ACLCA

2022 ACLCA PCR Open Standard – Process and Methods Toolkit

Creating standardized, consistent, and reliable PCRs & EPDs for transparency, procurement, and supply chain data

---

Guidance for

Quantifying Renewable Electricity Instruments in Environmental Product Declarations (EPDs)

Authors

- **Terrie Boguski,** Owner, Harmony Environmental
- **Beth Cassese,** EPD Program Manager, SCS Global Services
- **Alison Conroy,** Director, Global Sustainability, Novelis
- **Greg Cooney,** Senior Engineer – Office of Carbon Management, Department of Energy
- **John Cross,** Principal, Crosswind Consulting LLC, consultant to American Institute of Steel Construction
- **Mikaela DeRousseau,** Data & Methodology Manager, Building Transparency
- **Mark Englert,** Sustainability Senior Manager, USG
- **Francis Fetizanan,** Environmental Sustainability and LCA Consultant, Celanese
- **Suzana Gueiros,** Doctor in Product Engineering, Federal University of Rio de Janeiro
- **Geoff Guest,** Sustainability Research Scientist, Amazon
- **Connie Hensler,** Director Environmental Management & Product Stewardship, Interface
- **Luke Johnson,** Sustainability Specialist, Nucor
- **Christoph Koffler,** Technical Director Americas, Sphera
- **Anna Lasso, Founder,** SmartEPD
- **Keith Lindemulder,** Sustainability Manager, Commercial Metals Corporation
- **Mandy Montazeri,** Program Manager, TrueNorth Collective
- **Christopher Norman,** Environmental Engineer, Nucor
- **Carrie Pearson,** Product Sustainability Lead, Cargill
- **Vicki Rybl,** Senior Sustainability Consultant, JBE
- **Cheryl Smith,** Sustainability Leader, Owens Corning
- **Eric Tan,** Senior Research Engineer, National Renewable Energy Laboratory (NREL)
- **Cher Xue,** Program Manager, TrueNorth Collective

Problem

Many manufacturers are investing in renewable energy at the corporate level through different mechanisms like Renewable Energy Certificates (RECs) and Power Purchasing Agreements (PPAs). While existing standards and protocols, like ISO 14067 and GHG Protocol, establish minimum requirements to consider renewable electricity in carbon footprints, in North America (United States and Canada), there is currently no consensus on how to integrate these corporate renewable investments into product-level Life Cycle Assessments (LCAs), which serve as the background data and framework for EPD reporting.

Solution

Additional background and recommendations on how to quantify and communicate results follow.

Definitions

Attributes[1] – Descriptive or performance characteristics of a particular generation source. Attributes may be sold bundled or unbundled through a contractual instrument.

Additionality[1] – A criterion often applied to GHG project activities, stipulating that project-based GHG reductions should only be quantified if the project activities "would not have happened anyway" – i.e., that the project activity (or the same technologies or practices that it employs) would not have been implemented in its baseline scenario.

Bundled[1] – Bundled procurement / bundled REC – An energy attribute certificate or another instrument that is traded with the underlying energy produced.

Consumption mix – Production mix [fuels used by electricity supplier(s) to generate electricity], plus imports, minus exports

Contractual instrument[1] – Any type of contract between two parties for the sale and purchase of energy bundled with attributes about the energy generation, or for unbundled attribute claims.

CO_2 – Carbon dioxide

Double counting[1] – Double claims – Two or more reporting companies claiming the same emissions or reductions in the same scope, or a single company reporting the same emissions in multiple scopes.

Energy attributes[2] – The physical characteristics and the environmental benefits of electricity generation are determined by those physical characteristics. Energy attributes include, but are not limited to:

- Static information about the generation (technology type, nameplate capacity, location, commissioning date, project name, etc.).
- The released CO_2e emissions associated with the generation.
- The time and date (vintage, or sometimes a timestamp) of generation.

EAC[1] – Energy attribute certificate – A category of contractual instruments used in the energy sector to convey information about energy generation to other entities involved in the sale, distribution, consumption, or regulation of electricity. This category includes instruments that may go by several different names, including certificates, tags, credits, GOs etc.

EPD – Environmental product declaration – A type III ecolabel that provides environmental impacts throughout specified stages of the life cycle of a product.

GHG – Greenhouse gas – Any gaseous chemical contributing to global warming.

GO – Guarantee of origin – A green label or tracker used in Europe that guarantees that one MWh of electricity has been produced from renewable energy sources.

IPP – Independent power producer

kWh – kilowatt-hour – equal to 0.001 MWh

LCA – Life cycle assessment

LCI – Life cycle inventory

Market boundary[2] – refers to an area in which the laws and regulatory framework governing the electricity sector are sufficiently consistent between the areas of production and consumption. For this guidance, the market boundary is North America (United States and Canada).

MWh – megawatt-hour - equal to 1000 kWh

NA – North America

PPA[1] – Power purchase agreement – A type of contract that allows a consumer, typically large industrial or commercial entities, to form an agreement with a specific energy generating unit. The contract itself specifies the

commercial terms, including delivery, price, payment, etc. In many markets, these contracts secure a long-term stream of revenue for an energy project. In order for the consumer to say they are buying the electricity of the specific generator, attributes shall be contractually transferred to the consumer with the electricity.

Production mix – Total fuel mix used by the electricity supplier to generate electricity

REC[1] – Renewable energy certificate -– A type of energy attribute certificate (EAC) used in the U.S. and Australia. In the U.S., a REC is defined as representing the property rights to the generation, environmental, social, and other non-power attributes of renewable electricity generation. One REC equates to one MWh of renewable energy production.

Residual grid mix[3] – The mix which represents the emissions and generation that remain after certificates, contracts, and supplier-specific factors have been claimed and removed from the calculation. Residual mix factors are the preferred market-based default emission factors for any of an organization's electricity for which it cannot apply one of the more-preferred emission factors above. This is because the use of residual mix emission factors avoids double-counting of the emissions attributes of contractual instruments.

Revenue-grade meters[4] – devices that measure the output of solar systems. The accuracy of the meters is higher compared to typical power production meters referenced as +/-2% per the American National Standards Institute (ANSI) rule C12.1-2008.

