. Under the Market-Based Method, institutions apply the emissions rate (equal to zero for renewables, see note) for the portion of their total electricity use that the procurement covers. However, avoided emissions calculated by this method do not necessarily reflect the change in societal emissions caused by the development of renewable energy.

The Market-Based formula implicitly assumes that each MWh of renewable energy procured results in societal emission reductions equivalent to the emissions of a MWh from the institution's electricity grid, regardless of the location of the renewable energy project. However, given the spatially variable electricity grid emission rates, this assumption may not be valid. An organization located in a high-emissions electricity grid, as shown by the blue triangle in Kansas in Figure 6.1, could procure renewable energy in a low-emissions electricity grid, as shown by a green star in California in Figure 6.1. In this example, the avoided emissions from one MWh of renewable energy at the green star is likely less than the emissions from one MWh from the electricity grid at the blue triangle. The Market-Based method incentivizes organizations to procure renewable energy in locations where it is cheapest, with no connection to the true emissions reduction.

In contrast, the Project-Based Method attempts to accurately reflect societal changes in emissions from new electricity projects by comparing to a baseline scenario. This method requires significant effort and information, and

[8] Pehl, M. et al. (2017) Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. *Nature Energy,* 2(12), 939-945.

Table 6.2. Solar and wind capacities that would offset 100,000 tons of annual CO_2 emissions in different locations across the United States.

State	Solar	Wind
New Jersey	107 MW	97 MW
Kansas	76 MW	36 MW
Vermont	153 MW	107 MW

can have high uncertainty associated with baseline scenarios. However, if undertaken correctly, this method can capture the inequality of displaced emissions from each MWh in the two locations identified in Figure 6.1.

Because different locations of renewable energy projects results in changes to societal emissions, using the Project-Based Method has significant impacts on the incentives for institutions. Table 6.2 shows the renewable electricity capacities that would offset 100,000 tonnes of annual CO_2 emissions in different locations, using values from Figure 6.1:

Electricity Grid Emission Rates: Time-Averaged versus Time-Varying and Average versus Marginal
Standard emissions accounting methodologies use time-averaged electricity emissions rates (i.e. assume a constant rate at all times). However, the emissions rates of electricity grids can vary significantly in time. The use of average emissions rates also does not necessarily reflect the way that grid emissions change when an institution reduces consumption or introduces new renewable generation. The true emissions impact depends on the specific emissions rate of the individual electricity generator that reduces its output (the marginal change), while the accounting method simply assumes that the average rate is displaced.

Accurately accounting for these factors in emissions calculations increases the data requirements and complexity significantly. The required data are not available in most locations, although they are increasingly becoming available. Even if sufficient data were available, however, the calculation of emissions in this way may result in additional accounting uncertainties and challenges, which are discussed in Section 7.

6.4 Emissions Accounting impact on Goal Setting and Principles:

Emissions accounting choices, such as setting emissions boundaries and choosing a method to quantify emissions, will ultimately affect the emission reductions that an institution can achieve. For example, if an institution includes Scope 3 air travel and commuting emissions in their emissions inventory, setting a goal to achieve total-zero emissions (no carbon offsets) would be infeasible without carbon-free travel options. Decisions regarding accounting and goals should ultimately be guided by institutional principles and communicated transparently.

6.5 Accounting Recommendations:
It is recommended that institutions strive for as transparent an accounting framework as possible, and acknowledge that any chosen method will be imperfect.

For many institutions, the Market-Based Method provides a framework to reduce electricity emissions through procurement contracts while maintaining simplicity and reducing information collection requirements. To increase transparency, institutions could additionally estimate societal emission reductions caused by their actions using the Project-Based Method. This combination of methods provides institutions with incentives to transparently reduce emissions and consider the societal implications of their actions.

7. UNCERTAINTIES AND CHALLENGES

Given the complex interactions between institutional goal setting, actions and procurement, and emissions accounting, institutions face several challenges as they devise and execute an energy and emissions plan. Risks that result from inadequately addressing these challenges include setting goals that cannot be met, accounting for emissions in ways that are inaccurate or lack transparency, and taking actions that are inefficient or inconsistent with the institutional guiding principles. These risks are related to uncertainties that inevitably arise due to the inherent complexity of energy systems, particularly electricity grids, and the insufficient availability of information to accurately quantify the impact of the actions of a single institution. Institutions can acknowledge the uncertainties in their energy and emissions plans in order to minimize these risks and remain consistent with their guiding principles.

