The Distributed Renewable Energy Certification Code

V1.0

1. Introduction

Energy Attribute Certificates (EACs) are tradeable digital certificates which encapsulate the environmental and sustainability benefits generated by a renewable energy facility producing electricity. Generally denoted in 1 megawatt-hour (MWh) units, these EACs contain factual data about the type of facility which generated the zero-carbon electricity, and what time it was generated. Prior to their issuance, EACs often require certification by an independent third-party not affiliated either with the owner of the renewable energy asset or the EAC buyer.

Distributed Renewable Energy (DRE) systems, particularly those that are off-grid, present unique challenges within established EAC frameworks, such as the International REC (I-REC) standard, which in various instances can restrict their participation. For example, small off-grid devices such as solar lanterns, which have a significant local climate impact in replacing kerosene, cannot collect sufficient generation evidence to provide for issuance of EACs such as I-RECs; moreover, the scale at which these devices must be aggregated in order to reach MWh-level thresholds may be unmanageable for the local issuer, as each devices' generation must validated.

The Distributed Renewable Energy Certificate (D-REC) framework seeks to extend existing EAC mechanisms such as the I-REC framework by enabling a broad array of small, distributed renewable assets, to participate primarily through two mechanisms: aggregation, and automation. The following D-REC Code elaborates upon how small-scale DRE devices can issue D-RECs, and thereby participate in the wider global EAC marketplace.

2. Table of definitions

Term	Definition
Organization	An entity holding one or more D-REC trading accounts, and that will generate, trade, or redeem D-RECs
User	A specific individual from a participating Organization with the authority to make changes to account or initiate issuance, trade, or redemption requests
Account	A data store within the D-REC Platform that is attributed directly to a single Organization for the purpose of recording D-REC ownership
Device	One or more generating units of the same technology which produce electricity
Device Group	A group of generation installations using the same technology which can be referred to collectively as a single entity; they can be geographically dispersed
D-REC Platform	A software platform, consisting of database and Distributed Ledger elements, which enable the registration of Organizations and Devices, automated issuance of D-REC certificates, and trading and redemption of D-RECs
D-REC Certificate	A set of data variables, housed within a token structure on the D-REC Platform, which collectively represent a unit of generation at a specific time from a Device Group
Aggregation	A mechanism by which multiple devices and device groups are combined for the purpose of issuing D-REC certificates
Digital Twin	A set of algorithms by which generation data provided by devices and device groups are automatically validated to ensure the reported data is accurate
Distributed Ledger	A public, blockchain-based, system by which all stages of the D-REC lifecycle are recorded for transparency and accurate provenance reporting

Issuer	An I-REC Standard-designated organization, located in a particular Country, which will be responsible for certifying generation data prior to issuing an I-REC against that generation data
Reservation	The act of a D-REC Buyer specifying which D-REC Certificates should be transferred to their Account prior to issuing them into the Account of the DRE Asset owner, thereby removing them from general availability

3. Statement of principles

3.1 A D-REC is unique
A D-REC is unique, in that it's collective attribute values shall provide a unique signature; no two certificates can refer to the same particular event.

3.2 A D-REC is in accordance with historical facts
A certificate is issued in accordance with verified historical facts relating to a particular event over a period of time for a specific Device or Device Group, and cannot be issued for future events

3.3 A D-REC has a clear chain of custody
The reliability of the system used to track these certificates ensures there is a clear and uninterrupted chain of custody for the certificate from producer to end-user

3.4 D-REC data must be stored in an accessible store which clearly articulates provenance
A certificate must always be recorded in a data store such that its provenance can be recalled at any point; this includes any changes of ownership or active state which must be recorded

3.5 D-RECs are denoted in kWhs
1 D-REC corresponds to 1kWh, issued against the collective generation of Devices which are organized within Device Groups

4. User Registration

Users are specific individuals of an Organization which is participating in the D-REC ecosystem; they have access to the data housed within the D-REC platform, and in certain instances have the authority to make changes to the state of one or more D-REC Certificates. Each User will be identified by a First Name, Last Name, Email Address, and Password. While each User will be recorded by the D-REC Platform, all transactions which are recorded on the Distributed Ledger will only contain information about the Organization which is represented by the Users; no information about the Users shall be made public on the Distributed Ledger.

4.1 User types: Administrators and Participants

There are two user types accepted by the D-REC Platform: administrators and participants. Administrators can authorize other users from the same Organization, as well as approve account or device settings; they also are authorized to request D-REC trades or redemptions. The Administrator further can appoint Designated Users who possess the same level of access to the D-REC Platform. Participants are users who may observe the data and metadata housed within the D-REC Platform, but cannot make any state changes, such as request a D-REC Certificate trade or issue a Redemption request.