RNG – Renewable natural gas such as biomethane, which is a biogas that has been upgraded to a quality similar to fossil natural gas and has a methane concentration of 90% or greater.

Scope 1 emissions[1] – Emissions from operations that are owned or controlled by the reporting company

Scope 2 emissions[1] – Indirect emissions from the generation of purchased or acquired electricity, steam, heat or cooling consumed by the reporting company

Scope 3 emissions[1] – All indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions

Unbundled[1] – Unbundled procurement / unbundled REC – An energy attribute certificate or other instrument that is separate and may be traded separately from the underlying energy produced, unbundled RECs cannot claim additionality.

1. Introduction and background

1.1 Why is this needed?

As companies develop strategies to mitigate their environmental impacts, the Environmental Product Declaration (EPD) is considered a tool to reflect deliberate decisions -- from supply chain to process and design improvements -- and showcase environmental impact reduction at the product level. Decarbonization of the grid and use of renewable energy is one of the main corporate impact mitigation strategies worldwide, reducing the reliance on traditional fossil fuels and, therefore, lowering associated environmental impacts.

Many manufacturers are investing in renewable energy at the corporate level through different mechanisms like Renewable Energy Certificates (RECs) and Power Purchasing Agreements (PPAs). While existing standards and protocols, like ISO 14067 and GHG Protocol, establish minimum requirements to consider renewable electricity in carbon footprints, in North America, there is currently no consensus on how to integrate these corporate renewable investments into product-level Life Cycle Assessments (LCAs), which serve as the background data and framework for EPD reporting.

A 2021 survey was conducted among the LCA community to understand how prevalent the practice of using RECs and PPAs in LCAs is today. Of the 86 who responded, 60% were located in North America. A third of the participants' employers have been using RECs and PPAs in their LCA practices. 56% of the respondents believe

ISO 14040/14044 standards are not clear about the boundaries for these types of flows. Results also showed the key challenges of using RECs/PPAs in LCAs are inconsistent accounting (18%), no guidance or standard (6%), demonstrating additionality (5%), and availability of residual mix data (5%).

Ultimately this committee decided there is a great need for guidance that directs LCA practitioners on how to perform calculations with renewable energy investment and how to report and interpret results that will:

- Align with ISO standards;
- Be technically and scientifically defensible based on available tools and databases (e.g., no double counting);
- Produce repeatable results across the industry; and
- Allow manufacturers to credibly document corporate renewable investment at the product level.

This document references Corporate Accounting and Reporting Standard and its supplement guidance document, Scope 2 and Scope 3 Standard, which are developed by the Greenhouse Gas Protocol for its definition of Scope 1, 2, and 3 emissions. This document also considers ISO 14067, ISO 14025, ISO 14040, and ISO 14044 as normative references and provides guidance for how renewable electricity should be considered in LCAs and EPDs when reporting and aggregating environmental impact results.

For now, the scope of this guidance is limited to renewable electricity in North America (US and Canada), but it may be expanded in the future to consider renewable energy as a whole. There were limited tracking systems for renewable gas (RNG or biomethane) in the region at the time of document writing.

1.2 Contractual instruments and how they work

A contractual instrument is an agreement between two parties for the sale and purchase of renewable electricity bundled with attributes about the energy generation or for unbundled attribute claims. Typically, an energy purchaser will enter into a delivery contract with an independent power producer (IPP) to secure a long-term, predictable source of renewable electricity that is verified through the conveyance of Energy Attribute Certificates (EACs) to the purchaser. This process is fundamentally different from purchasing offsets, and the reader is directed to the EPA's publication 'Offsets and RECs: What's the Difference?' for further details.

1.2.1 Types of contractual instruments

There are several consensus-based approaches companies can take to quantify their corporate emissions outlined in the Appendix that take renewable electricity investment into consideration through the use of contractual instruments. However, these methods do not clearly define the steps to allocate corporate emissions reductions via contractual instruments to the plant or product level. Many manufacturers are now using contractual instruments, such as PPAs, to make investments in off-site renewable energy generation, directly contributing to additional renewable energy supply. When calculating and reporting product-level environmental impacts, both on-site renewable electricity and procured off-site renewable electricity requires a comprehensive approach to measurement and ease of tracking. This is where contractual instruments are used, the most common of which for North America are included in Table 1.

Table 1. Types of contractual instruments used for renewable electricity in North America

Category	Type of contractual instrument	Description	Items conveyed
Retail supply options Standardized products, generally short-term commitments	**Energy attribute certificates (EAC)** **Renewable energy certificates (RECs):** RECs serve as a regulatory role in states that have renewable energy supplier quotas as well as a voluntary role for consumers who want to purchase and support renewables.		Environmental attributes only
	Competitive green power products[5]: An optional product offering that allows customers in competitive retail electricity markets to procure bundled electricity and RECs from a competitive electricity supplier, who is not their default utility supplier. Participating customers usually pay a per-kilowatt-hour premium on their monthly electric bills for the renewable electricity. **Utility green power products[5]:** An optional utility service that allows customers to procure bundled electricity and RECs from their utility or default service provider. Participating customers usually pay a per-kilowatt-hour premium through an additional line item on their monthly electric utility bill for their renewable electricity. **Community choice aggregation (CCA)[6]:** Also known as Municipal Aggregation, CCAs are programs that allow local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider. CCAs are currently authorized in states such as California, Illinois, Ohio, Massachusetts, New Jersey, New York, and Rhode Island, as enabled by state legislation. CCAs can, though are not required, to source renewable electricity for their customers, either as a default supply option and/or as an opt-in product.		Electricity and environmental attributes
Project-specific supply options Customized, negotiated products that generally involve long-term commitments	**Direct contract:** A type of contractual instrument between a renewable generator and a consumer where other instruments or energy attribute certificates (EACs) may or may not exist. In the absence of EACs, best practice is to verify the contract and associated claim by a third party to convey a sole ownership right to claim a GHG emission rate.	**Physical power purchase agreements (PPA)[7]:** A contract for the purchase of power and associated RECs from a specific renewable energy generator (the seller) to a purchaser of renewable electricity (the buyer). Physical PPAs, which are usually 10 to 20-year agreements, define all of the commercial terms for the sale of renewable electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination. The project may be located on-site at the user's location, or be off-site with the electricity being grid-delivered to the user. Physical PPAs by non-utility consumers are generally only allowed in competitive electricity markets, and the renewable energy generator and customers must be located in the same power market to allow for physical delivery of electricity.	Electricity and environmental attributes
		Financial power purchase agreements (PPA)[8]: A financial PPA is also known as a virtual power purchase agreement or a contract for differences, is a financial arrangement between a renewable energy generator (the seller) and a consumer (the buyer). Financial PPAs, which are usually 10 to 20-year agreements, enable the renewable electricity generator to receive a known price for its sales of electricity over the term of the agreement since the buyer is contractually responsible for any difference between the wholesale price and the Financial PPA price (i.e., strike price). If the wholesale price is below the strike price, the buyer pays the renewable energy generator the difference. Conversely, if the wholesale price is above the strike price, the renewable energy generator pays the buyer the difference. In this way, the Financial PPA acts as a hedge against electricity price volatility for the buyer since the Financial PPA credit the buyer receives is correlated to electricity market prices. The renewable energy certificates generated by the renewable energy generator are usually contractually conveyed to the buyer. A Financial PPA does not include the electricity delivery to the buyer, and therefore the buyer can be located in a	Environmental attributes only

