E-liability Pilot Playbook

Introduction

The playbook provides a step-by-step framework for organizations to pilot and implement the E-liability method for accurately tracking emissions through complex supply chains. It sets out key processes, considerations, and actions to successfully implement the E-liability approach, as well as links to allied documents such as the E-liability Proto-Standard.

Further resources can be found on our website.

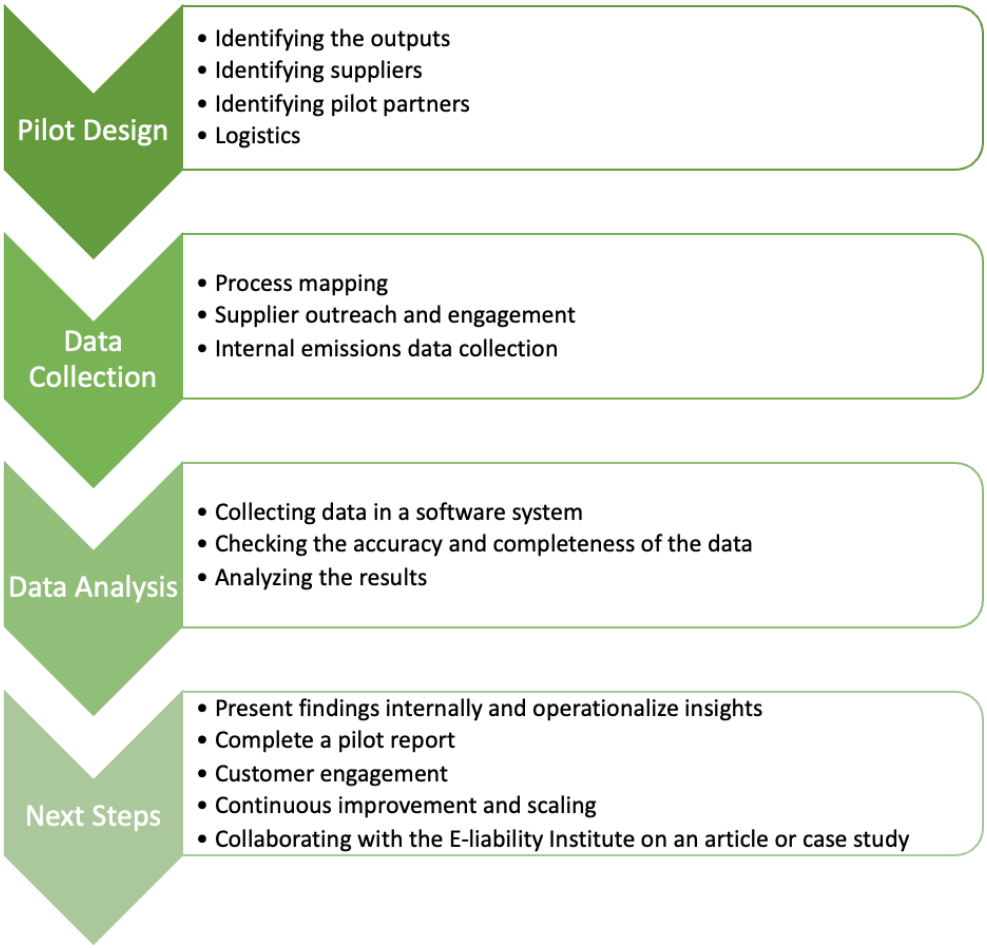
Framework for E-liability Pilot Implementation

An E-liability pilot involves four key stages (refer to **Figure 1** below):

- Stage 1: Pilot Design
- Stage 2: Data Collection
- Stage 3: Data Analysis
- Stage 4: Next Steps

Note that these stages, and steps and activities within each stage, can be iterative and flexible to the circumstances of the pilot and particular challenges or hurdles that you may come across.

Figure 1: Summary of the key stages within a pilot



Stage 1: Pilot Design

The goal of an E-liability pilot is to help an organization build the first iteration of a real-time, management-information system on the carbon content of its inputs, processes, and outputs via a bottom-up process. When the organization scales such a system, it can rethink its strategy and reimagine its purchasing and operations to reduce its environmental impact, potentially identifying new lines of business along the way.

The first stage of the pilot process is the design phase: Why are you doing it? (What is the "problem" that the pilot will help address?) What is the scope of the pilot? Who is going to be involved, particularly internally and in your supply chain? What data will you need to gather? How are you looking to use the E-liability information to inform your decision?

The pilot charter provides some helpful questions to consider when scoping a pilot, with further expansion below.

For a first approximation, organizations should focus on 3-4 key sources of emissions and key suppliers of relevant inputs, to capture a material proportion of an output's emissions.

Example: For the world's first E-liability pilot, involving Giti Tires, four raw materials were chosen because they constituted about 80% of the tire's weight, which was used as a first approximation. Part of the pilot's objective was to determine whether these heavier inputs were emissions-intensive and whether they presented decarbonization opportunities (Kaplan, Ramanna, and Reichelstein, 2023).

a) Identifying the outputs

To get started, identify the scope and objectives of the pilot, in particular, the specific products or services, or value chain, for which E-liabilities will be calculated.

When defining the scope of the pilot project, set clear objectives, such as accurate emissions tracking, identifying emissions hotspots in production or purchasing, and exploring emission reduction opportunities. The following questions may be helpful to understand why you may want to undertake a pilot:

- Which products or services have a high suspected carbon footprint? Either in your direct operations or in your supply chain, are there particular products or services where you think choices can be made in the design, suppliers, or the production process that might significantly vary the carbon content of that product or service?

Example: Heidelberg Materials focused its pilot on alternatives to using clinker in cement production, as clinker is by far the highest suspected contributor to cement-related emissions. (Kaplan, Ramanna, and Reichelstein, 2023).

- Do you have a question or hypothesis to test regarding the carbon content of particular processes that a more rigorous accounting methodology and measurement methodology would help you answer? This could be related to your decarbonization strategy.

Example: Hitachi Energy wanted to test whether using recycled copper was less emissions-intensive than using virgin-mined copper when manufacturing copper coils for its electric transformers (Ramanna and Kirk, 2023).

- Is there a popular product or service where it would be especially helpful to understand its carbon footprint? This could be a product or service where you can create a competitive advantage by offering a lower-carbon solution than competitors.

Example: Soprema, an international building materials supplier, undertook a pilot to measure and subsequently identify ways to lower carbon embedded in its products. It eventually wanted to report the carbon footprint of its products on every customer invoice to generate more business from carbon-conscious customers (Kaplan and Melotte, 2024).

- Are you early in your decarbonization journey and see the value of E-liability in informing your decarbonization strategy to better understand the emissions hotspots, and what your options are?

To focus the scope of a pilot, particularly through the first iteration, consider applying the Willie Sutton rule (espoused by the 1950s bank robber who, when queried about his occupational choice, responded, “That’s where the money was.”). Where would a carbon-focused Willie Sutton look for emissions in your operations and supply chain? Hence the guiding project design rule, “Go to where you suspect the carbon is”. This means, at first, focusing on what likely matters and what will be manageable, and it is particularly important for hard-to-abate sectors or industries with hundreds of inputs. This could involve tracking one input or raw material through a value chain or focusing on the E-liabilities of significant inputs or activities within a production process.