4.2 Designated users

Designated Users are authorized by the Administrator to execute state changes on the D-REC Platform, such as register Devices or Device Groups, trade D-REC Certificates, or issue Redemption requests. There can be multiple Designated Users from the same Organization, but there can only be one Administrator. The Administrator reserves the right to add or remove privileges for the Designated Users.

5. Organizations

5.1 Organization Registration

Once a User creates an account on the D-REC Platform, the User (who must be an Administrator or Designated User) is then authorized to provide information about the Organization which they represent. The Organization is the foundational unit of D-REC Certificate ownership; a D-REC can either be owned by an Organization, or redeemed either directly or on behalf of an Organization registered on the D-REC Platform.

Organizations can be of three types: Device owner or representative; Intermediary; Buyer or Beneficiary. Every transaction subsequent to the registration will only note the Organisation ID, not the personally-identifiable information regarding the Organization's Designated Users. In other words, every stage of the D-REC lifecycle which is noted on the Distributed Ledger shall document the organization ID, and the manner in which the organization was a party to the D-REC transaction. Note that when D-REC Certificate is redeemed, it can only be done so by a Buyer or on behalf of a Beneficiary.

5.2 Organization Accounts

The Account construct in the D-REC platform is a single data repository for all D-RECs that belong to an Organisation. Each Account has an associated Distributed Ledger address to which D-RECs will be assigned. The wallet address must be provided, or will be assigned, when the Organization is registered, as the D-REC platform will create an Account associated with the organization. All Designated Users can therefore access the D-RECs associated with an Organization's account, and initiate changes to the certificate's state (e.g. trade or redeem).

5.3 Location of Account Registration

Because the D-REC framework recognizes the same market boundaries as the I-REC framework, Organizations which request the issuance of D-RECs must be located in the same country as which the Device is located. For Organizations with assets in multiple countries, there must be an Organization account for each country of operation. However, the D-REC code will only enforce this for Organizations which act as device owners or representatives; Intermediaries, Buyers, and Beneficiaries may be located in a different jurisdiction or country from the Organization from whom the D-REC will be purchased.

5.4 Adherence to the I-REC framework

In the process of converting the D-REC - or to be precise, a set of 1,000 D-RECs - to an I-REC, the country-designated Issuer will need to be engaged. This Issuer has the relevant local regulatory context to understand whether the organization has the authority to create an I-REC from the underlying D-RECs; this will ensure there is no competing compliance mechanism under which the environmental attributes are accounted for. Unless a Buyer or Intermediary acting on behalf of a Beneficiary chooses to redeem the D-RECs, all D-RECs will be grouped into sets and then submitted to the local I-REC authorized Issuer. The grouping will take place at a Country level; in other words, D-RECs across multiple Organizations (of type DRE asset owner) will be consolidated and submitted to the I-REC designated Issuer. Please refer to Section 10 for more information.

6. Device Registration

Once an Organization's account has been established on the D-REC platform, and that Organization is either a DRE owner or representative, the individual DRE devices built, installed, owned and/or operated by the Organization can be registered. With respect to the D-REC Code, what is not critical is the specific role the Organization played in installing and commissioning the DRE asset; rather it should be clear that the Organization maintains title over the environmental value generated by the DRE asset, and that the Organization has the ability to monetize that value through D-REC Certification.

6.1 DRE devices

All DRE devices which generate D-RECs must be registered on the D-REC Platform. Metadata required to register the device is outlined in the Appendix. In short, information about the device's location, resource type, commissioning date, and nameplate capacity are required; such information also aligns with the requirement of the I-REC standard

6.2 Device Grouping

After a DRE Device has been registered on the D-REC Platform, and if it's nameplate capacity is less than 1MW, it must be assigned to a Device Group. Device Groups provide two benefits. Device Groups will reduce the complexity developers of smaller DRE assets must go through in order to more quickly monetize the environmental benefits of their assets; it will aid developers or resellers of smaller devices such as solar lanterns to more rapidly achieve the kWh-scale needed to issue D-REC certificates. The benefits of device grouping extends to buyers as well. Buyers likely will not have the ability to select individual devices into groups; by automatically grouping based on purchase criteria, D-REC buyers will have an ability to more quickly purchase D-RECs from a variety of similar DRE assets.