Category	Type of contractual instrument	Description	Items conveyed
		different power market than the renewable energy generator, including being located in a regulated electricity market.	
		Self-supply[5]: Self Supply refers to green power use by a consumer whereby the consumer owns the renewable electricity generator and is responsible for its maintenance and operation. The renewable electricity generator may be directly connected at or near the point of use, off-site with the electricity being grid-delivered to the user, or off-site with the power sold to others but the REC retained by the consumer. **Utility green tariffs[5]:** These are optional programs in regulated electricity markets offered by utilities and approved by state public utility commissions (PUCs) that allow eligible customers to buy bundled renewable electricity from a specific project through a special utility tariff rate. **Shared renewables[5]:** Shared renewables such as community solar, is an emerging model allowing multiple customers to buy, lease, or subscribe to a portion of a shared renewable electricity system that is located away from their home or business. The model is especially appealing to customers that do not have sufficient renewable resources, that rent, or that are otherwise unable or unwilling to install renewables on their residences or commercial buildings. Shared renewables can be in the form of 'community-owned' projects or third party-owned renewable electricity generators whose electricity is shared with multiple customers." "Many shared renewable projects do not convey the associated EACs to the project subscribers. In these cases, the buyer/consumer cannot claim to be using renewable electricity in the absence of receiving the associated energy attributes or EACs from the shared renewables project.	Electricity and environmental attributes

1.3 Existing methods addressing renewable investment

Several methods exist that provide guidance for the accounting of renewable investment in corporate and/or product-level LCAs or carbon footprint assessments. The committee assessed the approach used in each method to understand the scope and limitations and to identify an appropriate method to adopt for the purposes of this guidance document. A summary of the evaluation can be found in the Appendix.

The recommendation is to align primarily with ISO 14067 methodology but to include assessment categories beyond Global Warming Potential (GWP) in alignment with the product's Product Category Rules (PCR). If there are areas not covered in ISO 14067, secondary alignment is with the GHG protocol for Scope 2 emissions.

1.4 Acceptable contractual instruments for this guidance

In alignment with the GHG protocol for Scope 2 emissions, this guidance does not require that contractual instruments claimed to fulfill additionality criteria or be required to reflect, beyond the consumer's own indirect emissions footprint, whether the consumption of zero emissions electricity results in consequential direct emissions reductions on the grid system. Therefore, of the instruments included in Table 1, those that conform with the criteria defined in ISO 14067 Section 6.4.9.4.4 are acceptable for use under this guidance. In circumstances where RECs are not issued and tracked through one of the available systems if the manufacturer can provide evidence of contractual ownership and delivery of energy attributes between a generator and consumer through contractual instruments and attestations, it may use the energy attributes in a similar manner, while ensuring each attribute is only used once.

2. Proposed approach

2.1 Introduction

The first part of this chapter outlines inherent limitations in any proposed calculation method, particularly as it relates to market boundaries and the determination of an appropriate residual electricity grid mix. The second part proposes a methodology for calculating and reporting product-level electricity in LCA and EPD results. This proposed method leverages ISO 14067 Section 6.4.9.4 as its basis. This method focuses on credit allocation at the facility level cascaded to products and covers both on-site and off-site electricity generation.

2.2 Limitations

2.2.1 Market boundaries and residual grid mixes

According to climate-focused nonprofit CRS (Center for Resource Solutions) that operates the Green-e program, all of North America is considered one electricity “market” despite the fact that there are multiple grid interconnections. As such, the use of RECs in North America aligns with ISO 14067.

Another market boundary limitation is that unlike country-specific residual grid mixes that track guarantees of origin (GOs) as presented in Europe, regional grid mixes in the US lack spatial resolution in terms of contractual instrument allocation. Residual grid mixes for eGRID and/or NERC subregions and Canadian provinces are needed, but voluntary versus involuntary contractual instrument reporting is not currently structured in a way that allows the calculation of specific voluntary or involuntary residual grid mixes. Furthermore, there are significant challenges in developing residual grid mixes in North America, given there is no central repository of reliable data that covers 100% of all voluntary RECs traded. This is further explored in the Appendix.

2.2.2 Choice of databases

Some of the current LCI databases (like DATASMART, ecoinvent, and Sphera’s Managed LCA Content) available for grid modeling in North America include production and consumption mixes. Production mixes represent electricity generation within balancing authorities, eGRID subregions, NERC regions, or interconnections based on technology mixes and emissions data from the U.S. EPA’s eGRID database or other official statistics and reports. Consumption mixes include electricity traded between different balancing authorities. However, these electricity mixes do not subtract any contractual instruments (e.g. RECs) sold to and claimed by voluntary consumers and others, thus resulting in some double counting if used in conjunction with contractual instruments. The level of double counting is considered to be acceptable in the absence of a residual mix. This is further explored in the Appendix.

2.3 Proposed methodology

The proposed methodology involves the following procedure, which is detailed in the sections below.