Example: Hitachi Energy tracked copper, a critical material in its electrical transformers, through three tiers of the supply chain, from the copper mine to the company that produced copper rods, to the company that produced enameled copper wire, which was an input into Hitachi’s electric transformers (Ramanna and Kirk, 2023).

More advanced pilots could compare more than one product or service. Only analyzing one product will provide you with specific emissions data for that product and batch, but means that you may learn less about the process of emissions allocation across outputs. If possible, we recommend choosing two or more products, ideally with shared inputs or operational processes.

This could involve:

- Two or more similar products or services that draw from a common pool of inputs to test carbon allocation assumptions and drivers. For example, when comparing hip and knee surgeries at a hospital, common pool inputs would include surgical staff, nursing staff, use of the operating theaters, anesthetics, etc.
- Products or services created in different locations (i.e., different plant sites) that use similar but not identical equipment, processes, and other inputs.

Example: The Tata Steel pilot analyzed steelmaking emissions across two very different production locations, in India and the Netherlands, to gain new insights into

emissions-intensive processes and routes to decarbonization (Kaplan, Ramanna, and Jha, 2023).

Selecting two or more products or services to facilitate comparison enables you to make meaningful allocation decisions and generate actionable data for managerial decision-making.

b) Identifying suppliers

Once you have identified the key products or services that will be the focus of the pilot, and if relevant the key raw materials or components contributing to the product's emissions, the next step is to identify the key suppliers of those raw materials or components.

This is again where the Willie Sutton rule applies. You may want to engage suppliers responsible for a small share of emissions for your chosen outputs, if they also supply goods for many other outputs for the business, as the data can be transferable across different projects. E-liability accounting will almost always be implemented iteratively, with successive versions having improved accuracy and completeness as they encompass more inputs and suppliers, and go deeper up the supply chain.

You should also consider how to engage and align relevant tiers of suppliers to get buy-in. A key factor in a pilot's success is having a deep relationship with suppliers and being able to engage them from the very beginning of the project. You can invite suppliers to participate directly in the pilot, as was done in the case of the Hitachi Energy pilot. It is helpful if relevant suppliers already have strong existing processes to calculate their direct GHG emissions, but this is not critical at the beginning. A willingness to learn amongst selected suppliers is more important.

Often, suppliers are keen to cooperate, particularly with major customers, as they will also be under pressure to reduce their own environmental impacts. Being involved will also provide the supplier with the opportunity to learn from the pilot and shed light on decarbonization pathways. Having your key suppliers involved also makes it easier to approach their suppliers and involve multiple tiers of the supply chain. The E-liability Institute is happy to be involved in such initial team-building conversations.

If chosen suppliers are not receptive or willing and able to be involved in the pilot, you can consider having discussions with other suppliers and, if necessary, re-scoping the pilot to focus on a different product or service where the suppliers are indeed interested in being involved and providing the relevant data. You can also let your non-receptive supplier know that you have opened communication with other suppliers (which may include their competitors) to be involved with the pilot process. This can intrigue them into cooperating.

c) Identifying pilot partners

While engaging suppliers is necessary for a successful E-liability pilot, collaborating with other external partners also proves beneficial in maximizing the value of a pilot. These partners may include the pilot organization's downstream customer, an emissions-assurance provider, a technology enabler that can provide carbon bookkeeping software to help the pilot organization scale its pilot to multiple products and services, across the value chain, etc. These partners can provide valuable insights for running an impactful pilot, scaling the methodology, and driving strategic and operational decisions from the pilot learnings.

Example: A major liquefied natural gas (LNG) producer engaged multiple partners in its E-liability pilot. It involved a risk consulting team within an assurance firm that advised the company on carbon accounting practices from the risk and assurance perspective. It also engaged the law firm that helps the company draft and negotiate LNG contracts with its collaborators and customers. The company also invited an enterprise software provider that is designing a carbon accounting reporting and management tool to be an observer of the pilot. Last, but not least, the company included a downstream customer as an observer.

The risk consultants asked accounting questions and provided valuable inputs on ensuring the completeness, accuracy, and verifiability of the carbon accounting data. The law firm shared insights on how different contractual terms affect pricing and bridged the gap between accounting treatment and legal definitions. The technology enabler gathered valuable feedback from all parties to design a better product that can scale carbon accounting reporting and management across an enterprise and value chains. The customer appreciated the insights on capitalized emissions and allocation methods and shared feedback on interoperability, materiality, and verification.

d) Logistics

After you scope the pilot and identify key suppliers interested in participating, it is critical to re-engage internally to obtain high-level support (ideally from the C-Suite). Pilots invariably yield new insights, and some of these may rattle long-established players the wrong way, so having executive "air cover" for "surprises" is important.

You will also need to form a project team to lead the pilot. This will involve:

- A pilot project manager, who has day-to-day responsibility for the project. This should be someone who understands the supply chain of the selected product and key upstream and direct sources of emissions associated with the production of the selected outputs. The project manager should also have excellent interpersonal and communication skills, as well as endorsement from the executive team. The project manager will scope the

pilot, oversee the pilot's implementation, and coordinate team efforts to gather the carbon data and develop the allocations across products or services. The project manager will also communicate the project's findings and explain how they impact the organization's actions.

- An executive sponsor, often the CFO, CSO, or COO, who approves the pilot scope and acts as an enabler for the project manager to get access to internal resources. Obtaining high-level internal support, including Board buy-in, is cited as often being critical to a pilot's success.
- Staff from operations, procurement/supply chain management, sales, and finance are often important resources for the project manager. In particular, consider who is likely to have the information and data that you need. Identify key stakeholders and decision-makers involved in the pilot project, including environmental specialists, engineers, supply chain managers, and data analysts. Assemble a cross-functional team with diverse expertise relevant to the pilot, including representatives from environmental, supply chain, financial, and data analysis departments.

Example 1: The Giti Tire pilot project team was led by the Director of Quality Assurance, who had a direct reporting relationship to the company's CEO, who was the executive sponsor. The project manager worked closely with factory engineers to identify and set out each step of their manufacturing process, which then enabled the team to identify where they could make emissions reductions, with a focus on energy-intensive processes (Kaplan, Ramanna, and Reichelstein, 2023).

Example 2: With an experienced GHG specialist as the project manager, the liquefied natural gas (LNG) pilot involved the CSO as the sponsor, the engineers at the LNG site, an in-house chemist, finance, commercial and legal team members, as well as various external stakeholders mentioned in section (c) above (i.e., risk consultants, a law firm, a technology enabler, and a downstream customer). The team conducted weekly workshops on preset topics between the pilot organization, the E-liability Institute, and the aforementioned stakeholders, to deep dive on certain topics and to raise and address questions from multiple perspectives (e.g., accounting, legal, commercial, and assurance). Topics included an overview of the company's existing carbon accounting method and its comparison to E-liability, facility allocation and attributes, transportation emissions, reporting and assurance processes, and capitalized emissions.

You should also determine a plan of action for the pilot. Set a targeted end date for the pilot and determine accountability checkpoints. Pilots can take between 3 and 6 months from initial scoping to completion, with pilot managers working several hours per week on the pilot. This can be shorter depending on data availability. The typical pilot does not generally exceed 0.25 FTE of the project manager's total working hours.