For transparency and credibility reasons, it is recommended that institutions explores\ and documents the potential uncertainties and challenges listed below. Developing a rationale for major decisions will result in a clear narrative outlining how the plan conforms to an institution's guiding principles and mitigates foreseeable uncertainty. Understanding how these uncertainties relate to an institution's principles will ideally provide a framework that can serve as a guide when unforeseen challenges arise.

Uncertainty of Long Time Frames

The costs and challenges associated with meeting long-term energy and emission targets are dependent on how the energy system and electricity grids develop in the future. In one scenario, electricity-grid emissions are significantly reduced in a short time span, such that Scope 2 emissions reductions require less institutional action and can be achieved at lower cost. Conversely, the emissions intensity of the electricity grid might remain high for many years, requiring significant institutional procurement from clean energy sources and higher costs for a given level of emissions reduction.

Institutions will need to navigate this uncertain future, which will likely fall between these two extreme scenarios, through frequent re-evaluation of their energy and emissions plans based on the evolving state of the electricity grid. This uncertainty can be mitigated to an extent by choosing actions that are more local. For example, entering into a PPA for electricity produced within an institution's own grid will help encourage decarbonization of the local electricity supply, particularly for larger institutions, making further action easier once the PPA ends. A PPA for a project in a non-local grid would not have this effect, and further PPAs or a new action plan may be necessary after the first expires.

Unintended Consequences of Actions and Procurement

Actions and procurement taken by institutions may have indirect impacts that are not accounted for. An example of an indirect impact is the use of biofuels that are harvested using unsustainable land-use practices, leading to an increase in overall societal emissions. Institutions must be mindful of the impacts of their actions beyond the emissions accounting frameworks, which are typically focused on a single environmental impact metric - institutional emissions - to ensure their emission and energy plan is resulting in positive societal change.

System Boundary Definition

The way in which an institution defines its system boundaries when setting its emissions and energy targets may also create perverse incentives for that institution's actions. Furthermore, unclear system boundaries can lead to controversy when emissions targets and reductions are reported, which is discussed in detail in Case Study 3. Clearly demarcate what parts of the institution are included in institutional targets and establish a plan for how these boundaries may change as the institution evolves.

Examples of potential system boundary issues include:

- Providing onsite electric car charging: while lowering overall societal emissions, this would result in increased electricity consumption and carbon emissions for the institution. Therefore it could be disincentivized by some emissions targets.
- Maintaining consistency over time: if an institution decides to outsource a function that was previously performed on-site, then its apparent emissions would be reduced but societal emissions would remain unchanged. In the converse case, where a previously outsourced function is brought on-site, an institution may choose to exclude those emissions from the inventory going forward, or set an adjusted baseline. If not clearly defined and planned for, such exceptions complicate carbon accounting and may reduce its transparency.

Regulatory Action

The regulatory environment in the energy system is subject to large and abrupt changes due to political and regulatory cycles, which may in turn may change the way an institution's actions impact the environment.

Examples of regulatory impact on the additionality of energy procurement options have already been discussed in relation to REC pricing and biofuels production requirements. Counterintuitively, regulations aimed at promoting renewable energy or discouraging emissions producing processes may reduce the additionality of renewable energy procurement because the baseline case for societal emissions becomes lower as regulation increases.

An extreme example is a stringent cap-and-trade system. In these systems, a fixed number of emissions permits are available. If an institution voluntarily reduces its emissions, it frees permits to be used elsewhere. In such a system, societal emissions may only be reduced if emissions permits are purchased and retired.