1. Determine the renewable share at the corporate, facility, or product level
2. Identify the facility/facilities and product(s) to apply contractual instruments to and determine annual production volumes
3. Determine whether the contractual instrument is applicable
4. Use a balance sheet to allocate contractual instruments to annual production
5. Model allocated electricity covered by RECs
6. Model allocated electricity not covered by RECs using consumption grid
7. Retire the RECs and ensure the GWP result does not differ >10% for the duration of the EPD validity

2.3.1 Calculating renewable share

To promote further investment in renewable electricity, corporate entities should have the choice to allocate RECs within their businesses to provide them with the most benefit. By this methodology, a corporate entity can take purchased or generated RECs and apply them at the corporate, facility, or product level within the same market boundary. A robust plan must be in place to ensure that RECs are only allocated once.

The usage of RECs should be contemporary with their generation and the electricity usage being matched. Typically, this matching is on an annual basis at the time of writing, though there may be government or certifier guidelines that may use a different basis. Future requirements may also dictate a different basis, such as hourly matching. An electricity balance sheet shall be included as part of the LCA to detail total electricity and how RECs are allocated in relation to the facilities, products, and life cycle modules/stages covered by the EPD. This information, while required for verification of the LCA background report, does not need to be included in the EPD or any external reporting. A sample table is provided in the appendix. The Communicating Results section provides guidance on which REC details should be reported and whether they should be part of the EPD or LCA report.

The balance sheet shall be reported in the time period, which aligns with the data collection period of the EPD or per calendar year if there is no EPD applicable. Per the GHG Protocol Scope 2 Guidance, the contractual instruments used shall "be issued and redeemed as close as possible to the period of energy consumption to which the instrument is applied." A Green-e® Energy certified product may only include renewables that are generated in the calendar year in which the product is sold, the first three months of the following calendar year or the last six months of the prior calendar year.[8]

2.3.2 On-site renewable electricity

Manufacturers may invest in on-site, internally generated electricity from renewable energy sources and use the electricity directly in their operations. If electricity is not used on site and supplied to the grid or the RECs have been sold to a third party, they may not be used for the manufacturer's products or facilities. Some acceptable forms of on-site renewable electricity generation include[8]:

- Solar electric
- Wind
- Geothermal
- Hydropower from new generation capacity
- Solid, liquid, and gaseous forms of biomass
- Biodiesel (B100)
- Fuel cells, only if powered by hydrogen from one or more fuels from eligible sources, as listed above
- Ocean-based energy resources captured through tidal and wave technologies

For electricity generated on-site from renewable sources, power generation may be tracked through revenue-grade meters or may be estimated using generator specifications. Eligible RECs may be included on the balance sheet to be used in the calculation. An eligible REC is one for which the company has maintained ownership of the renewable attributes and shall retire it as part of the renewable energy claim. It shall also meet the market boundary requirements.

2.3.3 Off-site renewable electricity

To leverage off-site renewable electricity, the first step in this method is to verify whether the PPA or REC is applicable for environmental claims for the selected facility or product per market boundary definitions. Eligible RECs may be included on the balance sheet to be used in the calculation. For the purposes of this guidance, RECs purchased in the open market should be generated from projects that are no older than fifteen (15) years from the commercial online date.[8] If the RECs are part of a long-term PPA or on-site installation whose duration exceeds the fifteen-year limit, they should be included if they meet the other needed criteria.

Throughout the year, typically quarterly, companies will receive RECs for the renewable electricity production that will be available for contemporary use. Based on the schedule determined by the company (typically quarterly, semi-annually, or annually), it will retire RECs from the accumulated total to cover the determined amount of electricity consumption for the preceding time period for which it plans to claim renewable electricity use. Companies will typically want to retire their oldest RECs first to ensure maximum availability.

2.3.4 Application of RECs in LCA

For off-site renewable electricity, the secondary LCI dataset, which most closely represents the renewable electricity generation from the REC (generation type, location, etc.), should be used to model the REC portion of the electricity in the LCA. In the case of combustible renewable fuel (e.g., vegetable oil) generation, the combustion emissions should be modeled based on supplier specific data (if available), and upstream processing of fuel can be selected from proxy datasets. This approach will ensure the environmental credits will be multi-attribute -- beyond just reduced carbon -- and include impacts in other categories using the LCI data.

Ideally, a residual grid mix should be used to calculate impacts from electricity used during production that is not covered by contractual instruments. In the absence of a comprehensive electricity tracking system in place in North America, until a residual grid mix is available, this guidance recommends the consumption grid mix shall be used for any additional electricity not covered by another renewable electricity source (e.g., on-site generation) to align with ISO 14067. For any portion of the electricity used not covered by the RECs, the consumption grid mix for the manufacturer's location should be used, where available.

In the cases where on-site electricity generation is allocated to a product produced at the generated location, site-specific grid mixes used to model in the LCA shall be adjusted to reflect the on-site renewable electricity while the remaining electricity shall be assumed to be drawn from the electricity consumption mix if a residual grid mix is not available.

When plants use on-site and off-site renewable electricity, a combination of the approaches presented above is used. In this approach, the electricity flow in the plant is modeled to reflect the percentage of on-site power generation for which RECs are used, the off-site renewable electricity from the contractual instrument, e.g., REC (equivalent electricity), and any remaining electricity using electricity consumption mix of the region if a residual mix is not available. Any electricity required to produce a product that is not attributed to a renewable electricity source should be modeled using the residual mix or consumption mix based on availability.

It is recommended to include a sensitivity analysis in the LCA, which aligns with the ISO 14067 recommendation for countries like the US, where parts of the electricity from renewable sources might be sold/exported without being excluded from the supplied mix.

See the Appendix for further discussion.

2.3.5 Allocation and availability of RECs

The RECs allocated to a facility or product shall be retired and only attributed to the stated production volume to avoid double counting the renewable electricity. The RECs allocated to a given facility or product shall not exceed the electricity consumption that is allocated to the given production volume. In alignment with ISO 14067, total electricity consumed and allocated to a specific product can include electricity consumed at upstream sources as long as these sources are under the reporting entity/product owner's control, measured with primary data, deemed required for the product/facility-specific production volume and double counting is avoided.