The E-liability Institute provides support during the pilot process pro bono, with support from E-liability Institute staff throughout the scoping and execution phases. We recommend setting

up regular meetings with the E-liability Institute (i.e., every 2-4 weeks) to discuss progress and any questions that may arise through the pilot process.

Stage 2: Data Collection

The next stage in the pilot involves gathering emissions data. Pilots are part of an iterative process. The first pass of gathering data can be followed with more detailed data collection up the supply chain or with additional inputs and outputs.

For further details on these matters, please refer to the E-liability Proto-Standard.

a) Process mapping

You should map your production process flow to identify major emission sources. You will, at least at first, need to simplify complex manufacturing processes to identify major emissions sources along a production line. Creating an illustrative flowchart can be useful (refer **Figure 2** and **Figure 3** below for examples from the Giti Tire pilot and the Hitachi pilot, and **Figure 4** for a simplified process flowchart for a hip surgery operation). Applying the Willie Sutton rule, focus on energy-intensive processes and conduct a detailed analysis of emissions associated with these activities.

Figure 2: Example process flowchart from the Giti Tire pilot

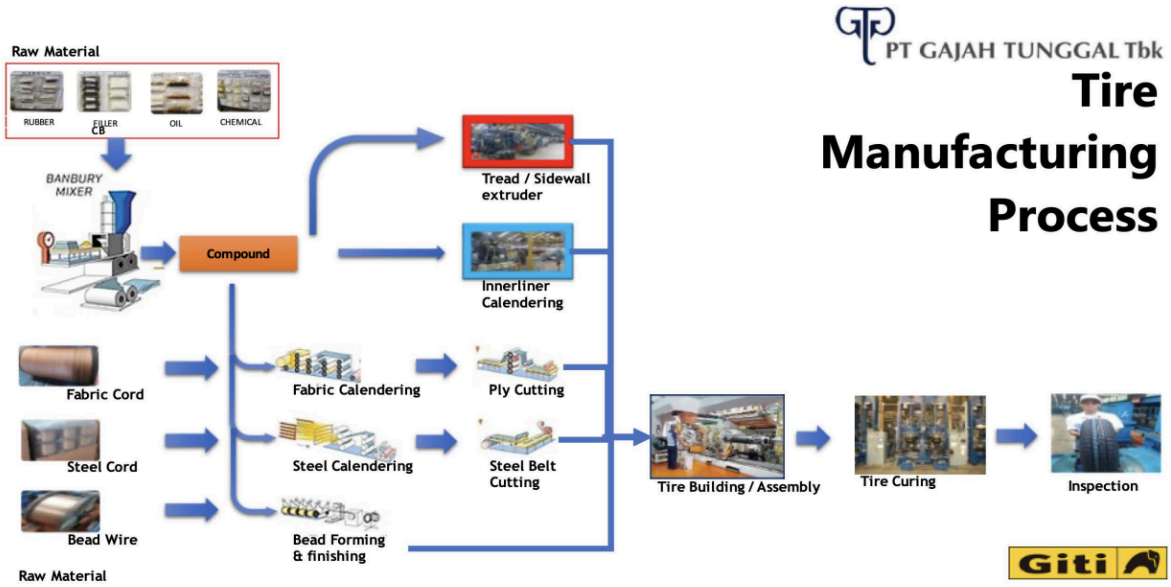


Figure 3: Example process flowchart of the copper value chain in transformer manufacturing from the Hitachi pilot

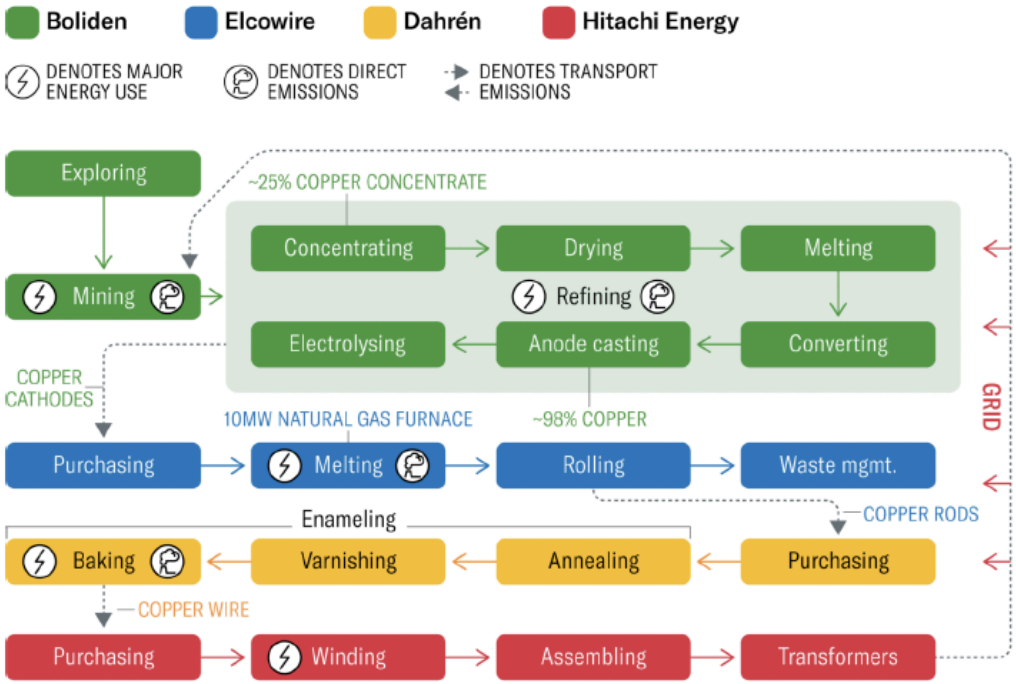
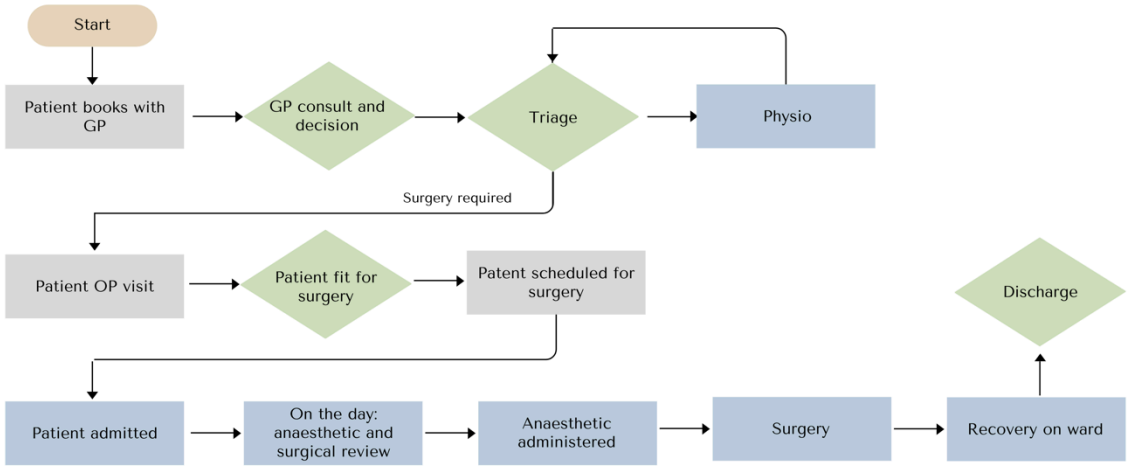


Figure 4: Example process flowchart for a (simplified) hip surgery



b) Supplier outreach and engagement

Once you map out the process, you can begin engaging with multiple intermediaries of the supply chain to gather emissions data of selected inputs. This could include tangible inputs,

services, transport, etc. Where useful, the E-liability Institute can join conversations to walk key suppliers through the E-liability methodology, as well as the pilot process and scope.