Secondary Effects
An institution's actions may have downstream effects on other institutions, companies, individuals, developers, and utilities, potentially amplifying or diminishing the emissions reductions that results from its actions. Some examples include:

- Deploying an emerging clean energy technology as an early adopter may help the technology reach maturity more quickly and reduce the cost for future adopters, leading to greater deployment of that technology.
- Significant emissions reductions or penetration of renewable energy in a given market demonstrates feasibility and may lead to more stringent regulations and ambitious targets in the future.
- It is generally assumed that new renewable energy sources displace fossil-fuel generators when added to the grid. However, as renewable energy penetration increases, new renewable energy may instead displace other renewable energy sources.

Quantifying these effects is challenging, and in some cases it may be impossible. Is it recommended that they be considered and assessed relative to an institution's principles. For example, an institution may chose to adopt a promising but presently more expensive technology over a cheaper alternative if that institution wishes to show leadership and long-term vision.

Unforeseen Challenges
The challenges discussed above are characteristic examples of the challenges that regularly arise within the complex energy system and include many of the most frequently occurring examples, but by no means constitute an exhaustive list. Uncertainty and unintended incentives can be minimized by careful system boundary definition and choice of an appropriate accounting method, but not eliminated.

Unforeseen challenges are likely to arise. Without a consistent set of principles, an institution may find itself being accused of changing the rules in favor of convenience or lower costs. Clearly defined guiding principles and a transparent plan enable an institution to respond consistently and predictably to these challenges.

8. SUMMARY CHECKLIST

This document has outlined the interlinked components and decisions that are required to create a consistent energy and emissions plan that benefits the institution and society. The components include Goal Setting, Action and Energy Procurement, and Emission Accounting. Importantly, this document has highlighted the need for all stakeholders to agree upon a set of institutional principles that drive decision making in order to effectively form a plan that is consistent with their goals.

The following checklist includes some of the important items that institutions should consider as they develop an emissions and energy plan. This is not intended to be an exhaustive, or linear, list: there will inevitably be other considerations that arise and aspects that will require iteration and revisiting. This list will, however, provide a solid foundations to guide your planning.

- [ ] Decide upon the principles that guide your institution's emissions reduction
- [ ] Characterize your institution's current energy infrastructure, end-uses, and emissions
- [ ] Select an appropriate accounting methodology
- [ ] Determine emissions accounting system boundaries
- [ ] Assess infrastructure and energy procurement options given your unique characteristics and capacity
- [ ] Develop clearly defined institutional goals
- [ ] Involve all key stakeholders at all steps of the process including administration, financial planners, facilities or other implementing departments, and energy end-users
- [ ] Consider long-term and society-wide impact of actions and the potential for unintended effects
- [ ] Consider flexibility of the plan to potential future technology and policy developments
- [ ] Transparently document the plan and present it to your community
- [ ] Measure and quantify the impact of your actions
- [ ] Update your plan regularly and as required, informed by data and feedback from all stakeholders

9. ADDITIONAL RESOURCES

EPA Green Power Partnership:
https://www.epa.gov/greenpower

Greenhouse Gas Protocol:
https://ghgprotocol.org/

Green-e:
https://www.green-e.org/

Rocky Mountain Institute Business Renewables Center:
http://businessrenewables.org/

Second Nature:
http://secondnature.org/

The Climate Registry:
https://www.theclimateregistry.org/

10 APPENDIX: CASE STUDIES

In this section, several case studies of institutional decarbonization plans are provided to illustrate successes and challenges of past emissions reduction plans. These examples include institutions and municipalities that set a range of ambitious emission goals, utilized local renewable resources, and engaged with stakeholders.

10.1 Stanford University

Stanford University is a leader in climate action amongst universities. Stanford completed an overhaul of its campus energy infrastructure in 2015 and has procured solar electricity to supply 65% of its consumption. These actions combined have reduced Stanford's emissions by 68%. Stanford's actions have been guided by its Energy and Climate Plan[9], which is distinctive in that it does not set any particular greenhouse gas emissions target.

Principles

Stanford's Energy and Climate Plan outlines a "comprehensive, practical and cost effective plan for reducing Stanford's greenhouse gas emissions through the way we construct and operate our facilities and supply energy to them"

The principles of Stanford's Energy and Climate Plan are:

- Holistic and long-term approach: recognize emissions reductions may come from a number of areas and activities of the campus; that Stanford operates within broader society's energy infrastructure, emissions reductions, and regulations; that both long-term and short-term improvements are necessary; and that short-term decisions may have long-term impacts (through long-lived infrastructure).
- Vision: Use Stanford's intellectual and financial resources to provide leadership in climate change solutions.
- Flexibility: Recognize that the ultimate vision of climate stability may take decades and require technologies that may not yet exist. Stanford's actions should have flexibility to accommodate new technologies and changes in climate science as they develop.