There should be an expectation that during the validity period of the EPD, RECs will be available and retired on a periodic basis to maintain the same percentage of renewable electricity claimed in the EPD. A commitment letter, long-term contract, annual audit plan, or other process as approved by the verifier should be included as part of the LCA report. In alignment with ISO 14025, if there are changes in circumstances during the validity period of

the EPD, such as a change in the percentage or type of renewable electricity, that could alter the content and accuracy, the organization should correct or amend it. At the time of writing, general practice is to update if GWP results change by more than 10%. There shall be a note in the EPD highlighting the need to update results if GWP results change by more than 10% if the percentage or type of renewable electricity changes.

2.3.6 Sample calculation

Product Z is produced in Indiana in the eGRID RFCW region. Annually, 100,000 kg of product is produced using 50,000 kWh of electricity. The manufacturer produces 5,000 kWh of electricity annually on-site through a solar array and has a wind PPA of 20,000 kWh annually from eGRID SRSO region. Since the contractual instrument is with a generator within the same market (North America) as the manufacturer's facility, the REC may be applied to production at the facility.

Scenario 1: The manufacturer allocates all RECs to the entire product volume.

Calculate renewable share:

- Production volume = 100,000 kg Product Z
- Total electricity consumption = 50,000 kWh
- On-site renewable electricity (on-site RE) = 5,000 kWh
- Off-site renewable electricity (off-site RE) = 20,000 kWh
- % Renewable electricity = (on-site RE + off-site RE) / Total electricity consumption
- Product Z % Renewable electricity = (5,000 kWh + 20,000 kWh) / 50,000 kWh = 50%

In the absence of a residual grid mix, the remainder of the facility electricity should be modeled using:

- Electricity using consumption mix = Total electricity consumption – (on-site RE + off-site RE) = 25,000 kWh

Scenario 2: The manufacturer allocates RECs to a portion of the product volume.

The manufacturer may also choose to market a portion of Product Z's production as 100% renewable electricity (Product Z_{RE}), but in the absence of a residual grid mix, it would need to use a consumption mix to model the electricity for the remaining portion of the product's production.

Calculate renewable share:

- Production volume = 100,000 kg Product Z
- Total electricity consumption = 50,000 kWh
- On-site renewable electricity (on-site RE) = 5,000 kWh
- Off-site renewable electricity (off-site RE) = 20,000 kWh
- Electricity using consumption mix = Total electricity consumption – (on-site RE + off-site RE) = 25,000 kWh
- Volume of Product Z_{RE} = [(on-site RE + off-site RE) / Total electricity consumption] * Product Z volume
    - Volume of Product Z_{RE} (100% renewable electricity) = [(5,000 kWh + 20,000 kWh) / 50,000 kWh] * 100,000 kg = 50,000 kg
- Volume of Product Z (100% electricity using consumption mix) = [(5,000 kWh + 20,000 kWh) / 50,000 kWh] * 100,000 kg = 50,000 kg

Separate results shall be reported in the EPD for the product with different REC allocations (e.g. Product Z and Product Z_{RE}) to ensure that product-specific volumes sold accurately match the allocated electricity consumed. It shall be clearly communicated to customers which results apply to the product they purchase.

If a manufacturer produces multiple products (Product Y and Product Z_{RE}) at a facility, the allocation would be similar to Scenario 2, but replace Product Z with Product Y.

3. Communicating results

3.1 Reporting in environmental product declarations (EPD)

Once product level impacts are calculated, this information can be used in the EPD. In the past, depending on PCR requirements, manufacturing results calculated with RECs were often added as a second scenario, with baseline results being the life cycle impacts without renewable energy contributions. However, with the increased use of EPDs for product comparison, having two sets of results can be confusing for the customers and will add redundant details. EPDs should report the life cycle impacts of a product as-is, with all the deliberate decisions that happen in the background. Therefore, we recommend only displaying designed-in impact results, which include renewable energy contributions. Details of the nature of renewable energy contributions shall be included in the interpretation section of the EPD, as noted in Table 2, and additional details, where relevant, shall be included in the LCA background report that supports the EPD, as noted in Table 3. Links to Green-e or additional information about the RECs should be included in the background report.

Table 2. Renewable Energy Certificate Details for Inclusion in the EPD

Renewable energy certificate technical scenario	
Parameter	**Value**
Renewable fuel type	Wind, solar, etc.
Percent of manufacturer's product-related electricity covered	%
If <100%, grid type used to model remaining electricity	Consumption grid, residual grid, supplier mix, etc.
Commitment pledged for entire validity of EPD	Yes / no

Table 3. Renewable energy certificate details for inclusion in the LCA background report

Renewable energy certificate technical scenario		
Parameter	**Unit**	**Value**
Renewable generator project name:		
Tracking system ID (unique generator ID):		
Renewable facility/generator owner:		
Renewable facility/generator location:	State / province	
Project vintage (build date):	Year	
Project generation date (year first produced renewable energy):	Year	
Nameplate capacity of project:	MW	
Certificate type:		
Certificate unique ID:		
Month and year of renewable energy generation:	Month / year	
Month and year certificate issued:	Month / year	
Utility to which the project is interconnected:		

3.2 Tying to carbon footprinting labels

While EPDs are considered the primary carbon footprint reporting method for building products in North America, other labels and frameworks exist across sectors and products. Examples of these programs and certifications include the Carbon Trust label, Carbonfree certification (CarbonFund), CarbonNeutral certification (Climate Impact Partners), and Carbon Neutral certification (SCS Global Services). Methodologies for labeling or certification under these programs require an LCA or other carbon footprint analysis conforming to one of several standards: ISO 14040/14044, ISO 14064, ISO 14067, GHG Protocol, and PAS 2060, among others.

ISO 14064 and ISO 14067 are corporate and product-level carbon footprinting standards, respectively. Both standards allow for the use of contractual instruments in the carbon footprint (see Section 1.3 of this document), provided they are unique, and no double-counting occurs.

It is recommended that companies publishing EPDs and pursuing carbon labels or carbon neutrality certifications use the guidance provided in this document, including only displaying results that include renewable energy contributions in the analyses, reporting, and public claims they pursue.