Example: A major medical equipment manufacturer wanted to understand the E-liabilities of its specialty plates produced to hold lab samples. It reached out to the suppliers of the three primary materials for its product offering. The company obtained primary data from the suppliers for two of the primary materials but was unable to for the third. This example highlights the importance of having supply chain partners who have a strong understanding and capability to provide product carbon footprint calculations or E-ledger inputs.

It may be helpful to establish a communication plan with suppliers to request emissions data for these materials. The pilot process can also enable the exploration of collaboration opportunities with suppliers to find emissions-reduction alternatives.

Example: After Giti Tires' suppliers learned that the company was actively invested in reducing its carbon footprint, they started to propose potential lower-emission alternatives (Kaplan, Ramanna, and Reichelstein, 2023). The carbon-black supplier proposed using circular production methods that stressed the importance of maximizing resource use and the lifecycle of products, which would reduce its respective emissions by 38%. The natural rubber supplier could switch from a domestic plantation supplier to a more productive one in Thailand to reduce emissions by 27%. The steel supplier could replace virgin ore smelted in basic-oxygen furnaces with recycled steel from electric-arc furnaces to reduce emissions by over 43%.

Where suppliers are keen to be engaged on pilots, they may be able to share specific emissions factors on their final products. If specific emissions data from suppliers are not readily available, consider using, as a first pass, publicly available emissions data, such as Environmental Product Declarations (EPDs) or Life Cycle Analysis (LCA) assessments. Using the E-liability approach, once you purchase the relevant materials from your supplier, the inherent emissions are transferred from the suppliers to the entity's own working E-liability statement.

Example 1: Heidelberg Materials was already producing EPDs to estimate the CO2 emissions for one specific product, produced at a specific plant, in a specific period (Kaplan, Ramanna, and Reichelstein, 2023). Using the E-liability approach, it was able to leverage this work and data to create a real-time management measurement system that reflected the actual carbon content from current cement recipes, production processes, energy purchasing, and materials sourcing.

Example 2: IDG, a security services company operating in Afghanistan, experienced challenges in calculating the emissions embedded in some of its purchased products or services (Ramanna, 2024). As food procurement was local, IDG found that suppliers were willing and able to share traceability information on products and services, which allowed the team to calculate the emissions data and benchmark these against industry averages.

Example 3: A major car manufacturer wanted to calculate the E-liabilities of the radiator grille used for its large EVs. The production process is complex and requires unique products, such as paints, agents, and specialized chemicals, that are made specifically for the car manufacturer. It worked closely with its supply chain partners to calculate the emissions data for these bespoke products to be able to have the data validated and assured.

Example 4: Soprema focused its pilot on bitumen weatherproofing systems, which was the original product line at its 1909 founding. Unfortunately, its high-volume suppliers were unable or unwilling to provide actual data about the carbon emissions embedded in the specific materials they sold to Soprema. For the first iteration of the pilot, the team settled for using average information about its input materials' emissions from EPDs and other publicly available data (Kaplan and Melotte, 2024).

Each tier of the supply chain should concentrate on the emissions that they have control over (i.e., their direct emissions and their purchased/acquired emissions, not downstream emissions). The E-liability pilot should capture actual transactions that have been made between suppliers and customers. This enables managerial insights to support real-time decarbonization decisions.

c) Internal emissions data collection

Your own direct emissions are a critical part of the pilot process. Using the process map, conduct a detailed analysis of emissions associated with your key activities.

In short, gathering emissions data within an entity involves extensive collaboration with various stakeholders across different departments. The project manager needs to communicate with front-line workers, line managers, HR personnel, engineers, and internal experts in fields like energy and sustainability. This collaborative approach ensures that a comprehensive and accurate picture of emissions-related data is collected.

If you already undertake emissions tracking and disclosure, you have a head start. Much of the necessary data may already be available. In this case, the project team needs to verify the accuracy of, and ensure the completeness of, the existing data and, where possible, get dynamic and lot-specific data.

Further detail is provided below on how you could identify, calculate, and allocate the emissions data for direct activities. A stylized example of a data center is set out in **Figure 5** below. For illustrative purposes, the time period of one month is used. Please also refer to **Table 1** in ***Stage 3: Data Analysis***.

Figure 5: Stylized example of internal emissions data collection in a data center

Example Data Centre			*For the month of: Jan-23*		**Output 1: "Standard" Product (services per kwH)**		**Output 2: "Premium" Product (services per kwH)**	
Inputs e.g. raw materials and activities	**Total emissions per month (in kgCO2e)**	**Unit of input**	**Total input capacity per month**	**Factor - Emissions per unit of input**	**Usage - Units of input per output 1**	**Total emissions per unit output 1**	**Usage - Units of input per output 2**	**Total emissions per unit output 2**
Fiber cable	*ab*	meter of cabling	*a*	*b*	*c*	*bc*	*d*	*bd*
Aluminum	*ab*	kilogram	*a*	*b*	*c*	*bc*	*d*	*bd*
Copper	*ab*	kilogram	*a*	*b*	*c*	*bc*	*d*	*bd*
Cooling	*ef*	run-time hours	*e*	*f*	*g*	*fg*	*h*	*fh*
Main electricity inlet usage	*ef*	run-time hours	*e*	*f*	*g*	*fg*	*h*	*fh*
Backup electricity inlet usage (diesel)	*ef*	run-time hours	*e*	*f*	*g*	*fg*	*h*	*fh*
Employee commuting	*ef*	employee hours	*e*	*f*	*g*	*fg*	*h*	*fh*
PPE depreciation (1/25)	*ef*	facility run-time hours	*e*	*f*	*g*	*fg*	*h*	*fh*

i. Calculate emissions per unit of output for direct inputs

Once you have identified all the direct inputs (such as raw materials), and your usage (or input capacity) of these direct inputs per month ("*a*"), you can obtain from your vendors the total emissions associated with each of those direct inputs ("*ab*") for that month. This would be ideally

calculated by the vendors on a product-batch basis and reported to you on their invoices (themselves using the E-liability method). From these two values, you can calculate the emissions factor for each unit of direct input simply by dividing "*ab"* by "*a"*. In **Figure 5** above, this would involve calculating "*b"* i.e., the emissions factor associated with 1 meter of fiber cabling, 1 kilogram of aluminum, and 1 kilogram of copper.

Where the vendor does not provide "*ab"*, you can use, as a first pass, values from emissions databases as described earlier.