The Stanford Energy Systems Innovations project was developed by the departments directly responsible for implementing it, with input sought from all stakeholders on campus.

Institutional Goals

Stanford does not have a specific greenhouse gas emissions target. Instead, they took a bottom-up approach. The philosophy was to begin with a vision to provide leadership in climate change solutions, to evaluate all

[9] Stanford University Energy and Climate Plan, 3rd edition (2015)

options for reducing emissions (against economic, reliability, and emissions reductions criteria), and then decide upon the most efficient options. Stanford announced the outcomes in terms of emissions reductions after deciding on actions, rather than announcing a goal and then determining how to achieve the goal.

Action & Procurement

Stanford's decarbonization plan is essentially to shift Scope 1 combustion emissions to Scope 2 electricity emissions, and to reduce Scope 2 emissions through reduction of electricity use (conservation and efficiency), and procurement of zero-emissions electricity. Stanford does not use carbon offsets.

A broad outline of Stanford's actions:

- Make campus energy systems as efficient as possible to reduce energy use (demand and supply side).
- Transform from on-campus combustion for heating and electricity generation, to using electricity from the grid and electrifying heating.
- Source electricity from sustainable and low-carbon sources over time.

Stanford retired its natural gas-fired cogeneration energy facility (that supplied almost all campus electricity and produced 90% of Stanford's greenhouse gas emissions), and replaced it with grid electricity and an electrified heating and cooling system that uses heat pumps to capture waste heat from the chilling system and transfer to the heating system. The project required the conversion of the campus from steam to hot water heating. Stanford's close balance between heating and cooling load, and relatively small seasonal variation, enabled this option to be particularly cost-effective.

Stanford has also procured a significant amount of renewable electricity. It has installed 5.5 MW of solar PV on the campus, and procured 73 MW of off-site solar PV (in the Mojave Desert in southern California), which will generate the equivalent of half Stanford's electricity consumption.

Emissions Accounting

Stanford reports its Scope 1 and 2 emissions to The Climate Registry, a voluntary emissions reporting registry with an emissions accounting protocol based on the GHG Protocol. Scope 3 emissions are estimated but not included in the official inventory.

Stanford's Scope 2 emissions are calculated using the market-based method to account for its renewable energy procurement.

Stanford's emissions accounting system boundary includes all facilities that Stanford owns or has operational control over. It excludes Stanford Hospital and Clinics and SLAC National Accelerator Laboratory, since they do not fall under the University's direct operational control.

Deeper Dive

Fortunate circumstances: Stanford is fortunate that its mild climate and mix of campus energy requirements lead to heating and cooling loads that are exceptionally balanced across the year. The balance of heating and cooling loads made the electrified heat-recovery campus heating and cooling system particularly cost-effective for Stanford: it was both the long-term lowest-cost option and reduced emissions the most amongst its campus energy options. Furthermore, Stanford's existing cogeneration plant was at the end of its life and so substantial capital expenditure was necessary regardless of the option chosen. This favorable mix of circumstances allowing the speed and magnitude of Stanford's actions is unlikely to be replicated for many other institutions.

Uncertain societal emissions reduction: California has an emissions cap on its electricity sector under its cap-and-trade program. Emissions reductions caused by Stanford may not decrease total Californian emissions since the same number of total emissions permits will be available (i.e. the emissions will be transferred elsewhere). Stanford's actions undoubtedly show leadership and demonstrate the type of structural changes needed for a long-term zero-emissions society, but this is an example of interactions with government policy that can restrict the impact institutions can have on reducing total societal emissions.