4. Citations

1. GHG Protocol Scope 2 Guidance, Greenhouse Gas Protocol. World Resources Institute. 2015. https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf
2. RE100 Technical Criteria. 12 December 2022. https://www.there100.org/sites/re100/files/2022-12/Dec%2012%20-%20RE100%20technical%20criteria%20%2B%20appendices.pdf
3. U.S. EPA Center for Corporate Climate Leadership – GHG Inventory Guidance – https://www.epa.gov/sites/default/files/2016-03/documents/electricityemissions_3_2016.pdf
4. New Jersey Revenue Grade Meter Requirement https://www.srectrade.com/blog/tag/revenue-grade-meter
5. U.S. EPA. Green Power Supply Options https://www.epa.gov/green-power-markets/green-power-supply-options
6. U.S. EPA. Community Choice Aggregation https://www.epa.gov/green-power-markets/community-choice-aggregation
7. U.S. EPA. Guide to Purchasing Green Power https://www.epa.gov/sites/default/files/2016-01/documents/purchasing_guide_for_web.pdf
8. Center for Resource Solutions. Green-e® Renewable Energy Standard for Canada and the United States. Version 4.2 https://www.green-e.org/docs/energy/Green-e%20Standard%20US.pdf
9. ISO 14067:2018 - Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification.
10. EUR 29682 EN JRC Technical Reports. Suggestions for updating the Product Environmental Footprint (PEF) Method. https://publications.jrc.ec.europa.eu/repository/handle/JRC115959
11. Guideline for Claim of “Made with Renewable Energy” or “Reduced Carbon Footprint” Based on Power Purchase Agreement. Version 1.0, February 2018. SCS Global Services. https://cdn.scsglobalservices.com/files/program_documents/SCS_GUI_ReducedCarbonFootprint_021318.pdf

5. Other references

- Directive 2009/28/EC of the European Parliament and of the Council. Article 15. https://www.legislation.gov.uk/eudr/2009/28/article/15
- 2013/179/EU: Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013H0179
- European Residual Mixes. Version 1.0. 2021-05-31. Association of Issuing Bodies (AIB). https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2020/AIB_2020_Residual_Mix_Results.pdf
- ISO 14027: 2017 - Environmental labels and declarations — Development of product category rules
- ISO 14044: 2006 - Environmental management — Life cycle assessment — Requirements and guidelines
- ISO 14071: 2014 - Environmental management — Life cycle assessment — Requirements and guidelines
- Prado, Valentina, et. all. “Energy apportionment approach to incentivize environmental improvement investments in the chemical industry”. Journal of Cleaner Production. 18 February 2020.
- U.S. DOE. Renewable Energy Guidance for Industry. August 2021. ORNL/SPR-2021/2026.
- U.S. DOE. Office of Electricity. “Learn More About Interconnections”. https://www.energy.gov/oe/services/electricity-policy-coordination-and-implementation/transmission-planning/recovery-act-0
- U.S. EPA Green Power Markets website. https://www.epa.gov/green-power-markets
- U.S. EPA. “Offsets and RECs: What’s the Difference?” February 2018. https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf

6. Appendix

6.1 REC balance table

As described in 2.3.1 Calculating renewable share, a REC Balance Table or equivalent information shall be provided as part of the confidential LCA report.

6.1.1 Instructions

1. The product owner is required to document every unique combination of Renewable Electricity (RE) attributes being allocated to product-specific volumes produced at their specified facilities for the most recent calendar year or twelve-month period.
2. Production facility information shall include company name, facility name, facility locale/state, or province/country.
3. Production volume information for each product at a given facility shall include a product ID, product name, declared unit, quantity, and start/end date time period of the stated production volume quantity.
4. The amount of electricity consumed (in kWh) at a given facility allocated to a specific product for the specified production volume shall be stated. Such allocated consumed electricity shall follow allocation rules as stated in the relevant PCR.
5. Renewable electricity allocated to a facility/product-specific production volume shall include the registry/serial#, purchasing organization, source type, grid region, amount of kWh allocated, and generation time window.
6. The RE generation time window, start date, and end date shall align with the temporal guidance discussed earlier.
7. The specified RE certificates allocated to a given facility-/product-specific production volume shall be retired and only attributed to the stated production volume to avoid double counting the RE attributes.
8. The RE certificates allocated to a given facility-/product-specific production volume shall not exceed the electricity consumption that is allocated to the given production volume.
9. Note, the total electricity consumed and allocated to a specific product can be electricity consumed at upstream sources other than the facility stated so long as these other sources are under product owner control, measured with primary data, deemed required for the product-/facility-specific production volume and double counting is avoided.

6.1.2 Definitions

Table 4. REC balance table definitions

Data category	Data field	Definition
	Record #	A numbered list for each unique renewables allocation to a given product.
Company and manufacturing facility information	**Company name**	The name of the company that owns the product.
	Facility name	The facility at which the product is manufactured.
	Locale	The town/city/village where the manufacturing facility is located.
	State/province	The state or province where the manufacturing facility is located.
	Country	The country where the manufacturing facility is located.
Production volume	**Product ID**	A unique product ID.
	Product name	The trade name of the product as it is declared in the EPD.
	Unit	The declared unit as it is required by the PCR.
	Quantity	The total production volume for the specified year.
	Start date	The start date for which the total production volume is considered.
	End date	The end date for which the total production volume is considered.

Electricity consumed	**Life cycle module**	The life cycle module stage at which the electricity is being consumed.
	kWh	The total amount of electricity consumed at the given module that is allocated to the stated product produced at the stated facility.
	kWh/unit	The amount of electricity consumed per declared unit.
	Grid region	The regional grid name where the electricity is assumed to be consumed.
Renewable electricity (RE) allocated	**Registry / serial#**	The registry/serial number of the given amount of RE procured and allocated to the specified production volume.
	Purchasing organization	The organization that purchased the procured RE.
	Source type	The type of RE contractual instrument.
	Grid region	The regional grid mix where the RE is generated.
	kWh allocated	The amount of RE allocated to the specified production volume.
	Generation time window	The start date when a portion the stated RE was generated.
		The end date when the stated RE was generated.
	Meets time threshold?	A temporal threshold test to see if RE generation start and end date fall within the acceptable range relative to the production volume start and end dates.
	RE <= consumed?	A RE quantity threshold test to see if the RE allocated to the production volume is less than or equal to the total electricity consumption allocated to the production volume.
kWh per product unit	**(1) RE per unit**	The amount of RE allocated to a declared unit of the given product for the specified life cycle module/stage.
	(2) Residual per unit	The amount of residual grid electricity allocated to a declared unit of the given product for the specified life cycle module/stage.
	(1) + (2) = Total per unit	A check to see that (1) + (2) is equivalent to the total amount of electricity consumed per declared unit at the given module that is allocated to the stated product produced at the stated facility.