Next, you calculate the usage of direct inputs (such as raw materials) per output ("*c*" and "*d*"). To determine these values, the project manager can engage with factory floor workers, line managers, HR, and engineers. The expert opinions of workers who are directly involved in these processes provide valuable insights into how variations in inputs impact eventual emissions per unit of output.

Once you have values "*c*" and "*d*", you can use the emissions factor per unit of input "*b*" to calculate the total emissions attributable to each output ("*bc*" and "*bd*").

Where an input material is used to create more than one product, you should track the usage factor associated with each product separately (e.g., "*c*" and "*d*") and allocate a portion of the total emissions embedded in that input "*ab*" to each product.

> **Example:** A factory produces one type of body wash and one type of shampoo. A distinct blend of inputs is required for each, including colorants, fragrances, and surfactants before they are processed in the same industrial mixer in separate batches. These E-liabilities are distinct between product lines and are added to each product's input materials' E-liabilities separately.

You also need to adjust for losses or scrap. For example, if you use 125 units of an input to obtain a net of 100 units in the output product, the emissions from all 125 input units get assigned to the output products (to account for the 20% loss in production). This reflects the fact that the E-liability approach is a full-accounting system.

ii. Calculate emissions per unit of output for indirect inputs

Likewise, for all other inputs (or "activities"), you first calculate capacity per month ("*e*") and the total emissions per month for that activity ("*ef"*). In **Figure 5**, this would include activities such as cooling, main electricity inlet usage, backup electricity inlet usage, employee commuting, and PPE depreciation. From these two data points, calculating the emissions factor per unit of activity capacity ("*f*") is by simple division.

- Analyzing electricity usage data is crucial for estimating emissions from activities relying on electrical energy. As a first pass, the project manager can calculate the emissions associated with electricity use from utility bills and emissions databases.
- Indirect emissions can be understood similarly to “overhead costs” and include factors such as emissions from administration and capital assets. Estimating indirect emissions requires a comprehensive approach. The project manager can work with relevant experts to assess emissions attributable to the depreciation of buildings and industrial equipment. This involves considering the embedded emissions within the raw materials used for the construction of that capital asset and the asset's lifetime. Collaborating with experts in engineering, finance, and sustainability can aid in arriving at accurate estimates for these emissions.

Example: A company seeks to estimate emissions from employee commuting (“*ef*”) using the best available data sources. This includes travel logs, surveys, or transportation records. The project manager might collaborate with HR to obtain data on commuting distances, modes of transportation used, and average fuel efficiency for different modes. By combining this information with emission factors for each mode, the emissions resulting from employee commuting can be calculated.

In addition, the company seeks to determine the equivalent emissions incurred by employees while working from home at the employer’s direction. The project manager might seek information from employees on their home energy emissions and determine an appropriate amount to apportion to the activities.

Next, you should calculate the usage factor of indirect inputs or activities per output (“*g*” and “*h*”). This could involve discussions with factory floor workers, line managers, and the HR department. These conversations aim to understand the time spent on specific tasks, processes, or operations that directly contribute to emissions. By collecting information on the duration of these activities, the project manager can establish a baseline for emissions linked to each task.

Once you determine the usage factors (“*g*” and “*h*”), you can calculate the total emissions embedded in each output for each of those indirect inputs or activities (“*fg*” and “*fh*”).

For example, to estimate the emissions associated with energy for a given unit of output that is produced on a machine (“*fg*”), you first determine the emissions associated with the energy usage of that machine in the relevant time period (“*ef*”). Then, with the machine capacity (in run hours) per period (“*e*”), which should be known by production staff, you can calculate the electricity emissions per run hour for the equipment being used (“*f*”). Next, you can multiply the emissions per run hour by the run hours required to produce one unit of output (“*g*”).

Allocating emissions from overhead and capital assets to products and services can generate interesting insights. For overheads, you will need to calculate the emissions per period and decide on an appropriate allocation basis to the relevant product. For example, the allocation of HQ operating emissions to a particular site could be based on the % of employees at that site or the revenues generated at that site. This sort of allocation must be defensible via a causal logic.

For multi-period capital assets (such as buildings and machinery), you should capitalize and allocate the embedded emissions of those assets over their estimated useful life. This could be via a depreciation schedule, which first allocates capital-asset emissions to a period, and then via allocation of the period emissions quota to outputs produced in that period. This could also be directly done based on the total number of outputs estimated to be produced by that capital asset over its useful life. For example, if the total units of widgets produced over the useful life of a piece of equipment are estimated to be 1,000, the company could divide the embodied emissions of the machine by the 1,000 units of widgets expected to be produced. Regardless of the allocation schedule used, it should be defensible via a causal logic.

The same principles can be applied to leasing and rental transactions. You should calculate the proportionate emissions of the leased asset over the duration of that leased asset and allocate these to the relevant outputs.

For further details on these matters, please refer to the E-liability Proto-Standard.

Stage 3: Data Analysis

Once you have emissions data for key inputs, raw materials, and activities, you can use the E-liability approach to calculate emissions at the level of individual products or services using any standard costing methodology commonly applied in financial accounting.

The primary emissions data you collect as a pilot may differ significantly from industry averages and emissions factors from databases that you have been using. As you allocate the primary data to products, using rigorous causal logic, you can gain new managerial insights, including opportunities for innovation and decarbonization in your procurement and operations, potential new products and services, and repricing your products and services to reflect any emissions advantages.

Example 1: Heidelberg Materials sought an alternative measurement system to assign an appropriate share of plant-level, energy-related, and purchased emissions to each of the plant's outputs (Kaplan, Ramanna, and Reichelstein, 2023). The pilot followed a multi-step process for allocating direct and indirect emissions from major processes at the plant to products (outputs) using appropriate drivers such as the product's relative clinker or slag content, and its milling time, akin to an activity-based costing approach.

Example 2: Tata Steel Nederland explored how E-liability could be used to provide more dynamic data than the traditional LCA approach used in steelmaking (Kaplan, Ramanna, and Jha, 2023). The dynamic data enables better strategic decision-making. Tata Steel Nederland purchases raw materials from across the world, which are then blended together to maintain homogenous hot metal chemistry. TSN noted considerable variation in the E-liability of different batches of steel, due to variations in the origins of the raw materials and their arrival times. With this data, TSN could better manage procurement and delivery to keep emissions low. Tata Steel Nederland also applied costing principles so that short-term fluctuations in monthly production do not cause excessive emissions variability that would disadvantage its customers.

a) Collecting data in a software system

The Sample Emissions Worksheet is a simple annotated sample activity-based costing spreadsheet. You can use the sample spreadsheet as a basic template and adapt it to fit your specific E-liability pilot needs, though no single spreadsheet works for all pilots. Together with the below advice, the spreadsheet can be used to help you in:

1. Gathering complete data
2. Aggregating data
3. Checking the accuracy of data
4. Analyzing data

To fill in your spreadsheet, you will want to gather data points set out in Table 1 below.