6.3 Device Grouping Methodology

While the D-REC framework provides a default grouping mechanism, the Organization which is registering the device also has the option of overriding this default grouping. Automatic grouping, which is the default on the D-REC Platform, will utilize five variables: Country, Fuel Type (e.g. solar, wind), Installation Configuration (e.g. SHS, Mini Grid, etc.), Standards Compliance (e.g. I-REC, Gold Standard), and Off-taker Type (e.g. school, hospital, etc.). In other words, for every Device which shares the same values for the aforementioned variables, the D-REC platform automatically will assign that new Device into a Device Group with other similar Devices. For each Device and Device Group, the D-REC platform will assign a unique identifier which subsequently will be used during the D-REC issuance phase.

Each Device Group will contain the list of Device IDs, with each Device ID corresponding to a unique Device registration. If an Organization registers a Device, and no existing Device Group is identified, then the D-REC platform will create a new group. However, as noted earlier, an Organization may choose to group devices based on additional, or entirely different variables.

6.4 Device Grouping Restrictions

A critical aspect of the Device Group is that it is defined by both the Organization and the Country. A single Device Group cannot contain devices from multiple DRE developers, nor can a single Device Group contain devices installed in multiple countries, even if they are owned by the same Organization. This is to respect the market boundary requirements specified by I-REC and other standards. Restricting device groups to a single developer will facilitate disbursement of proceeds from the D-REC sale, as well as offering developers the ability to customize the Device Group, which would not be feasible if multiple Organizations were represented in a single Device Group.

A further restriction is applied to the Standards Compliance flag; a single group cannot contain devices that seek to receive certification from different standards. As noted earlier, the D-REC Code will support the enhancement of multiple standards, such as I-REC, Gold Standard, etc. When a Device is registered, the DRE asset owner specifies which standard they wish that device to adhere to (if any); when the D-REC platform specifies how the different devices shall be grouped, it will ensure that only those devices which adhere to the same standard will be grouped. Therefore, devices that wish to submit their D-RECs to the local I-REC Issuer to generate a corresponding I-REC shall be grouped together, while other devices which may align with the Gold Standard will be grouped separately, even though the other variables used to define a Device Group may be the same.

6.5 Social Impact Metadata

The D-REC code provides Organizations, when registering a Device, to provide additional context which may be of interest to the D-REC buyer. This may include a long description of the benefit the DRE asset is providing, one or more labels which the D-REC code will specify (e.g. women-owned business), and images. This information will not be used to certify the D-REC, but rather will be made available to the D-REC Buyer should they wish to use it as a purchase criteria. Another verifier or 3rd-party may use the labels to further certify the D-REC for a particular purpose or impact.

7. Issuing D-RECs

Once a Device has been registered, and assigned to a Device Group either by the D-REC Platform or by the DRE Organization, it can begin submitting generation data for certification. The D-REC Code will specify a default issuance period of daily, although in subsequent revisions of the code either a Buyer or a DRE Organization may choose to issue certificates at a different frequency.

7.1 Submitting generation data

A Device will submit generation data when the DRE Organization chooses to engage with the D-REC platform to issue D-REC certificates; this data can be sent to the platform at any frequency, but by default the generation data will only be analyzed once during the day, prior to a daily issuance event. When the Device submits data, it will send a timestamp, a generation value, and the units if applicable; if the units are not specified, then the D-REC Platform will default to Watt-hours (Wh). Note that the device does not submit two timestamps, indicating a beginning or ending time - rather, the D-REC platform will use the last recorded time as the beginning time, and the submitted timestamp as the ending time. If there is no previously recorded timestamp, then the Commissioning Date is used. This is to simplify the process for device owners, as the previously submitted time does not need to be persisted locally.

7.2 Generation data submitted to the D-REC platform for each device

Even though a particular Device may have been assigned to a Device Group, generation data must be submitted to the D-REC platform for each Device, as individual devices are validated prior to aggregating the total generation amount of the group. In some instances, Watt-hour data may not be available, as in the case of non GSM-enabled small solar devices; in such a case, the timestamp, which will correspond to the payment period from the user, will be used to derive a generation value, as once again the D-REC Platform will maintain the prior payment time (or initial payment if the device is newly deployed). For each device, the D-REC Platform will utilize the “Digital Twin” algorithm to determine whether the generation data is as expected.

Upon issuance, each D-REC will be assigned a unique serial number; it will also contain the relevant Device or Device Group ID, the start and end time for the issuance period, and other metadata necessary for the Distributed Ledger. The Appendix has further information on the D-REC certificate structure.

7.3 Digital Twin Verification

The D-REC Code will specify one or more algorithms which will validate, in an automated manner,

whether the generation data supplied by the device is accurate. It does so by generating an expected
generation value given the following variables for a particular device: generation reporting start and end time, capacity, vintage (i.e. time from Commissioning Date), and Longitude / Latitude. Future revisions of the algorithm may also take into consideration factors such as weather. The current version of the D-REC Code only has provision for validating data supplied by a solar system, but in future revisions, support for additional generating types will be added.