10.2 American University

American University (AU) has been recognized as a strong advocate for climate change action, and was awarded the US EPA Green Power Purchaser Award in 2012. In 2008 AU took a pledge to address climate change, signing onto the American College and University Presidents' Climate Commitment (ACUPCC - now known as the Second Nature Climate Leadership Statement). In 2010, the University outlined its plan to reach carbon neutrality by 2020[10]. Since the commitment, AU has reduced its net carbon footprint by approximately 54%, through a combination of energy efficiency and green energy actions. AU's goal is to take a cost-neutral path to carbon neutrality.

Principles
The "Climate Action Plan outlines [American University's] path to neutralizing the university's greenhouse gas emissions (GHGs)" and calls for "acting on [its] values through social responsibility, service and an active pursuit of sustainability." While AU does not explicitly state guiding principles for its emissions and energy planning, it identifies several "transformational goals" relevant to their climate commitment. These were adopted from the University's broader strategic vision:

- Leadership and Innovation: demonstrate leadership and innovation by encouraging innovation and high performance, and winning recognition and distinction
- Global Diversity: reflect and value diversity and "bring the world to AU and AU to the world"
- Education and Research: epitomize the scholar-teacher ideal by studying climate change side by side with students

Institutional Goals
Signatories to the ACUPCC commit to setting a target date for achieving climate neutrality "as soon as possible". Therefore, the goal is a mix of top-down and bottom-up approaches. The target itself is top-down (achieve carbon neutrality), however the timing of the commitment depends upon each institution's specific resources and ability to decarbonize.

American University set a goal to be carbon neutral by the year 2020: "Recognizing the need to rapidly reduce global greenhouse gas emissions in order to avert the worst impacts of global warming, this plan establishes the year 2020 as the University's target date for achieving carbon-neutrality. This date is intentionally ambitious and reflects a desire to encourage innovation and demonstrate extraordinary leadership in addressing one of the great issues of our time."

In addition to the carbon neutrality goal, AU also implemented several broader sustainability 'policies': a Green Building Policy, requiring new or renovated buildings to conform to LEED Silver certification or better; a Sustainable Purchasing Policy, providing guidelines for the purchase of sustainable and emissions reducing products; and a Zero

[10] American University Carbon Neutral by 2020 Report

Waste Policy, setting the long-term goal of zero waste.

Action & Procurement
To achieve its emissions target, American University implemented four mitigation strategies. Each mitigation strategy included a number of specific actions to contribute towards the overall carbon neutrality target. The four strategies in their stated order of importance are:

1) Reduce Consumption: incrementally reduce electricity and transportation emissions through efficiency projects and with targeted tactics, and eliminate emissions from paper, waste and agricultural inputs;

2) Produce Renewable Energy: to the extent practical, on-campus renewable energy projects should be implemented, including solar, small-scale waste combustion, and wind energy, with a goal of supplying approximately 2.5% of electricity consumption;

3) Buy Green Power: buy RECs and green power. As a first step, AU committed to purchasing unbundled RECs for 100% of its electricity consumption, transitioning later to contracts for green power, with bundled RECs.

4) Buy/Develop Offsets: for the remaining emissions, which predominantly consist of travel, offsets were to be purchased in the shorter term, with a goal of developing it's own local projects in the longer term. This is recognizing that travel is a large and mostly unavoidable source of emissions, at least in the short to medium term. Offsets were to follow the ACUPCC Voluntary Carbon Offset Protocol, although this has varied in practice for locally developed offset projects.

Emissions Accounting
American University accounts Scope 1 and 2 emissions, and transport-related emissions in Scope 3. Scope 2 emissions are calculated using the market-based method to account for onsite and offsite renewable energy generation and procurement. Scope 3 transport related emissions include employee and student commuting, AU financed travel, and study abroad air travel. AU uses an operational boundary for its Scope 1 and 2 emissions.

Emissions are reported and publicly available in the Second Nature Climate Commitment Reporting Platform. AU uses the CA-CP Greenhouse Calculator (http://campuscarbon.com/Calculator.aspx) to determine its Greenhouse Gas Inventory, as recommended by the ACUPCC. The calculator adopts the IPCC national level protocol, which is similar to the GHG Protocol.