Table 1: Suggested data points for the emissions spreadsheet

Data needed	**Suggested approach**
The amount of raw material used	Request data directly from suppliers. This should already be known to your purchasing managers and cost accountants.
The number of hours per month of direct activities	Talk with factory floor workers, line managers, HR dept, etc.
The number of hours per month of indirect activities	Talk with factory floor workers, line managers, HR dept, etc. to calculate the number of hours of a given activity (e.g., employee commuting) based on best estimates.
The monthly emissions of each activity	For raw materials obtained from suppliers, request this information directly from them. Insist on primary data from key suppliers, at least. Approach the E-liability Institute for help in gathering this information by explaining to the suppliers the purpose of the pilot

	project. Analyze internally gathered direct emissions data. Calculate indirect emissions based on best estimates i.e. depreciation of buildings and industrial equipment according to the embedded emissions of raw materials and useful life cycle of the building/equipment.
Emissions factor, i.e., the emissions per or unit of raw materials and activities	This is the simple division values "*b*" and "*f*" provided in Figure 5.
Usage, i.e., The units of each input (kg of raw material/hour of activity) for each output	Talk with factory floor workers, line managers, HR dept, engineers, etc. The main data point is the expert opinion of workers on the front line of production.

You will need to engage with your suppliers. You do not need to share the spreadsheet directly with them if you do not want to; what matters is obtaining the key numbers related to the input. For example, if you use copper, your supplier will need to provide you with data on the embedded carbon (or E-liabilities) per kg of copper you purchase from them.

After gathering this data, you can calculate the emissions factor of each activity and the total emissions per output.

If an upstream tier of your supply chain participates in the pilot (e.g., tier -2), the emissions per output of that tier's finished goods will become the raw material input data for the next tier (-1) in the chain.

Make sure to go through each product or output to check you are not missing any important activities or raw materials. You can fact-check by engaging with managers and workers on the ground. Specifically, you should:

- Verify the precise sources for the unit of input (Column B) and confirm that capacity (Column E) is correct.
- Confirm the hours or raw material input for each output (Columns F/H)

b) Checking the accuracy and completeness of the data

Once you have entered the data into the spreadsheet, review it for accuracy and completeness. Below are some common capacity-related questions and suggested approaches.

For further details on these matters, please refer to the E-liability Proto-Standard.

i. Capacity considerations

From an emissions allocation standpoint, you must allocate redundant capacity in addition to the actual utilized production capacity.

> **Example:** It is cheaper for a steel company to run a blast furnace 24/7, even though they only use the furnace 6 hours per day for smelting materials. However, the emissions from the full 24 hours of blast furnace operations must be allocated to the products produced during the 6 hours of actual smelting.

You can further ensure data accuracy by comparing input capacity with actual production capacity. Divide the total input capacity per month (Column D) by the usage for each output (Columns F, H, J). This should closely match your actual monthly production. Significant deviations could indicate potential errors, such as:

- Incorrect total input capacity: The actual production capacity may differ from the initial assumption.
- Incorrect usage: Double-check with workers on the ground that your hours per activity are correct. Ensure that you are not under-allocating redundant capacity as per the blast furnace example above.

ii. Underproduction of outputs relative to capacity

If production output systematically falls below long-run capacity, you need to investigate the causes (such as operational inefficiencies or worker absenteeism). Underutilizing capacity can mean the emissions per unit output will increase as noted below.

iii. Avoiding the 'death spiral'

When dividing capacity by actual units produced, exercise caution to prevent initiating a "death spiral". This occurs when you allocate emissions to reduced production, causing emissions per unit to rise as production decreases. In cases of short-run fluctuations in output production, we recommend that you use practical or normal capacity instead of the actual delivered capacity for such a period.

To reiterate, only use this calculation if the reduced capacity is temporary and expected to reverse. Once you have evidence to suggest production volumes will be consistently less than current capacity (e.g., due to reduced demand caused by shifts in customer preferences), then you should cut down your capacity. This will result in a one-time impairment of the emissions associated with that eliminated capacity, akin to a write-off in financial accounting books. This adheres to E-liability's full-allocation principle.

You can also use expected volume (at the time of onboarding new capacity) as the preferred denominator volume for newly acquired multi-period assets, rather than start-up capacity. This calculation is relevant when the short-run production from the newly purchased asset is known, in advance, to be below the asset's long-run capacity.

Example: A watch manufacturer suffered an electrical fire which temporarily decreased production from 1,000 units per month to 500, before returning to 1,000 the following month. During this time, indirect (overhead) emissions remained the same. In their emissions spreadsheet, the watch manufacturer decreased production for the month in question to 500, which doubled the amount of indirect emissions per unit. A hypothetical customer of the watch manufacturer may refuse to buy these watches as they had twice as many indirect emissions relative to the usual stock (the beginnings of a "death spiral"). To fix the problem, for accounting purposes, the watch manufacturer used the hypothetical maximum capacity of 1,000 for the month in question and allocated indirect emissions accordingly. Of course, the unallocated emissions from this temporary setback will still need to be allocated to future production over the long run.

c) Analyzing the results

After completing the above steps, you will have a first pass at the carbon emissions of the individual products or services that were part of your pilot, including all the carbon emissions of the individual raw materials and activities embedded in it.

The next step is to dig into the data: What insights do they reveal? Are the results roughly consistent with your EPD or LCA reports (if available) or are they materially different? How do the results compare with industry averages? How do your suppliers and customers view the results – are they supportive of them or defensive about what has been revealed? What about your production managers and engineers? If you have run the pilot on two or more production batches (or cycles), do the results vary across the batches? If so, why? Likewise, is there variance across different products in the pilot (if two or more products were chosen)? What is driving that variance? Does that variance match your expectations or is it surprising?

Using real-time, primary data (and understanding the variance therein) will help you to identify emissions reduction opportunities - both internally (e.g., through energy, labor, product design, and machine efficiency) and in procurement (e.g., by purchasing lower-emissions inputs and using lower-carbon transport options).

But stay modest and humble about drawing too many insights from your pilot. The pilot data is only as good as the comprehensiveness of inputs used in the pilot and the quality of emissions data on those inputs. The more assumptions (e.g., secondary data) you used in that process, the less likely you can draw substantive conclusions from the pilot. Regardless, with the pilot,

you will have learned *how to* allocate emissions from purchasing, transportation, and production to output products. The knowledge of that process will enable you to develop higher-quality insights over subsequent iterations.

Over time, the process will suggest several managerial options for innovation and decarbonization in your procurement, transport, and operations. You can even explore potential new products and services, after factoring in how providing improved product-level emissions data to customers enhances those relationships, and you can consider amending your pricing to reflect your emissions-related competitive advantages if any. Additionally, you can collaborate with suppliers to source lower-emission materials.

Example: Soprema developed a carbon-adjusted dual financial emissions statement that estimated the financial value of designing products with reduced embedded emissions (Kaplan and Merlotte, 2024). This revealed where it would be less expensive to reduce embedded emissions through product redesign and sourcing decisions than by purchasing valid carbon-removal offsets.