In the current iteration of the D-REC Code, the D-REC Platform will exercise the following check:

Expected Generation = Nameplate * Solar Irradiance / 365 * Degradation Rate from Commissioning * Reporting Time Period

If Reported Generation is within two (2) standard deviations of expected generation, accept the reported generation value and issue the D-REC certificate.

As more devices, types, regions, and vintages are represented on the D-REC Platform, the algorithm likely will take reported values into consideration when validating a reported generation number, thereby reducing the theoretical bias which may be present in the early stages of code deployment.

7.4 Digital Twin Verification: Device Groups

In the case of a Device Group, even though each Device in the group will be independently validated, D-RECs will be issued against the collective group. Therefore, if a particular device has not reported generation within the issuance period, if other devices within the same group have reported a generation reading, and the cumulative total kWh for the group exceeds 1kWh, then D-RECs will be issued for the group. Such an approach would only work if a Device Group contains devices for a single DRE Organization, which further reinforces the need to impose such a restriction. If a Device is not assigned to a Device Group (either because it's nameplate exceeds 1MW, or the DRE Organization chose not to include it in a Device Group), then D-RECs will be issued only against the generation reported for that single device.

Upon issuance of one or more D-REC Certificates, the certificates will be assigned to the Account of the DRE asset owner or representative.

8. Redeeming and Trading D-RECs

Upon issuance and assignment to the DRE asset owner's account, a D-REC is then available for trading and/or redemption. If the DRE Device registrant is the same as

the Organization which shall redeem the D-REC, then it is doing so to account for self-consumption of onsite renewable energy. For all other D-RECs, there will be a transfer from the DRE asset owner's Account to that of the buyer, representative, or intermediary, upon which it further can be traded or simply redeemed.

9. Buyer-defined Reservation

Prior to the general availability of a D-REC, the D-REC Code will specify that a check be performed if a Buyer-defined aggregation will Reserve (i.e. purchase) the D-REC. A Buyer-defined Reservation is a request from a D-REC buyer (or intermediary) to aggregate issued D-REC Certificates for purchase and transfer them to a Buyer's Account the moment they become available. To accomplish this, a Buyer will specify the number and type of D-RECs to Reserve; for example, a Buyer may wish to purchase all D-RECs that represent solar systems providing power to primary schools. In such a case, the Buyer will specify the Country, Off-taker, and Fuel Code. The D-REC Platform will subsequently review this Reservation request, and on a daily basis check if any issued D-RECs meet the Buyer's criteria. Only those D-RECs which are not accounted for by a Buyer-defined Reservation will be available for general sale. A D-REC trade requires assigning the active D-REC from one Account to another; the D-REC can only exist in a single Account at any time. The D-REC trade is written to the Distributed Ledger for record-keeping. Upon a Buyer or authorized representative issuing a redemption request (and thereby removing the D-REC from circulation), the D-REC Platform will remove the D-REC certificate from the Buyer's Account, and write the transaction to the Distributed Ledger for record-keeping purposes.

10. Integration with the I-REC Registry

Integration between the D-REC Code and the I-REC framework is still being defined; however, the following likely will be the manner in which the integration occurs:

- For each country in which the I-REC is accepted, the D-REC platform will be registered as a device in that country; the platform will show as a single device
- In the case of a Buyer-defined Reservation, a further entry will be made in the countries across which the Buyer seeks to aggregate; therefore, there could be multiple device entries should the Buyer-defined Reservation span multiple country boundaries
- For Device Groups not accounted for in a Buyer-Defined Aggregation, the D-RECs, upon issuance, will be submitted to the country-designated Issuer. A corresponding I-REC with a "D-REC Validated" label will then be issued and placed on the I-REC Registry, in the trade account associated with the D-REC Platform. If a Device Group is incorporated into a Buyer-defined Reservation, then it will be included in the trade account associated with that definition

- If that I-REC is then subsequently traded and redeemed by a Buyer, then all of the 1,000 D-RECs that were used to constitute the I-REC will then be removed from circulation. This will be done by the D-REC Platform, as each D-REC for which there was an I-REC issued will house the I-REC serial number in its metadata. Each active D-REC will be moved to an “I-REC Redemption Account” on the D-REC Platform to remove them from circulation
- In the case that an underlying D-REC is redeemed (either all or a portion of the 1,000 D-RECs which constitute an I-REC), then the I-REC will be moved into a “D-REC Platform Redemption” account in the I-REC Registry to remove it from circulation