Deeper Dive
American University's Climate Action Plan is notable for several reasons. While setting an ambitious target of carbon neutrality by 2020, it also seeks to achieve that goal via a cost-neutral pathway. Savings through energy efficiency actions, onsite renewable generation, and competitive long-term renewable energy procurement were

assessed to be sufficient to cover any additional costs to purchase offsets for scope 3 emissions.

As an early and interim measure to reduce its scope 2 electricity emissions footprint, AU committed to purchasing unbundled RECs for 100% of campus electricity consumption. While the additionality of unbundled RECs may not be clear, this was seen as a valuable step to demonstrate leadership, begin driving on-campus energy efficiency actions, and to begin on the path towards procuring 100% clean energy.

Transitioning from this interim measure, the University aimed to be purchasing 100% green power from local renewable energy projects by 2014 (with the associated bundled RECs to be retired). As of 2017, approximately 50% of the University's electricity consumption is sourced from local green energy projects, while unbundled RECs are still currently purchased to cover the remaining electricity consumption. The unbundled RECs were purchased from a high emissions intensity grid region, in order to maximize the "carbon-value" of each REC. It should be noted that as the unbundled RECs are outside of the grid region in which the electricity is consumed, the RECs cannot be used to claim zero-emissions electricity under the market-based accounting method. However, the RECs can be reported separately in the Greenhouse Gas Inventory as an effective "neutralization" of emissions from the University's electricity consumption.

In the fourth strategy, to offset remaining emissions, the university proposed to develop or partner for local offset projects. In practice, this can make the third-party verification of offsets challenging - a requirement if the ACUPCC Voluntary Carbon Offset Protocol is to be followed. In at least one case, a local University implemented project was not officially verified, although carbon offset reductions were claimed. This is not necessarily an issue, however institutions should be aware of their these challenges for individually run projects.

10.3 Duke University

Duke University announced its Climate Action Plan[10] in 2009, which set a goal for Duke to be "climate neutral" by 2024. Duke is a signatory of the American College & University Presidents' Climate Commitment that commits it become climate neutral. Duke is also developing a broader Sustainability Strategic Plan that includes water, recycling, and natural resources. A distinctive element of Duke's Climate Action Plan is the prominent role of carbon offsets, implemented through its Carbon Offsets Initiative[11]. An instructive example from Duke is its recent controversy regarding a proposed combined heat and power (CHP) plant and the associated emissions accounting.

Principles

Duke's Climate Action Plan[11] does not explicitly list principles, but does discuss values such as encouraging innovation, serving as an example to other institutions, and shows a strong focus on the educational aspects of its plan. The ACUPCC itself includes a strong theme of demonstrating leadership.

Duke lists more specific principles associated with its Carbon Offsets Initiative. Offsets should provide significant local, state, and regional environmental, economic, and societal co-benefits beyond emissions reductions. Offsets must be real, measurable, verifiable, and additional.

Institutional Goals

Duke's emissions target is to be "climate neutral" by 2024. Climate neutrality is defined as net-zero emissions, which allows offsets to neutralize remaining emissions. Duke's plan includes a 45% emissions reduction by 2024 compared to 2007, with the remaining emissions to be balanced by local offset projects.

Action & Procurement

Duke's actions are far-reaching and holistic, including efforts on its energy systems (switching from coal to natural gas, steam to hot water conversion, on-site solar energy), energy efficiency and conservation (energy use per square foot of buildings has decreased by 10%), transportation (incentives and guidelines for commuting and air travel, campus fleet replacement), offsets, and educational and communication initiatives.

Duke's Carbon Offsets Initiative[12] projects include innovative methane capture from swine farms, community-based energy efficiency projects, and potential carbon sequestration through forestry and land conservation. The existing swine methane capture project offsets approximately 2,000 tonnes of CO_2 per year, compared with a total offset target of 185,000 tonnes by 2024, which highlights the size of the challenge.

Coal was previously used to generate 90% of Duke's steam requirements. A major early project was the construction of a new steam plant fueled by natural gas and the conversion of the existing steam plant to natural gas. Coal use was discontinued in 2011 and resulted in a 12% total emissions reduction.