Stage 4: Next Steps

Now that you have a clearer understanding of the emissions associated with the relevant product or service, and identified potential reduction strategies, the next stage involves sharing your findings both internally and externally, including with customers. Continue to enhance your efforts by collecting more extensive and deeper primary data across your organization's supply chain.

a) Present findings internally and operationalize insights

We recommend presenting the pilot results to your executive or management team, and discussing how the organization can use feedback and insights from the pilot to inform decision-making. Consider the following actions:

- Collaborate with suppliers and internal teams to explore innovations and sustainable practices for reducing emissions. For example, include emissions as a KPI to drive performance alongside cost and quality in areas such as procurement or sales.
- Investigate opportunities for utilizing lower-carbon energy sources, energy-efficient processes, and low-carbon alternatives for raw materials and transportation.
- Launch educational webinars that discuss insights from the pilot, covering topics such as sustainability, carbon emissions, emerging environmental challenges and comparison of E-liability carbon accounting with existing carbon measurement approaches such as LCA/EPDs, and GHG Protocol Scopes.
- In making these presentations, we recommend you stay inquisitive to allow stakeholders to point out ways to improve your data and processes – do not be defensive if

participants attack your pilot. Try to understand the sources of their pushback, which can be both rational and fear-based.

We also encourage reflection on the pilot experience:

- What key questions arose during the pilot? For instance, about your data collection and management systems.
- How can the outcomes of the pilot help inform your business strategy and decarbonizing decisions?
- How will this impact your organization's relationships with customers and stakeholders? What new lines of business can this open up?
- How will this influence your reporting and disclosure framework?
- How does the E-liability method compare to your current carbon-measurement practices in terms of:
    - Ease of implementation?
    - Accuracy?
    - Utility for decision-making?
    - Utility for competitive differentiation?
- Which potential challenges could arise when scaling this approach across other products, services, or suppliers?

Often, barriers to scaling are organizational and sociological, rather than technical, highlighting the need for careful management of internal and external stakeholders during scaling efforts. There's no point being right if stakeholders are in denial about the analysis.

Example: IDG is considering how to use the insights from the pilot to create a carbon reduction plan (Ramanna, 2024). Options being considered include creating procurement rules to balance the dollar cost and the carbon cost, as well as carbon budgets and targets for organizational units.

b) Complete a pilot report

The E-liability Institute aims to document the learnings and insights from pilots. After completing the pilots, we expect organizations to complete a post-pilot report. The report will summarize the objectives, design, processes, insights, and action implications from the completed pilot project for the pilot organization, its value chain, its investors, its regulators, and the general public. If this report is especially novel, we can explore having it published for a wider audience.

You can access the pilot report template here.

c) Customer engagement

Your organization now has an opportunity to communicate its emissions data and reduction efforts to customers and stakeholders, demonstrating its commitment to decarbonization actions and environmental sustainability. Explore how to leverage lower-emissions products as a source of competitive advantage by providing credible and timely product-level emissions information to environmentally sensitive customers. For example, one of Giti's customers, a luxury car manufacturer, was already considering how it might include lower-emission tires in its premium-level cars. Collaborate closely with your customers, who likely face similar pressures to reduce their environmental impact, to find solutions that best meet their needs.

d) Continuous improvement and scaling

E-liability pilots are part of an iterative process. During the initial pilot, you learn about the method's measurement and allocation processes. After the first pass at gathering data, follow up with more detailed data collection up the supply chain or with additional inputs and outputs. In circular supply chains, each subsequent iteration improves the accuracy of output data. This iterative approach leads to a more comprehensive and accurate emissions management system.

The E-liability Institute currently encourages information technology firms who are creating solutions for E-liability to scale and become auditable. We can connect you with these companies, if helpful, although we cannot directly attest to the quality of their products. You will have to do your own due diligence on this front.

e) Collaborating with the E-liability Institute on an article or case study

The E-liability Institute offers pilot support on a pro bono basis when we see the pilot as having wider learning potential. In exchange, we seek opportunities to prepare case studies, short articles, and learning materials that share lessons learned from implementing the E-liability method. Your team can co-author and/or review these materials, which we will publish in the public domain only after obtaining explicit approval from your organization and camouflaging any proprietary or competitively sensitive information.

Pilot FAQ

General

What are the main benefits of using E-liability carbon accounting in my organization?
E-liability carbon accounting can help your organization verifiably compete on emissions reductions. In particular, after implementing the method, you may be able to:

- Obtain accurate and auditable emissions data for your products and services.

- Identify emission reduction opportunities to improve sustainability practices.
- Foster collaborations with suppliers and customers to produce cleaner products.
- Transform lower-emissions products into a competitive advantage in the market.
- Provide credible and timely product-level emissions information to customers for informed decisions.
- Become more accountable for actual reductions in emissions to external stakeholders, including shareholders, investors, environmental NGOs, and regulators.

How do we start our first pilot project?
Begin by identifying an emissions-related practical problem that is urgent and/or important to the company. Then, contact the E-liability Institute to determine if we can support a pilot to help you generate accurate data to address that problem.

How long does the pilot project typically last?
The duration of the pilot may vary depending on the complexity of your problem, the cooperation of your supply chain, and the level of data availability within your own organization. Once a pilot organization has finalized the pilot design and scope, it usually takes 2-4 months for a pilot organization to collect and analyze the data. This can be shorter depending on the availability of personnel and resources, with key participants usually working <10 hours per week in support of the project.

What are good outputs to select for a pilot?
Outputs should ideally be complex enough to allow your organization to learn about accounting and measurement challenges from the pilot, but they should be common enough to provide you with scale economies from the pilot. Usually, organizations choose two outputs that share common input resources, ensuring meaningful allocation between products and non-trivial calculations. This generates new insights and interesting managerial decision-making opportunities.

What services does the E-liability Institute offer?
We provide pro-bono technical advice to help an organization build the first iteration of a real-time, management-information system on the carbon content of its inputs, processes, and outputs. To be clear, the host organization is always responsible for the pilots, with the E-liability Institute team offering suggestions of ways to address knotty issues and offering an overall assessment of the fidelity of the pilot process. Pilots typically meet with the Institute every 2-4 weeks to discuss progress and any questions that arise.

How can we engage with suppliers?
E-liability pilots can bring together companies within a value chain to work together on solutions to reduce emissions. The host organization usually meets with its key suppliers early in the pilot process. The E-liability Institute often participates actively in these meetings to provide an overview of the methodology and pilot process. E-liability pilots involve 1-on-1 supplier

relationships and can be governed by an NDA with no need to publicly release sensitive product-specific emissions information.

What are the roles and responsibilities of the Institute and the pilot organization?
The E-liability Institute provides the methodology and advice in the spirit of mutual learning. We can help with:

- Providing guidance on technical accounting questions.
- Scoping and defining the pilot objectives and parameters.
- Offering support and resources for data collection, analysis, and reporting.
- Facilitating regular meetings with the organization and the supply-chain partners to review progress and address questions.

The pilot organization is responsible for implementing and driving the pilot. This includes:

- Designating a project team, including a pilot project manager and an executive sponsor.
- Collaborating with E-liability Institute in scoping the pilot and identifying key products, suppliers, and raw materials.
- Coordinating data collection efforts, engaging with suppliers, and gathering relevant (primary) emissions data.
- Calculating and allocating emissions data.
- Collaborating with E-liability Institute to analyze the emissions data and draw actionable insights.
- Presenting pilot findings internally and externally as appropriate.