6.2 Existing methods addressing renewable investment

Table 5 lists the methods reviewed by the committee along with a summary of the approach and key limitations. For additional information on the guidance and requirements of each of the methods presented, refer to the source guidance documents. Note that the committee also reviewed the GHG Protocol Product Life Cycle Accounting and Reporting Standard. The Standard provides guidance for companies to quantify and publicly report an inventory of GHG emissions and removals associated with a product but does not specify requirements around electricity sources beyond those outlined in other methods in the table.

Table 5. Existing methods for modeling of contractual instruments in LCA and GHG accounting

Method & scope	Summary of approach	Limitations
GHG Protocol[1] Corporate GHG accounting	Two distinct methods for Scope 2 accounting: 1. A location-based method reflects the average emissions intensity of grids in which energy consumption occurs. It quantifies GHG emissions based on average energy generation emission factors for defined geographic locations. 2. A market-based method reflects emissions from electricity that companies have purposefully chosen. It derives emission factors from contractual instruments, including bundled and unbundled attribute claims. The presence of contractual information in any market where a company has operations triggers the requirement to report according to the market-based method. It derives emission factors from contractual instruments, including energy attribute certificates, such as RECs, direct contracts such as PPAs, and supplier-specific emission rates.	• Emission factors do not include transmission and distribution (T&D) losses or upstream life-cycle emissions associated with the technology or fuel used in generation • Focuses on carbon as a metric instead of the multi-attribute impacts considered in traditional LCA
ISO 14067[9] Product carbon footprinting using LCA	Double counting the benefits of using renewable fuels should be avoided. Supplier-specific GHG emission factors may be used if: • There is a dedicated transmission line, and the dedicated electricity is not sold to a third party, or • The electricity product is guaranteed through a contract, cannot be claimed by another entity and is produced within the country, or within the market boundaries where consumption occurs. If a supplier-specific electricity product is not available, then the carbon footprint must use the residual grid mix, meaning that the contracted renewable electricity product(s) for other electricity consumers must be known and excluded. Retail supply options and project-specific supply options may be applied if the electricity is produced within the country or market boundaries where consumption occurs.	• Focuses on carbon as a metric instead of the multi-attribute impacts considered in traditional LCA • When a contractual instrument (like a REC) is used, the electricity must be produced within the country or market boundaries where consumption occurs.
Product Environmental Footprint (PEF)[10] LCA	Requires the following electricity mix to be used, in hierarchical order: 1. Supplier-specific electricity product shall be used if, for a country, there is a 100% tracking system in place, or if: • available, and • the set of minimum criteria to ensure the contractual instruments are reliable is met. 2. The supplier-specific total electricity mix shall be used if: • available, and • the set of minimum criteria to ensure the contractual instruments are reliable is met. 3. The 'country-specific residual grid mix, consumption mix' shall be used. Country-specific means the country in which the life cycle stage or activity occurs. This may be an EU country or non-EU country. The residual grid mix prevents double counting with the use of supplier-specific electricity mixes in (a) and (b). 4. As a last option, the average EU residual grid mix, consumption mix (EU-28+EFTA), or region representative residual grid mix, consumption mix, shall be used.	• Application of this method to the United States or the NERC interconnections is challenging because there is no single standardized and centralized tracking system available that would cover 100% of generating resources in the market. • At this time, the PEF standard is a recommendation and final implementation of the method is to be determined.

	Minimum criteria are as follows: 1. Convey attributes; 2. Be a unique claim; and 3. Be as close as possible to the period to which the contractual instrument is applied.	
SCS Guidance[11] LCA	In addition to complying with the ISO 14067 standard, the following verification criteria shall be met: • The contractual instrument shall contractually provide full rights to the environmental benefits of the renewable energy source to the manufacturer (purchaser); no other party shall make a benefit claim on the same instrument. • Contractual instruments shall not be used to offset the emissions outside of an organization's direct or indirect emissions.	• There are no clear instructions on how to choose the representative grid mixes, isolating the voluntary investments from the rest of the grid. • No clear allocation method specified for how to allocate total RECs between products. • On-site renewable electricity generation is not included in this guideline. Methodology should address both on-site and off-site situations. • The method was not developed in a consensus-based manner, and was written by a single party which verifies all EPDs under this program.

6.3 Residual grid mix

This section summarizes the work group's exploration of residual grid mixes within North America. At the time of writing, the final recommendation is for any electricity not covered by a contractual instrument to use a residual grid mix if available. If a residual grid mix is not available, the appropriate consumption mix shall be used. A sensitivity analysis per ISO 14067 is recommended.

6.3.1 Evaluation

In many places in the world, including North America, electricity is not tracked with guarantees of origin (GOs). The use of a residual grid mix is critical for avoiding double counting of electricity that has been sold to specific consumers. The United States Environmental Protection Agency's (EPA) eGrid database publishes both US national and subregional emissions rates, but does not publish a residual mix emissions rate that reflects the removal of claimed voluntary (e.g. REC) purchases. For the purposes of this guidance, a residual grid mix would ideally be calculated by subtracting all unique renewable electricity voluntarily certified under one of the contractual instruments detailed in Table 1.

Table 6 outlines the renewable data sources identified by the committee and details the information they track and the limitations of each when used to calculate a residual grid mix. Due to the way renewable electricity production is tracked in North America, there is no centralized clearinghouse for tracking all voluntary renewable electricity purchased.

Table 7 then discusses potential approaches to developing a residual grid mix for the purposes of this guidance and the associated benefits and challenges.