Duke has made significant progress toward its goal. Total inventory emissions have been reduced 23% since 2007, from

[11] https://sustainability.duke.edu/sites/default/files/2009dukecap.pdf
[12] http://sustainability.duke.edu/carbon_offsets/

340,000 to 260,000 tonnes of CO_2 per year, including a 37% reduction from its energy systems.

Duke University proposed a 21 MW combined heat and power (CHP) plant to built, owned, and operated by the utility Duke Energy, which would reduce emissions and increase energy resiliency for the campus. The plant would be built on Duke University land and enable the Duke University campus to operate in islanded mode from the main grid. The CHP plant would burn natural gas to generate electricity, and also generate steam using the waste heat. Duke University would purchase the steam, enabling the amount of natural gas burned in the campus steam plants to be reduced by 50%. The University's project proposal document claimed the reduced gas use would decrease its emissions inventory by 18%. However, the proposal has generated controversy, with student and faculty groups opposing the proposal. The opponents have challenged the emissions accounting[13] justifying the project (discussed further below), the "lock-in" of long-lived fossil-fuel infrastructure, and claimed that there was inadequate consultation with the University community.

The opposition to the CHP project caused the University to delay its consideration and form a subcommittee[14] to evaluate the project in light of the criticisms. The subcommittee recommended that the CHP should only proceed if it can be fuelled by biogas, which would likely be captured from North Carolinian swine operations similar to Duke's existing offset project, and also recommended alternative emissions accounting that claims a much smaller 3% emissions decrease due to the project (discussed further below).

Emissions Accounting

Duke's emissions inventory includes Scope 1 and 2 emissions, and Scope 3 emissions from air travel paid by the institution and from commuting. The transportation emissions currently represent 33% of Duke's accounted emissions inventory (electricity is 42% and steam plant 22%). The inclusion of Scope 3 emissions in institutional emissions goals is relatively uncommon and is discussed further below.

The inventory boundary includes the University operations but excludes the Duke University Health System's hospital and outpatient clinics.

Deeper Dive

Breadth of emissions accounting:
By including transportation emissions in its inventory, Duke takes a broader view in its climate actions than institutions who exclude transport. Transportation emissions are an important part of the climate challenge, but many institutions do not include transportation in emissions goals because the emissions are difficult to address, since they do not have direct control over transport choices of students and employees, and because these emissions are difficult to precisely measure. These difficulties are evident in the fact that Duke's transportation emissions have risen 27% since 2007, while it has been able to reduce energy emissions by 37%. Duke's inclusion of transportation emissions makes their emissions reduction task more challenging, but encourages a more

13 http://www.dukechronicle.com/article/2016/10/response-to-the-duke-chp-overview-document
14 https://duke.app.box.com/s/b4g84xjw7zv11giw324m93bzi3qlkrf0

holistic approach to emissions reduction. For example, Duke will have an incentive to encourage electric car adoption by its employees and to provide charging infrastructure as a way to reduce its emissions inventory. Institutions that exclude transportation from emissions goals will have a disincentive for providing electric car charging on campus, since that would increase Scope 2 emissions. Duke's inclusion of transportation also increases its need for carbon offsets in order to achieve net-zero emissions.

Proposed CHP emissions accounting controversy:
In Duke University's CHP proposal, it proposed that there would be no change in the University's Scope 2 electricity emissions accounting. It would continue using Duke Energy's generation fleet average emissions rate since Duke Energy would own the CHP plant and the University would continue to purchase its electricity from the Duke Energy 'grid'. The 18% emissions reduction would accrue due to reduced natural gas use by the University's steam plants. However, opposition was expressed[15] to this accounting, for the key reasons that the CHP plant would have a higher electricity generation emissions rate than the Duke Energy average, and that since the CHP plant was being built on Duke University land and would enable Duke to operate in islanded mode from the grid, it would clearly be built primarily to serve the University, so the University should 'own' the CHP plant for emissions accounting purposes and treat its natural gas use as a Scope 1 emission for the University. By this emissions accounting, the CHP plant would reduce Duke's emissions inventory by 10%. The subcommittee that subsequently evaluated the CHP project[16] proposed an emissions accounting method that also includes electricity transmission losses and methane leakage from the natural gas system, which further reduces the emissions reduction from the CHP plant to just 3%.