What are the potential success factors and barriers that a pilot project may encounter?
Key success factors that drive pilot progress include:

- Strategic alignment between the E-liability Institute and the pilot organization (e.g., ambitions about being a first mover, wanting to competitively differentiate through decarbonization).
- Executive sponsorship and support within the pilot organization.
- Having a deep relationship with suppliers and being able to directly engage them from the start of the project. For example, you can invite suppliers to participate directly in the pilot or identify suppliers who already have strong existing processes to calculate their direct emissions and/or have commitments to sustainability. Often, suppliers are keen to cooperate, particularly with major customers, as they will also be under pressure to reduce their own environmental impacts.
- Technical capacity to support the gathering of internal and external emissions data. Sometimes, in the first iteration of a pilot, the organization uses data already collected for EPD/LCAs. However, the organization should be committed to primary data measurement over time.

- An effective and dedicated project manager to lead the project team and drive the pilot forward. Throughout pilots, the Institute meets regularly with project managers and the project team to monitor progress, work through any questions, and determine the next steps.
- Having internal deadlines (e.g., with executive sponsors) or external deadlines (e.g., a G20 or COP presentation slot) that motivate the completion of a pilot by a certain point in time, to share the pilot results and insights with key stakeholders.

How can I leverage E-liability when engaging with my customers?
Undertaking an E-liability pilot can enable you to transform lower-emissions products into a competitive advantage in the market. This applies to all kinds of products and services, including goods typically considered commodities. We have published studies showing how apparently commodity products, such as copper and steel and cement, can have major differences in carbon content, depending on sourcing and production decisions. Applying the Willie Sutton rule, you can focus on high-carbon impact products and engage with customers to start co-development and foster collaborations on cleaner products. This creates a feedback loop that informs your strategy and decarbonization journey.

Data collection

How can we ensure data accuracy and integrity in the E-liability statement?
We suggest working closely with your assurance providers to verify and validate primary emissions data. At first, you are unlikely to be able to meet the “reasonableness” standard of audits, but over time, as your methods improve and with input from auditors, you can make progress to that end.

My organization already undertakes EPD or LCAs. How is this different?
Pilots often leverage data from EPDs and LCAs. However, unlike a standard and static EPD/product life-cycle emissions report, which many companies produce only every three years, the E-liability approach produces dynamic, real-time reports on all of an organization’s products, based on its current processes, sourcing, and designs.

In the first iteration of any E-liability pilot, the downstream organization can accept, from its suppliers, the EPDs for the relevant component as the first pass at determining its purchased carbon emissions. The EPD, however, is valid only for that product from the factory that produced the EPD at some point in time in the past. The calculation of the EPD also typically uses industry averages, not actual, data for its components. Often, these are inaccurate estimates of the carbon content of its components.

The EPD represents an approximation for the component’s carbon content and remains the same for several years. This means that, even if somewhat accurate at the time of production, it becomes obsolete quickly when it does not reflect changes made by organizations that alter

their carbon footprint. For example, it will not capture the emissions changes should the supplier produce the product at a different factory, use a different energy source, use a modified (lower carbon) production process, source from different suppliers, use a different bill of materials (recipe) in its production process, or use a different transportation approach to move the component from supplier to the purchasing entity's plant.

The benefits of E-liability materialize when the emissions data shifts from an approximate number, produced only once every 3 years, to a carbon number that reflects the component's current product design, production process, energy supplier, sourcing decision, and transportation choice. Stated differently, E-liability accounting enables carbon measurement and reporting to shift from a performative disclosure focus to an operational, real-time management system that encourages every organization in the supply chain to innovate and continually reduce the carbon embedded in its output products when there is a market opportunity.

How can pilot organizations best help suppliers capture data accurately?
The approach depends on the supplier's journey: some may have a lot of information, while others may not know where to start. The E-liability Institute is also happy to join meetings with key suppliers to build supplier understanding of the methodology and pilot process, as well as to share pilot resources.

What if suppliers don't know their carbon footprint? Can they use proxies?
Ideally, key suppliers should be directly involved in the pilot. If not, understanding why they lack this knowledge (e.g., coal shipment mixing) can guide strategic approaches (e.g., focusing on major sources). For the pilot, it's recommended to focus on suppliers with good technical capabilities and a willingness to engage. Proxy factors or industry averages may be utilized if absolutely needed or when calculating actual emissions with primary data is not cost-efficient.

Do pilot organizations usually assess all data or a portion?
Pilot organizations usually assess a portion of the data, focusing on specific business units or products. This allows for a more manageable and meaningful pilot. Upon completion of an initial pilot, organizations can then scale to include more supply-chain stakeholders, more emissions categories (such as overhead emissions), and additional products or services.

Do organizations use a simple spreadsheet file to do their E-liability pilots? Or do they typically rely on technology platforms with turnkey solutions?
Our first few E-liability pilots used a simple spreadsheet file (we have a template for pilots to start with, accessible here) to input and analyze the data for the relevant products. Some pilot organizations are now engaging with third-party technology providers to run their E-liability pilots, especially for more complex pilots that involve a longer value chain or multiple products. It is the pilot organization's responsibility to choose the appropriate technology tool for its pilot.

Creating an E-ledger

What is the process to incorporate carbon offsets? Are there specific methodologies or guidelines to follow?

In addition to E-liabilities, we have a framework for E-assets (Kaplan, Ramanna, and Roston, 2023). Only offsets that *remove* existing carbon from the atmosphere may be used to reduce an organization's reported emissions (i.e., emissions avoidance does not count as it simply lowers future E-liability). The E-asset system addresses challenges in current carbon-offset markets, including chicanery, fraud, inconsistent reporting, lack of auditing, and the risk of mismanagement. E-assets promote transparency, accountability, and efficiency in carbon accounting, offering a more robust and reliable framework. Learn more here. We are happy to discuss details specific to your organization's situation.

Can an E-liability balance sheet be converted to dollars and cents?

In the E-ledger, the carbon balance will always be measured in CO_2 and other GHG emissions units. The E-ledger runs as a separate and independent carbon accounting system, with no need to convert from emissions to monetary units. Of course, the E-ledger numbers are inputs into markets and can help determine carbon prices. Moreover, entities are free to include conversion factors as part of their voluntary disclosure, but such conversion will necessarily be subjective, absent some sort of global carbon price.

Alignment with the ESG reporting ecosystem

How can we use E-liability to improve SBTi or GHG Protocol Scopes 2 & 3 reporting?

E-liability takes a bottom-up approach to calculate the emissions associated with products and services. Having good E-ledger data means you can more accurately calculate your SBTi and GHG Protocol measures, should you need to do so.

How can E-liability help with upcoming carbon content regulation, like CBAM in the EU?

Carbon-border tax adjustment mechanisms, like CBAM in the EU, will likely be applied to the actual declared carbon content embedded in imported goods. E-liability helps by providing a methodology for accurately calculating and verifiably reporting embedded emissions through complex and geographically diverse supply chains. E-liability uses primary, supplier-specific auditable data at the product level, enabling companies to meet CBAM requirements. While CBAM sectors may not cover all industries, conducting an E-liability pilot provides valuable insights and feedback to regulators, aligning with the spirit of upcoming regulations. Other jurisdictions, including the UK and the US, have also signaled intentions to introduce CBAM-like mechanisms.