Table 6. Data sources for renewable generation

Data source	Information tracked	Limitations
EIA-923	Total renewable generation by facility, technology, geography (>X MW)	Does not include small-scale solar (– fill gap with EIA-861M
EIA-861M	Small scale solar generation by state and type (res/com/ind)	Specific locations within each state are not included No details on the particular installation tech/size
eGRID	EIA-923 + emission factor data	Does not include small-scale solar (– fill gap with EIA-861M
LBNL RPS Compliance	State-level RPS compliance targets and achievement by year and tier (some states have multiple compliance tiers or tech-specific carve outs)	Limited data on the technology shares (some information on carve outs)
NREL Voluntary Green Gen	Generation by contract vehicle (PPAs, unbundled RECs, etc.), by state	No data on the technology shares
State-level RPS compliance reports (e.g., PA, NJ)	Applicable technology types and amounts Sources of generation (in-state vs. import)	Specific locations within each state are not included
REC clearinghouse data (e.g., PJM-EIS, M-RETS, NEPOOL)	Residual grid mix RPS retired certificates by reporting year / state / tech / import dource (PA)	For PJM-EIS, Residual mix excludes compliance MWh, so residual mix is all non-renewable Do not appear to differentiate between compliance and voluntary

Table 7. Potential approaches to developing a residual grid mix

Approach	Description	Benefit	Challenges
1	Remove all non-hydro renewables; recompute regional grid mixes	• Easy	• Incorrect, especially at regional scale because unclaimed renewable energy is removed from the fuel mix
2	Retain all RPS-required renewable generation; net out remainder	• Achievable(?) • More accurate than approach 1 • Reasonably easy to implement/update	• Mapping states to FERC regions or balancing authorities • Imperfect data • State RPS technology variability
3	Remove all contractually-obligated renewables; leave remainder	• Should provide same result as approach 2	• REC transaction data is not fully transparent, nor consistent
4	Recommend CRS Green-e calculated data	• Available	• Includes only about 50% of voluntary MWh • Not 100% transparent • Not life-cycle values • CO_2e only

For this guidance, the committee obtained 2020 data from CRS, the developers of the Green-e® certification program in the US certifying approximately half of the RECs on the US market. To test the sensitivity of the 2020 eGRID baseline emission rate when removing voluntary Green-e® certified RECs from the emission calculation, Table 8 presents the percent difference across eGRID regions. Four regions show a difference greater than 5% with the SPSO region going up to 16%. These changes to the baseline emission rates are notable considering the data only represent ~50% of all voluntary certified RECs in the US market.

CRS also provided the committee with voluntary Green-e® certified renewable generation for 2020 broken out by renewable generation technology across eGRID and NERC regions. The committee initially believed these data may be used to modify existing LCI datasets to approximate a residual grid mix. However, the committee agreed that leaving the electricity modeling up to LCA practitioners may lead to inconsistent implementation and that efforts are best focused on recommending mechanisms be established that allow centralized, aggregated tracking of all involuntary and voluntary renewable generation. Only after policies and mechanisms are put into place that can track 100% of contractual instruments will it be worthwhile for providers of LCI datasets such as Sphera's Managed LCA Content, ecoinvent, USLCI, and DATASMART to create residual grid mixes for North America.

Strong conclusions may be drawn that voluntary instruments warrant additional consideration when calculating residual grid mixes and current consumption mixes are underrepresenting emissions by not excluding voluntary contractual instruments.

Table 8. Percentage difference between 2020 baseline emission rate (inclusive of all generation) and adjusted emission rate (excludes all 2020 Green-E® certified RECs)

eGrid subregion	**2020 CO2e Emissions** tons	**2020 Net generation** MWh	**Emission rate** lbs CO2e/MWh	**Assumed voluntary RE emissions** lbs CO2e/MWh	**Certified voluntary RE** MWh	**Adjusted emission rate** lbs CO2e/MWh	**Difference** lbs CO2e/MWh	**Difference** percent
					12-month vintage 2020			
AKGD	2,557,432	4,659,917	1,098	0	23,215	1,103	5.5	0.50%
AKMS	399,522	1,496,130	534	0	-	-	-	-
AZNM	70,012,956	165,394,893	847	0	309,612	848	1.6	0.19%
CAMX	50,351,935	196,129,978	513	0	4,530,643	526	12	2.4%
ERCT	169,823,316	414,911,396	819	0	39,767,779	905	87	10.6%
FRCC	100,795,433	241,403,268	835	0	1,412,297	840	4.9	0.59%
HIMS	1,400,759	2,450,535	1,143	0	-	-	-	-
HIOA	5,470,199	6,618,705	1,653	0	-	-	-	-
MROE	15,809,335	20,714,885	1,526	0	-	-	-	-
MROW	111,236,072	227,120,021	980	0	12,358,132	1,036	56	5.8%
NEWE	25,565,657	96,795,891	528	0	322,448	530	1.8	0.33%
NWPP	85,796,739	286,004,986	600	0	7,585,708	616	16	2.7%
NYCW	12,605,747	39,727,442	635	0	-	-	-	-
NYLI	6,356,304	10,559,287	1,204	0	-	-	-	-
NYUP	9,883,912	84,654,342	234	0	34,633	234	0.1	0.04%
PRMS	14,592,590	18,215,878	1,602	0	2,643	1,602	0.2	0.01%
RFCE	92,572,477	283,765,353	652	0	92,175	653	0.2	0.03%
RFCM	49,192,807	85,325,787	1,153	0	113,392	1,155	1.5	0.13%
RFCW	244,476,328	496,410,171	985	0	951,200	987	1.9	0.19%
RMPA	36,670,878	64,065,081	1,145	0	1,286,689	1,168	23	2.0%
SPNO	33,399,418	70,017,393	954	0	6,294,367	1,048	94	9.9%
SPSO	70,948,081	152,288,973	932	0	21,009,212	1,081	149	16.0%
SRMV	59,226,139	159,992,962	740	0	545,726	743	2.5	0.34%
SRMW	80,432,435	108,641,153	1,481	0	1,462,399	1,501	20	1.4%
SRSO	105,866,752	246,150,586	860	0	1,365,669	865	4.8	0.56%
SRTV	88,231,707	211,540,764	834	0	41,309	834	0.2	0.02%
SRVC	101,720,864	326,493,675	623	0	2,103,236	627	4.0	0.65%