The controversy over Duke's proposed CHP plant and proposed emissions accounting has drawn significant public attention, which is unfortunate given Duke's leading efforts overall on climate action. The example highlights the need to consult broadly amongst stakeholders within the institution in developing action plans, and the need for credible and transparent emissions accounting approaches to be agreed upon.

[15] http://www.dukechronicle.com/article/2016/10/response-to-the-duke-chp-overview-document
[16] https://duke.app.box.com/s/b4g84xjw7zv11giw324m93bzi3qlkrf0

10.4 City of Chicago

In 2017, the City of Chicago announced[17] that all public buildings will be powered by renewable electricity by 2025. This target is part of Chicago's Climate Action Plan[18], which outlines five strategies to ensure a "livable climate for the world" and promote local job growth. These five strategies include both reducing emissions and preparing for the changes in climate that will occur in the near future. To create the plan, the city employed a Task Force, a committee of advisory experts that consulted leading scientists and local stakeholders to shape the final plan.

Principles:

Chicago's Climate Action plan outlines criteria that are used to evaluate the validity of emission mitigation actions. These criteria include:

- Reduction Potential: Total achievable greenhouse gas emissions reductions.
- Cost-Effectiveness: Cost of implementation and the potential savings generated.
- Feasibility: Ease of achievement and potential to overcome barriers.
- Benefits and burdens: Advantages and drawbacks to the action, such as savings to residents, job creation and quality of life improvements.
- Regional Impact: level of opportunity for the larger six-county area (area surrounding Chicago)
- Rapid deployment: opportunity to effect changes quickly.

Goals:

In consultation with scientists and local officials, Chicago's Climate Action Plan Task Force set two overarching emission targets: reduce emissions by 25% by 2020 and 80% by 2050 relative to a 1990 emission baseline. Within these overarching targets, smaller targets exist for individual sectors, such as the 100% renewable energy supply to public buildings by 2025.

Action and Procurement:

Chicago's Climate Action Plan identifies 26 emission reduction actions, that in aggregate should allow the city to achieve their 2020 emission goals. These actions, alongside nine other adaptation actions, are grouped into five key strategies that aim to build energy efficiency, procure clean and renewable energy, improve public transportation, reduce waste and industrial pollution, and adapt infrastructure for upcoming climate change.

Accounting:

Chicago's Climate Action Plan tracks emissions within a geographical boundary that includes six surrounding counties. This plan includes the accounting of Scope 1, which include transportation, industrial, agricultural, and waste and wastewater emissions, and Scope 2 emissions. The plan also includes the carbon dioxide equivalent accounting of the six greenhouse gases identified in the Kyoto Protocol. To

[17] https://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2017/april/RenewableEnergy2025.html
[18] http://www.chicagoclimateaction.org/filebin/pdf/finalreport/CCAPREPORTFINALv2.pdf

measure emissions, the city of Chicago applies several GHG protocols to each relevant sector. For more information, please consult the city's 2010 regional greenhouse gas emission inventory document[19].

Deeper Dive:

The City of Chicago's Climate Action Plan is notable due to its exhaustive planning stage, ambitious target and broad scope. This plan provides a useful example of engaging all relevant stakeholders to set emission targets and emission reduction actions. The plan's diversity of emission reduction actions reflect the engagement with a planning task force, funding partners, municipal departments and local civic leaders.

The city's appointment of an independent research advisory committee and engagement with scientists, such as researchers from leading universities, and economic analysts allowed their emission targets and reduction actions to be justifiable to local legislators and in-line with global energy climate goals. The plan outlines economic and environmental co-benefits of actions, and ultimately presented the argument for the plan's adoption. Engagement with all sectors and municipal departments manifest in the identification of 35 emission reduction actions across five key strategies and areas.

For more information about the lessons learned during the formation of this plan, please refer to the Lessons Learned[20] document provided by the city of Chicago.

19 http://www.chicagoclimateaction.org/filebin/Chicago_2010_Regional_Greenhouse_Gas_Emissions_Inventory_May_2012.pdft

20 http://www.chicagoclimateaction.org/filebin/pdf/LessonsLearned.pdf